MANUFACTURER'S DATA BOOK

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 26JUL12

MISSISSIPPI POWER

DEKALB, MISSISSIPPI

KEMPER COUNTY 1 – IGCC PROJECT

P.O. NO: 17496-0001

REQ. NO: MC202

ITEM NO: HX1027

PROCESS CONDENSATE TRIM HEATER

1 – 20" x 216" NEU EXCHANGER

ENERGY JOB NO: X-7930 A

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**
MM187157 0 Unit 1

ENERGY EXCHANGER COMPANY PO: MPC17496-0001
X7930-A-MDB Rev: 0
IGCC - GASIFIER - MULTIPAGE - SHELL AND TUBE HEAT EXCHANGER - MAN

Mississippi Power
Kemper County 1 – IGCC Project
P.O. No: 17496-0001
Req. No: MC202
Item No: HX1027
Energy Job No: X-7930 A

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 08-BB

Client:	SOUTHERN CO.	Purchase Order #:	MPC-17645; MPC17496 & MPC- 17497
EWO:	MPC9117.T61401	Supplier:	ENERGY EXCHANGERS
Shop Order #	SO # 7930 A/B	Location:	TULSA, OK
Project:	KEMPER COUNTY IGCC UNIT	Supplier Ref. #:	

Item #	Description	Qty Ordered	Qty Released	Balance
	21-216-NEU exchangers Tag # HX1027/HX2027--SO# 7930 A/B	2	2	0
	THE UNITS & FINAL DOCUMENTATION ARE COMPLETE			

This (is not) a complete shipping release.

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: 6/29/12
Bill Bronaugh
IQS

SECTION 2

REV	LN #							
		Energy Exchanger Company						HEAT EXCHANGER SPECIFICATION SHEET
2	1					P.O. No.: 17496-0001		
0	2					REV. 0 AS PURCHASED		
2	3	**Customer**	SOUTHERN COMPANY SERVICES			**Job No.:** X-7930 "AS BUILT"		
2	4	**Address**	BIRMINGHAM, AL			**Rev.:** 2	**Date:**	5/31/2012
	5	**Plant Location**	KEMPER COUNTY, MS			**File:**	10-7309	
	6	**Service of Unit**	PROCESS CONDENSATE TRIM HEATER			**Item:** HX1027/2027		
2	7	**Size** 20-216	**Type** NEU	**Horizontal**		**Connected In** 1	**Parallel** 1	**Series**
	8	**Surf./Unit** ☐ Gross ☑ Eff	959.77 ft²; **Shells/Unit**	1		**Surf./Shell** ☐ Gross ☑ Eff.	959.77	ft²

PERFORMANCE OF ONE UNIT (line 9)

REV	LN #	Item	Units	Shell Side In		Shell Side Out		Tube Side In		Tube Side Out	
	10	**Fluid Allocation**		**Shell Side**				**Tube Side**			
	11	**Fluid Name**		LP STEAM				CONDENSATE			
	12	**Fluid Quantity, Total**	lb/hr	5528 X 1.1				108315 X 1.1			
1	13	**Vapor (In/Out)**								29 X 1.1 (2)	
	14	**Liquid**						108315 X 1.1		108286 X 1.1	
	15	**Steam**		5528 X 1.1							
	16	**Water**				5528 X 1.1					
	17	**Noncondensable**									
	18	**Temperature (In/Out)**	°F	281.		266.9		215.1		261.	
	19	**Density (Vapor/Liquid)**	Lb/Ft³						60.44	2.6	57.90
	20	**Viscosity**	cP						0.29	0.0200	0.22
	21	**Molecular Weight**									
	22	**Molecular Weight, Noncondensable**									
	23	**Specific Heat**	Btu/lb-F						0.9510	0.2940	0.9740
	24	**Thermal Conductivity**	Btu/hr-ft-F						0.3050	0.0250	0.2590
	25	**Latent Heat**	Btu/lb								
	26	**Inlet Pressure**	psia	40.				628.5			
	27	**Velocity**	ft/sec	21.13				4.72			
	28	**Pressure Drop, Allow./Calc.**	psi	2.00	/	0.20		7.00	/	7.00	
	29	**Fouling Resistance (Min.)**	Hr-Ft-°F/Btu	0.0005				0.001			

REV	LN #					
	30	**Heat Exchanged**	5204000 X 1.1	**Btu/hr; M.T.D. (Corrected)**	20.12	°F
	31	**Transfer Rate, Service**	296.43	**Btu/hr-ft²-F; Clean**	776.67	**Btu/hr-ft²-F**

CONSTRUCTION OF ONE SHELL (line 32) — **Sketch (Bundle/Nozzle Orientation)**

REV	LN #	Item		Units	Shell Side	Tube Side
	33				**Shell Side**	**Tube Side**
1	34	**Design/Test Pressure**		psig	85/FV/280	790 / 1030 (6)
	35	**Design Temperature (Max/Min)**		°F	350/10	285/10
	36	**No. Passes Per Shell**			1	4
	37	**Corrosion Allowance**		inch	0.125	0.125
	38	**Connections**	In		1 - 6" 150RF	1 - 4" 600RF
	39	**Size &**	Out		1 - 2" 150RF	1 - 4" 600RF
	40	**Rating**	Intermediate			

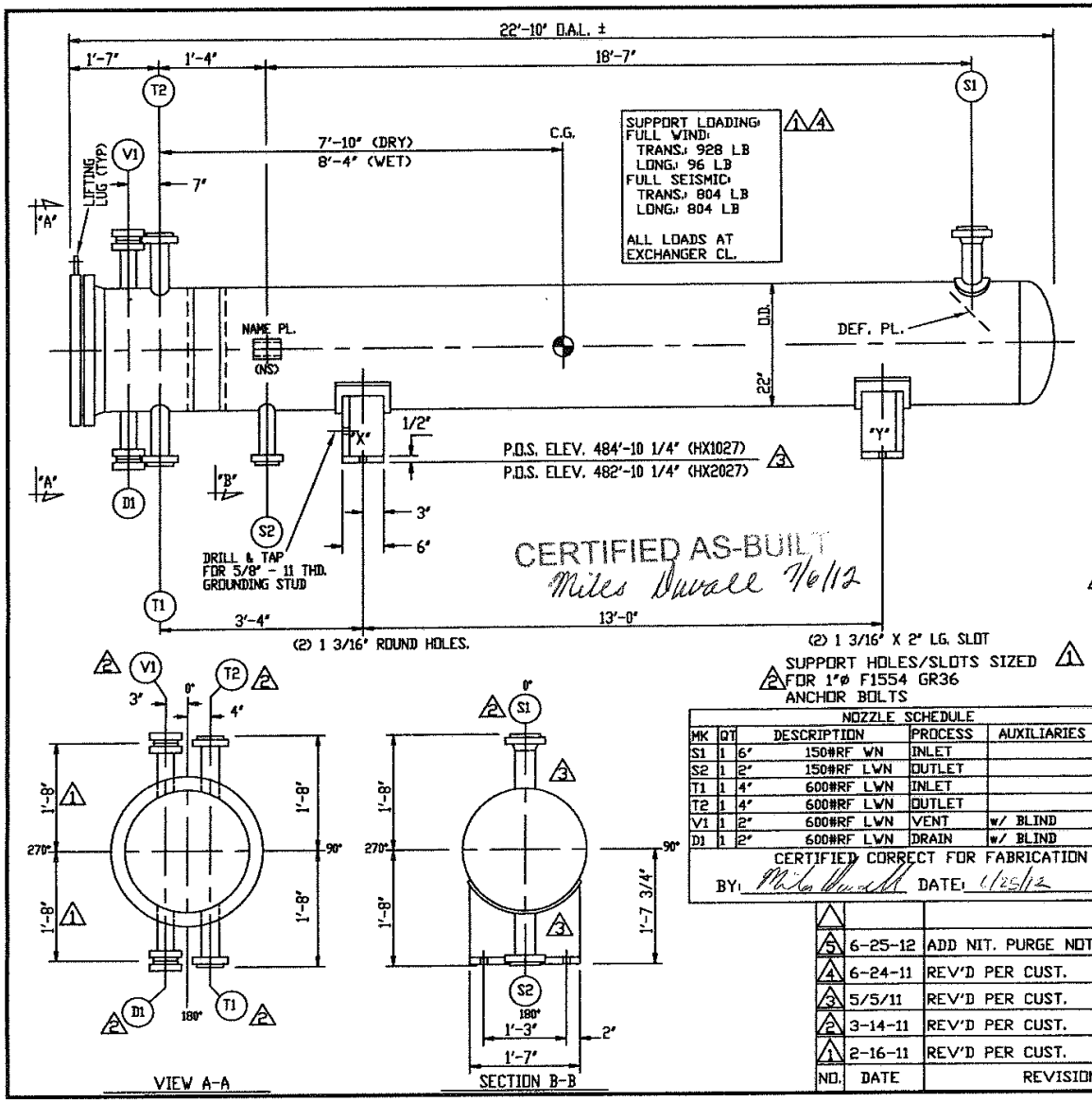
REV	LN #			
	41	**Tube No.** 133 U'S **OD** 0.75 **in; Thk.** ☑ Min ☐ Avg 0.083 **in; Length** 18. **ft; Pitch** 1 **in** 30°		
0	42	**Tube Type** BARE	**Material** SA-179	
1	43	**Shell** SA-106B ☑ ID ☐ OD 21.25	**in ;Shell Cover** SA-516-70	☑ Integ. ☐ Remov.
1	44	**Channel or Bonnet** SA-516-70N (PWHT)	**Channel Cover** SA-266-2or4N	☐ Integ. ☑ Remov.
1	45	**Tubesheet-Stationary** SA-266-2or4N	**Tubesheet - Floating**	
1	46	**Floating Head Cover**	**Impingement Protection** DEFLECTOR BEYOND BENDS (SA-36)	
1	47	**Baffles-Cross** 14 - SA-36 **Type** V D-SEG	**% Cut (** ☑ Dia ☐ Area **)** 25. **Spacing c/c** 15.0 **Inlet**	**in**
	48	**Baffles-Long**	**Seal Type**	
	49	**Supports - Tube** **U-Bend**	**Type**	
	50	**Bypass Seal Arrangement**	**Tube-Tubesheet Joint** FULL STRENGTH WELD PER UW-20 (5)	
	51	**Expansion Joint**	**Type**	
	52	**ρv² - Inlet Nozzle** **Bundle Entrance**	**Bundle Exit**	
1	53	**Gaskets - Shell Side**	**Tube Side** 321 SS GMGC	
	54	**- Floating Head**		
1	55	**Code Requirements** ASME SECTION VIII, DIV. 1 (STAMP: YES)	**TEMA Class** R	
1	56	**Weight/Shell** 8250 **Filled With Water** 11500	**Bundle** ---	

REMARKS (line 57)

58 1) THERE ARE TWO TRAINS AND EACH TRAIN HAS ONE EXCHANGER (HX1027 & HX2027). FLOW RATE AND DUTY ARE FOR ONE TRAIN.
59 2) FLASHING IS DUE TO DISSOLVED GAS.
60 3) BAFFLE AT U-BEND IS FULL CIRCLE BAFFLE WITH WINDOW CUT-OUT AT CENTER (WxH = 7.125" x 5.5")
61 4) APPLY NACE FOR WET H2S SERVICE ON TUBE SIDE.
62 5) PER FIG UW-20.1 (c) or (d).
63 6) TUBESIDE IS SUBJECT TO STEAM OUT OF 15 PSIG @ 250°F (BOTH BELOW THE DESIGN PRES./TEMP)
64
65

\\Eesbs01\d\data sheets\s\X-7930

MM187157



DESIGN DATA	SHELL	TUBE
DESIGN PRESSURE P.S.I.G.	85	790
VACUUM PRESSURE P.S.I.G.	FV	N/A
TEST PRESSURE P.S.I.G.	280	1030
DESIGN TEMP. Deg. F.	350	285
M.D.M.T. Deg. F.	10	10
CORROSION ALLOWANCE	1/8"	1/8"
NUMBER OF PASSES	1	4
RADIOGRAPH	SPOT	SPOT
HEAT TREAT REQUIRED	NO	YES (U-BENDS: YES)
MAWP (H&C) P.S.I.G.	215	792
LIMITED BY:	150# FLANGE RATING	CHANNEL COVER

ESTIMATED WEIGHTS, LBS.

DRY: 8250 BUNDLE: ---- WET: 11500

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-516-70N
SHELL: SA-106B
TUBESHEETS: SA-266-2or4N
BAFFLES: SA-36
TUBES: SA-179
(133 U) 3/4" O.D.X 0.083" (MIN) X 18'-0" LG.
TUBE PITCH 1" ▷ SURFACE 960 SQ. FT.

GENERAL NOTES

ALL BOLT HOLES TO STRADDLE NATURAL CENTER LINES.
INSULATION: 1 1/2" THK. TYPE "HC" (BOTH SIDES) 3
PAINT: SEE PAINT MAP DWG X-7930-AA
GASKETS: 1/8" THK 321 SS GMGC
(1) SPARE SET OF GASKETS PER EXCHANGER REQUIRED.
TUBE-TS JOINT: FULL STRENGTH WELDED AND EXPANDED (2 GROOVES) 1
TUBE SIDE IS IN WET H2S SERVICE. PWHT & NACE MR0175 APPLY 1 2
NITROGEN PURGE REQUIRED BOTH SIDES 5

NOZZLE SCHEDULE

MK	QT	DESCRIPTION	PROCESS	AUXILIARIES
S1	1	6" 150#RF WN	INLET	
S2	1	2" 150#RF LWN	OUTLET	
T1	1	4" 600#RF LWN	INLET	
T2	1	4" 600#RF LWN	OUTLET	
V1	1	2" 600#RF LWN	VENT	w/ BLIND
D1	1	2" 600#RF LWN	DRAIN	w/ BLIND

CERTIFIED CORRECT FOR FABRICATION
BY: Miles Durall DATE: 1/25/12

CUST: MISSISSIPPI POWER CO.
c/o SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No: MC202 1
ITEM NO: HX1027/2027
SERVICE: PROCESS CONDENSATE TRIM HEATER
SHIP TO: KEMPER CO., MS

NO.	DATE	REVISIONS	
5	6-25-12	ADD NIT. PURGE NOTE	DM/MD
4	6-24-11	REV'D PER CUST.	WE/DN
3	5/5/11	REV'D PER CUST.	MD/SG
2	3-14-11	REV'D PER CUST.	DM/SM
1	2-16-11	REV'D PER CUST.	DN/SG

ASSEMBLY AND SPECIFICATIONS FOR
3 TWO (2) 20 - 216 N E U

DWN. BY: DN
DATE: 1-18-11
CKD. BY: MD

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

DWG. NO. X-7930-A REV 5

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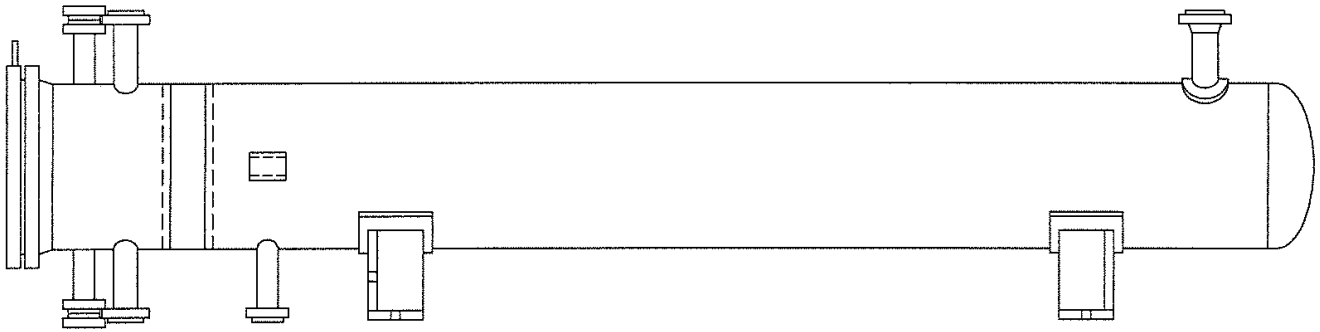


1 COATING DATA SHEET - SYSTEM 6 APPLIES.
ABRASIVE BLAST PER SSPC-SP10 WITH AN ANCHOR PROFILE OF 2 TO 3 MILS.
FIRST COAT WITH CARBOLINE THERMALINE 450 NOVOLAC (4.0-5.0 MILS DFT)
SECOND COAT WITH CARBOLINE THERMALINE 450 NOVOLAC (4.0-5.0 MILS DFT)
(8-10 MILS TOTAL DFT) (COLOR: MFR STD GREY)

CERTIFIED AS-BUILT

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17496-0001 REQ No.: MC202
SERVICE:	PROCESS CONDENSATE TRIM HEATER
ITEM NO:	HX1027/2027

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

NO.	DATE	REVISIONS
1	5/12/11	REVISED PER CUSTOMER MD/SG

PAINT MAP

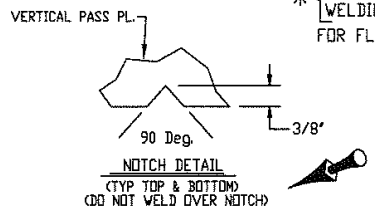
DWN. BY D.MORRISON
DATE 3- 11-11
CKD. BY SM

Energy Exchanger Co.
1944 No. Garnett Rd. • Tulsa, Okla. 74116

DWG. NO. X-7930-AA
REV 1

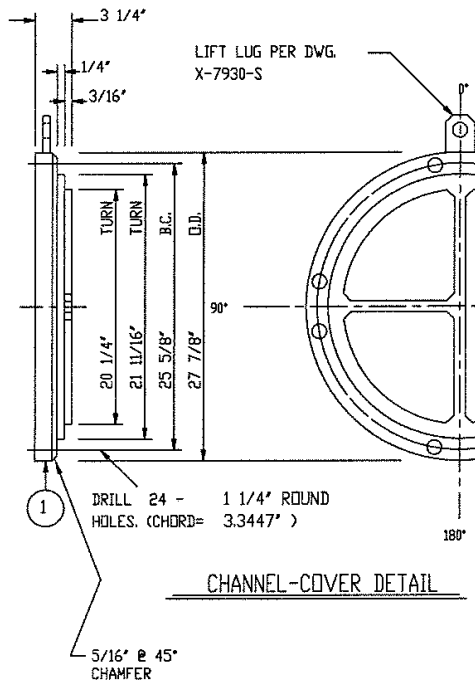
MM187157

COVER NOTES:
1) MACHINE ALL COVER SURFACES TO 250 Ra EXCEPT GASKET FACE TO BE 125 Ra.
2) ALL COVER PASS PLATE GROOVE WIDTHS TO BE 1/2" WIDE.
3) ALL COVER PASS PLATE GROOVE JUNCTIONS TO BE NOTCHED 3/8" AT 45°

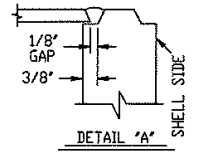


NOTCH DETAIL
(TYP TOP & BOTTOM)
(DO NOT WELD OVER NOTCH)

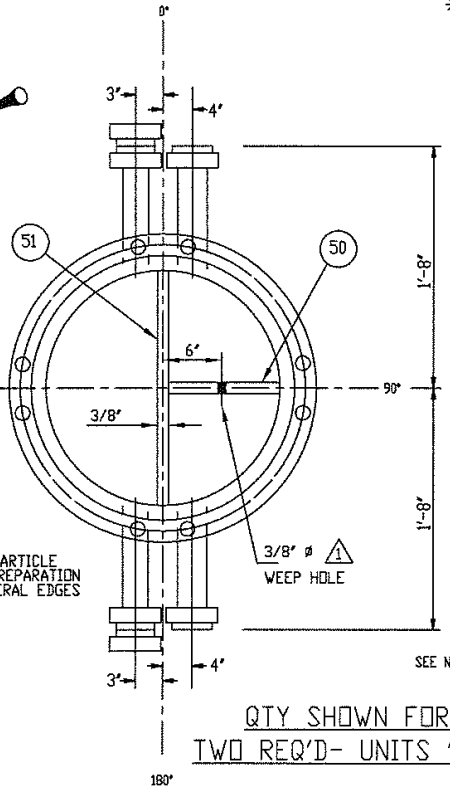
* MACHINE GASKET FACING AFTER ALL WELDING AND HEAT TREATMENT.
FOR FLANGE DETAILS SEE DWG. X-7930-K



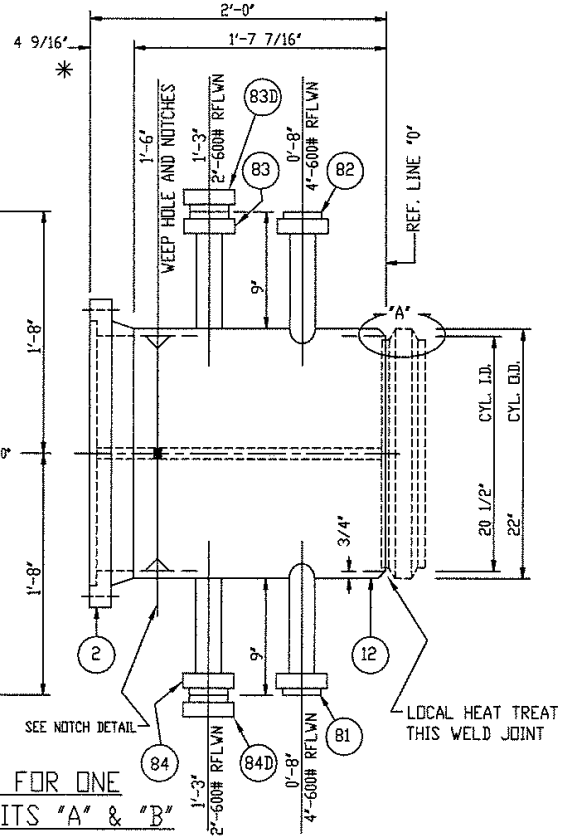
CHANNEL-COVER DETAIL



DETAIL "A"



CHANNEL END VIEW



CHANNEL SIDE VIEW

QTY SHOWN FOR ONE
TWO REQ'D- UNITS "A" & "B"

CERTIFIED AS-BUILT

NOTES:
1) ALL BOLT HOLES TO STRADDLE CENTER LINES.
2) FOR WELD AND BEVEL DETAILS SEE DWG. X-7930-S
3) FOR JOB NOTES SEE DWG. X-7930-R
4) NOZZLE SWING DIMENSION = 43 3/4"

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17496-0001 REQ No.: MC202
SERVICE:	PROCESS CONDENSATE TRIM HEATER
ITEM NO:	HX1027/2027

NO.	DATE	REVISIONS
1	5/12/11	REVISED PER CUSTOMER MD/SG

FRONT CHANNEL DETAILS

DWN. BY D.MORRISON
DATE 3-11-11
CKD. BY SM

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

DWG. NO. X-7930-B
REV 1

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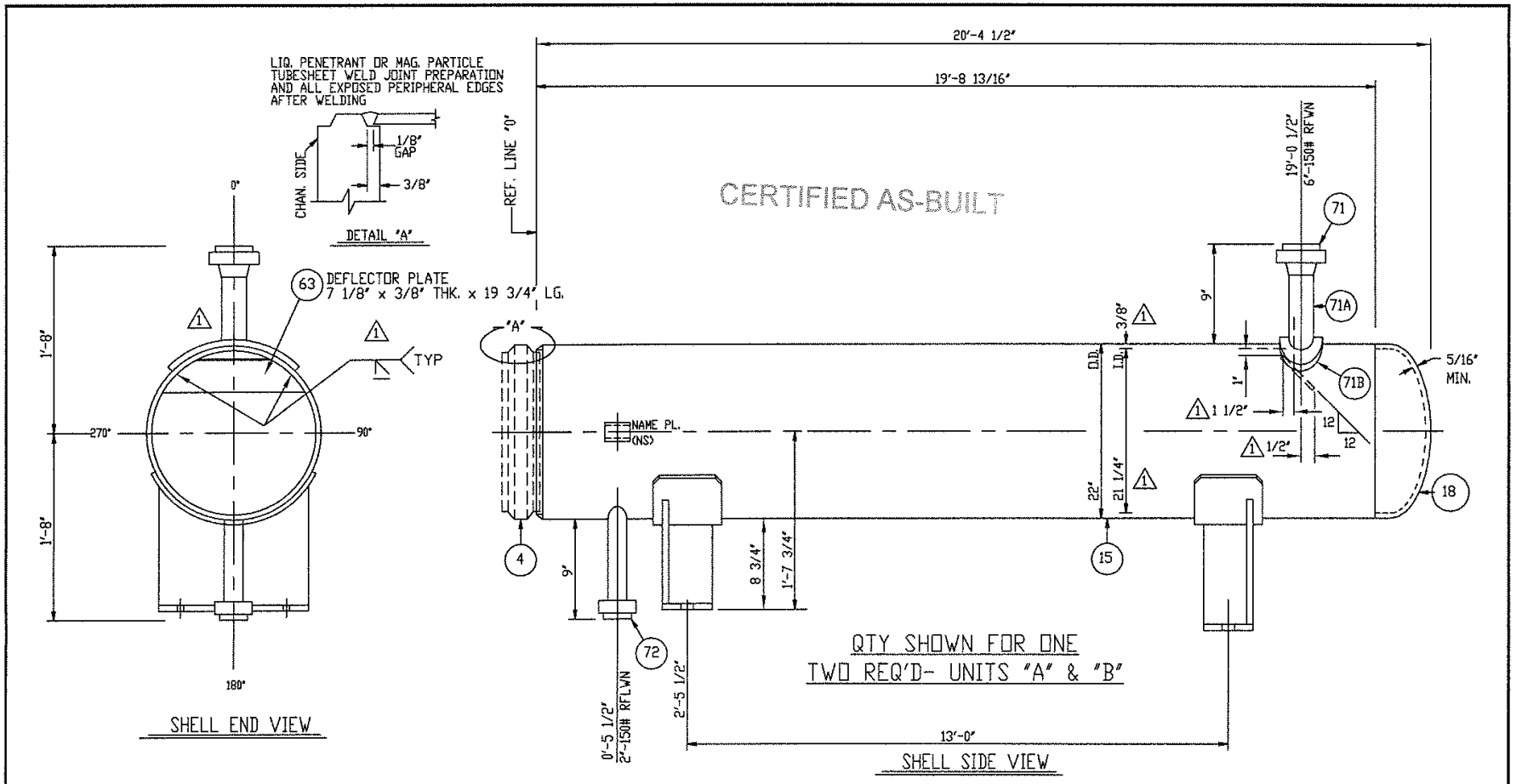

NOTES:

1) FOR WELD AND BEVEL DETAILS SEE DWG. X-7930-S
2) FOR JOB NOTES SEE DWG. X-7930-R
3) SEE SUPPORT (DWG. X-7930-D) DETAILS FOR REFERENCE. 1
4) SEE NAME PLATE (DWG. X-7930-Q) DETAILS FOR REFERENCE.

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17496-0001 REQ No.: MC202
SERVICE:	PROCESS CONDENSATE TRIM HEATER
ITEM NO:	HX1027/2027

NO.	DATE	REVISIONS
1	5/12/11	REVISED PER CUSTOMER MD/SG

SHELL DETAILS

DWN. BY	D.MORRISON
DATE	3-11-11
CKD. BY	SM

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

DWG. NO.	REV
X-7930-C	1

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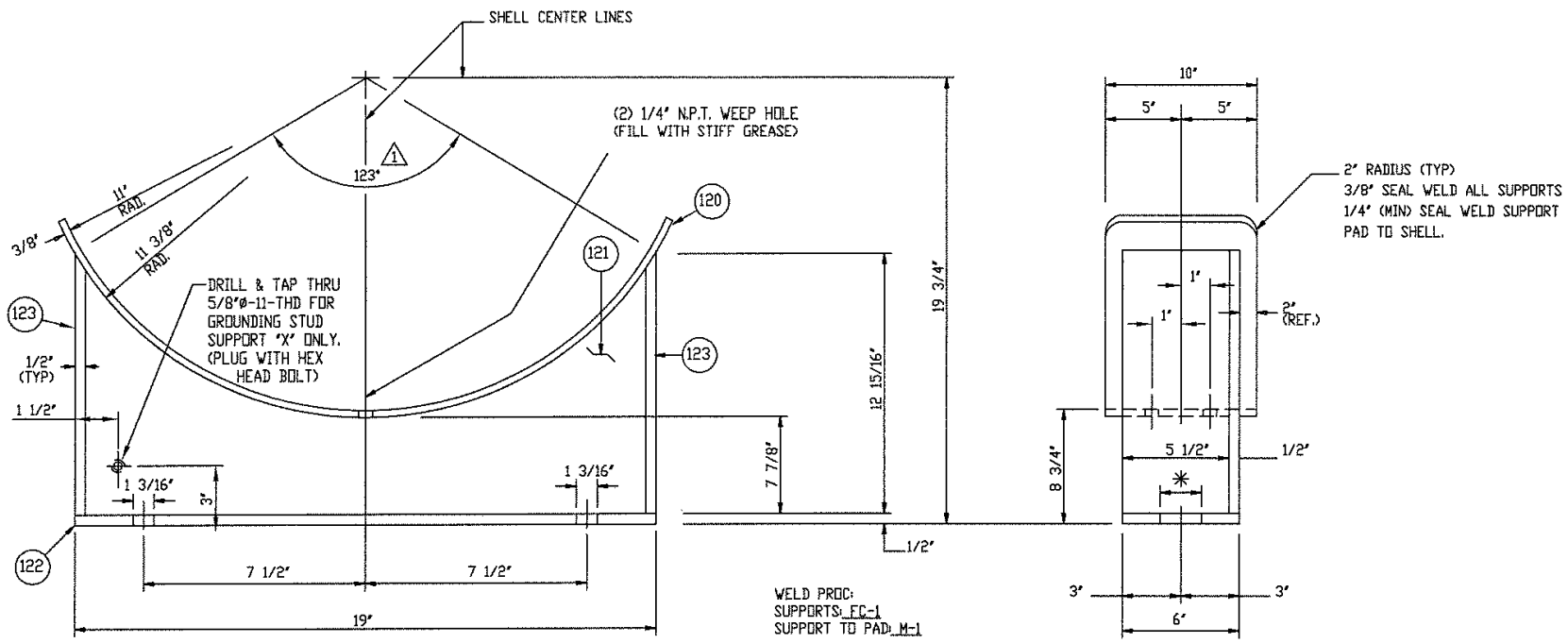


CERTIFIED AS-BUILT

✳ ONE REQUIRED MARKED "X" W/ (2) 1 3/16" ROUND HOLES.
ONE REQUIRED MARKED "Y" W/ (2) 1 3/16" X 2" LG. SLOTS.
⚠1 (1" DIA. ASTM F1554 GR 36 ANCHOR BOLTS BY OTHERS)

QTY SHOWN FOR ONE
TWO REQ'D- UNITS "A" & "B"

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES	
P.O. NO:	17496-0001	REQ No.: MC202
SERVICE:	PROCESS CONDENSATE TRIM HEATER	
ITEM NO:	HX1027/2027	

NO.	DATE	REVISIONS
1	5/12/11	REVISED PER CUSTOMER MD/SG

SUPPORT DETAILS

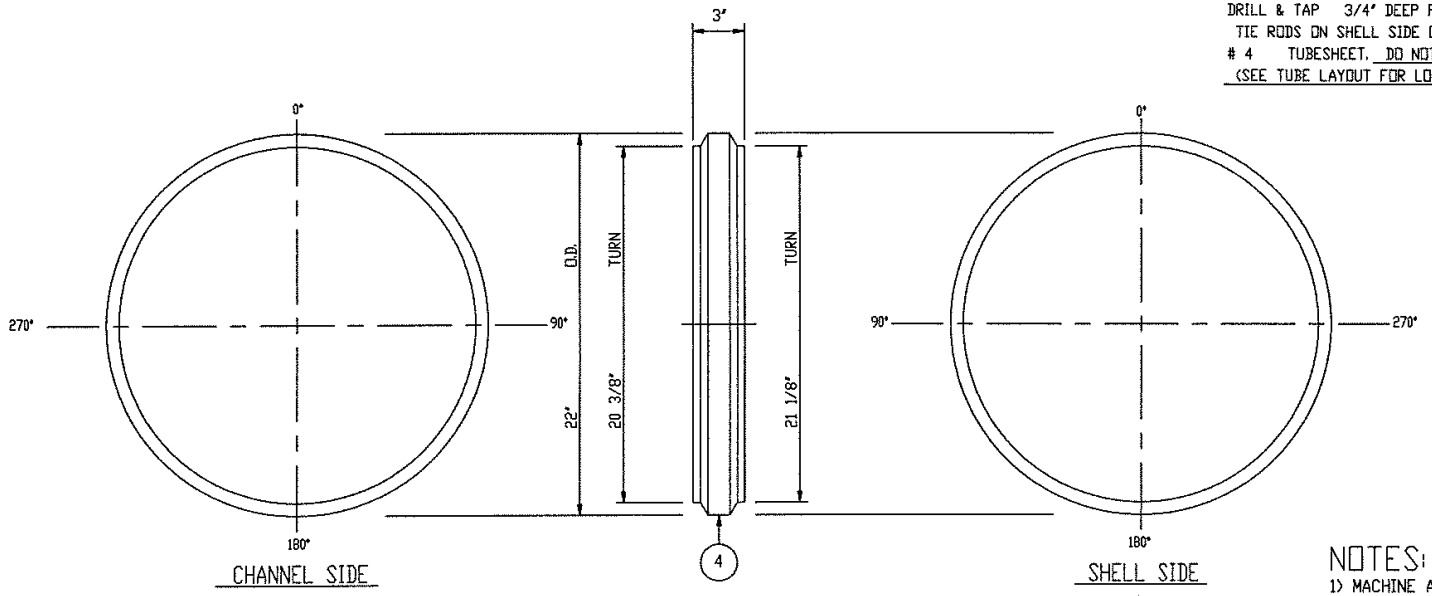
DWN. BY D.MORRISON
DATE 3-11-11
CKD. BY SM
DWG. NO. X-7930-D
REV 1

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

NOTE: SEE DWG. X-7930-R FOR JOB NOTES.

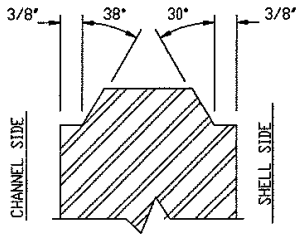
MM187157

DRILL & TAP 3/4" DEEP FOR 6- 1/2" DIA.
TIE RODS ON SHELL SIDE OF
4 TUBESHEET. DO NOT DRILL THRU!!
(SEE TUBE LAYOUT FOR LOCATIONS.)

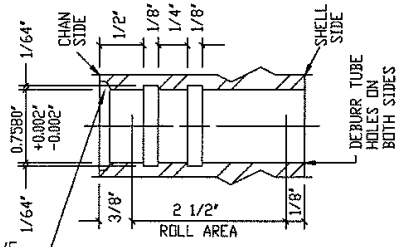


QTY SHOWN FOR ONE
TWO REQ'D- UNITS "A" & "B"

STRENGTH WELD TUBE TO TUBESHEET. REMOVE OIL AND GREASE OR OTHER FOREIGN MATTER FROM TUBESHEET, TUBEHOLES AND TUBE ENDS PRIOR TO WELDING OF TUBES. HELI-ARC WITH FILLER METAL. WELD EACH TUBE INDIVIDUALLY WITH (2) TWO OR MORE PASSES. WELD PROCEDURE = SW-1
DYE CHECK TUBE TO TUBESHEET WELDS BEFORE AND AFTER TUBE ROLLING.
PREHEAT TO 200 deg.F. PRIOR TO WELDING.
FINAL TUBE ROLLING AFTER HEAT TREAT.
BUBBLE TEST AT 15 P.S.I.G. PRIOR TO ROLLING



TUBESHEET DETAIL



TUBE HOLE GROOVING DETAIL

NOTES:
1) MACHINE ALL SURFACES TO 250 Ra EXCEPT GASKET FACE TO BE 125 Ra.
1 2) REAM & RING-GROOVE TUBE HOLES BEFORE POST-WELD HEAT TREAT.
3) FOR JOB NOTES SEE DWG. X-7930-R

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17496-0001 REQ No.: MC202
SERVICE:	PROCESS CONDENSATE TRIM HEATER
ITEM NO:	HX1027/2027

CERTIFIED AS-BUILT

NO.	DATE	REVISIONS
1	8/18/11	REVISED NOTE 2/EEC MD/SG

TUBESHEET DETAILS

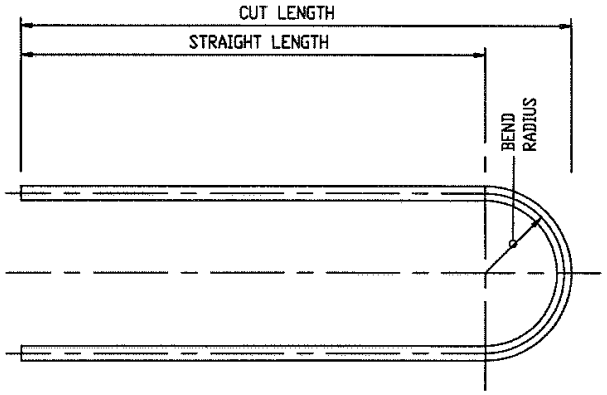
DWN. BY D.MORRISON
DATE 3-11-11
CKD. BY SM

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

DWG. NO. X-7930-F
REV 1

MM187157

ROW	NO.OF TUBES	BEND RADIUS	BEND DIAMETER	BEND LENGTH	STRAIGHT LENGTH	CUT LENGTH	DEVELOPED LENGTH
A	16	1 1/8"	2 1/4"	0'-3 9/16"	18'-0"	18'-1 1/2"	36'-3 9/16"
B	14	2"	4"	0'-6 5/16"	18'-0"	18'-2 3/8"	36'-6 5/16"
C	16	2 7/8"	5 3/4"	0'-9 1/16"	18'-0"	18'-3 1/4"	36'-9 1/16"
D	15	3 3/4"	7 1/2"	0'-11 13/16"	18'-0"	18'-4 1/8"	36'-11 13/16"
E	16	4 5/8"	9 1/4"	1'-2 9/16"	18'-0"	18'-5"	37'-2 9/16"
F	14	5 1/2"	11"	1'-5 5/16"	18'-0"	18'-5 7/8"	37'-5 5/16"
G	14	6 3/8"	12 3/4"	1'-8 1/16"	18'-0"	18'-6 3/4"	37'-8 1/16"
H	12	7 3/16"	14 3/8"	1'-10 5/8"	18'-0"	18'-7 9/16"	37'-10 5/8"
J	10	8 1/16"	16 1/8"	2'-1 3/8"	18'-0"	18'-8 7/16"	38'-1 3/8"
K	6	8 15/16"	17 7/8"	2'-4 1/8"	18'-0"	18'-9 5/16"	38'-4 1/8"



TOTAL NO. REQUIRED: 133
SIZE: 3/4" O.D. X 0.083" (MIN)
MATERIAL: SA-179

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

MATERIAL HARDNESS SHALL NOT EXCEED 22 HRC

STRESS RELEIVE U-BENDS PLUS 1'-0" STR. LEN.
BY ELECTRIC RESISTANCE @ 1150°F ±25°F

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

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: PROCESS CONDENSATE TRIM HEATER
ITEM NO: HX1027/2027

CERTIFIED AS-BUILT

NO.	DATE	REVISIONS
1	2-16-11	REV'D PER CUST. DN/SG

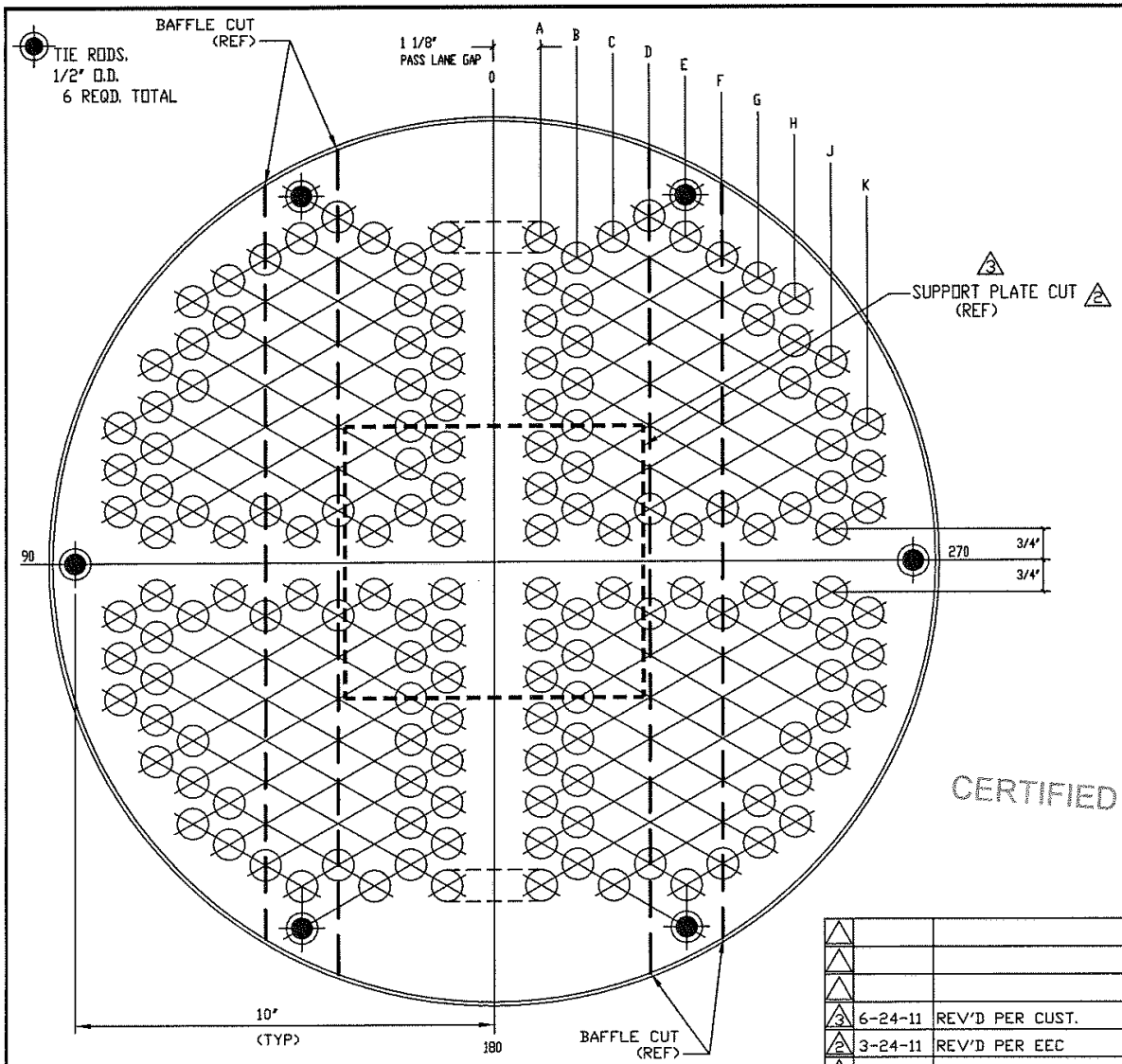
TUBE BENDING SCHEDULE

DWN. BY DN
DATE 1-18-11
CKD. BY DN

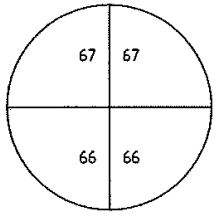
Energy Exchanger Co.
3844 No. Garnett Rd. • Tulsa, Okla. 74116

DWG. NO. X-7930-G
REV 1

MM187157



VIEW LOOKING AT SHELL SIDE OF NO. 4 TUBESHEET



TUBE DISTRIBUTION

NOTES:

1) DRILL AND REAM TUBE HOLES IN TUBESHEETS TO 0.758" ±0.002" DIA. 2
   FOR 133 - 3/4" O.D. U-TUBES.
   TOTAL HOLES = 266
2) TUBE PITCH = 1" ROT. TRIANGLE. (30°) 1
3) NUMBER OF PASSES = 4
4) SEE DRAWING X-7930-F
   FOR TUBE GROOVING DETAILS.
5) BAFFLE O.D. = 21 1/16"
6) O.T.L. = 19 13/16"

CERTIFIED AS-BUILT

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: PROCESS CONDENSATE TRIM HEATER 1
ITEM NO: HX1027/2027

NO.	DATE	REVISIONS	
3	6-24-11	REV'D PER CUST.	WE
2	3-24-11	REV'D PER EEC	DM/SM
1	2-16-11	REV'D PER CUST.	DN/SG

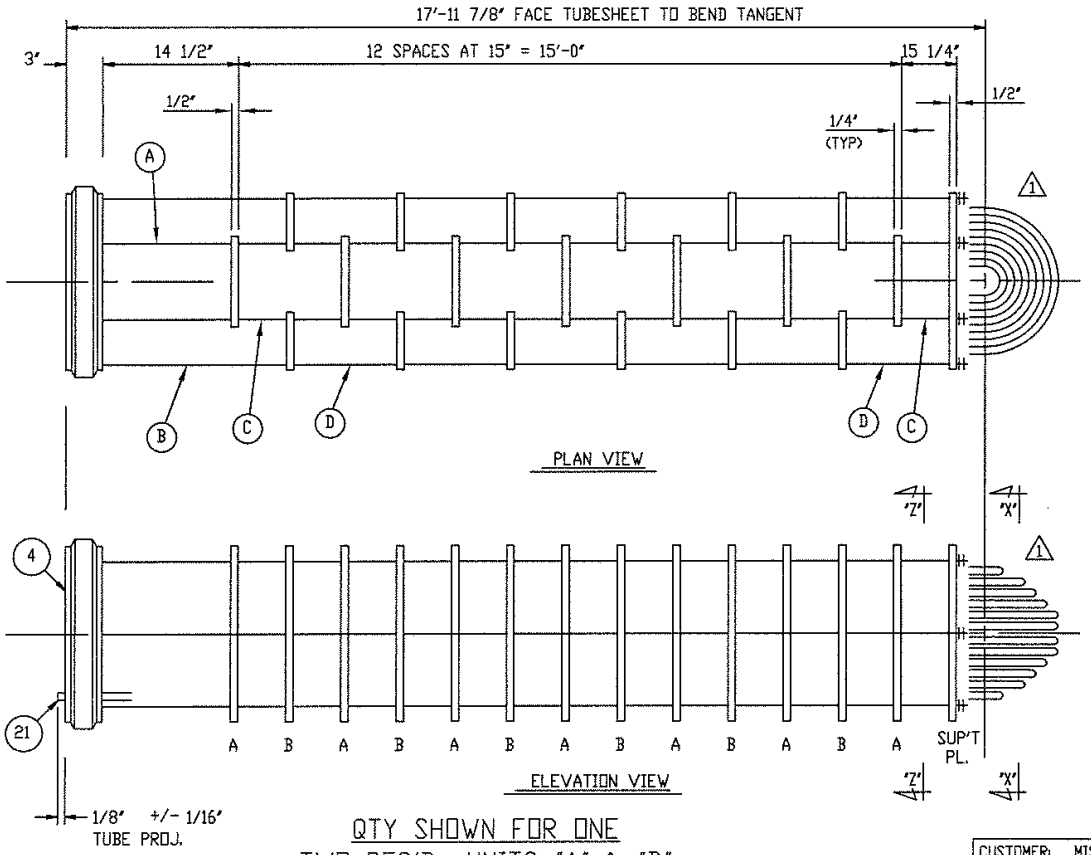
TUBE LAYOUT

DWN. BY: DN
DATE: 1-18-11
CKD. BY: MD

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

DWG. NO. X-7930-H
REV 3

MM187157

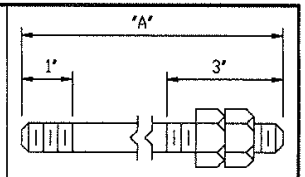


CERTIFIED AS-BUILT

QTY SHOWN FOR ONE
TWO REQ'D- UNITS "A" & "B"

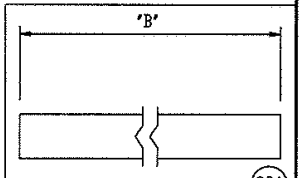
NOTES:
1) FOR SECTION AND VIEW DETAILS SEE DWG. X-7930-J1 & J2
2) FOR JOB NOTES SEE DWG. X-7930-R

STRENGTH WELD TUBE TO TUBESHEET. REMOVE OIL AND GREASE OR OTHER FOREIGN MATTER FROM TUBESHEET, TUBEHOLES AND TUBE ENDS PRIOR TO WELDING OF TUBES. HELI-ARC WITH FILLER METAL. WELD EACH TUBE INDIVIDUALLY WITH (2) TWO OR MORE PASSES. WELD PROCEDURE = SW-1
DYE CHECK TUBE TO TUBESHEET WELDS BEFORE AND AFTER TUBE ROLLING.
PREHEAT TO 200 deg.F. PRIOR TO WELDING.
FINAL TUBE ROLLING AFTER HEAT TREAT.
BUBBLE TEST AT 15 P.S.I.G. PRIOR TO ROLLING



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

REQ'D.		'A'
R1	6	17'-8"
R2		
R3		
R4		



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

REQ'D.		'B'
A	4	14"
B	2	29 1/4"
C	52	14 3/4"
D	12	29 3/4"
E		
F		
G		

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17496-0001 REQ No.: MC202
SERVICE:	PROCESS CONDENSATE TRIM HEATER
ITEM NO:	HX1027/2027

NO.	DATE	REVISIONS
1	5/12/11	REVISED PER CUSTOMER MD/SG

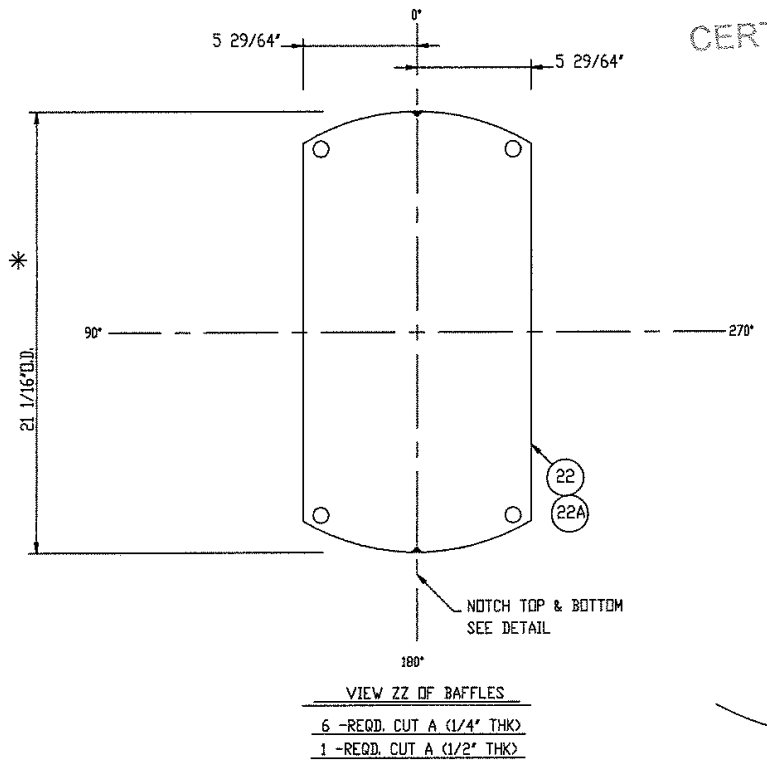
BUNDLE DETAILS

DWN. BY D.MORRISON
DATE 3-11-11
CKD. BY SM
DWG. NO. X-7930-I
REV 1

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

MM187157

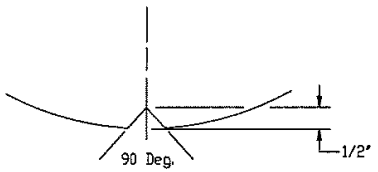
CERTIFIED AS-BUILT



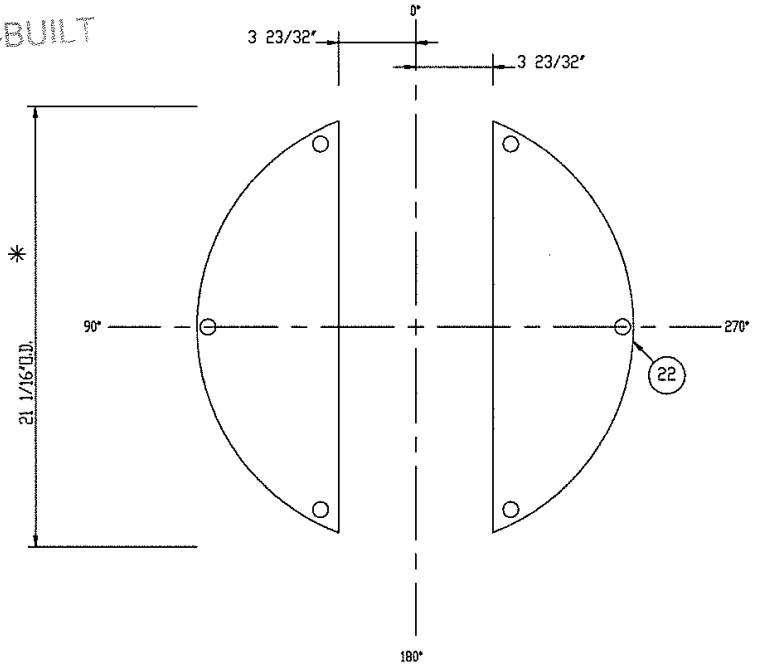
VIEW ZZ OF BAFFLES

6 -REQD. CUT A (1/4" THK)

1 -REQD. CUT A (1/2" THK)



NOTCH DETAIL



VIEW ZZ OF BAFFLES

6 -REQD. CUT B (1/4" THK)

QTY SHOWN FOR ONE

TWO REQ'D- UNITS "A" & "B"

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17496-0001 REQ No.: MC202
SERVICE:	PROCESS CONDENSATE TRIM HEATER
ITEM NO:	HX1027/2027

NOTES:

1) FOR JOB NOTES SEE DWG. X-7930-R
2) DRILL TUBE HOLES IN BAFFLES 25/32" DIA. & DEBURR.
3) DRILL TIE ROD HOLES 9/16" DIA.
   SEE TUBE LAYOUT (DWG. X-7930-H) FOR LOCATION. 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 (DWG. X-7930-H) FOR BAFFLE CUT LOCATIONS. 1

NO.	DATE	REVISIONS
1	5/12/11	REVISED PER CUSTOMER MD/SG

BAFFLE DETAILS

DWN. BY	D.MORRISON
DATE	3-11-11
CKD. BY	SM

Energy Exchanger Co.
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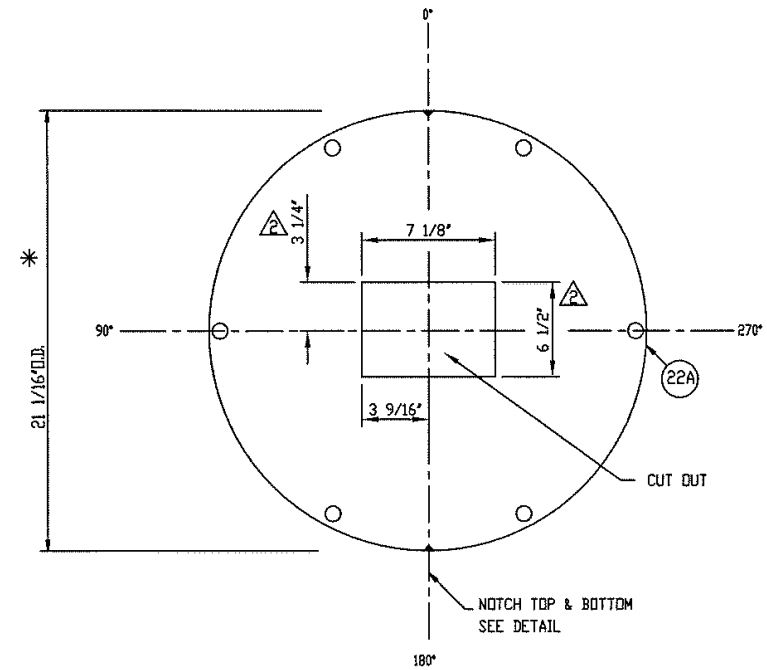
DWG. NO.	REV
X-7930-J1	1

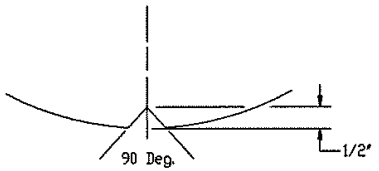
MM187157



VIEW XX OF SUP'T PL.

1/2" THK

1 -REQD



NOTCH DETAIL

CERTIFIED AS-BUILT

QTY SHOWN FOR ONE
TWO REQ'D- UNITS "A" & "B"

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17496-0001 REQ No.: MC202
SERVICE:	PROCESS CONDENSATE TRIM HEATER
ITEM NO:	HX1027/2027

NOTES:

1) FOR JOB NOTES SEE DWG. X-7930-R
2) DRILL TUBE HOLES IN BAFFLES 25/32" DIA. & DEBURR.
3) DRILL TIE ROD HOLES 9/16" DIA.
   SEE TUBE LAYOUT (DWG. X-7930-H) FOR LOCATION. 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 (DWG. X-7930 H) FOR BAFFLE CUT LOCATIONS. 1

NO.	DATE	REVISIONS	
2	6-24-11	REV'D PER CUST.	WE/DA
1	5/12/11	REVISED PER CUSTOMER	MD/SG

BAFFLE DETAILS

DWN. BY D.MORRISON

DATE 3-11-11

CKD. BY SM

Energy Exchanger Co.
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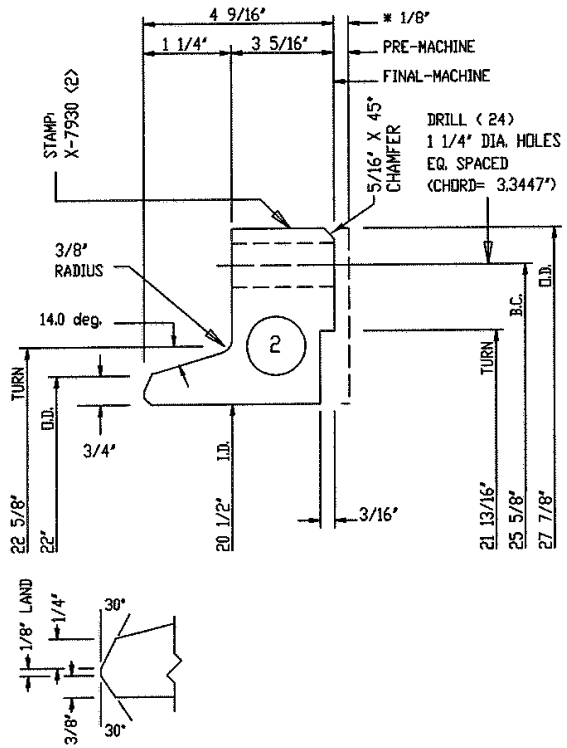
DWG. NO. X-7930-J2

REV 2

MM187157



#2 GIRTH FLANGE (TWO) REQ'D.

CERTIFIED AS-BUILT

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17496-0001 REQ No.: MC202
SERVICE:	PROCESS CONDENSATE TRIM HEATER
ITEM NO:	HX1027/2027

NOTES:

1) SEE DWG. X-7930-R FOR JOB NOTES.
2) MACHINE ALL SURFACES TO 250 Ra
   EXCEPT GASKET SURFACES MACHINE TO 125-250 Ra
3) * FINAL MACHINE FACING AFTER FINAL WELDING AND POST WELD HEAT TREATMENT.

NO.	DATE	REVISIONS

GIRTH FLANGES

DWN. BY	D.MORRISON
DATE	3-11-11
CKD. BY	SM

Energy Exchanger Co.
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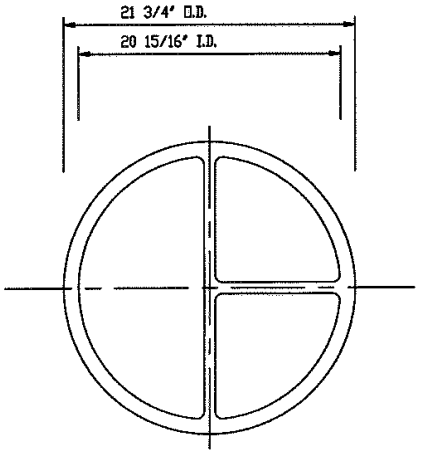
DWG. NO.	REV
X-7930-K	0

MM187157



(1)-REQUIRED.
CHANNEL COVER GASKET
1/8" THK 321 STN STL GMGC
RIB WIDTH TO BE 7/16" WIDE.

CERTIFIED AS-BUILT

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

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17496-0001 REQ No.: MC202
SERVICE:	PROCESS CONDENSATE TRIM HEATER
ITEM NO:	HX1027/2027

NO.	DATE	REVISIONS
1		
2		
3		
4		
5		
6		

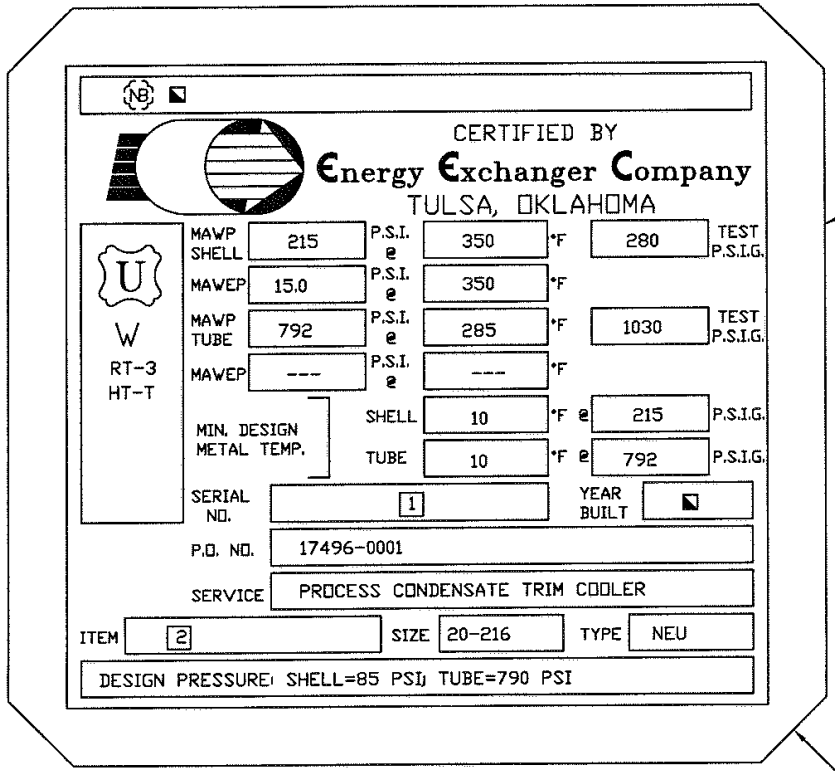
GASKET DETAILS

DWN. BY D.MORRISON
DATE 3- 9-11
CKD. BY

Energy Exchanger Co.
1944 No. Garnett Rd. • Tulsa, Okla. 74116

DWG. NO. X-7930-0
REV 0

MM187157



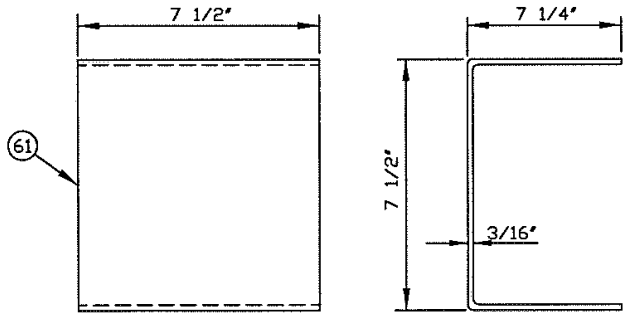
NAME PLATE DETAIL

TWO - REQ'D.

SHOP TO ASSIGN AT COMPLETION OF FABRICATION

60

CLIP CORNERS & SEAL WELD TO NAME PLATE BRACKET



NAME PLATE BRACKET DETAIL

TWO - REQ'D.

1 X-7930 A
X-7930 B

2 HX1027
HX2027

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17496-0001 REQ No: MC202
SERVICE:	PROCESS CONDENSATE TRIM HEATER
ITEM NO:	HX1027/2027

CERTIFIED AS-BUILT

NO.	DATE	REVISIONS

NAME PLATE DETAILS

DWN. BY D.MORRISON

DATE 3-11-11

CKD. BY

Energy Exchanger Co.

DWG. NO. X-7930-Q

REV 0

MM187157

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.
5. CHANNEL COVER AND BODY FLANGE PERIPHERAL GASKET SURFACES SHALL HAVE A FLATNESS TOLERANCE OF 1/32" AND MEASURED WITH A DIAL GAUGE. PASS PL. GROOVES AND PASS PLATE EDGES SHALL BE MEASURED WITH A STRAIGHT EDGE.
6. DELETED
7. ALL FLAME-CUT BEVEL WELDS SHALL BE GROUND TO BRIGHT METAL PRIOR TO WELDING.
8. MATCH MARKS REQUIRED ON CHANNEL COVER AND ALL TEMA FLGS. WITH A SCRIBED LINE 1/8" DEEP AT THE 90° AND 270° POSITIONS.
9. THE FOLLOWING PARTS SHALL BE STAMPED WITH MANUFACTURER'S SERIAL NUMBER & ITEM NUMBER: CHANNEL FLANGE, CHANNEL COVER.
10. TUBESHEET AND TUBE HOLES SHALL BE CLEANED AND DEGREASED IMMEDIATELY PRIOR TO ASSEMBLY WITH A CHLORIDE FREE SOLVENT.
11. PRIOR TO ASSEMBLY, ALL INTERNALS SHALL BE CLEAN AND FREE OF LOOSE SLAG, SCALE OR OTHER DEBRIS.
12. ANY WELD DEFECTS SHALL HAVE THE DEFECT REMOVED AND CONFIRMED. IF ORIGINALLY RT, THEN RT REPAIR AND ALSO MT.

M.T. REQUIREMENTS

1. DELETED
2. MT ALL LIFTING LUG WELDS
3. DELETED
4. TEMPORARY ATTACHMENT WELDS SHALL BE REMOVED, THE AREAS DRESSED, AND EXAMINED.
5. DELETED
6. DELETED
7. MT ALL CHANNEL SIDE WELDS AFTER PWHT.

HEAT TREAT REQUIREMENTS

TOP CHANNEL & BTTM CHANNEL:
- 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 & SHELLSIDE: 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. 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.
3. SHOULD A PAD COVER A WELD, GRIND FLUSH AND 100% EXAMINE EXTENDING 6" BEYOND THE PAD EDGE.
4. DELETED
5. DELETED

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) BRINELL HARDNESS LIMITS SHALL BE 225 MAX. IN WELD OR HAZ OF STRENGTH WELDED TUBE-TO-TUBESHEET JOINTS. THESE WELDS ARE MACRO HARDNESS TESTED ON THE TUBE MOCK-UP MOCK-UP AND RESULTS INCLUDED WITH THE MOCK-UP.
   - D) HARDNESS SHALL BE DETERMINED USING A 10mm DIA. BALL UNLESS OTHERWISE SPECIFIED.
   - E) ONE READING IN THE WELD METAL OF EACH LONG. SEAM AND ONE READING IN EACH HEAT AFFECTED ZONE.
   - F) ONE READING IN THE WELD METAL OF EACH CIRC. SEAM AND ONE READING IN EACH HEAT AFFECTED ZONE.
   - G) ONE READING IN THE WELD METAL OF NOZZLE TO EXCHANGER WELDS AND ONE READING IN EACH HEAT AFFECTED ZONE IN 50% OF THE NOZZLES.
   - H) 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.
   - I) TESTING SHALL BE DONE ON ACCESSIBLE INSIDE AND, OUTSIDE SURFACES.

HYDROTESTING REQUIREMENTS

1. HOLD FOR AT LEAST ONE HOUR. A HYDROTEST CHART IS REQ'D.
2. MINIMUM TEST WATER TEMP. = 50 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.
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. BUBBLE TEST TUBE TO TUBESHEET WELDS WITH 15 PSIG AIR PRIOR TO ROLLING.
7. 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 NOZZLE GASKET SURFACES SHALL BE COATED WITH RUST VETO 342 PRIOR TO INSTALLING THE GASKETS AND SHALL BE PROTECTED BY METAL COVERS, PROVIDE A 1/4" N.P.T. WITH PLUG IN BOTTOM NOZZLE COVERS FOR DRAINING PURPOSES.
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-O-G (DRY) WITH A 3" CIRCLE ON HORZ. & VERTICAL CENTERLINES.
7. MARK ON TWO SIDES OF EXCHANGER 180° APART IN 3" LETTERS: "NO WELDING OR BURNING PERMITTED ON THIS EXCHANGER"
8. 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."

CERTIFIED AS-BUILT

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES		
P.O. NO:	17496-0001	REQ No.:	MC202
SERVICE:	PROCESS CONDENSATE TRIM HEATER		
ITEM NO:	HX1027/2027		

NO.	DATE	REVISIONS	
2	6-25-12	REV'D PER CUST.	DM/
1	8-10-11	REV'D PER EEC	WE/SM

JOB NOTES

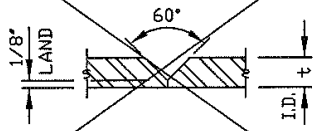
DWN. BY: D.MORRISON
DATE: 3/11/11
CKD. BY: SM

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

DWG. NO.: X-7930-R
REV: 2

MM187157

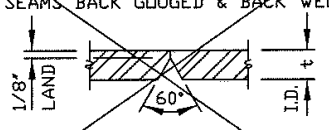
t=LESS THAN 7/16"
LOCATE LONG SEAM 15° ABOVE CL
UNLESS OTHERWISE SPECIFIED.
ALL SEAMS BACK GOUGED & BACK WELDED



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

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

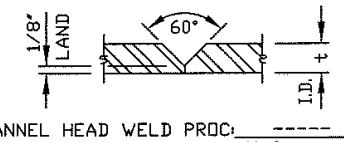
t=7/16" TO 5/8"
LOCATE LONG SEAM 15° ABOVE CL
UNLESS OTHERWISE SPECIFIED.
ALL SEAMS BACK GOUGED & BACK WELDED



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

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

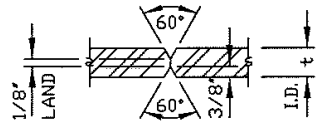
t=7/16" TO 5/8"
ALL SEAMS BACK GOUGED & BACK WELDED



CHANNEL HEAD WELD PROC: -----
SHELL HEAD WELD PROC: M-6

CIRC WELD BEVEL
(CYL TO HEAD)

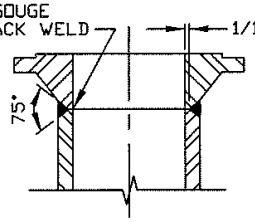
t=OVER 5/8"
LOCATE LONG SEAM 15° ABOVE CL
UNLESS OTHERWISE SPECIFIED.
ALL SEAMS BACK GOUGED & BACK WELDED



CHANNEL WELD PROC: A-1-H
SHELL WELD PROC: -----

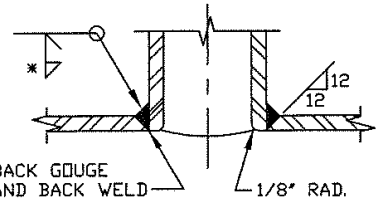
LONG OR CIRC WELD BEVEL
(CYL TO FLG, OR CYL)

BACK GOUGE
AND BACK WELD
1/16" LAND



CHANNEL WELD PROC: -----
SHELL WELD PROC: M-6

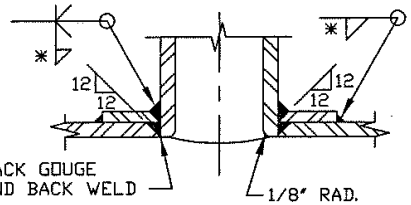
WELD-NECK FLANGE INSTALLATION



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

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.

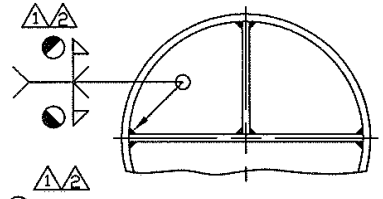


CHANNEL WELD PROC: -----
SHELL WELD PROC: M-1

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
DEFLECTOR PL. TO SHELL: M-1

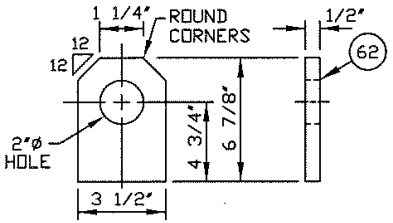


1/4" (MIN.) AT FRONT CHANNEL

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

WELD PROCEDURE: M-1-H

PASS PLATE WELDS



SEAL WELD W/ 1/4" FILLET
WELD PROCEDURE: M-1

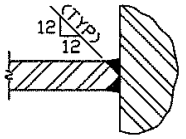
LIFTING LUG DETAIL

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

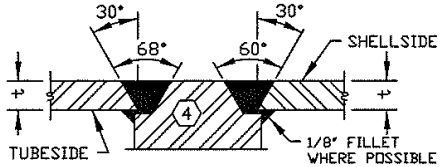
* ALL FILLETS WELDS TO BE 3/8" UNLESS NOTED OTHERWISE

BEVEL PASS PLATE TO A POINT



WELD PROC: M-1-H

PASS PLATE TO TUBESHEET WELD



CHANNEL WELD PROC: A-1-H
SHELL WELD PROC: A-1

CIRCUMFERENTIAL SEAM
(TUBESHEET TO CYL)

CERTIFIED AS-BUILT

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES		
P.O. NO:	17496-0001	REQ No.:	MC202
SERVICE:	PROCESS CONDENSATE TRIM HEATER		
ITEM NO:	HX1027/2027		

NO.	DATE	REVISIONS	
2	6-24-11	REV'D PER CUST.	WE/DW
1	5/12/11	REVISED PER CUSTOMER	MD/SG

WELD & BEVEL DETAILS

DWN. BY: DM
DATE: 3-11-11
CKD. BY: SM

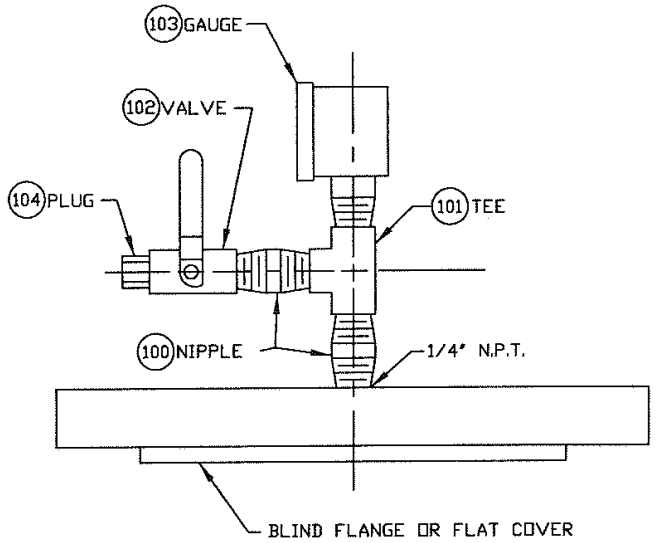
Energy Exchanger Co.
1844 No. Garnett Rd. - Tulsa, Okla. 74116

DWG. NO.: X-7930-S
REV: 2

MM187157

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.

CERTIFIED AS-BUILT

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17496-0001 REQ No: MC202
SERVICE:	PROCESS CONDENSATE TRIM HEATER
ITEM NO:	HX1027/2027

NO.	DATE	REVISIONS

NITROGEN PURGE DETAILS

DWN. BY D.MORRISON
DATE 6/25/12
CKD. BY

Energy Exchanger Co.
1944 No. Garnett Rd. • Tulsa, Okla. 74116

DWG. NO. X-7930-X
REV 0

MM187157

BILL OF MATERIAL

PART NO	TWO 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" THK (MIN) PER BEND SCHEDULE	SA-179	133	266		1			*
	FORGED RING MATERIAL								
2	FLG 27 7/8" O.D.X 20 1/2" I.D.X 4 9/16" THK	SA-266-2or4N	1	2		1			*
	TUBESHEETS & COVERS								
4	TUBESHEET 22" O.D.X 3" THK	SA-266-2or4N	1	2		1			*
1	COVER 27 7/8" O.D.X 3 1/4" THK	SA-266-2or4N	1	2		1			*
	BAFFLES								
22	BAFFLES 21 1/16" O.D.X 1/4" THK	SA-36	12	24					*
22A	FIRST & LAST BAFFLES 21 1/16" O.D.X 1/2" THK	SA-36	2	4					*
	HEADS								
18	ELLIP HD. 22" O.D.X 5/16" THK(min) W/2" SF	SA-516-70	1	2					*
	CYLINDERS								
12	R&W CYL 20 1/2" I.D.X 3/4" THK X 1'-7 7/16" LG.	SA-516-70N	1	2		1			*
	(67" WRAP) X 3/4" THK X 19 11/16" LG.								
15	SML.S.PIPE 22" ODX(0.3750" SchSTD)X 19'-9 1/16" LG.	SA-106B	1	2					*

MATERIAL MAY NOT ORIGINATE FROM CHINA OR NORTH KOREA
1) BASE MATERIAL HARDNESS SHALL NOT EXCEED 22 HRC
2) SA-105N BASE HARDNESS SHALL NOT EXCEED 187 HB

* DENOTES PRELIMINARY ORDER

CERTIFIED AS-BUILT

⚠ REQ No: MC202
SERVICE: PROCESS CONDENSATE TRIM HEATER

NO.	DATE	DESCRIPTION

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

CUST: MISSISSIPPI POWER CO. c/o SOUTHERN COMPANY SERVICES
P.O.: 17496-0001 ITEM: HX1027/2027

PB/M	DR: DN	CK: MD	DATE: 1/18/11	DWG. NO.	REV
FB/M	DR: DM	CK: [signature]	DATE: 3-11-11	X-7930-1BM	0

MM187157

BILL OF MATERIAL

PART NO	TWO REQ'D, DESCRIPTION OF ONE	MATERIAL SPEC.	QTY ONE	TOT QTY	REV	NOTE	PO NO	PROMISED	
	ASME FLANGES								
71	ASME 6" - 150 # RF WN W/ (SchXH BORE)	SA-105	1	2					*
72	ASME 2" - 150 # RF LWN X 10" LG(2.000"BORE)	SA-105	1	2					*
81	ASME 4" - 600 # RF LWN X 13" LG (MIN) (4.000"BORE)	SA-105N	1	2		2			*
82	ASME 4" - 600 # RF LWN X 13" LG (MIN) (4.000"BORE)	SA-105N	1	2		2			*
83	ASME 2" - 600 # RF LWN X 12" LG (2.000"BORE)	SA-105N	1	2	1	2			*
84	ASME 2" - 600 # RF LWN X 12" LG (2.000"BORE)	SA-105N	1	2	1	2			*
71A	SMLS.PIPE 6 5/8" ODX(0.4320" SchXH)X 7" LG.	SA-106B	1	2	1				*
71B	WELD PAD 9 3/4" O.D. X 3/8" THK	SA-516-70	1	2					*
83D	ASME 2" - 600 # RF BLIND	SA-105N	1	2		2			*
84D	ASME 2" - 600 # RF BLIND	SA-105N	1	2		2			*

SEE DWG X-7930-1BM FOR MATERIAL NOTES

* DENOTES PRELIMINARY ORDER

CERTIFIED AS-BUILT

⚠ REQ No.: MC202
SERVICE: PROCESS CONDENSATE TRIM HEATER

NO.	DATE	DESCRIPTION					
⚠1	3-24-11	REV'D PER EEC DM/	PB/M	DR: DN	CK: MD	DATE: 1/18/11	DWG. NO. X-7930-2BM / REV 1
			FB/M	DR: DM	CK:	DATE: 3-11-11	

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

CUST: MISSISSIPPI POWER CO. c/o SOUTHERN COMPANY SERVICES
P.O.: 17496-0001
ITEM: HX1027/2027

MM187157

BILL OF MATERIAL

PART NO	TWO 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-7930-D		2	4					
41	1 1/8" ROUND X 8-THREAD STUDS X 9 1/8" LG. 1&2	SA-193B7	24	48					
42	1 1/8" HEAVY HEX NUTS 8-THREAD	SA-194-2H	48	96					
43	5/8" ROUND X 11-THREAD STUDS X 4 3/8" LG. (2"-600# RF)	SA-193B7	16	32					
44	5/8" HEAVY HEX NUTS 11-THREAD (2"-600# RF)	SA-194-2H	32	64					
45	GASKET 0.175" THK 321 STN STL SP. WD FLEXIBLE GRAPHITE FILLED								
	W/ 1/8" THK C'ST OUTER COMPRESSION RING FOR (2"-600# RF)		2	4					
	MISC. MATERIAL								
60	STD. NAME PLATE	STN.STL.	1	2					
61	STD. NAME PLATE BRK'T.	SA-516-70	1	2					
62	LIFTING LUGS 3 1/2" X 1/2" THK X 6 7/8" LG	SA-516-70	1	2					
23	FT. 1/2" O.D. TIE RODS	C'STL	107	214					
23A	FT. 3/4" O.D. SPACER TUBING	SA-214	107	214					
23B	1/2" TIE ROD HEX NUTS	C'STL	12	24					
63	DEFLECTOR PLATE 7 1/8" X 3/8" THK X 19 3/4" LG	SA-516-70	1	2	2				
50	PASS PLATES 9 15/16" X 3/8" THK X 24" LG.	SA-516-70N	1	2					
51	PASS PLATES 20 3/8" X 3/8" THK X 24" LG.	SA-516-70N	1	2					
	NITROGEN PURGE MATERIAL								
100	1/4" PIPE NIPPLE X 2" LG. (THRD. OUTSIDE EACH END)	C. STL.	4	8	3				
101	1/4" STRAIGHT TEE (THRD. INSIDE EACH END)	C. STL.	2	4	3				
102	1/4" PIPE VALVE (INSIDE THRD.) (#5X713)	BRASS	2	4	3				
103	1/4" PRESSURE GAUGE (#5X939)(P570K-60LM)(0-60 PSIG)		2	4	3				
104	1/4" PIPE PLUG	C. STL.	2	4	3				
	SUPPORT MATERIAL								
120	PLATE 10" X 3/8" THK X 26 1/2" LG.	SA-516-70	2	4					
121	PLATE 19" X 1/2" THK X 13" LG.	SA-516-70	2	4					
122	PLATE 6" X 1/2" THK X 19" LG.	SA-516-70	2	4					
123	PLATE 5 1/2" X 1/2" THK X 13" LG.	SA-516-70	4	8					
125	5/8" DIA X 11 THD HEX HD BOLT X 2" LG	C'STL	1	2					

* DENOTES PRELIMINARY ORDER

CERTIFIED AS-BUILT

REQ No: MC202
SERVICE: PROCESS CONDENSATE TRIM HEATER

NO.	DATE	DESCRIPTION
3	6/25/12	ADD NITROGEN PURGE PER CUST DM/
2	5/31/12	CORRECT P/N 63 THK. / EEC MD/SG
1	5/12/11	REV. PER CUSTOMER MD/SG

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

CUST: MISSISSIPPI POWER CO. c/o SOUTHERN COMPANY SERVICES
P.O.: 17496-0001 ITEM: HX1027/2027

PB/M	DR: ----	CK: ----	DATE: ----	DWG. NO.	REV
FB/M	DR: DM	CK: SM	DATE: 3-11-11	X-7930-3BM	3

MM187157

X-7930 PACKING LIST

LINE NO	SPARE PARTS LIST	MATERIAL SPEC.	QTY ONE	TOT QTY	REV	NOTE	PO NO	PROMISED	
SP1	SPARE GASKETS PER DWG. X-7930-D		1 SET(S)	2 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: PROCESS CONDENSATE TRIM HEATER

NO.	DATE	DESCRIPTION
△		
△		
△		
△		
△		
△		

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

CUST: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O.: 17496-0001 ITEM: HX1027/2027

PB/M	DR: ----	CK: ----	DATE: ----	DWG. NO.	REV
FB/M	DR: DM	CK: [signature]	DATE: 3/14/11	X-7930-PL	0

MM187157

Energy Exchanger Company

CERTIFIED AS-BUILT
Miles Dowell 5/31/12

DATE: 1/18/2011
PAGE: 1 OF 25 △1

MECHANICAL CALCULATIONS

CUSTOMER:	MISSISSIPPI POWER c/o SOUTHERN COMPANY SERVICES
DESTINATION:	KEMPER COUNTY, MISSISSIPPI
P.O. No.:	17496-0001 △1
ITEM No.:	HX1027/2027
E.E.C. SERIAL No.:	X-7930 A/B
SERVICE:	PROCESS CONDENSATE TRIM HEATER
REQ No.:	MC202 △1

DESIGN DATA		
	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE	85 PSIG / FV	790 PSIG
DESIGN TEMP.	350°F	285°F
M.D.M.T.	10 °F	10 °F
CORR. ALLOW.	1/8"	1/8"
NO. PASSES	ONE	FOUR
M.A.W.P. (H&C)	215 PSIG	792 PSIG
LIMITED BY	150# FLANGE RATING	CHANNEL COVER

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)

REVISION LOG

DATE	PAGE	REV.	DESCRIPTION
2/16/2011	AS NOTED	1	PER CUSTOMER COMMENTS
4/7/2011	25	2	REV'D ANCHOR BOLT DIAM PER CUSTOMER
6/23/2011	AS NOTED	3	ADDED FV FOR STEAM OUT TUBE SIDE PER CUST.

W.O. No.: X-7930

SHELL SIDE

NOM. SIZE	PRESS.	TEMP.	C.A.	RT	H.T.	TEMA
22.000"	85.0psig	350deg.F	0.1250"	SPOT	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 = 85.0psig TEMP = 350deg.F

O.D.	NOM. THK.	RW=0/PIPE=1	CORR.ALLOW	EFFICIENCY
22.0000"	0.3750"	1	0.1250"	0.85

ATM.STRS	DES.STRS	STRS/STRS	MAWP N-C	MAWP CORR.
17100.0psi	17100.0psi	1.000	438.808psig	270.399psig

P*(RO)
---------- = 0.06418" + CORR. ALLOW. = 0.18918" + MTOL. = 0.21620"
S*E+(.4*P)

****

ASME CODE SEC.VIII DIV.I UG-32 [ELLIPTICAL HEAD]

====DESIGN CONDITIONS=======ELLIPTICAL HEAD CALCULATIONS ON O.D. FORMULA====

SHELL HEAD

MATERIAL: SA-516-70 PRESS = 85.0psig TEMP = 350deg.F

O.D.	(min)THK.	CORR.ALLOW	EFFICIENCY
22.0000"	0.3125"	0.1250"	0.85

ATM.STRS	DES.STRS	STRS/STRS	MAWP N-C	MAWP CORR.
20000.0psi	20000.0psi	1.000	495.627psig	294.287psig

P*(RO) 0.0000
---------- = 0.05475" + CORR. ALLOW. = 0.17975" + MTOL. = 0.17975"
S*E+(.9*P)

****

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

Ext Press Chart No.=	1
Ext Press Chart....=	CS-2
OD.....=	22.00000
T.....=	0.20313
L.....=	240.00000
Temp.....=	350.00000
Stress from MT.....=	20000.00000
Yield from MT.....=	33050.00000
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.....=	108.30502
L/DO.....=	10.90909
A.....=	0.00011
B.....=	1481.60242
PA1.....=	0.00000
PA2.....=	0.00000
PA.....=	18.23987

Ellip. Head External pressure calculations:

Ext Press Chart No.=	1
Ext Press Chart....=	CS-2
OD.....=	22.00000
RO.....=	19.80000
T.....=	0.18750
Temp.....=	350.00000
Stress from MT.....=	20000.00000
Yield from MT.....=	33050.00000
A.....=	0.00118
B.....=	12212.38477
PA1.....=	115.64759
PA2.....=	207.31763
PA.....=	115.64759

MM187157

FRONT CHAN.

NOM. SIZE	PRESS.	TEMP.	C.A.	RT	H.T.	TEMA
20.000"	790.0psig	285deg.F	0.1250"	SPOT	1150deg.F	R

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

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

CHAN. CYL

MATERIAL: SA-516-70N PRESS = 790.0psig TEMP = 285deg.F

I.D.	NOM. THK.	RW=0/PIPE=1	CORR.ALLOW	EFFICIENCY
20.5000"	0.7500"	0	0.1250"	0.85

ATM.STRS	DES.STRS	STRS/STRS	MAWP N-C	MAWP CORR.
20000.0psi	20000.0psi	1.000	1191.589psig	988.372psig

P*(R+CA)
---------- = 0.49596" + CORR. ALLOW. = 0.62096" + MTOL. = 0.62096"
S*E-(.6*P)

****

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

Ext Press Chart....=	1 CS-2
Actual Chart Used..=	1 CS-2
Material.....=	SA-516-70
OD.....=	22.00000
T.....=	0.62500
L.....=	25.00000
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.....=	35.20000
L/DO.....=	1.13636
A.....=	0.00578
B.....=	17235.64648
PA1.....=	0.00000
PA2.....=	0.00000
PA.....=	652.86536

MM187157

```
NOZZLE REINFORCEMENT CALCULATIONS/ ASME SEC.VIII DIV.I UG-37 & UG-16
NOZ NO= S1      6.00"    150 LB RF  WN
[INLET   ] SHELL SIDE
PRESSURE =   85.0psig   TEMP =  350.0deg.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.     =  21.34375"                I.D.     =   5.76100"
O.D.     =  22.00000"                O.D.     =   6.62500"
THK.     =   0.32812"                THK.   XH=   0.43200"
T        =   0.20312"                TN       =   0.30700"
TR       =   0.05457"                TRN      =   0.01643"
ET       =   0.14856"                ETN      =   0.29057"

MIN STD. WT. PIPE+C.A.=  0.37000"   TR+C.A.=  0.17957"
LIMITS=  12.02200"
fr1= 1.0000 fr2= 1.0000 fr3= 1.0000 fr4= 1.0000     F=   1.00000
Min weld sizes:NS=  0.0000" NP=  0.3039" PS=  0.1436" IF=  0.0000"

AREA REQD.                 A =   0.32802in^2
EXCESS IN CYL.             A1=   0.89296in^2
EXCESS IN NOZ.(OUTSIDE)    A2=   0.29511in^2  H =   0.50781"
AREA OF FILLETS              =   0.28125in^2
AREA AVAILABLE               =   1.46932in^2

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

PAD MATL.= SA-516-70      S=  20000.psi
PAD O.D.=   9.62500"    THK.=   0.37500"    AREA=   1.12500in^2
PAD TO CYL. WELD=   0.37500"    AREA=   0.14062in^2
ARC=   6.729"
PAD RET. DIM.=   9.625"  X    9.750"

< AREA REQD-AREA AVAILABLE >  =   -2.26630in^2

MAWP COR=   411.0psig  LIMITED BY AR

All Weld Paths are stronger than the required strength /[UG-41 UG-45 UW-15]
```

```
EXTERNAL PRESSURE:

NOZTYP[ 0.0] X-7930          6.00"- 150# RF  WN   PRESS= -15 TEMP= 350
<<<<<< CYLINDER >>>>  <<<<<< NOZZLE >>>>>>
      SA-106B                SA-106B
OPER STRS=17100.0000  OPER STRS=17100.0000  Area reqd.      A=  0.5654
ATM STRS =17100.0000  ATM STRS =17100.0000  Excess in cyl A1=  0.0902
C.A.      =   0.12500 C.A.      =   0.12500 Excess in noz A2=  0.2838 H= 0.5078
I.D.      =  21.34375 I.D.      =   5.76100 Excess in noz A3=  0.0000 H= 0.0000
O.D.      =  22.00000 O.D.      =   6.62500 Area fillets     =  0.2812
THK.      =   0.32812 THK.   XH=   0.43200 Area avail.      =  0.6552
T         =   0.20312 TN        =   0.30700 Noz neck weld   =  0.3750 A= 0.1406
TR        =   0.18813 TRN       =   0.02760 Pad weld        =  0.3750 A= 0.1406
ET        =   0.01500 ETN       =   0.27940 Internal weld   =  0.0000 A= 0.0000
PIPE F=1.0000 E1=1.0000  SHELL TOL=0.8750 (Min USED)  NOZ TOL=0.8750 (Nom USED)
MIN STD. WT. PIPE+C.A.=0.37000   TR[using abs(P)]+C.A.=0.13465   CHORD=  0.0000
LIMITS=  12.02200    fr1= 1.0000 fr2= 1.0000 fr3= 1.0000 fr4= 1.0000
Min weld sizes: NS= 0.0000 NP= 0.3039 PS= 0.1436 IF= 0.0000
PAD MATL.= SA-516-70    O.D.= 9.62500 THK.= 0.37500 AREA= 1.12500 S= 20000.
Area reqd-Area avail =<< -1.21477>>
```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```
NOZZLE REINFORCEMENT CALCULATIONS/ ASME SEC.VIII DIV.I UG-37 & UG-16
NOZ NO= T1 & T2      4.00"    600 LB RF  LWN
[INLET/OUTLET] FRONT CHANNEL SIDE
PRESSURE =  790.0psig   TEMP =  285.0deg.F
OFFSET VERTICAL NOZZLE: OFFSET =   4.00000"

-------CYLINDER----------------------NOZZLE-------
SA-516-70N                        SA-105N
OPER STRS=   20000.0 psi          OPER STRS=   20000.0 psi
ATM STRS =   20000.0 psi          ATM STRS =   20000.0 psi
C.A.     =   0.12500"             C.A.     =   0.12500"
I.D.     =  20.50000"             I.D.     =   4.00000"
O.D.     =  22.00000"             O.D.     =   6.00000"
THK.     =   0.75000"             THK.     =   1.00000"
T        =   0.62500"             TN       =   0.87500"
TR       =   0.41976"             TRN      =   0.08598"
ET       =   0.20524"             ETN      =   0.78902"

MIN STD. WT. PIPE+C.A.=  0.33237"   TR+C.A.=  0.54476"
LIMITS=   8.50000"
fr1= 1.0000 fr2= 1.0000 fr3= 0.0000 fr4= 0.0000     F=   1.00000
Min weld sizes:NS=  0.3536" NP=  0.0000" PS=  0.0000" IF=  0.0000"

AREA REQD.               A =   1.78398in^2
EXCESS IN CYL.           A1=   0.87227in^2
EXCESS IN NOZ.(OUTSIDE) A2=   2.46570in^2  H =   1.56250"
AREA OF FILLETS            =   0.14062in^2
AREA AVAILABLE             =   3.47859in^2

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

< AREA REQD-AREA AVAILABLE >  =   -1.69461in^2

MAWP COR=  1127.0psig  LIMITED BY AR



      External pressure for steam out:

NOZTYP[ 9.0] X-7930          4.00"- 600# RF  LWN  PRESS= -15 TEMP= 250  INLET
<<<<<< CYLINDER >>>>  <<<<<< NOZZLE >>>>>>
      SA-516-70N              SA-105N
OPER STRS=20000.0000  OPER STRS=20000.0000  Area reqd.     A=  0.1592
ATM STRS =20000.0000  ATM STRS =20000.0000  Excess in cyl A1=  2.3379
C.A.     =   0.12500  C.A.     =   0.12500  Excess in noz A2=  2.6537 H= 1.5625
I.D.     =  20.50000  I.D.     =   4.00000  Excess in noz A3=  0.0000 H= 0.0000
O.D.     =  22.00000  O.D.     =   6.00000  Area fillets    =  0.1406
THK.     =   0.75000  THK.     =   1.00000  Area avail.     =  5.1323
T        =   0.62500  TN       =   0.87500  Noz neck weld   =  0.3750 A= 0.1406
TR       =   0.07490  TRN      =   0.02580  Pad weld        =  0.0000 A= 0.0000
ET       =   0.55010  ETN      =   0.84920  Internal weld   =  0.0000 A= 0.0000
LWN  F=1.0000 E1=1.0000  SHELL TOL=0.8750 (Min USED)  NOZ TOL=0.8750 (Nom USED)
MIN STD. WT. PIPE+C.A.=0.33237   TR[using abs(P)]+C.A.=0.13278   CHORD=  4.6240
LIMITS=   8.50000    fr1= 1.0000 fr2= 1.0000 fr3= 0.0000 fr4= 0.0000
Min weld sizes: NS= 0.3536 NP= 0.0000 PS= 0.0000 IF= 0.0000
Area reqd-Area avail =<< -4.97313>>
```


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

DESIGN CONDITIONS		GASKET and BOLTING CALCULATIONS		TABLE	
Design Pres=	790.0 psig	Eff.Gsk OD=	21.6875"	No.Passes=	4
Neg. Pres=	None	Eff.Gsk ID=	20.9375"	N=	0.375"
Design Temp=	285 deg.F	THK= 0.1250"	col.=1	b=	0.188
Flg Matl=SA-266-2or4N	Gsk Matl=SS GMGC			y=	10100psi
Bolt Matl=SA-193B7	Gsk Face=FLAT FACE	w= 0.0000"		m=	4.250

Corr Allow=	0.1250"	Wm2=	194201 #	Am =	16.4378in^2
Flange Desn	Sfo 20000.0 psi	Hp =	129115 #	Ab =	17.4720in^2
Atm.	Sfa 20000.0 psi	H =	281828 #	W =	423872 #
Bolting Desn	Sb 25000.0 psi	Wm1=	410944 #	Wm1=	410944 #
Atm.	Sa 25000.0 psi	Gasket Width Check		Nmin =	0.3230"

CONDITION	LOAD	x	LEVER ARM =	MOMENT	
	HD =	267148 #	hD= 1.96875"	MD=	525948 in#
Operating	HG =	129115 #	hG= 2.15625"	MG=	278405 in#
	HT =	14680 #	hT= 2.29688"	MT=	33718 in#
				Mo=	838072 in#
Gasket Seating	HG =	423872 #	hG= 2.15625"	mo=	913974 in#

Allow.Stress-STRESS CALCULATIONS-Operating		SHAPE CONSTANTS			
1.5 Sfo Long Hub,SH	23080.3 psi	K	= 1.3434	h/ho=	0.3471
Sfo Radial Flg,SR	4103.6 psi	T	= 1.7788	F =	0.8718
Sfo Tang Flg,ST	13546.1 psi	Z	= 3.4855	V =	0.3537
Sfo .5(SH+SR)or.5(SH+ST)	18313.2 psi	Y	= 6.7336	f =	1.0168
J(APP.2-14)= 0.6421		U	= 7.3996	e =	0.2421in^-1

Allow.Stress-STRESS CALCULATIONS-Gsk.Seating		g1/go= 1.5000	d = 29.428In^3
1.5 Sfa Long Hub,SH	25170.6 psi	ho = 3.6012"	
Sfa Radial Flg,SR	4475.2 psi		
Sfa Tang Flg,ST	14772.9 psi		
Sfa .5(SH+SR)or.5(SH+ST)	19971.7 psi		
J(APP.2-14)= 0.6757			

OTHER STRESS FORMULA FACTORS	
t	3.1250"
Alpha	1.7565
Beta	2.0087
Gamma	0.9875
Delta	1.0370
Lambda	2.0245
M	40389 #
m	44046 #

O.D.	27.8750"	THK.		3.3125"	
I.D.	20.5000"	T-Adder		0.0000"	
GO	0.7500"	G1		1.0625"	
HUB O.D.	22.6250"	HUB LEN		1.2500"	
HUB ANG	14.0363deg	RIB LENGTH		35.5938"	
G(MEAN)	21.3125"	G(CALC)		21.3125"	
G(MIN.)	21.1250"	G(MAX.)		23.5000"	
B.C.	25.6250"	B.S.C.F.		1.0000	
No. BOLTS	24	BOLT DIAMETER		1.1250"	
R	1.5000"	E		1.1250"	
BOLT SPAC	3.3447"	TORQUE		462ft#	
MIN. SPAC	2.5000"	TEMA MAX. SPAC		6.1974"	
FLG TURN	0.1875"	FACING		RECESS	
BPRIME	0.0000"	BG1		0.0000"	
FLG RWT	362Lbs	FLG FWT		273Lbs	

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

EXCHANGER TYPE....=	N E U	MATERIAL.....=	SA-266-2or4N
PRESSURE.....=	790.0 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.....=	17.4720 in^2
d.....=	21.3125"	C.....=	0.3000
W.....=	423872 #	Wm1.....=	410944 #
hG (ASME).....=	2.1562"	hG (TEMA).....=	2.1562"
G (TEMA).....=	21.3125"	E (MOD.) x (10)-6..=	28.2 psi
COVER THK SET HOLD=	[NO]		

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

$$THK = d \sqrt{\frac{C\,P}{S\,E} + \frac{1.9\,Wm1\,hG}{S\,E\,d^3}} = 3.0549"$$

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

$$THK = d \sqrt{\frac{1.9\,W\,hG}{S\,E\,d^3}} = 2.0184"$$

[PER TEMA RCB-9.2 FLAT CHANNEL COVER]
MAXIMUM DEFLECTION = 0.0300"
DEFLECTION at 2.7262" THICK = 0.0300"

$$Y = \frac{G}{E\,(3.062)^3}\left|0.0435\,G^3\,P + 0.5\,Sb\,Ab\,hG\right| = 0.0212"$$

[COV THK Min] TEMA Deflection	=	2.7262" +	0.1875" =	2.9137"
[COV THK Min] CODE Operating	=	3.0549" +	0.1875" =	3.2424"
[COV THK Min] CODE Gasket Seating	=	2.0184" +	0.1875" =	2.2059"

ACTUAL COVER THICKNESS USED (SET HOLD[NO])= 3.2500"

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

/// INDIVIDUAL COMPONENTS ///
MAWP CORR. MAIN FLG = 792.0 Limited by: Flange stress.
MAWP CORR. COVER = 792.0

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Input Echo, Tubesheet Number 1, Description: X-7930 TS

Shell Design Pressure	Ps	85.00	psig
Shell Thickness	ts	0.3750	in.
Shell Corrosion Allowance	cas	0.1250	in.
Inside Diameter of Shell	Ds	21.250	in.
Shell Temperature for Internal Pressure	Ts	350.00	F
Shell Material		SA-106 B	

*Note: Using 2 * Yield for Discontinuity Stress Allowable (UG-23(e)), Sps. Make sure that material properties at this temperature are not time-dependent for Material: SA-106 B*

Shell Material UNS Number		K03006	
Shell Allowable Stress at Temperature	Ss	17100.00	psi
Shell Allowable Stress at Ambient		17100.00	psi

Channel Type:		Cylinder	
Channel Design Pressure	Pt	790.00	psig
Channel Thickness	tc	0.7500	in.
Channel Corrosion Allowance	cac	0.1250	in.
Inside Diameter of Channel	Dc	20.500	in.
Channel Design Temperature	TEMPC	285.00	F
Channel Material		SA-516 70N	

*Note: Using 2 * Yield for Discontinuity Stress Allowable (UG-23(e)), Sps. Make sure that material properties at this temperature are not time-dependent for Material: SA-516 70*

Channel Material UNS Number		K02700	
Channel Allowable Stress at Temperature	Sc	20000.00	psi
Channel Allowable Stress at Ambient		20000.00	psi

Number of Tubes Holes	Nt	266	
Tube Wall Thickness	et	0.0830	in.
Tube Outside Diameter	D	0.7500	in.
Total Straight Tube Length	Lt	216.00	in.
Straight Tube Length (bet. inner tubsht faces)	L	213.00	in.
Design Temperature of the Tubes		220.00	F
Tube Material		SA-179	
Tube Material UNS Number		K01200	
Is this a Welded Tube		No	
Tube Material Specification used		Smls. tube	
Tube Allowable Stress at Temperature		13400.00	psi
Tube Allowable Stress At Ambient		13400.00	psi
Tube Yield Stress At Operating Temperature	Syt	23640.00	psi
Tube Pitch (Center to Center Spacing)	P	1.0000	in.
Tube Layout Pattern		Triangular	

Fillet Weld Leg	af	0.1250	in.
Groove Weld Leg	ag	0.1250	in.
Tube-Tubesheet Joint Weld Type		Full Strength	
Method for Tube-Tubesheet Jt. Allow.		UW-20	
Tube-Tubesheet Joint Classification		d	

Radius to Outermost Tube Hole Center	ro	9.525	in.
Largest Center-to-Center Tube Distance	Ul	1.5000	in.
Length of Expanded Portion of Tube	ltx	2.5000	in.
Tube-side pass partition groove depth	hg	0.0000	in.

Tubesheet TYPE: U-tube, Integral both sides, Conf. a

Tubesheet Design Metal Temperature	T	350.00	F
Tubesheet Material Specification		SA-266 2or4N	

*Note: Using 2 * Yield for Discontinuity Stress Allowable (UG-23(e)), Sps. Make sure that material properties at this temperature are not time-dependent for Material: SA-266 2or4N*

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Tubesheet Material UNS Number		K03506	
Tubesheet Allowable Stress at Temperature	S	20000.00	psi
Tubesheet Allowable Stress at Ambient	Tt	20000.00	psi
Thickness of Tubesheet	h	3.0000	in.
Tubesheet Corr. Allowance (Shell side)	Cats	0.1250	in.
Tubesheet Corr. Allowance (Channel side)	Catc	0.1250	in.
Tubesheet Outside Diameter	A	22.000	in.
Area of the Untubed Lanes	AL	74.250	in²
Is Exchanger in Creep range (skip EP, Use 3S for Sps)		NO	

Stress Reduction Option	Perform Elastic-Plastic Calculation		
Perform Differential Pressure Design		NO	
Run Multiple Load Cases		YES	
Shell Side Vacuum Pressure	Pexts	15.0000	psig
Tubesheet Integral with		Both	
Tubesheet Extended as Flange		No	

ASME TubeSheet Results per Part UHX, 2007 A-09

Elasticity/Expansion Material Properties :

Shell - TM-1 Carbon Steels with C<= 0.3%

Elastic Mod. at Design Temperature	350.0 F	0.28100E+08	psi
Elastic Mod. at Ambient Temperature	70.0 F	0.29400E+08	psi

Channel - TM-1 Carbon Steels with C<= 0.3%

Elastic Mod. at Design Temperature	285.0 F	0.28375E+08	psi
Elastic Mod. at Ambient Temperature	70.0 F	0.29400E+08	psi

Tubes - TM-1 Carbon Steels with C<= 0.3%

Elastic Mod. at Tubsht. Design Temp.	350.0 F	0.28100E+08	psi
Elastic Mod. at Ambient Temperature	70.0 F	0.29400E+08	psi

TubeSheet - TM-1 Carbon Steels with C<= 0.3%

Elastic Mod. at Design Temperature	350.0 F	0.28100E+08	psi
Elastic Mod. at Ambient Temperature	70.0 F	0.29400E+08	psi

Tube Required Thickness under Internal Pressure (Tubeside pressure) :

Thickness Due to Internal Pressure:

= (P*(D/2-CAE)) / (S*E+0.4*P) per Appendix 1-1 (a)(1)

= (805.00*(0.7500/2-0.000)/(13400.00*1.00+0.4*805.00)

= 0.0220 + 0.0000 = 0.0220 in.

Tube Required Thickness under External Pressure (Shellside pressure) :

External Pressure Chart	CS-1	at	220.00	F
Elastic Modulus for Material			29000000.00	psi

Results for Max. Allowable External Pressure (Emawp):

TCA	ODCA	SLEN	D/T	L/D	Factor A	B
0.0830	0.75	222.52	9.04	50.0000	0.0134718	13900.00

EMAWP = (2.167/(D/T)-0.0833)*B = 2175.5540 psig

Results for Reqd Thickness for Ext. Pressure (Tca):

TCA	ODCA	SLEN	D/T	L/D	Factor A	B
0.0126	0.75	222.52	59.69	50.0000	0.0003087	4476.86

EMAWP = (4*B)/(3*(D/T)) = (4 *4476.8633)/(3 *59.6889) = 100.0044 psig

Summary of Tube Required Thickness Results:

Total Required Thickness including Corrosion all.	0.0220	in.
Allowable Internal Pressure at Corroded thickness	3253.95	psig
Required Internal Design Pressure	805.00	psig
Allowable External Pressure at Corroded thickness	2175.55	psig
Required External Design Pressure	100.00	

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Detailed Tubesheet Results for load Case 1 corr. (Fvs + Pt)

Results for ASME U-tube Tubesheet Calculations for Configuration a,
Per Edition 2007 A-09, Original Thickness :

Minimum Required Thickness for Shear [HreqS]:
= 1/(4 * Mu) * (Do/(0.8 * S)) * |Ps - Pt| + Cats + Catc
= 1/(4 * 0.250) * (19.80 /(0.8 * 20000.00)) * |-15.00 - 790.00 | + 0.250
= 1.2461 in.

UHX-12.5.1 Step 1:

Compute the Equivalent Outer Tube Limit Circle Diameter [Do]:
= 2 * ro + dt
= 2 * 9.5246 + 0.7500 = 19.799 in.

Determine the Basic Ligament Efficiency for Shear [mu]:
= (p - dt) / p
= (1.000 - 0.750) / 1.000 = 0.250

UHX-12.5.2 Step 2 :

Compute the Ratio [Rhos]:
= Ds / Do (Configurations a, b, c)
= 21.5000 / 19.7992 = 1.0859

Compute the Ratio [Rhoc]:
= Dc / Do (Configurations a, e, f)
= 20.7500 / 19.7992 = 1.0480

Moment on Tubesheet due to Pressures (Ps, Pt) [Mts]:
= Do²/16 * [(Rhos-1)*(Rhos²+1)* Ps - (Rhoc-1) * (Rhoc²+1) * Pt]
= 19.799²/16 * [(1.086 - 1) * (1.086² + 1) * -15.000 -
(1.048 - 1) * (1.048² + 1) * 790.000]
= -2019.1654 psig*in.²

UHX-12.5.3 Step 3, Determination of Effective Elastic Properties :

Compute the Ratio [rho]:
= ltx / h = 2.5000 / 2.7500 = 0.9091 (must be 0 <= rho <= 1)

Compute the Effective Tube Hole Diameter [d*]:
= max(dt - 2tt*(Et/E)(St/S)(rho), dt - 2tt)
= max(0.7500 -2*0.0830 *(.28100E+08/.28100E+08)*
(13400 /20000)*(0.909), 0.7500 -2*0.0830)
= 0.6489 in.

Compute the Effective Tube Pitch [p*]:
= p / sqrt(1 - 4 * min(AL * CNV_factor, 4*Do*p)/(Pi * Do²))
= 1.0000 / sqrt(1 - 4 * min(74.25 *1.000 , 4*19.799 *1.000)
(3.141* 19.799²))
= 1.1480 in.

Compute the Effective Ligament Efficiency for Bending [mu*]:
= (p* - d*) / p* = (1.1480 - 0.6489) / 1.1480 = 0.43474

E*/E and nu* for Triangular pattern from Fig. UHX-11.3.
h/p = 2.750000 ; mu* = 0.434743
E*/E = 0.459088 ; nu* = 0.304726 ; E* = 12900383. psi

Note: As h/p (2.750) is > 2, data values for h/p = 2 were used.

UHX-12.5.4 Step 4:

Compute Shell Coefficient [betaS]:
= ((12 * (1-nus²))^0.25)/((Ds + ts) * ts)½
= ((12 * (1 - 0.30²))^0.25) / ((21.5000 + 0.2500) * 0.2500)½
= 0.7796 1/in.

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Determine Shell Coefficient [ks]:
= betaS * Es * ts³ / (6 * (1 - rnus²))
= 0.780 * .28100E+08 * 0.250³ / (6 * (1 - 0.300²))
= 62688.7617 psig*in.²

Determine Shell Coefficient [Lambdas]:
= (6*Ds*ks)/h³ * (1 + h*betaS + *(h*betaS)²/2)
= 6* 21.500 * 62688.762 /2.750³ * (1 + 2.750 *0.780 + 2.298)
= 2116043.2500 psig

Determine Shell Coefficient [deltaS]:
= Ds²/(4 * Es * Ts) * (1 - nus/2)
= 21.500²/(4 * .28100E+08 * 0.250) * (1 - 0.3 /2)
= 0.0000139827

Calculate Parameter [OmegaS]:
= rhos * ks * betaS * deltaS(1 + h * betaS)
= 1.0859 * 62688.76 * 0.7796 * 0.000014 (1 + 2.7500 * 0.7796)
= 2.3328 in.²

Determine Channel Coefficient [betac]:
= ((12 * (1 - nuc²))^0.25)/((Dc + tc) * tc)^0.5
= ((12 * (1 - 0.30²))^0.25)/((20.7500 + 0.6250) * 0.6250)^0.5
= 0.4974 1/in.

Determine Channel Coefficient [kc]:
= betac * Ec * tc³ / (6 * (1 - rnus²))
= 0.497 * .28375E+08 * 0.625³ / (6 * (1 - 0.300²))
= 631024.0000 psig*in.²

Determine Channel Coefficient [Lambdac]:
= (6*Dc*kc)/h³ * (1 + h*betac + (h*betac)²/2)
= 6*20.750 *631024 /(2.750³) * (1 + 2.750 *0.497 + 0.935)
= 12477578.0000 psig

Determine Channel Coefficient [deltaC]:
= Dc²/(4 * Ec * Tc) * (1 - nuc/2)
= 20.750²/(4 * .28375E+08 * 0.625) * (1 - 0.3 /2)
= 0.0000051592

Calculate Parameter [OmegaC]:
= rhoc * kc * Betac * deltaC(1 + h * betac)
= 1.0480 * 631024 * 0.4974 * 0.000005 (1 + 2.7500 * 0.4974)
= 4.0178 in.²

UHX-12.5.5 Step 5:

Diameter ratio [K]:
= A / Do = 22.0000 / 19.7992 = 1.1112

Determine Coefficient [F]:
= (1 - nu*)/E* * (Lambdas + Lambdac + E * ln(K))
= (1 - 0.30)/.12900E+08 * (.21160E+07 + .12478E+08 +
= .28100E+08 * ln(1.11))
= 0.9462

UHX-12.5.6 Step 6:

Moment Acting on Unperforated Tubesheet Rim [M*]
= Mts + OmegaC * Pt - OmegaS * Ps
= -2019.165 + 16.143 * 790.000 - 5.442 * -15.000
= 1189.8807 psig*in.²

UHX-12.5.7 Step 7:

Maximum Bending Moment acting on Periphery of Tubesheet [Mp]:
= ((M*) - Do²/32 * F * (Ps - Pt)) / (1 + F)
= ((1189.88) - 19.799²/32 * 0.946 * (-15.00 - 790.00)) / (1 + 0.95)
= 5405.7222 psig*in.²

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Maximum Bending Moment acting on Center of Tubesheet [Mo]:
= Mp + Do²/64 * (3 + rnu*)(Ps - Pt)
= 5405.72 + 19.799²/64 * (3 + 0.305)(-15.00 - 790.00)
= -10889.0059 psig*in.²

Maximum Bending Moment acting on Tubesheet [M]:
= Max(|Mp|, |Mo|)
= Max(|5405.722 |, |-10889.006|)
= 10889.0059 psig*in.²

UHX-12.5.8 Results for Step 8:

Tubesheet Bending Stress at Original Thickness:
= 6 * M / ((mu*) * (h - hg')²)
= 6 * 10889.006 / ((0.4347) * (2.7500 - 0.0000)²)
= 19871.9941 psi

The Allowable Tubesheet Bending Stress [SigmaAll]:
= 2 * S = 2 * 20000.00 = 40000.00 psi

Tubesheet Bending Stress at Final Thickness [Sigma]:
= 6 * M / ((mu*) * (h - hg')²
= 6 * 9502.534 / ((0.4436) * (1.7970 - 0.0000)²
= 39807.1680 psi

Required Tubesheet Thickness, for Bending Stress [HreqB]:
= H + CATS + CATC = 1.7970 + 0.1250 + 0.1250 = 2.0470 in.

Required Tubesheet Thickness for Given Loadings (includes CA) [Hreq]:
= Max(HreqB, HreqS) = Max(2.0470 , 1.2461) = 2.0470 in.

UHX-12.5.9 Step 9:

|Ps - Pt| = |-15.00 - 790.00 | = 805.000 psig

Shear Stress check [Tau_limit]:
= 3.2 * S * MU * h / Do
= 3.2 * 20000.00 * 0.250 * 2.750 / 19.80 = 2222.31 psig

Average Shear Stress at the Outer Edge of Perforated Region [Tau]:
= 1/(4* Mu) * (Do/h) * |Ps - Pt|
= 1/(4*0.250)*(19.80/2.75)*|-15.00-790.00|psi
= 5795.77 psi

UHX-12.5.10 Results for Step 10:

Note: For a given Shell thickness of: 0.250 in.
Min. Shell len. adjacent to the tubesheet is: 4.173 in.

Axial Shell Membrane Stress [Sigmasm]:
= Ds² / (4 * ts * (Ds + ts)) * Ps
= 21.5000² / (4 * 0.2500 * (21.5000 + 0.2500)) * -15.000
= -318.793 psi

Axial Shell Bending Stress [Sigmasb]:
= 6*ks/ts² * (betaS * P's + 6*(1 - rnu*) / (E*) *
Do/h³ * (1 + h * betaS/2) * (Mp + Do² / 32 * (Ps - Pt)))
= 6*62688.76 /0.250² * [0.780 *0.00 + 6*(1 - 0.305)/.12900E+08 *
19.799 /2.750³ * (1 + 2.750 * 0.780 /2) *(5405.72 + 19.799²/32 *
(-15.00 - 790.00))]
= -18088.387 psi

Shell Membrane + Bending Stress [Sigmas]:
= |Sigma_sm| + |Sigma_sb| (Should be <= 1.5*Ss)
= 18407.180 psi (Should be <= 25650.00)

Note: For a given Channel thickness of: 0.625 in.
Min. Channel len. adjacent to the tubesheet is: 6.482 in.

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Axial Channel Membrane Stress [Sigmacm]:
= Dc² / (4 * tc * (Dc + tc)) * Pt
= 20.7500² / (4 * 0.6250 * (20.7500 + 0.6250)) * 790.000
= 6365.275 psi

Axial Channel Bending Stress [Sigmacb]:
= 6*kc/tc² * [Betac * (deltaC*Pt) - 6*(1 - nu*) / (E*) *
Do/h³ * (1 + h * Betac/2) * (Mp + Do²/32 * (Ps-Pt))]
= 6*631024 /0.625² * [0.497 * 0.00 - 6*(1 - 0.305)/.12900E+08 *
19.799 /2.750³ * (1 + 2.750 * 0.497 /2) *(5405.72 + 19.799²/32 *
(-15.00 - 790.00))]
= 42035.566 psi

Channel Membrane + Bending Stress [Sigmac]:
= |Sigmacm| + |Sigmacb| (Should be <= 1.5*Sc)
= *48400.840 psi (Should be <= 30000.00)(OK FOR SIMPLY SUPPORTED PER UHX 12.6.3)*

Step 11, The Cylinder-to-Tubesheet Juncture is Overstressed.
Performing a simplified Elastic-Plastic calculation
(option 3) to reduce the overstress condition.
Modify Es and/or Ec and Recompute from Step 4 onwards.

Ec = Ec * (1.5 * Sc / Sigmac)½
= .28375E+08 * (1.5 * 20000.00 / 48400.84)½
Ec = 22339326.0 psi

Tubesheet Bending Stress at Original Thk., after Elas-Plas iteration:
= 6 * M / ((mu*) * (h - h'g)²
= 6 * 11242.491 / ((0.4347) * (2.7500 - 0.0000)²
= 20517.0898 psi (Should be <= 40000.00)

Note: Tubesheet is Not overstressed after Elas-Plastic iteration
the design is acceptable. Recomputing tubesheet required thkickness.

Required Tubesheet Thk., for Bending Stress after Elas-Plas iteration [HreqB]:
= H + CATS + CATC = 1.8421 + 0.1250 + 0.1250 = 2.0921 in.

Required Tubesheet Thk. after Elas-Plas iteration (includes CA) [Hreq]:
= Max(HreqB, HreqS) = Max(2.0921 , 1.2461) = 2.0921 in.

Tube Weld Size Results per UW-20:

Tube Strength [Ft]:
= 3.1415 * t * (do - t) * Sa
= 3.1415 * 0.083 * (0.750 - 0.083) * 13400.00 = 2330.551 lb.

Fillet Weld Strength [Ff]:
= .55 * 3.1415 * af * (do + 0.67*af) * Sw (but not > Ft)
= .55 * 3.1415 * 0.125 * (0.750 + 0.67*0.125) * 13400.00
= 2330.5510 lb.

Groove Weld Strength [Fg]:
= .85 * 3.1415 * ag * (do + 0.67*ag) * Sw (but not > Ft)
= .85 * 3.1415 * 0.125 * (0.750 + 0.67*0.125) * 13400.00
= 2330.5510 lb.

Max. Allow. Tube-Tubesheet Joint load, Lmax
= Ft = 2330.5510 lb.

Design Strength Ratio [fd]:
= 1.0000

Weld Strength Factor [fw]:
= Sot / (Min(Sot, S)) = 1.0000

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Min Weld Length [ar]:
= 2 *(((0.75 * do)² + 1.07*t*(do - t)* fw * fd))½ - .75 * do)
= 0.1008 in.

Minimum Required Fillet Weld Leg afr 0.0504 in.
Minimum Required Groove Weld Leg agr 0.0504 in.

Tube-Tubesheet Jt allowable, 2330.55 is >= tube strength 2330.55 lb.
Note: This tube-tubesheet joint is a Full Strength joint

Stress/Force summary for loadcase 1 corr. (Fvs + Pt):

Stress Description	Actual		Allowable	Pass/Fail
Tubesheet bend. stress	20517.1	<=	40000.0 psi	Ok
Tubesheet shear stress	5795.8	<=	16000.0 psi	Ok
Stress in Shell at Tubesheet	18407.2	<=	25650.0 psi	Ok
Stress in Channel at Tubesheet	48400.8	<=	67560.0 psi	Ok

Thickness results for loadcase 1 corr. (Fvs + Pt):

Thickness (in.)	Required	Actual	P/F
Tubesheet Thickness :	2.0921	3.0000	Ok
Tube-Tubesheet Fillet Weld Leg :	0.0504	0.1250	Ok
Tube-Tubesheet Groove Weld Leg :	0.0504	0.1250	Ok

U-Tube Tubesheet results per ASME UHX-12 2007 A-09
Results for 8 Load Cases:

Case#	--Reqd. Thk. + CA Tbsht	Extnsn	-------- Tubesheet Stresses Bend	Allwd	Shear	Allwd	Case Type	Pass/ Fail	
1uc	1.687	...	15616	40000	5313	16000	Fvs+Pt	Ok	
2uc	0.634	...	2128	40000	660	16000	Ps+Fvt	Ok	3
3uc	1.566	...	13358	40000	4653	16000	Ps+Pt	Ok	
8uc	0.249	...	325	40000	99	16000	Fvs+Fvt	Ok	
1c	2.092	...	20517	40000	5796	16000	Fvs+Pt-Ca	Ok	
2c	0.878	...	2765	40000	720	16000	Ps+Fvt-Ca	Ok	5
3c	1.921	...	17504	40000	5076	16000	Ps+Pt-Ca	Ok	
8c	0.499	...	423	40000	108	16000	Fvs+Fvt-Ca	Ok	
Max:	2.0921	... in.	0.513		0.362	(Str. Ratio)			

Load Case Definitions:
Fvs,Fvt - User-defined Shell-side and Tube-side vacuum pressures or 0.0.
Ps, Pt - Shell-side and Tube-side Design Pressures.
Ca - With or Without Corrosion Allowance.

Shell and Channel Stress Summary:

Case#	-- Integral Cyl. Reqd. Thk. Shell	Channel	Shell Stress	Allwd	Channel Stress	Allwd	Pass Fail	
1uc	...	...	12937	25650	36249	67560	Ok	
2uc	...	...	6811	25650	2851	30000	Ok	
3uc	...	...	7553	25650	33696	67560	Ok	1
8uc	...	...	1163	25650	383	30000	Ok	
1c	...	...	18407	25650	48401	67560	Ok	
2c	...	...	10131	25650	4091	30000	Ok	
3c	...	...	10474	25650	44656	67560	Ok	3
8c	...	...	1732	25650	562	30000	Ok	
Max	...	...	0.718		0.716			

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Summary of Thickness Comparisons for 8 Load Cases:

Thickness (in.)	Required	Actual	P/F
Tubesheet Thickness :	2.0921	3.0000	Ok
Tube Thickness :	0.0220	0.0830	Ok
Tube-Tubesheet Fillet Weld Leg :	0.0504	0.1250	Ok
Tube-Tubesheet Groove Weld Leg :	0.0504	0.1250	Ok

Given Shell Thickness: 0.3750 in.
Given Channel Thickness: 0.7500 in.

Min Shell length of thk, (0.375) adj. to tubesheet: 5.081 in.
Min Channel length of thk, (0.750) adj. to tubesheet: 7.058 in.

Note: This is a full strength Tube to Tubesheet Joint.

Tubesheet MAWP used to Compute Hydrotest Pressure:

Stress / Force Condition	Tubeside (0 shellside) MAWP	Stress Rat.	Shellside (0 tubeside) MAWP	Stress Rat.
Tubesheet Bending Stress	1624.73	1.000	1419.19	1.000
Tubesheet Shear Stress	2222.30	1.000	2222.30	1.000
Shell Stress (Axial, Junc)	2222.30	0.770	527.43	1.000
Tubesheet-Channel Junction	1115.57	1.000	527.43	0.375
Tube Pressure Stress	3253.94	1.000	2175.54	1.000
Minimum MAWP	1115.57		527.43	

Tubesheet MAPnc used to Compute Hydrotest Pressure:

Stress / Force Condition	Tubeside (0 shellside) MAPnc	Stress Rat.	Shellside (0 tubeside) MAPnc	Stress Rat.
Tubesheet Bending Stress	2089.65	1.000	1843.79	1.000
Tubesheet Shear Stress	2424.33	1.000	2424.33	1.000
Shell Stress (Axial, Junc)	2424.33	0.518	897.94	0.995
Tubesheet-Channel Junction	1677.87	1.000	897.94	0.495
Tube Pressure Stress	3253.94	1.000	2175.54	1.000
Minimum MAPnc	1677.87		897.94	

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

$$t = b \sqrt{\frac{q\,B}{1.5\,S}}$$

TUBE SIDE PRESSURE DROP q = 11.00000

FRONT PASS PLATE THK..... = 0.37500
MATERIAL..... = SA-516-70N
STRESS OPER..... = 20000.00
FRONT Chan ID..... = 22.00000
FRONT Chan OAL..... = 0.00000
a..... = 23.56250
b..... = 9.93750
TABLE RCB-9.132..... = Short sides fixed
a/b..... = 2.37107
B..... = 0.75000
t..... = 0.16479

Min fillet leg [both sides] = 3/4t = .75 x 0.16479 = 0.12359

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Energy Exchanger Company

Customer :	SOUTHERN / MISS. POWER CO.	Item No.	HX1027/2027	W.O. :	X-7930
Subject :	Seismic and Wind Loading Factors	Date	6/29/2011	By :	DN/MD

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	
Ss	0.204	g
S1	0.087	g
R (Table 15.4.2)	3	
Fa	1.2	
Fv	1.7	
Sms	0.2448	g
Sm1	0.1479	g
Sds	0.1632	g
Sd1	0.0986	g
Cs = Sds/(R/I)	0.0680	
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	48	sf
ADDITIONAL WEIGHT	316.8	lbs

Input Echo, Horizontal Vessel Item 1, Description: X-7930 SPTS

Design Internal Pressure		85.00	psig
Design Temperature		350.00	F
Corrosion Allowance for Vessel		0.1250	in.
Shell Material		SA-106 B	
Shell Material UNS Number		K03006	
Shell Operating Allowable Stress		17100.00	psi
Shell Ambient Allowable Stress		17100.00	psi
Head Material		SA-516 70	
Head Material UNS Number		K02700	
Head Operating Allowable Stress		20000.00	psi
Head Ambient Allowable Stress		20000.00	psi
Density of Shell and Head Material		0.2830	lb./in³
Density of Stored Liquid		59.7420	lb./ft³
Liquid Height in Vessel		21.5000	in.
NOTE: Liquid Height is not entered, it is being set equal to the vessel ID.			
Extra Weight		6888.490	lb. ← INCLUDES SNOW LOAD
Saddle Reaction Force Factor	ftr	3.00	
Distance from Center of Vessel to Support	B	19.75	in.
Baseplate Length		19.0000	in.
Baseplate Thickness		0.5000	in.
Baseplate Width		6.0000	in.
Number of Ribs (inc. outside ribs)		2	
Rib Thickness		0.5000	in.
Web Thickness		0.5000	in.
Web Location		Side	
Height of Center Web		8.2500	in.
Design Temperature of Base Structure		100.00	F
Saddle\Baseplate\Rib\Web Material		SA-516 70	
Saddle\Baseplate\Rib\Web Material UNS Number		K02700	
Operating Allowable Stress		20000.00	psi
Ambient Allowable Stress		20000.00	psi
Force Coefficient (Shape factor)	Cf	0.800	
Extra Area		0.0000	in²
User defined Wind Pressure on Vessel	Wpre	16.14	psf
Seismic Zone Idenifier, Zone		0 Zone 0	
User Entered Seismic Zone Coefficient		0.0680	
Diameter Basis for Vessel		OD	
Shell Diameter		22.000	in.
Shell Length Tangent to Tangent		19.984	ft.
Thickness of Shell		0.3750	in.
Shell Joint Efficiency		0.8500	
Head Type		Elliptical	
Head Thickness		0.3125	in.
Head Joint Efficiency		0.8500	
Distance from Saddle to Vessel Tangent		29.250	in.
Saddle Width		6.000	in.
Saddle Bearing Angle		120.0000	degrees
Wear Pad Thickness		0.3750	in.
Wear Pad Extension above Horn of Saddle		2.0000	in.
Wear Pad Width		10.000	in.
Stiffening Ring Present		N	

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Results for Horizontal Vessel Number 1, Description: X-7930 SPTS

Vessel Stress Summary

Shell Allowable Stress used in Calculation	17100.00	psi
Shell Compressive Yield used in Calculation	30450.00	psi
Head Allowable Stress used in Calculation	20000.00	psi
Volume of Vessel	51.89	ft.**3
Weight of Vessel, Empty	8717.06	lb.
Weight of Vessel, Full	11816.80	lb.
Shell Thk. + CA, Reqd. vs. Actual	0.190 / 0.375	in.
Head Thk. + CA, Reqd. vs. Actual	0.188 / 0.312	in.
Shell M.A.W.P. , Reqd. vs. Actual	85.00 / 333.37	psig
Head M.A.W.P. , Reqd. vs. Actual	85.00 / 294.29	psig

	Actual	Allowable	
Long. Stress at Top of Saddles	4952.41	14535.00	psi
Long. Stress at Bottom of Saddles	-1331.41	-15118.57	psi
Long. Stress at Top of Midspan	-543.10	-15118.57	psi
Long. Stress at Bottom of Midspan	4164.10	14535.00	psi
Tangential Shear in Shell	2291.70	13680.00	psi
Circ. Stress at Horn of Saddle	-10187.31	-25650.00	psi
Circ. Stress at Tip of Wear Plate	-7370.66	-25650.00	psi
Circ. Compressive Stress in Shell	-892.24	-15225.00	psi

Wind(ASCE #7) and Seismic Results :

Transverse Wind Load Component, Ftw:

```
Ftw = ( AFT * Cf * QZ * Cnv_Fac) * 0.5
Ftw = ( 8276.812 * 1.000 * 16.1440 * 0.00694 )* 0.5
Ftw = 463.961 lb.
```

Longitudinal Wind Load Component, Flw:

```
Flw = ( AFL * QZ * Cnv_fac)
Flw = ( 855.299 * 16.1440 * 0.00694 )
Flw = 95.888 lb.
```

Transverse Earthquake Load Component, Fte:

```
Fte = ( Cs * Wo ) * 0.5
Fte = ( 0.0680 * 11816.80 ) * 0.5
Fte = 401.771 lb.
```

Longitudinal Earthquake Load Component, Fle:

```
Fle = Cs * Wo
Fle = 0.0680 * 11816.80
Fle = 803.543 lb.
```

Saddle Reaction Force due to Transverse Forces, Qr:

```
Qr = ftr * Max( Ftw, Fte ) * B / E
Qr = 3.0 * Max( 463.96 , 401.77 ) * 19.7500 / 19.2691
Qr = 1426.624 lb.
```

Saddle Reaction Force due to Longitudinal forces, Ql:

```
Ql = Max( Flw, Fle, Flf, Flu ) * B / Ls
Ql = Max( 95.89 , 803.54 , 0.00 , 0.00 ) * 19.7500 / 181.3125
Ql = 87.528 lb.
```

Load Combination Results for Q + Wind or Seismic or Friction or User

```
Q = Wo/2 + Max( Qr, Ql )
Q = 5908.40 + Max( 1426.62 , 87.53 )
Q = 7335.026 lb.
```


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Summary of Loads on this Saddle Support:

Vertical Load on this Saddle	7335.03	lb.
Transverse Shear Load on this Saddle	463.96	lb.
Longitudinal Shear Load on this Saddle	803.54	lb.

Formulae and substitutions for ZICK Analysis

Shell and Head Required Thickness and MAWP :

Shell:

Thickness Due to Internal Pressure:

```
= (P*(D/2-CAE)) / (S*E+0.4*P) per Appendix 1-1 (a)(1)
= (85.74*(22.0000/2-0.000)/(17100.00*0.85+0.4*85.74)
= 0.0647 + 0.1250 = 0.1897 in.
```

Max. All. Working Pressure at Given Thickness (MAWP):
Less Operating Hydrostatic Head Pressure of 0.74 psig

```
= (S*E*(T-CA-CAE)) / ((D/2-CAE)-0.4*(T-CA-CAE)) per Appendix 1-1 (a)(1)
= (17100.00*0.85*(0.2500))/(22.0000/2-0.000-0.4*0.2500)
= 333.37 - 0.74 = 332.63 psig
```

Maximum Allowable Pressure, New and Cold (MAPNC):

```
= (SA*E*T) / (D/2-0.4*T) per Appendix 1-1 (a)(1)
= (17100.00*0.85*0.3750)/(22.0000/2-0.4*0.3750)
= 502.36 psig
```

Actual stress at given pressure and thickness (Sact):

```
= (P*((D/2-CAE)-0.4*(T-CA-CAE))) / (E*(T-CA-CAE))
= (85.74*(((22.0000/2-0.000)-0.4*(0.2500)))/(0.85*(0.2500))
= 4398.13 psi
```

Elliptical Head:

Thickness Due to Internal Pressure:

```
= (P*(D-2.0*CAE)*K) / (2*S*E+2*P*(K-0.1)) per Appendix 1-4 (c)
= (85.74*(22.0000-2*0.000)*1.00)/(2*20000.00*0.85+2*85.74*(1.00-0.1))
= 0.0552 + 0.1250 = 0.1802 in.
= 0.0625 in. ( Per Ug 16b )
```

Max. All. Working Pressure at Given Thickness (MAWP):
Less Operating Hydrostatic Head Pressure of 0.74 psig

```
= (2*S*E*(T-CA-CAE)) / (K*(D-2*CAE)-2*(T-CA-CAE)*(K-0.1)) per Appendix 1-4(c)
= (2*20000.00*0.85*(0.1875))/(1.00*22.0000-2*(0.1875)*(1.00-0.1))
= 294.29 - 0.74 = 293.54 psig
```

Maximum Allowable Pressure, New and Cold (MAPNC):

```
= (2*SA*E*T) / (K*D-2*T*(K-0.1)) per Appendix 1-4 (c)
= (2*20000.00*0.85*0.3125)/(1.00*22.0000-2*0.3125*(1.00-0.1))
= 495.63 psig
```

Actual stress at given pressure and thickness (Sact):

```
= (P*(K*(D-2*CAE)-2*(T-CA-CAE)*(K-0.1))) / (2*E*(T-CA-CAE))
= (85.74*(1.00*22.0000-2*(0.1875)*(1.00-0.1)))/(2*0.85*(0.1875))
= 5827.18 psi
```

Longitudinal Bending (+-) at Midspan

```
= ( 3 * Q * L * K.2 / ( PI * R^2 * ( T - CA )))
= ( 3 * 7335 * 19.98 * 0.4858 ) /
  ( PI * 10.7500 * 10.7500 * ( 0.3750 - 0.1250 )))
= 2353.60 psi
```

Compute the area ratio [K]:

```
= Pi * (Sin(Delta)/Delta - Cos(Delta) ) / (Delta + Sin(Delta) * Cos(Delta) -
  (Delta + Sin(Delta) * Cos(Delta) - 2 * Sin(Delta) * Sin(Delta)/Delta)
= Pi * (Sin(1.396 ) / 1.396 - Cos(1.396 )) / ( 1.396 + Sin(1.396 ) *
  Cos(1.396 ) - 2 * Sin(1.396 ) * Sin(1.396 )/ 1.396 )
= 9.3799
```


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Compute the moment fraction [X]:

```
= (1 - (1 - A/L + ( R² - H² )/(2 * A*L ) )/(1 + (4*H )/( 3 * L ) ) )
= (1 - (1 - 2.438 /19.984 + (0.896² - 0.452²)/( 2 * 2.438 * 19.984 ) ) /
  (1 + (4 * 0.452 )/(3 * 19.984 ) ) )
= 0.1417
```

Intermediate Product [K.1]:

```
= K * X  * 4 * A / L
= 9.380 * 0.142 * 4 * 2.438 / 19.984 = 0.6485
```

Longitudinal Bending (+-) at Saddle

```
= ( 3 * Q * L * K.1 / ( PI * R^2 * ( T - CA )))
= ( 3 * 7335 * 19.98 * 0.6485 ) /
  ( PI * 10.7500 * 10.7500 * ( 0.3750 - 0.1250 )))
= 3141.91 psi
```

Longitudinal Pressure Stress

```
= DP*((SID/2+CA)-0.4*(T-CA))/(2.0*(T-CA))
= 85.0 * (( 21.25 / 2 + 0.1250 - 0.4 * ( 0.375 - 0.1250 )) /
  ( 2.0 * ( 0.375 - 0.1250 ))
= 1810.50 psi
```

Note: The Longitudinal Stress from Zick Analysis is combined with the Longitudinal Pressure Stress to get the total stress.

Tangential Shear in Shell near Saddle

```
= Q * K.4 * (( L-H-2A )/( L+H ))/( R*(T-CA))
= 7335 * 1.1707 * (( 19.98 - 0.45 - 2 * 2.44 )/
  ( 19.98 + 0.45 ))/( 10.7500 * ( 0.3750 - 0.1250 ))
= 2291.70 psi
```

Circumferential Stress at Tip of the Wear Plate (L >= 8R)

```
= -Q/(4*(T-CA)*(SADWTH+1.56*SQRT(R*(T-CA))))-3.0*Q*K13/
   (2*(T-CA)^2)
= -7335 /( 4 * 0.2500 * (6.00 + 1.56*SQRT(10.7500 *0.2500 )))
  -3 * 7335 * 0.0370 / ( 2 * 0.2500 ^2 )
= -7370.66 psi
```

Note: Wear Plate thk. could Not be considered in this formula because,

Saddle-Tangent Distance A (29.2) is > R/2 (5.4 in.)

Circumferential Stress at Horn of Saddle (L >= 8R)

```
= -Q /(4*TEM*(SADWTH+1.56*SQRT(R*(T-CA))))-3.0*Q*K.7/(2*TEB)
= -7335 /( 4 * 0.2500 * (6.00 + 1.56*SQRT(10.7500 *0.2500 )))
  -3 * 7335 * 0.0530 / ( 2 * 0.0625 )
= -10187.31 psi
```

Circumferential Compression at Bottom of Shell

```
= (Q*( K.9/( TEM9 * WPDWTH ) ) )
= ( 7335 *( 0.7603 /( 0.6250 * 10.000 ) ) )
= -892.24 psi
```


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RESULTS for VESSEL RIBS, WEB and BASE

Moment of Inertia of Saddle - Lateral Direction

	Y	A	AY	Ay^2	Io
Shell	0.1250	3.1394	0.3924	0.0491	0.0164
Wearplate	0.4375	3.7500	1.6406	0.7178	0.0439
Web	4.1875	3.5625	14.9180	62.4690	15.0710
BasePlate	8.0000	3.0000	24.0000	192.0000	0.0625
Totals	12.7500	13.4518	40.9510	255.2358	15.1938

Value C1 = Sumof(Ay)/Sumof(A) = 3.0443 in.
Value I = Sumof(Ay²) + Sumof(Io) - C1*Sumof(Ay) = 145.7639 in**4
Value As = Sumof(A) - Ashell = 10.3125 in²

K1 = (1+Cos(b)-.5*Sin(b)^2)/(pi-b+Sin(b)*Cos(b)) = 0.2035

Fh = K1 * Q = 0.2035 * 7335.026 = 1492.837 lb.

Tension Str., St = (Fh/As) = 144.7600 psi
Allowed Str., Sa = .6 * Yield Stress = 22800.0000 psi

d = B - R*Sin(theta) / theta = 10.1098 in.
Bending Moment, M = Fh * d = 1257.6931 ft.lb.

Bending Stress, Sbnd = (M * C1 / I) = 315.2018 psi
Allowed Str., Sa = .66 * Yield Str. = 25080.0020 psi

Minimum Thickness of Baseplate

= (3 * Q * BasePlateWidth / (2 * BasePlateLength * AllStress))½
= (3 * 7335 * 6.00 / (2 * 19.000 * 25080.002))½
= 0.372 in.

Calculation of Axial Load, Intermediate Values and Compressive Stress:

Effective Baseplate Length (e)
= (Bplen - Clearance) / (Nribs - 1)
= (19.0000 - 1.0) / (2 - 1) = 18.0000 in.

Baseplate Pressure Area (Ap)
= e * Bpwid / 2
= 18.0000 * 6.0000 / 2 = 54.0000 in²

Axial Load (P)
= Ap * Bp
= 54.00 * 64.34 = 3474.49 lb.

Area of the Rib and Web (Ar)
= (Bpwid - Clearance - Webtk) * Ribtk + e/2 * Webtk
= (6.000 - 1.0 - 0.500) * 0.500 + 18.0000 /2 * 0.500
= 6.750 in²

Compressive Stress (Sc)
= P/Ar
= 3474.49 / 6.7500 = 514.7387 psi

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Check of Outside Ribs

Inertia of Saddle, Outer Ribs - Axial Direction

	Y	A	AY	Ay^2	Io
Rib	2.7500	2.5000	6.8750	6.4573	6.9323
Web	0.2500	4.5000	1.1250	3.5874	0.1875
Values	1.1429	7.0000	8.0000	10.0446	7.1198

KL/R < Cc (8.4659 < 123.2882) per AISC E2-1 9th Edition

$Sca = (1-(Klr)^2/(2*Cc^2))*Fy/(5/3+3*(Klr)/(8*Cc)-(Klr^3)/(8*Cc^3)$

$Sca = (1-(8.47)^2/(2 * 123.29^2)) * 38000 /$
$(5/3+3*(8.47)/(8* 123.29)-(8.47^3)/(8*123.29^3)$

Sca = 22400.70 psi

AISC Unity Check on Outside Ribs (must be <= 1.0)

Check = Sc/Sca + (Rm/Z)/Sba

Check = 514.74 / 22400.70 + (2569.22 /4.450) / 25080.00

Check = 0.05

PV Elite is a registered trademark of Intergraph Corporation [2010]

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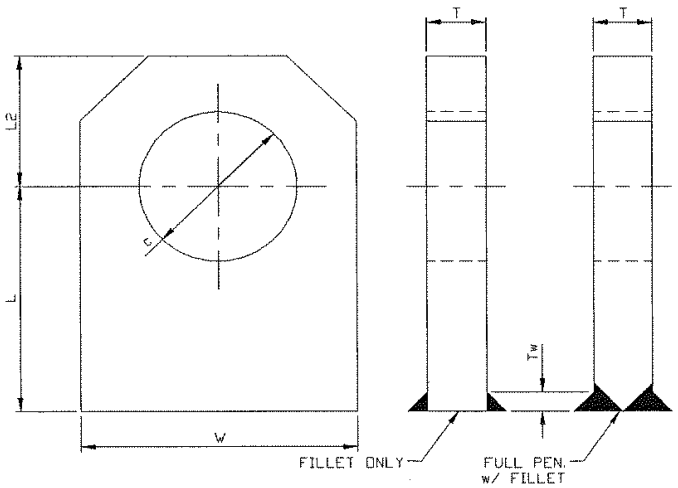
Energy Exchanger Company

Customer :	MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES	Item No	HX1027/2027	W.O. :	X-7930
Subject :	LIFTING LUG CALCULATION	Date	2/16/2011	By :	DN/MD

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=	4 1/4 in
L =	4 3/4 in
L2=	2 1/8 in
OAL =	6 7/8 in
C=	2 in
Analysis Type	Full Pen w/ Fillet (1)
Impact Factor	1.500
Occasional Load Factor	1.125
Heaviest Lug Load	600 #
	(CHANNEL COVER)
Weld Group Area (Aw)	3.182 in^2
Weld Group Inertia (Iw)	5.321 in^4
Shear Area (As)	0.563 in^2
Lug Inertia (I)	3.199 in^4



Allowable Loading

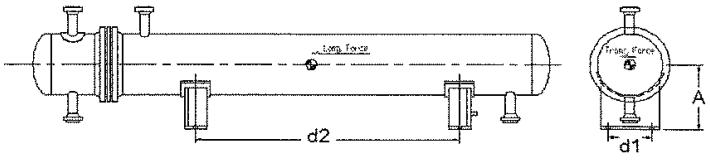
Shear Stress	17100 psi
0.4 * Yield * Occ Factor	
Bearing Stress	32062.5 psi
MIN(0.75*Yield*Occ Factor, 0.9*Yield)	
Combined	28215 psi
MIN(.66*Yield*Occ Factor, 0.75*Yield)	

Calculated Loads

Primary Shear in Welds	282.89 psi
Load*Impact/(Aw)	
Bending Shear Stress in Welds	401.72 psi
Load*Impact*(W+2*Tw)/2/(Iw)	
Total Combined Shear	684.60 psi
Shear in Lug Above Hole	1066.67 psi
Load*Impact/(As)	
Pin Hole Bearing Stress	900.00 psi
Load*Impact/(T*C)	
Bending Stress @ Lug Base	2840.14 psi
Load*Impact*L/(W^2*T/6)	
Tensile @ Lug Base	423.53 psi
Load*Impact/(W*T)	
Total Combined Stress @ lug Base	3263.67 psi

Energy Exchanger Company

Customer :	MISSISSIPPI POWER c/o SOUTHERN COMPANY SERVICES	Item Nc	HX1027/2027	W.O. :	X-7930
Subject :	ANCHOR BOLTING CALC	Date	4/7/2011	By :	DN/MD



Static Balance

Near Saddle Ref Dimension:	40 in	Number of Bolts (Fixed only)*	2
Far Saddle Ref Dimension:	196 in	Bolt Diam.	1 in
COG Ref Dimension:	94 in	Bolt Area (Ab)	0.551 in^2
Weight	11500 lb	Bolting Material	F1554 (Gr 36)
Dim A	19.75 in	Allowable Stress Shear	11800 psi
Dim d1	15 in	Allowable Stress Tension	11800 psi
Dim d2	156 in		
Reaction Forces		Greatest Transverse Load (Ft)	464 lb
Near Saddle (Rfn)	7519 lb	Greatest Longitudinal Load (Fl)	804 lb
Far Saddle (Rff)	3981 lb		
Rf = 0 or Rff if COG outside saddles	0 lb		
Transverse Shear Calculation:		* Longitudinal shear foces countered by bolting	
Ss = Ft/(total bolts*bolt area) =	211 psi	in stationary support only.	
		transverse forces counter by full bolting	
Longitudinal Shear Calculation:		(fixed support bolts * 2)	
Sl = Fl/(fixed bolts*bolt area) =	730 psi		
		All calcualted stresses are less than allowable	
Transverse Overturning Moment Calc		Anchor bolting design is accebtale.	
Stm = (48*(Ft*A/12)/(d1*total bolts)-(Weight/total bolts))/Ab			
Stm =	-4109 psi		
		CALCULATION IS FOR SIZING OF SUPPORT	
Longitudinal Overturning Moment Calc		**HOLES & SLOTS. THIS CALCULATION DOES**	
Slm = (48*(Fl*A/12)/(d2*total bolts)-(Weight/total bolts))/Ab		**NOT REPLACE OR RELIEVE THE**	
Slm =	-5033 psi	**CIVIL/STRUCTURAL ENGINEERING DESIGN**	
		FOR THE PARTY SUPPLYING ANCHOR BOLTS	

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, DEKALB MS. (Name and address)
4. Type: HORIZ. (Horiz., vert., or sphere) | HEAT EXCHANGER (Tank, separator, kd. vessel, heat exh., etc.) | X-7930 A (Mfg's serial No.)
   N/A (CRN) | X-7930-A REV. 5 (Drawing No.) | 6044 (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.): 19'-8 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	22" O.D.	19'-8 13/16"	SA-106B	3/8"	1/8"	S	NONE	0.85	1 *(1)*	SPOT	0.85	N/A	N/A

7. Heads: (a) SA-516-70 (Mat'l Spec. No., Grade or Type) (H.T. - Time & Temp.) (b) NA (Mat'l Spec. No., Grade or Type) (H.T. - Time & Temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)	END	5/16"	1/8"			2:1					X	S	NONE	0.85
(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 215 (internal) 15 (external) psi at max. temp. 350 (internal) 350 (external) °F Min. design metal temp. 10 °F at 215 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. 280 P.S.I.G. Proof test NA

Items 12 and 13 to be completed for tube sections.

12. Tubesheet: SA-266-4N [Stationary (Mat'l Spec. No.)] | 22" [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" THK (MIN) (Nom. thk., in. or gauge) | 133 (Number) | "U" [Type (Strait or U)]

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

14. Shell (a) No. of course(s): 1 (b) Overall length (ft & in.): 1'-7 7/16"

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	20 1/2" I.D.	1'-7 7/16"	SA-516-70N	3/4"	1/8"	1	SPOT	0.85	1 *(1)*	SPOT	0.85	1150° F.	1-HR.

15. Heads: (a) SA-266-4N (Mat'l Spec. No., Grade or Type) (H.T. - Time & Temp.) (b) NA (Mat'l Spec. No., Grade or Type) (H.T. - Time & Temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)	END	3 1/4"	3/16"						21 5/16"					
(b)														

If removable, bolts used (describe other fastening) a) SA-193B7 ; 1 1/8" DIA; 24 (Mat'l Spec. No., Grade, size, No.)

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FORM U-1 (Back)

16. MAWP 792 (internal) NA (external) psi at max. temp. 285 (internal) NA (external) °F Min. design metal temp. 10 °F at 792 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. 1030 P.S.I.G. 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	6"-150#	RF-WN	SA-106B	SA-105	0.4320"	1/8"	SA-516-70	WELDED	WELDED	SHELL
OUTLET	1	2"-150#	RF-LWN	SA-105	—	0.5300"	1/8"	WELD	WELDED	—	SHELL
INLET	1	4"-600#	RF-LWN	SA-105N	—	1.0000"	1/8"	WELD	WELDED	—	CHANNEL
OUTLET	1	4"-600#	RF-LWN	SA-105N	—	1.0000"	1/8"	WELD	WELDED	—	CHANNEL
VENT	1	2"-600#	RF-LWN	SA-105N	—	0.6600"	1/8"	WELD	WELDED	—	CHANNEL
DRAIN	1	2"-600#	RF-LWN	SA-105N	—	0.6600"	1/8"	WELD	WELDED	—	CHANNEL

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: PROCESS CONDENSATE TRIM COOLER; P.O. NO: 17496-0001; ITEM NO.: HX1027
SIZE:20-216, TYPE:NEU, TUBES DESIGNED W/ 0" C.A., SAFETY RELIEF DEVICES BY OTHERS
LINES 14-18 INCLUDES (1) 27 7/8" O.D. X 20 1/2" I.D. X 4 9/16" THK., SA-266-4N RING
(1) Tubesheet to cylinder circumferential seams are Type 7 joints w/efficiency of 1.0

CERTIFICATE OF SHOP COMPLIANCE

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

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

Date 6-22-12 Name ENERGY EXCHANGER COMPANY (Manufacturer) Signed Mark Wells (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 6.22.2012, 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 6.22.12 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.)

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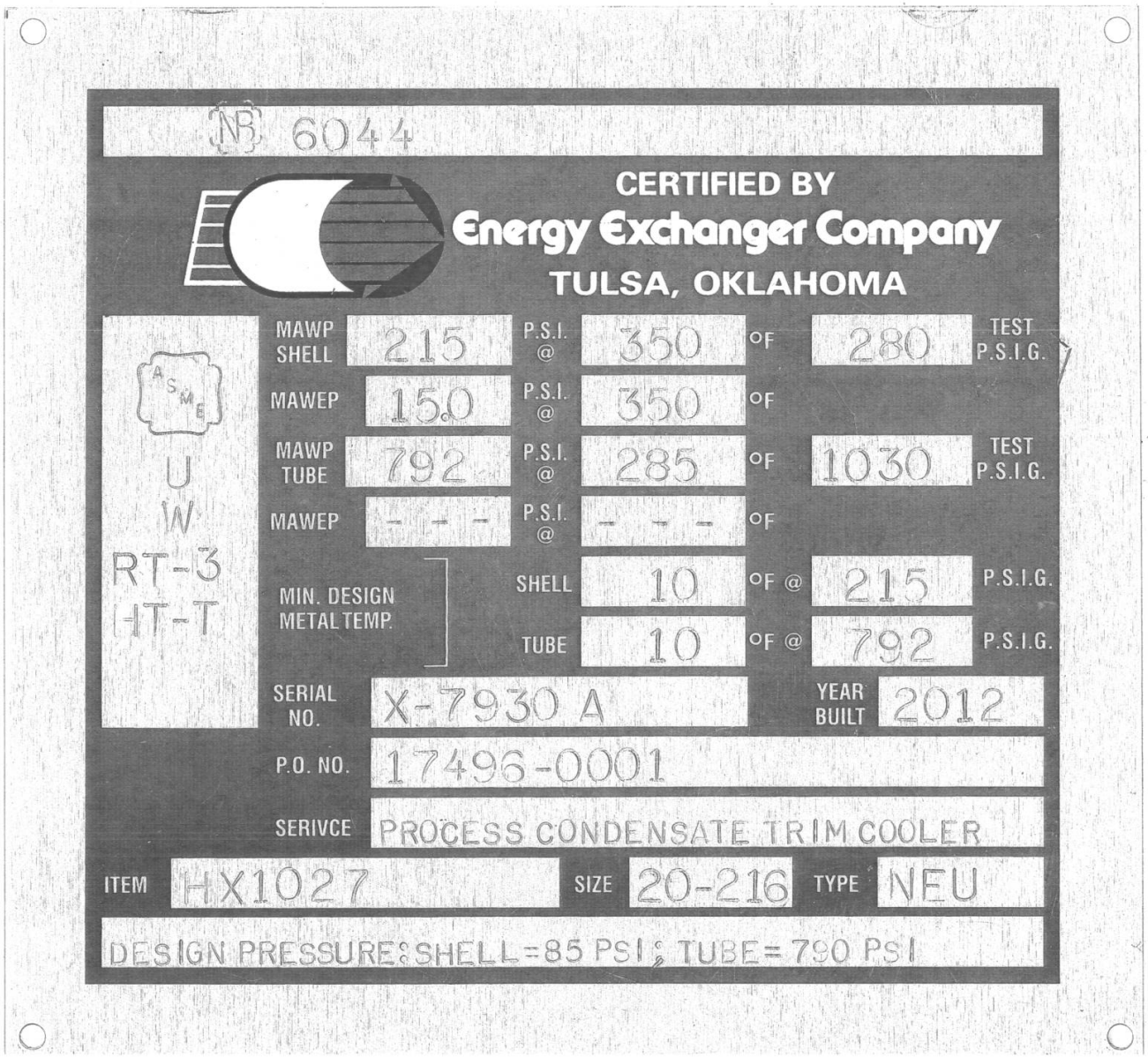
NB 6044
CERTIFIED BY
Energy Exchanger Company
TULSA, OKLAHOMA
ASME
U
W
RT-3
HT-T
MAWP SHELL 215 P.S.I. @ 350 °F 280 TEST P.S.I.G.
MAWEP 150 P.S.I. @ 350 °F
MAWP TUBE 792 P.S.I. @ 285 °F 1030 TEST P.S.I.G.
MAWEP - - - P.S.I. @ - - - °F
MIN. DESIGN METAL TEMP.
SHELL 10 °F @ 215 P.S.I.G.
TUBE 10 °F @ 792 P.S.I.G.
SERIAL NO. X-7930 A
YEAR BUILT 2012
P.O. NO. 17496-0001
SERIVCE PROCESS CONDENSATE TRIM COOLER
ITEM HX1027
SIZE 20-216
TYPE NEU
DESIGN PRESSURE: SHELL=85 PSI; TUBE=780 PSI

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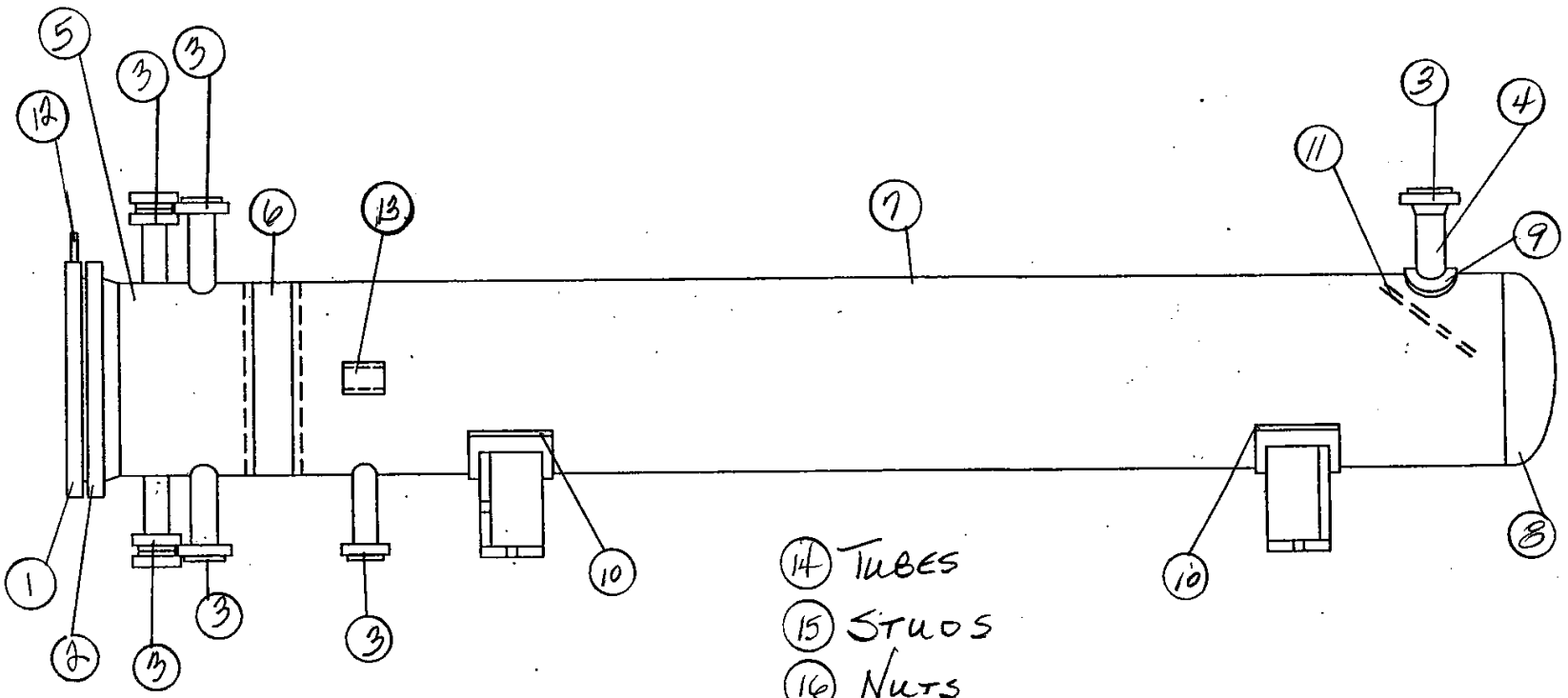
SECTION 4



(14) TUBES
(15) STUDS
(16) NUTS
(17) PASS PLATES

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

X-7930 A+B

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ENERGY EXCHANGER COMPANY
MATERIAL HEAT NUMBER INDEX

Project: Kemper County 1 - IGCC

CUSTOMER:	**Southern Co. (for) Mississippi Power Company**	**ITEM NO:**	**HX1027/HX2027**	**PAGE:**	**1 of 2**
DESTINATION:	**DeKalb, Mississippi**	**SERVICE:**	**Process Condensate Trim Heater**	**DATE:**	**June 12, 2012**
P.O. No:	**17496-0001**	**DESCRIPTION:**	**2-20" x 216" NEU Exchangers**	**JOB NO:**	**X-7930 A/B**
Req. No:	MC202				

PART NO.	HEAT NO.	SLAB NO.	STEEL PRODUCER	GRADE	DESCRIPTION	PCS	SIZE
1	227N568		Arcelormittal	SA-266-4N	**(#1 Channel Cover)**	2	27 7/8" OD x 3 1/4" thk.
2	110786		Nucor	SA-266-4N	**(#2 Channel Flange)**	2	27 7/8" OD x 20 1/2" ID x 4 9/16" thk.
3	B847		FCI	SA-105-N	**(Nozzle Flange T-1 & 2)**	4	4" 600# RF LWN x 13" lg.
3	C855AN		FVC	SA-105-N	**(Nozzle Flange V-1 & D-1)**	4	2" 600# RF LWN 12" lg.
3	3021551		Galperti	SA-105-N	**(Nozzle Flange V-1 & D-1)**	4	2" 600# RF Blind
3	JFS		Coffer	SA-105	**(Nozzle Flange S-1)**	2	6" 150# RF WN Sch X-Hvy. Bore
3	G136		FCI	SA-105	**(Nozzle Flange S-2)**	2	2" 150# RF LWN x 10" lg.
4	X22424		U.S.S.	SA-106-B	**(Nozzle Pipe S-1)**	2	6" Sch X-Hvy. X 7" lg.
5	R4137	11B	ArcelorMittal	SA-516-70N	**(Channel Cylinder)**	2	20 1/2" ID x 3/4" thk. x 1'-7 7/16" lg.
6	227N568		ArcelorMittal	SA-266-4N	**(#4 Tubesheet)**	2	22" OD x 3" thk.
7	MA2051		U.S.S.	SA-106-B	**(Shell Cylinder)**	2	22" OD x 3/8" thk. x 19'-8 13/16" lg.
8	AWDL W0I628	F12	SSAB	SA-516-70	**(Shell Head) Unit B**	1	22" OD x 5/16" (min) thk. 2:1 Ellip.w/2" S.F.
8	AWGD 811P02140	H066332	ArcelorMittal	SA-516-70	**(Shell Head) Unit A**	1	22" OD x 5/16" (min) thk. 2:1 Ellip. w/2" S.F.

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

ENERGY EXCHANGER COMPANY

By: Regina Patterson

Reviewed / Accepted
I.Q.S. # 3
William Brenaugh

MM187157

ENERGY EXCHANGER COMPANY
MATERIAL HEAT NUMBER INDEX

Project: Kemper County 1 - IGCC

CUSTOMER:	**Southern Co. (for) Mississippi Power Company**	**ITEM NO:**	**HX1027/HX2027**	**PAGE:**	**2 of 2**
DESTINATION:	**DeKalb, Mississippi**	**SERVICE:**	**Process Condensate Trim Heater**	**DATE:**	**June 12, 2012**
P.O. No:	**17496-0001**	**DESCRIPTION:**	**2-20" x 216" NEU Exchangers**	**JOB NO:**	**X-7930 A/B**
Req. No:	MC202				

PART NO.	HEAT NO.*	SLAB NO.	STEEL PRODUCER	GRADE	DESCRIPTION	POS.	SIZE
9	1502456	03	Nucor	SA-516-70	**(Shell Weld Pads)**	2	9 3/4" OD x 3/8" thk.
10	1502456	03	Nucor	SA-516-70	**(Support Pads)**	2	10" x 3/8" thk. x 26 1/2" lg.
11	1502456	03	Nucor	SA-516-70	**(Deflector Plate)**	2	7 1/8" x 3/8" thk. x 19 3/4" lg.
12	B1T7537	03	Nucor	SA-516-70	**(Lifting Lugs)**	2	3 1/2" x 1/2" thk. x 6 7/8" lg.
13	W0H543	24	SSAB	SA-516-70	**(Name Plate Brackets)**	2	7 1/2" x 3/16" thk. x 22" lg.
14	181069		Benteler	SA-179	**(Tubes)**	238	3/4" OD x .083" (min) x V/L
14	548853		Benteler	SA-179	**(Tubes)**	34	3/4" OD x .083" (min) x V/L
15	108465		Vulcan Thrd. Prod.	SA-193-B7	**(Studs)**	48	1 1/8" (8 Thd) x 9 1/8" lg.
16	MR851		Unytite	SA-194-2H	**(Nuts)**	96	1 1/8" (8 Thd)
17	821T00580	J031960	ArcelorMittal	SA-516-70	**(Pass Plates)**	2	9 15/16" x 3/8" thk. x 24"lg.
17	821T00580	J031960	ArcelorMittal	SA-516-70	**(Pass Plates)**	2	20 3/8" x 3/8" thk. x 24" lg.

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

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 6/26/12

ENERGY EXCHANGER COMPANY

By: Lynda Patterson

Reviewed / Accepted
I.Q.S. # 3
William Brenaugh

MM187157

OKLAHOMA FORGE, INC.

Certification of Analysis and Tests

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

ENERGY EXCHANGER COMPANY 1844 N. GARNETT ROAD TULSA, OK 74116 USA	1199 JIM ELDER 5/17/2011	111-51903 DELIVERY 6/20/2011

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

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 — **2**
ARCELOMITTAL 227N568 SA266-10 GR4 NORMALIZED — Part #1

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 — **2**
NUCOR 110786 SA266-10 GR4 NORMALIZED — Part #2

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 — **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:

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

VERIFIED BY
JUN 27 2011

INSPECTION DEPARTMENT 1
REVIEWED
WITNESSED ☐ DATE: 6/28/11

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.

EEC QC 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

MM187157

 1221

FCI FORGED COMPONENTS INC.

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

REPORT NUMBER 50080
DATE 6/20/2011
FCI ORDER NUMBER 52462
Processed I.A.W. EN10204 3.1

Part #3

CUSTOMER ORDER NUMBER 56074-12
SOLD/SHIPPED TO PROGRESSIVE SUPPLY
P.O. BOX 470748
TULSA OK 74147 USA

Noz. T1+T2

Item	Quantity	Description
1	4	4" X 600 X 14" LG RF LWN

X-7430-81 & 82

HEAT NUMBER: B847
MATERIAL TYPE: SA105N ✓
Material Origin: USA ✓ **Manufactured in** USA ✓
I.A.W. ASME 2010 ED.

CHEMICAL ANALYSIS

C	.210 ✓
Mn	1.230 ✓
P	.0090 ✓
S	.0130 ✓
Si	.230 ✓
Cr	.080 ✓
Mo	.030 ✓
V	.050 ✓
Cu	.160 ✓
Ni	.060 ✓
Cb	.002
Al	.024
C E	.46

PHYSICAL PROPERTIES

Yield PSI	55,700 ✓
Tensile PSI	79,600 ✓
Elongation	30 ✓
Reduction of Area	67 ✓
Hardness	163 HBW ✓

VERIFIED BY
JUL 11 2011
EEC QC DEPT

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

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 6/20/12

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: Helen Fielder

Name: Helen Fielder Title: QA Representative

Reviewed / Accepted
Reviewed / Accepted
I.Q.S. # 3
William Brenaugh

Date printed: 6/20/2011 12:14:35 PM

MM187157

Part #3

This MTR applies to your PO# 1221

Material Test Report

Heat Code: C855AN

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: 57063-12	Sales Order: 97178	Line: 1
Attn: Accounts Payable	Item Code: lwn020600120a002a1	Qty Shipped: 10	
P.O. Box 470748	Item Desc: LWN,SA105N, 600#, 2 x 12",RF&D		
Tulsa, OK 74147	Supplier: STEEL DYNAMICS INC	Supplier Heat: A110108	

Spec: ASME SA105N, 2007 Edition, 2009 Addenda

Element	(%wt)	Ladle	Product	EPCRA	CAS#	Element	(%wt)	Ladle	Product	EPCRA	CAS#
C	Carbon	0.19				Cb	Columbium	0.000			
Mn	Manganese	1.13			7439-96-5	Sn	Tin	0.009			
P	Phosphorous	0.008				Al	Aluminum	0.031			
S	Sulphur	0.003				N	Nitrogen	0.0058			
Si	Silicon	0.24				As	Arsenic	0.004			7440-38-2
Cu	Copper	0.18			7440-50-8	Sb	Antimony	0.002			7440-36-0
Ni	Nickel	0.08			7440-02-0	CE	C+Mn/6+(Cr+Mo+V)/5	0.43			
Cr	Chromium	0.13			7440-47-3	Cu+Ni+Cr+Mo		0.42			
Mo	Molybdenum	0.03				Cr+Mo		0.11			
V	Vanadium	0.03									

Mechanical Testing		Other	
HBW	149	Country of Origin	USA
Elg (%)	32.0	Manufactured In	USA
RA (%)	68.0	Production Method	EAF
Tensile (ksi)	77.687	EF	YES
Yield (ksi)	44.811	VD	YES
Charpy Temp (F)		Fully Killed	YES
		Reduction Ratio (Mill) x:1	14.9:1
Heat Treat		Made to Fine Grain Practice	YES
Heat Treatment	NORMALIZED		

VERIFIED BY
AUG 05 2011
EEC QC DEPT
L. Patterson

Noz. V1+D1
X-7930-83+84

NACE MR0175 & MR0103 LATEST EDITION. CE=C+(Mn/6)+((Cr+Mo+V)/5)+((Ni+Cu)/15), Elongation in 2" round specimen.
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

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 8/26/11

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.: 1006739
Certification Date: 7/29/2011
Issued By: Stephanie Kobs

This report is issued in compliance with the requirements of EN10204 3.1 / ISO 10474 3.1.b

Puneet Saggar - Plant Metallurgist

Reviewed / Accepted
I.Q.S. # 3
William Brenaugh WB

MM187157

Part #3

GALPERTI, INC.
160 Southbelt Industrial Drive
Houston, Texas 77047
PH. 713-433-0700 – FAX 713-433-5680
Email: galpmail@galperti-am.com

TEST/CERTIFICATE: 3.1B | EN 10204 | INTERNAL JOB: 111106

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
002929/B	04/01/2011	119520 X-7930-83D + 84D	03/25/2011

ITEM	DESCRIPTION	QUANTITY	B/P	MATERIAL	HEAT N°		#
037/037	3" 150 BL RF A105 B1 F	25	B	ASTM A/SA105 03c	3021550		A
040/040	4" 300 BL RF A105 B1 F	20	B	ASTM A/SA105 03c	3019786		B
041/041	6" 300 BL RF A105 B1 F	20	B	ASTM A/SA105 03c	101952N/02		C
042/042	2" 600 BL RF A105 B1 F	258	A	ASTM A/SA105 03c	3021551		D

Noz. V1+D1

CHEMICAL ANALYSIS

#		C %	MN %	SI %	P %	S %	CR %	NI %	MO %	CU %	V %	SN %	AL %	NB %	TI %	N %	CB%	FL%
A		0.200	1.070	0.250	0.009	0.016	0.070	0.080	0.020	0.210	0.002			0.001			0.001	0.41
A	C	0.190	1.090	0.270	0.012	0.019	0.080	0.090	0.010	0.220	0.002			0.001			0.001	0.41
B		0.190	1.030	0.240	0.005	0.015	0.050	0.090	0.025	0.180	0.002		0.002	0.001			0.001	
B	C	0.180	1.050	0.220	0.002	0.014	0.040	0.100	0.035	0.190	0.002		0.005	0.001			0.001	
C		0.180	1.180	0.190	0.010	0.004	0.100	0.090	0.030	0.200	0.017		0.026	0.002			0.002	0.42
C	C	0.170	1.160	0.170	0.007	0.001	0.090	0.100	0.040	0.210	0.012		0.027	0.002			0.002	0.41
* D		0.210	1.050	0.240	0.008	0.019	0.070	0.080	0.030	0.220	0.002		0.002	0.001			0.001	0.42
D	C	0.200	1.030	0.260	0.011	0.022	0.060	0.090	0.020	0.230	0.002		0.004	0.001			0.001	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	78,735	47,993	28.0	68.0				150
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	77,641	47,567	28.0	67.2				158
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	77,992	49,358	28.0	66.0				150
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	78,075	46,845	31.0	68.9				157

NOTES

O = OBTAINED
S = STANDARD

#	HEAT TREATMENTS
A A	Normalized at 900 dgr.C for 1 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 1.1/2 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 250 microinch

INSPECTION DEPARTMENT
VERIFIED BY ☐ REVIEWED ☐ WITNESSED ☐ DATE: 6/16/11
STANDARD
B1 = 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	INT. INSPECT DATE	INT. INSPECTOR
Stamped on product	04/01/2011	D.RUZICKA

INSPECTION AUTHORITY

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

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

MM187157

Part #3

Material Test Report

Heat Code: JFS

ISO 9001:2008 Certified

An Ameri-Forge Group Company
13770 Industrial Rd. Houston, TX 77015
Sales: (713) 868-4421 Fax: (713) 455-8366

Progressive Supply Inc.	PO: 119532	Sales Order: 94151	Line: 10
PO Box 470748	Item Code: 0151600102-0020F	Qty Shipped: 104	
Tulsa, OK 74147-0748	Item Desc: FLG 06.00 0150 WN RF XH		
	Supplier: CMC	Supplier Heat: 3021470	

Spec: ASTM A105/A105M-(10)/ASME SA 105/SA 105M-(08a) Section II Part A

Element	(%wt)	Ladle	Product	EPCRA	CAS#
C	Carbon	0.20			
Mn	Manganese	1.04			7439-96-5
P	Phosphorous	0.010			
S	Sulphur	0.020			
Si	Silicon	0.24			
Cu	Copper	0.23			7440-50-8
Ni	Nickel	0.08			7440-02-0

Element	(%wt)	Ladle	Product	EPCRA	CAS#
Cr	Chromium	0.07		✓	7440-47-3
Mo	Molybdenum	0.02			
V	Vanadium	0.003			
Cb	Columbium	0.001			
C.E.		0.41			
CuNiCrMo		0.401			
CrMo		0.091			

X-7930-71 Noz. 51

Mechanical Testing

Test Lab	AFG
Test Bar Size	Test Piece
HBW	156 - 156
Elg (%)	27
RA (%)	55
Tensile Specimen Size (in)	.497
Tensile (ksi)	78.4
Yield (ksi)	48.6
Gauge Length	2

Other

MILL	CMC-TEXAS
MHC	3021470
Country of Origin	USA (US)

This MTR applies to your PO# 1221

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 6/26/12

No Weld repair performed. Chemical Analysis results shown are actual. Forgings are capable of passing hydrostatic test compatible with the appropriate rating. Elongation taken from a round specimen. All material supplied under this order is certified to be free of mercury contamination and no mercury bearing equipment was used in manufacturing, fabrication or testing. Yield strength was determined using the 0.2% offset method.
No weld repair performed on this product.
Product compliant with NACE MR0175, latest edition and dimensions to ASME B16.5

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 Service (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.

JUN 16 2011

EEC QC DEPT

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

Certification No.: 205991
Certification Date: 4/20/2011

L. Patterson Nicholas Tepovich

This report is issued in compliance with the requirements of EN10204 3.1 / ISO 10474 3.1.b

Nicholas Tepovich - Metallurgic Lab Manager

MM187157

Part #2

FCI FORGED COMPONENTS INC.

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

REPORT NUMBER 48289
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

This MTR applies to your PO# 1221

X-7930-72 Noz. S2

Item	Quantity	Description
5	5	2" X 150 X 12" LG RF LWN

HEAT NUMBER: G136
MATERIAL TYPE: SA105
Material Origin: ITALY ✓ **Manufactured in** USA ✓
I.A.W. ASME 2010 ED.

CHEMICAL ANALYSIS

C	.160 ✓
Mn	1.220 ✓
P	.0130 ✓
S	.0060 ✓
Si	.220 ✓
Cr	.200 ✓
Mo	.005 ✓
V	.004 ✓
Cu	.036 ✓
Ni	.015 ✓
Cb	.003 ✓
Sn	.002
Ti	.0170
Al	.025
C E	.41

PHYSICAL PROPERTIES

Yield PSI	46,992 ✓
Tensile PSI	76,623 ✓
Elongation	37.1 ✓
Reduction of Area	71.8 ✓
Hardness	150 HBW ✓

VERIFIED BY
JUN 16 2011
EEC QC DEPT

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 6/24/11

Heat Treatment AS FORGED ✓
Temperature
Time at Temperature
Cooling Media

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 Helen Fielder

Name: Helen Fielder Title: QA Representative

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

MM187157

UNITED STATES STEEL

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

DATE: 02/04/11
TIME: 11:04:35
SERIAL NO: F0062922

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	VEHICLE ID
DR00486 01		D1721000	

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

MAIL TO ADDRESS
This MTR applies to your
PO# 10109

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

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 ASME SA53-*2010 EDITION GRADE B ASME SA106-*2010 EDITION GRADE B/C 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

(2 pcs.) STOCK X-7930-71A

MATERIAL COND: AS-ROLLED

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

WALL: 0.432 (10.972) in (mm)

PRODUCT IDENTIFICATION	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: 42,100		MIN: 70,000	MAX:	MIN:	MIN:	4110	5
				MAX: 71,800		MAX: 110,200		29.0	MAX: 99.5		
X22424 *NOTE A	STRIP/L/B	AR	1.5	49,800	.50	75,500	0.66	38.3	85.4	4110	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	SN	AS	SB	C.E.* MAX .43
X22424	HEAT		19	111	005	007	22	03	01	02	01	032	005	00	0001	001	000		00	00	003	.38
X22424	PROD		21	106	006	005	21	03	02	03	02	032	007	00	0003	002	005		007	00	00	.40
X22424	PROD		20	114	007	008	23	03	01	03	01	030	006	00	0000	001	000		003	00	00	.41
			**	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
APR 14 2011
EEC QC DEPT
L Patterson

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 2/2/12

Reviewed / Accepted
I.Q.S. # 3
William Brenaugh

Part #4

MM187157

UNITED STATES STEEL

TUBULAR PRODUCTS

CERTIFIED TEST REPORT

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

DATE: 02/04/11
TIME: 11:04:35
SERIAL NO: P0062922

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER
DR00486 01		D1721000

MATERIAL COND: AS-ROLLED

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

WALL: 0.432 (10.972) 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			12	12	12	15				
X22424	OK		**	END OF DATA THIS SHEET **	T	B	+ 32	3/4	AR	27	26	20	24	10	10	10	10

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 ____ OD/ID ____X L ____ L/T __X 10.0/10.0% NOTCH
FULL LENGTH MPI		
FULL LENGTH UT		ID ____ 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

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 BEARING EQUIPMENT IS PROTECTED BY A DOUBLE BOUNDARY OF CONTAINMENT.
*NOTE A SEE ATTACHED REPORT FOR TENSILE RESULTS.
** 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 02/04/11

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 2/2/12

Reviewed / Accepted
I.Q.S. # 3
William Brenaugh

**

Part #4

MM187157

UNITED STATES STEEL

TUBULAR PRODUCTS
TENSILE TEST REPORT

DATE: 02/04/11
TIME: 11:04:51
PAGE: 1

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	HEAT	SERIAL NUMBER: F0062922
DR00486 01		D1721000		

SOLD TO ADDRESS

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

MAIL TO ADDRESS

VENDOR

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

HEAT	PIPE/ LOT	TYPE/ DIR/ LOC	TEST COND	YIELD	EXT%	TENSILE	Y/T	ELONG %	REDUC AREA
X22424	2013	STRIP/L/B	AR	49,800	0.50	75,500	0.66	38.3	
X22424	2012	STRIP/L/B	AR	51,000	0.50	75,500	0.68	40.0	
X22424	2011	STRIP/L/B	AR	51,500	0.50	76,000	0.68	43.0	

Part #4

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 6/26/12

Reviewed / Accepted
I.Q.S. # 3
William Brenaugh

MM187157

09/19/2011 From: AMERICAN ALLOY STEEL To: ENERGY EXCHANGERS
P.O.# 1346 S.O.# :396462 AA PL#:5909370
Item :7 (1 PC) 3/4" X 60" X 96" X-7930-12 Part #5
:TAG: -

TEST CERTIFICATE

ARCELORMITTAL PLATE LLC

SHIP TO:
AMERICAN ALLOY STEEL
6230 N HOUSTON ROSSLYN RD
NORTH HOUSTON TX 77091

PAGE NO: 01 OF 02
FILE NO: 0284-01-32
MILL ORDER NO: 36071-002
MELT NO: R4137
SLAB NO: 11B
DATE: 01/16/10

SOLD TO:
AMERICAN ALLOY STEEL, INC
P. O. BOX 40469
HOUSTON TX 77240-0469

SEND TO: 01-C

PLATE DIMENSIONS / DESCRIPTION

TOTAL QTY	GAUGE	WIDTH	LENGTH	DESCRIPTION	PIECE WEIGHT
1	.75"	75"	480"	RECTANGLE	7657#

BHN 159 TO 166
CERTIFIED BY
AMERICAN ALLOY STEEL
BY LMS DATE 9-19

CUSTOMER INFORMATION

CUSTOMER PO: 80702

SPECIFICATION(S)

THIS MATERIAL HAS BEEN MANUFACTURED AND TESTED IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND SPECIFICATION(S).

AM ALLOY-TUF-37 REV 8 YR 06
ASME SA516 GR 60
ASME SA516 ED 04 GRADES 60/65/70 06 ADDENDA
THE MANAGEMENT SYSTEMS FOR MANUFACTURE OF THIS PRODUCT ARE CERTIFIED TO ISO 9001:2000 (CERTIFICATE NO. 30130) AND ISO 14001 (CERTIFICATE NO. 006928).

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE 9/20/11

CHEMICAL COMPOSITION

	C	MN	P	S	CU	SI	NI	CR	MO
MELT:R4137	.19	1.09	.006	.001	.06	.35	.04	.04	.01

	V	TI	B	AL	CB	SB	AS	SN	CEF
MELT:R4137	.001	.003	.0007	.033	.001	.0010	.0020	.004	.39

CARBON EQUIVALENT FORMULA (CEF)
CEF = C + (MN * .1667) + ((CR + MO + V) * .2000) + ((CU + NI) * .0667)

MANUFACTURE

FINELINE - VACUUM DEGASSED - MCQUAID-EHN GRAIN SIZE PER E112 - 7-8

HEAT TREAT CONDITION

MATL OR TEST	HEAT TREAT DESCRIPTION	NOM TEMP	HOLD MINS	COOL MTHD
PL/TEST	NORMALIZE	1650F	28	AIR COOL

VERIFIED BY
SEP 21 2011
EEC QC DEPT

AMERICAN ALLOY STEEL
Reviewed By:

WE HEREBY CERTIFY THE ABOVE INFORMATION IS CORRECT:

ARCELORMITTAL PLATE LLC
QUALITY ASSURANCE LABORATORY
139 MODENA ROAD
COATESVILLE, PA 19320

Elinore Zaplitny
SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

Reviewed / Accepted
I.Q.S. # 3
William Bromaugh

MM187157

09/19/2011 From: AMERICAN ALLOY STEEL To: ENERGY EXCHANGERS
P.O.# :1346 S.O.# :396462 AA PI#:5909370
Item :7 (1 PC) 3/4" X 60" X 96"
:TAG: X-7994 & 95 LN 15B

Part #5

TEST CERTIFICATE

PAGE NO: 02 OF 02
FILE NO: 0284-01-32
MILL ORDER NO: 36071-002
MELT NO: R4137
SLAB NO: 11B
DATE: 01/16/10

TENSILE PROPERTIES

SLAB NO.	LOC	DIR	YIELD STRENGTH PSI X 100	TENSILE STRENGTH PSI X 100	ELONGATION GAGE LGTH	%	%R.A.
11B	BOT.	TRANS.	485	739	8.00"	28.0	64.0

GENERAL INFORMATION

ALL STEEL HAS BEEN MELTED AND MANUFACTURED IN THE U.S.A.
MATERIAL HAS BEEN VACUUM DEGASSED AND CALCIUM TREATED FOR SULFIDE SHAPE CONTROL.
FINELINE MOD FOR SULPHUR
TEST CERTS. ARE PREPARED IN ACCORD. WITH PROCEDURES OUTLINED IN EN 10204:2004 TYPE 3.1.

B/L #01202 UMP 63044

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE 1/26/12

...of the
...ne.
...STEEL
Reviewed By:

WE HEREBY CERTIFY THE ABOVE INFORMATION IS CORRECT:

ARCELORMITTAL PLATE LLC
QUALITY ASSURANCE LABORATORY
139 MODENA ROAD
COATESVILLE, PA 19320

Elinore Zaplitny
SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

MM187157

UNITED STATES STEEL

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

DATE: 01/05/11
TIME: 04:06:47
SERIAL NO: L0034428

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	VEHICLE ID
DR49778 01	R83114	6019	LT8380

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

MAIL TO ADDRESS
This MTR applies to your
PO#_____

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 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-7930-15

MATERIAL COND: AS ROLLED | O.D.: 22.000 (558.800) In (mm) | WALL: 0.375 (9.525) 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:	1290	5
				MAX: 71800		MAX: 110200	0.93	28.0	MAX: 99.0		
MA2050 S212AA	STRIP/L/B	AR	1.500	55000	.50	78500	0.71	44.0	B 81.2	1290	5
MA2051 S213AA	STRIP/L/B	AR	1.500	57000	.50	78000	0.73	41.6	B 77.7	1290	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
MA2050	HEAT	19	104	009	002	18	13	06	10	03	024		03	0002	001	002		.41
MA2050 S212AA	PROD	21	105	011	004	19	14	05	10	03	030		03	0005	002	004		.43
MA2050 S212AA	PROD	21	105	010	004	19	14	05	10	03	029		03	0005	002	004		.43
MA2051	HEAT	19	103	009	002	19	13	06	09	03	024		03	0002	001	002		.40
MA2051 S213AA	PROD	21	105	009	004	20	14	05	09	03	030		03	0006	002	004		.43
MA2051 S213AA	PROD	19	102	008	004	19	13	06	08	03	028		03	0005	002	003		.40
		** END OF DATA THIS SHEET **																

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

DECIMAL PC 3 FOR ELEMENTS ARE INDICATED BY THE LEFT MARGIN, VERTICAL DOTTED LINE OR DECIMAL POINT.

VERIFIED BY
JUL 11 2011
EEC QC DEPT
R. Patterson

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 6/21/11

Reviewed / Accepted
I.Q.S. # 3
William Branaugh

Part #1

MM187157

UNITED STATES STEEL

TUBULAR PRODUCTS

CERTIFIED TEST REPORT

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

DATE: 01/05/11
TIME: 04:06:47
SERIAL NO: L0034428

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	
DR49778 01	R83114	6019	0019513

MATERIAL COND: AS ROLLED

O.D.: 22.000 (558.800) 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										
MA2050 S212AA	OK				T	B	+ 32	2/3	AR	82	80	85	82	100	100	100	100
MA2051 S213AA	OK				T	B	+ 32	2/3	AR	81	90	89	86	100	100	100	100
			**	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 X L/T ____ 10.0% NOTCH
FULL LENGTH MPI		
FULL LENGTH UT	X	ID X OD/ID ____ L X L/T ____ 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 01/05/11

Reviewed / Accepted
I.Q.S. # 3
William Branaugh

Part # 7

MA2051 S213AA mtr

MM187157

PRESCOR, INC.

P.O. BOX 9856 TULSA, OK 74157-0856
800-333-4433 LOCAL: 918-224-6626
888-PRESCOR FAX: 918-224-1780
www.prescor.com

MILL TEST REPORT

____	FLANGED & DISHED	____	VARIOUS
____	FLANGED ONLY		See each item
____	DISHED ONLY		
____	HEMISPHERICAL	____	CIRCLE
____	WELD CAPS	____	TEST PIECE
XX	2:1 ASME ELLIPTICAL HEADS - TOLERANCE PER UG-81		

CUSTOMER: ENERGY EXCHANGER COMPANY | CUSTOMER ORDER NO.: X-7930 1170 | OUR JOB NO.: 170758 | DATE: 5-13-2011

CODE	QTY.	SIZE O.D. & THK.	PLATE MFG'R.	HEAT NO.	SLAB NO.	ASTM NO.	YIELD PSI	TENSILE PSI	% ELONG.	BEND TEST	C	MN	P	S	SI
AWDL	1	(3/8")NOM 22" X 5/16"MIN	SSAB	W0I628	F12	SA 516 70	SEE ATTACHED			L	.18		"B"		
AWGD	1	(3/8")NOM 22" X 5/16"MIN	MITTAL	811P02140	H066332	SA 516 70	SEE ATTACHED			L	.18		"A"		

Reviewed / Accepted
I.Q.S. # 3
William Brownagh

XX	THESE HEADS ARE HOT FORMED ABOVE 1650 DEGREES FAHRENHEIT, AIR COOLED AND NORMALIZED, AND ARE EXEMPT FROM THE HEAT TREATMENT REQUIREMENTS OF PARA UCS-79(d) OF THE ASME UNFIRED PRESSURE VESSEL CODE, SECTION 8.
	COLD FORMED. THESE HEADS NORMALIZED AFTER FORMING, PER UCS-79(d).
	SPECIAL MATERIAL FORMED PER REQUIREMENTS AND TEMPERATURE RANGE OF THAT MATERIAL'S SPECIFICATIONS, AND PER UG-79(a).
	TEST PIECES PER UCS 85-C.

ALL PRESCOR HEADS ARE SEAMLESS AND FORMED PER UG-79.

We certify that this is a true copy of the original Mill Test Report now in our files.

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 5/26/12 By Sherry Tockey

PRESCOR, INC.

"This Certified Test Report has been delivered to a consignee of material purchased from PRESCOR, INC. to avoid the possibility of its misuse, on the redelivery of this report to a third party it must be recertified by and under the name of such Consignee."

Part #8

MM187157

Last #8

ArcelorMittal Burns Harbor Plate

QUALITY ASSURANCE
REPORT OF TEST AND ANAYLSES

SHIPMENT NO.	DATE SHIPPED	CAR OR VEHICLE NO.	PAGE
803-16018	11-24-10	IHB-MCCOO-BNSF TTPX 804917	5

SOLD TO
003
RYERSON PROCUREMENT CORP
PO BOX 4725
NORCROSS GA 30091-4725

SHIP TO
RYERSON PROCUREMENT CORP
THEIR SIDING
6434 N ERIE
TULSA OK

NOTE	SERIAL NUMBER	PAT NO	HEAT NUMBER	NO. PCS.	SIZE AND QUANTITY: THICKNESS	WIDTH OR DIA.	LENGTH	WEIGHT	YIELD POINT	TENSILE STRENGTH	ELONG.	RED.
					INCHES	INCHES	INCHES	POUNDS	PSI	PSI	IN	% %

QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A.
PLATES - ASTM A516-06 GR 70 PVQ, ASME SA516
GR 70 PVQ 2010 EDITION --- MILL
TEST PCS NORM 1650F FOR 1HR/IN
AIRCL
NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)
TEST CERTS ARE PREPARED IN ACCORDANCE WITH PROCEDURES OUTLINED
IN EN 10204:2004-TYPE 3.1
CO# M1661579 GH 841-0659
TEST SPECIMENS LABORATORY HEAT TREATED AND YIELD STRENGTH @ .5% E.U.L.

H066332	811P02140	5	3/8	96		240	AWGD	12250	52900	75100	8	21
(M55)MFST REF#:35992												
H066333	811P02140	4	3/8	96		240	AWGB	9800	53800	75400	8	23
(M55)MFST REF#:35992												
H066337	811P02170	4	3/8	96		240	AWGC	9800	53700	75100	8	24
(M55)MFST REF#:35992												

(1 pc.) X-7930-18 "A"

Q-QUENCH TEMPERATURE | T-TEMPER TEMPERATURE | N-NORMALIZE TEMPERATURE

SERIAL NUMBER	PAT NO.	HEAT NUMBER	HARD BHN OTHER BHN	BEND	THICKNESS INCHES	TYPE	SIZE	DIR	TEST TEMP °F	CHARPY IMPACT: ENERGY FT LBS 1	2	3	SHEAR(%) 1	2	3	LAT. EXP MILS 1	2	3

HEAT NUMBER	CHEMICAL ANALYSIS C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti	Al	B	Cb	N	Sn	MOLIAD GRAIN SIZE
* 811P02140	.16	1.05	.020	.007	.31	4.242	.16	.04	.007	.002	.002	.032	.0003	.002	.005	.005	
811P02170	.16	1.06	.013	.005	.33	0.228	.18	.03	.006	.002	.003	.044	.0003	.002	.006	.006	

I certify that the above results are a true and correct copy of actual results contained in records maintained by ArcelorMittal Burns Harbor and are in full compliance with the requirements of the specification cited above. This test report cannot be altered and must be transmitted intact with any subsequent third party test reports, if required.

BHPLTRPT.TIF

D. W. ELWOOD PER WNK
SUPV. QUALITY ASSURANCE

INSPECTION DEPARTMENT
REVIEWED
WITNESSED DATE: 6/26/12

VERIFIED BY
MAY 18 2011
EEC QC DEPT

Reviewed / Accepted
I.Q.S. # 3
William Brenaugh

MM187157

323

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

Mill Test Report

Page 2

NUCOR It's our Nature.

Issuing Date : 04/16/2011 B/L No. : 290884 Load No. : 292914 Our Order No. : 89840/4 Cust. Order No. : MUS-233153

Vehicle No: LW 62100

Specification : 0.3750" x 96.000" x 480.000"
ASTM A516 70-10/ASME SA516 70 PVQ 2010 Normalized Test
Coupons at 1650 F

Sold To : METALS USA - SOUTHCENTRAL
2800 N 43RD STREET EAST
MUSKOGEE,OK 74403

Ship To : METALS USA - PLATES AND SHAPES
TRACK 747
MUSKOGEE,OK 74401

Marking : X-7930-71B, 63, 120

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
1502456	0.19	1.05	0.020	0.000	0.22	0.23	0.08	0.10	0.02	0.030	0.006	0.001	0.002		0.0007	0.0001	0.010	0.41	0.27

Tensile Test								Charpy Impacts													
Plate Serial No	Pieces	Tons	Dir.	(psi) Yield	(psi) Tensile	Elongation % in 2"	Elongation % in 8"	Dir.	1	(%) shear	2	(%) shear	3	(%) shear	Ave.	(%) shear	Size	Temp	Min Ave.
1502456-03	6	14.70	T	54,900	81,900		22.2												
1502456-04	5	12.25	T	59,900	80,000		18.8												
1502456-05	2	4.90	T	52,100	78,000		18.6												
1502456-03	6	14.70	T	53,800	78,700		25.4	N											
1502456-04	5	12.25	T	74,100	77,800		18.1	N											
1502456-05	2	4.90	T	53,200	77,100		22.9	N											

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 6/20/12

VERIFIED BY
JUN 20 2011
EEC QC DEPT
L. Patterson

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh WB

Part #9, 10, 11

NACE MR0175 ANNEX 2.1.2 COMPLIANT

Test coupons only, normalized 60 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 9001:2008 certified (#008083) 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 09-MMPQA-546

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. Depretis

T. A. Depretis, Metallurgist

04/26/2011 10:32:37 AM

MM187157

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"	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 .7930 .62

Cut to 6 7/8" 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.

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

April Pitts

April Pitts - QA Engineer

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 6/26/12

VERIFIED BY
Nov 23 2012
EEC QC DEPT
K. Patterson

Reviewed / Accepted
I.Q.S. # 3
William Brenaugh

Part # 19

MM187157

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 101 EAST ILLINOIS ENID OK 73702	Customer P.O. No.: MUS-231893	Mill Order No.: 41-277716-01	Shipping Manifest : HT964418
	Product Description: ASTM A516-70(86)/ASME SA516-70(89A) STOCK NB BRACKETS	Ship Date: 07 Sep 10 Cert Date: 07 Sep 10	Cert No: 631110772 (Page 1 of 1)
	Size: 0.188 X 96.00 X 480.0 (IN)	X.7930-61	

Tested Pieces				Tensiles					Charpy Impact Tests							
Heat Id	Piece Id	Piece Dimensions	Tst Loc	YS (PSI)	UTS (PSI)	%RA	Elong % 2in Siz	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
INSPECTION DEPARTMENT
REVIEWED

VERIFIED BY
SEP 19 2011
EEC QC DEPT

(F) Cust Part # :

WITNESSED ☐ DATE: 6/21/12

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

Jason Thomas
SENIOR METALLURGIST

Reviewed / Accepted
I.Q.S. # 3
William Brumagh

Part #13

MM187157

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

X-7930 (266pcs)

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 10013785

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

CHECKED FEB 2 2 2010

L Jatterson

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 6/26/12

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			

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

MM187157

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			

138 pcs

34 pcs

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

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 6/28/12

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

part #14

MM187157

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:

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	INSPECTION DEPARTMENT			064	
0001	000002	181070	REVIEWED WITNESSED ☐ DATE 7/26/19			065	

Reviewed / Accepted
I.Q.S. # 3
William Brenaugh

Part #14

MM187157

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:

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Page:
Page:

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	
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	

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 4/26/12

Reviewed / Accepted
I.Q.S. # 3
William Brenaugh

Part # 14

MM187157

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:

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 ✓

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 6/26/12

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

Page 14 of 14

MM187157

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:

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 stenciling, marquage par peinture FSD = Farbstrahldrucker, Colour jet printer, Imprimante à jet d'encre de c LS = Längsschablonierung, longitudinal stenciling, 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

INSPECTION DEPARTMENT
REVIEWED ☒ FRED WHITE
WITNESSED ☐ DATE: 6/26/12

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

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.

Part #14

MM187157

TUBES INC.

Part #14

900 E. PECAN
SAND SPRINGS, OK 74063
918-245-5100

MANUFACTURER'S CERTIFICATE OF COMPLIANCE

IN ACCORDANCE WITH EN 10204 3.1

CUSTOMER: ENERGY EXCHANGER COMPANY

CUSTOMER ORDER NO: 1200 TAG: X7930

OUR ORDER NO: T-44125-20

PRODUCT DESCRIPTION: SA179 CARBON STEEL U-BENDS
266 PCS 3/4" OD X .083 MW X V/L

CUSTOMER FURNISHED MATERIAL.

ALL U-BENDS WERE STRESS RELIEF ANNEALED @ 1150 +/- 25°F PLUS 12" PAST TANGENT IN ACCORDANCE WITH SA-556 AND PURCHASE ORDER REQUIREMENTS. ✓

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

5/17/11

BRIAN TURNER - QUALITY
CERTIFICATION COORDINATOR

VERIFIED BY
MAY 24 2011
EEC QC DEPT

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 6/20/12

Reviewed / Accepted
I.N.S. # 3

MM187157

DATE: 01/12/12

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

Part #15

CERTIFIED MATERIAL TEST REPORT

ENERGY EXCHANGERS
1844 N. GARNETT RD.
TULSA OK 74116

LOT # 108465
HEAT # 108465
STOCK # B7S112C912
1-1/8-8 X 9-1/8 ASTM A-193 B-7
CUS PO# 1744
ORDER # 28168

X-7930.41

SPECIFICATIONS:

ASTM A193 B7 ALL THREAD ROD

VENDOR: VULCAN THREADED PRODUCTS, INC. QTY SOLD 48

- CHEMICAL COMPOSITION -

C %	MN %	P %	S %	SI %	NI %	CR %
00.4000	00.9000	00.0150	00.0260	00.2400	00.1030	00.8410

MO %	CU %	CO %	V %	AL %	FE %	TA %
00.1630	00.2400		00.0070	00.0010		

TI %	ZN %	SE %	CB %	W %	N %	SN %
						00.0080

- CHARPY IMPACT -

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

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 1/24/12

- MECHANCIAL PROPERTIES -

TENSILE STRENGTH: 134,200 Psi
YIELD : 119,000
ELON : 20.00
RA : 60.00

HARDNESS : 27 HRC
PROOF STRESS: 0 Psi

COMMENTS:

MELTED & MFG IN THE USA
TEMPERING TEMP 1430 F
META S2/S1/S3

VERIFIED BY
JAN 17 2012
EEC QC DEPT

W. M. HEITGRAS COMPANY

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

QUALITY CONTROL MANAGER

MM187157

Part #16

DATE: 05/31/11

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

CERTIFIED MATERIAL TEST REPORT

X-7930-42

ENERGY EXCHANGERS
1844 N. GARNETT RD.
TULSA OK 74116

LOT # MR851
HEAT # B09364
STOCK # HZHHN112-S
1-1/8-8 ASTM A-194 2-H HEAVY
CUS PO# 1242
ORDER # 276291
TAG # STOCK

STOCK

SPECIFICATIONS:

ASTM A-194 2H HEAVY HEX NUT

VENDOR: UNYTITE, INC.

QTY SOLD 700

- CHEMICAL COMPOSITION -

C %	MN %	P %	S %	SI %	NI %	CR %
00.4600	00.7100	00.0110	00.0190	00.2300	00.0100	00.0600

MO %	CU %	CO %	V %	AL %	FE %	TA %
00.0100						

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

- CHARPY IMPACT -

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

- MECHANCIAL PROPERTIES -

TENSILE STRENGTH: 0 Psi
YIELD : 0
ELON : 0.00
RA : 0.00

HARDNESS : 28.9HRC
PROOF STRESS: 600 Psi

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 6/26/12

COMMENTS:

HRB 102.3 HARDNESS
TEMPERING 1031 F/45M W.C.
HEAT TREAT T:MIN. 850 F
COUNTRY OF ORIGIN: U.S.A.

W.M. HEITGRAS COMPANY

QUALITY CONTROL MANAGER

VERIFIED BY
MAY 3 1 2011
EEC QC DEPT

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

L. Patterson

MM187157

09/19/2011 From: AMERICAN ALLOY STEEL To: ENERGY EXCHANGERS
P.O.# :1346 S.O.# :396462 AA PL#:5109135
Item :1 (1 PC) 3/8" X 96" X 164"
:TAG: X-7930-50+51 Part # 17

ArcelorMittal Burns Harbor Plate

QUALITY ASSURANCE
REPORT OF TEST AND ANALYSES

SHIPMENT NO. 803-08925 | DATE SHIPPED 06-09-11 | CAR OR VEHICLE NO. THB-MCCOO-BNSF THB 018465 | PAGE 8

SOLD TO: AMERICAN ALLOY STEEL INC
PO BOX 40469
HOUSTON TX 77040-0469

SHIP TO: AMERICAN ALLOY STEEL INC
BNSF TR# 7226 MILE 66.4 LN SEG 492
6230 N HOUSTON ROSSLYN RD
HOUSTON TX

NOTE	SERIAL NUMBER	PAT NO.	HEAT NUMBER	NO. PCS.	SIZE AND QUANTITY: THICKNESS	WIDTH OR DIA.	LENGTH	WEIGHT	YIELD POINT	TENSILE STRENGTH	ELONG	RED.
					INCHES	INCHES	INCHES	POUNDS	PSI	PSI	IN %	%

QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A. ✓
PLATES - ASME SA516 GR 70 PVQ 2010 EDITION,
ASME SA516 GR 65 PVQ 2010 EDITION,
ASME SA516 GR 60 PVQ 2010 EDITION,
CH-V SA20S5 PLT L 15/12 FTLBS AT
-50F --- PLT NORM & COOL IN STILL
AIR --- TEST CERTS ARE PREPARED IN
ACCORD WITH PROCEDURES OUTLINED IN
EN 10204:2004 TYPE 3.1
NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)

BHN 153 TO 159 ✓
CERTIFIED BY
AMERICAN ALLOY STEEL
BY [illegible] DATE 9-19-11

CO# 85354 GH 361-7984 ✓
PLATES HEAT TREATED ✓ TEST SPECIMENS ATTACHED & YIELD STRENGTH @ .5% EUL

J031961	813S62790	2	.375	96	360		7350	54300	77200	8	24	
			N 1650 DEG F - 21 MIN									
J031960 →	821T00580	3	.375	96	360		11025	50200 ✓	74200 ✓	8	24 ✓	
			N 1650 DEG F - 21 MIN									

Certified a true copy of the original, retained in our file.
AMERICAN ALLOY STEEL
Reviewed By:
DG 7/12/11

Q-QUENCH TEMPERATURE T-TEMPER TEMPERATURE N-NORMALIZE TEMPERATURE

SERIAL NUMBER	PAT NO.	HEAT NUMBER	HARD BHN BHN	BEND	CHARPY IMPACT: THICKNESS INCHES	TYPE	SIZE	DIR	TEST TEMP F	ENERGY FT LBS 1	2	3	SHEAR(%) 1	2	3	LAT. EXP MILS 1	2	3
J031961		813S62790			.375	V	3/4	L	-50	68	64	66						
J031960		821T00580			.375	V	3/4	L	-50	79	91	90						

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE 9/22/11

HEAT NUMBER	CHEMICAL ANALYSIS: C ✓	Mn ✓	P ✓	S ✓	Si ✓	Cu ✓	Ni ✓	Cr ✓	Mo ✓	V ✓	Ti ✓	Al ✓	B	Cb ✓	N	Sn	GRAIN SIZE
813S62790	.17	1.06	.017	.003	.345	.229	.18	.03	.005	.002	.002	.037	.0002	.002	.004	.007	
✶ 821T00580	.17	1.03	.014	.005	.320	.217	.18	.03	.008	.002	.002	.030	.0002	.002	.005	.002	

AMERICAN ALLOY
PLATE# 5109135

VERIFIED BY
I certify that the above results are a true and correct copy of actual results contained in records maintained by ArcelorMittal Burns Harbor and are in full compliance with the requirements of the specification cited above. This test report cannot be altered and must be transmitted intact with any subsequent third party test reports, if required.

BHPLTRPT.TIF

SEP 2 1 2011

D. W. ELWOOD PER WNK
SUPV. QUALITY ASSURANCE

EEC QC DEPT
L. Patterson

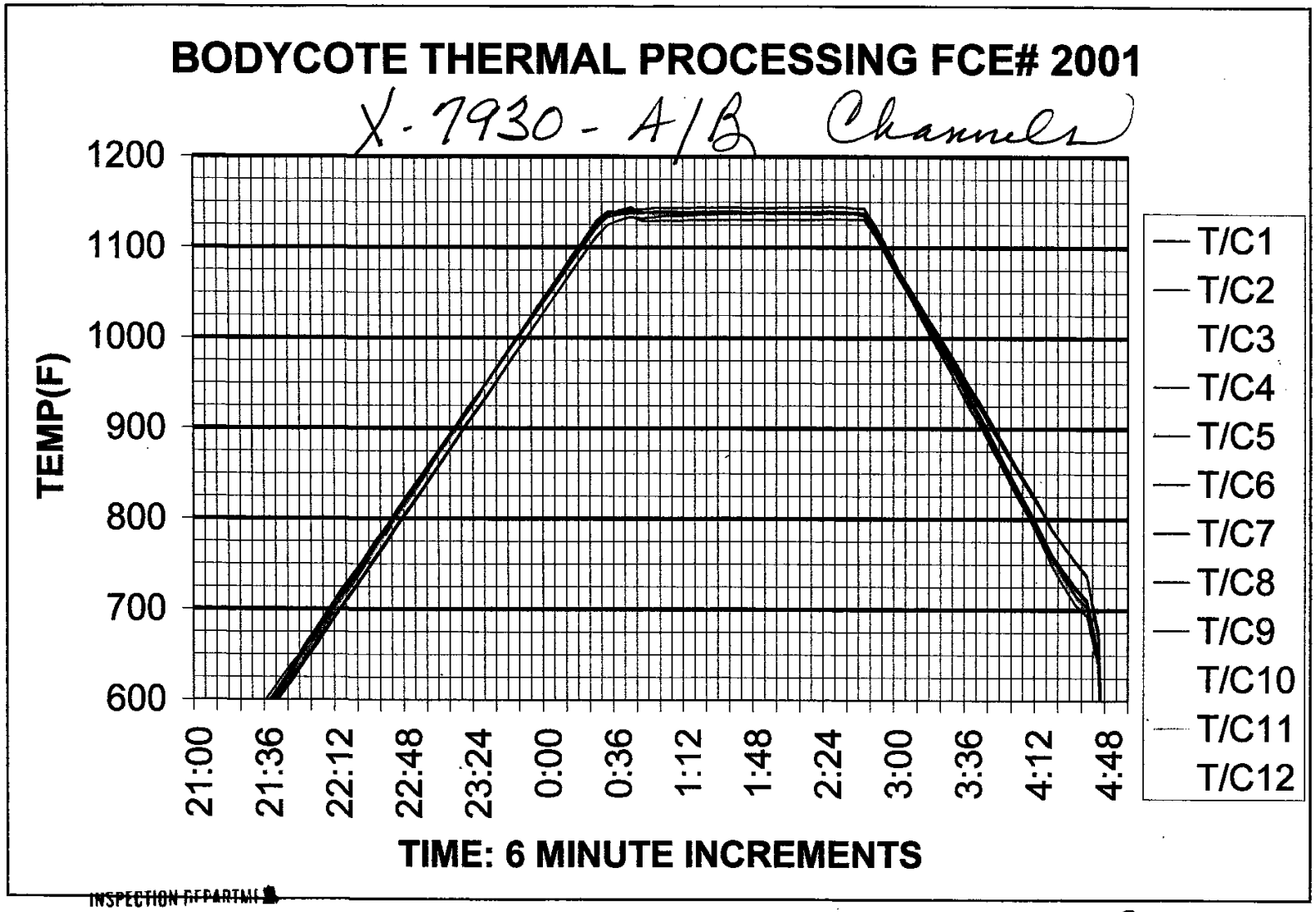
Reviewed / Accepted
I.Q.S. # 3
William Brenaugh

MM187157

SECTION 5

ENERGY EXCHANGERS
JOB#54276
PO#PX 9535

6/12/12



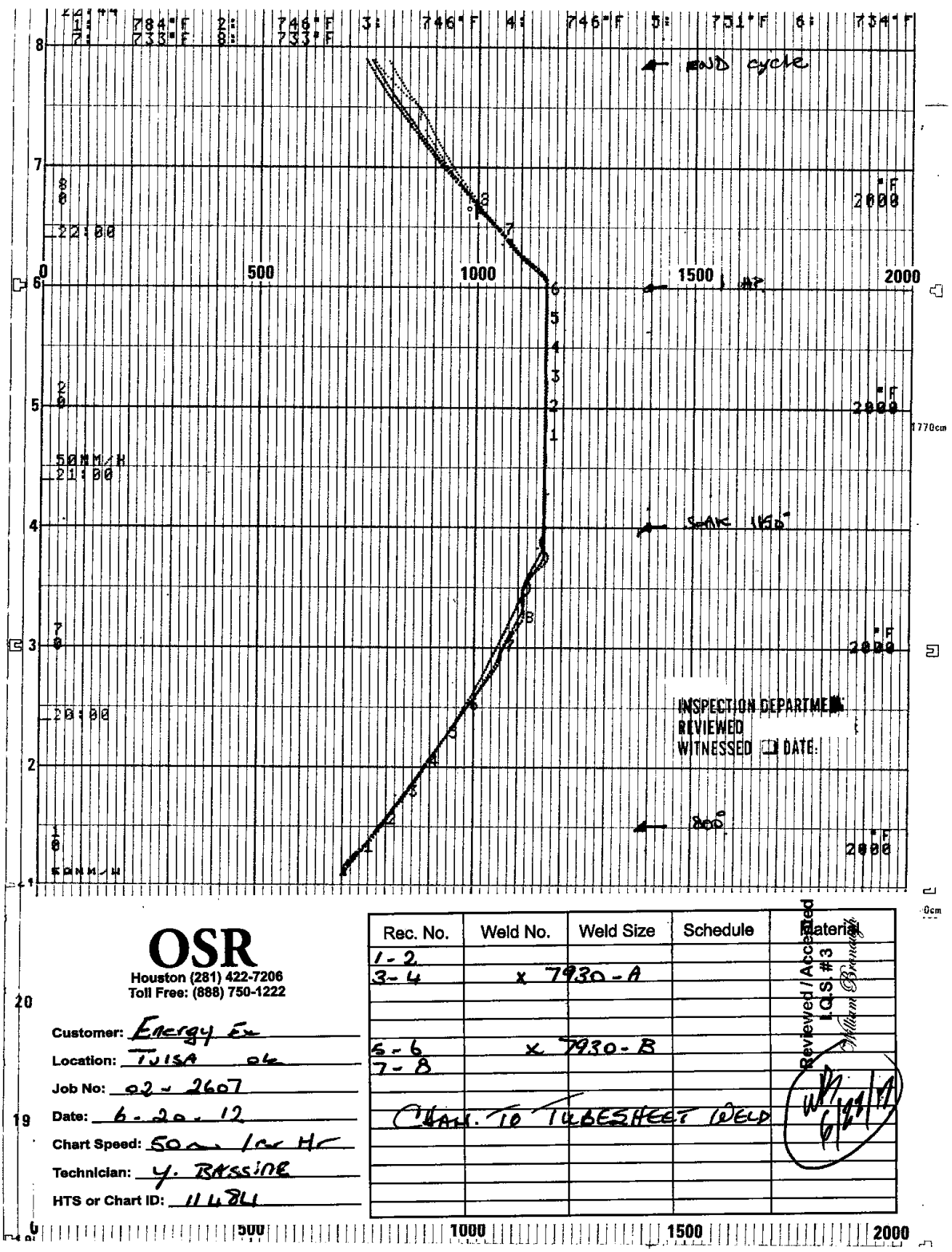
INSPECTION DEPARTMENT
REVIEWED
WITNESSED - 5 DAYS

CALIBRATION DATE 5/10/12
CALIBRATION DUE DATE 8/10/12

Reviewed / Accepted
I.Q.S. # 3
William Bodycote 6-22-12

SIGNED BY CHRIS HELTON

MM187157



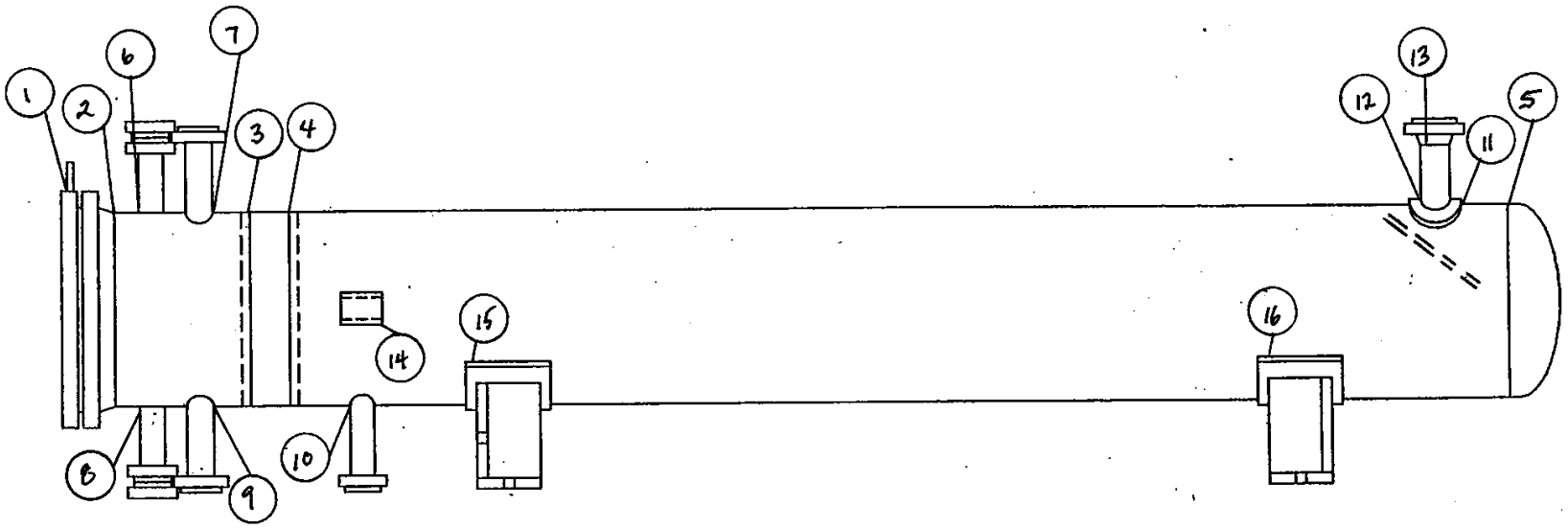
OSR
Houston (281) 422-7206
Toll Free: (888) 750-1222

Customer: Energy Ex
Location: TULSA OK
Job No: 02-2607
Date: 6-20-12
Chart Speed: 50mm/hr HC
Technician: Y. BASSINE
HTS or Chart ID: 11484

Rec. No.	Weld No.	Weld Size	Schedule	Material
1-2				
3-4	x 7930-A			
5-6	x 7930-B			
7-8				
CHAN. TO TUBESHEET WELD				

Reviewed / Accepted
I.Q.S. #3
William Brunson
6/19/12

MM187157



NDE/WELD MAP

Reviewed / Accepted
I.Q.S. # 3
William Brenaugh

X-7930A

MM187157

ENERGY EXCHANGER COMPANY

CUSTOMER: SOUTHERN COMPANY SERV. P.O.#: 17496 - 0001
TAG: HX 1027 ENERGY JOB # X-7930 A

NDE/WELD INDEX

Part #	Consumable	WPS	Weld Stamp	NDE Procedure	NDE Technician
1	E-7016-1	M-1	H	MT	MW / BC
2	L-61	A-1H	U	MT RT	
3	L-61	A-1-H	E	MT	
4	L-61	A-1	E	MT	
5	E-7016-1	M-6	W	MT	
6		M-1-H	O/S	MT RT	
7		M-1-H	S	MT	
8		M-1-H	D	MT	
9		M-1-H	R	MT	
10		M-1	S	MT	
11		M-1	R	MT	
12		M-1	R	MT	
13		M-6	L	MT	
14		M-1	S	MT	
15		M-1	S	MT	
16	—	M-1	S	MT	—

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE:

Reviewed / Accepted
I.O.S. #3
William Bronaugh

ENERGY EXCHANGER COMPANY

JOB # X-7930 A

P.O.# 17496-0001

PART IDENTIFICATION CHANNEL SPOT UW 51

TYPE OF MATERIAL SA 516-70 MATERIAL THICKNESS 22"K 3/4"

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 1-2		✓			✓	✓		✓				6-8-12
L1 1-2		✓			✓	✓		✓				6-9-12
CH R1 1-2	✓											
2-3	✓											
3-4	✓											
4-5	✓											
5-T	✓											
CH L1 1-2	✓											
2-3	✓											

INSPECTION DEPARTMENT
REVIEWED
WITNESSED DATE:

RADIOGRAPHIC DATA

1. RT DATE 6-7-12
2. MATERIAL EXAMINED:
   ( ) 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 2-4
   SENSITIVITY LEVEL 2-4
   LOCATION (FS) (SS)
5. FILM DATA:
   FILM TYPE 80
   FILM DENSITY MAX
   FILM DENSITY MIN
6. SOURCE DATA:
   ISOTOPE Ir192 SIZE 0.106
   CURIES 89 E.T. 29
   S.O.D. 11 S.S.O.F. 3/4

RADIOGRAPHER S. Howard

INTERPRETER B. SW- TII 193332 DATE REVIEWED 6-8-12

CUSTOMER INSPECTOR DATE REVIEWED

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

readersheet(A99).doc

MM187157

ENERGY EXCHANGER COMPANY

JOB # X-7930 A

P.O.# 1749600001 AFWHT

PART IDENTIFICATION CH SPOT

TYPE OF MATERIAL SA 516 70 MATERIAL THICKNESS 22 x 3/4

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												
T-2	✓											
CH L1												
T-2	✓											

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE:

RADIOGRAPHIC DATA

1. RT DATE 6-12-12
2. MATERIAL EXAMINED:
   - (✓) 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 0.016
   - LOCATION (FS) (SS)
5. FILM DATA:
   - FILM TYPE fuji 100
   - FILM DENSITY MAX. 2-4
   - FILM DENSITY MIN. 2-4
6. SOURCE DATA:
   - ISOTOPE Ir192 SIZE 0.149
   - CURIES 94 E.T. 120
   - S.O.D. 11" S.S.O.F. 3/4

RADIOGRAPHER S. Howard

INTERPRETER [signature] TII 193332 DATE REVIEWED 6-13-12

CUSTOMER INSPECTOR [signature] Reviewed / Accepted I.Q.S. # 3 William Bronaugh DATE REVIEWED 6/13/12

readersheet(A99).doc

MM187157

ENERGY EXCHANGER COMPANY

JOB # X-7930 A

P.O.# 17496-0001

PART IDENTIFICATION Shell Spot uw-51

TYPE OF MATERIAL SA-106 B MATERIAL THICKNESS 22" O.D 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
SH #2 1-2	✓											

INSPECTION DEPARTMENT
REVIEWED
WITNESSED DATE

RADIOGRAPHIC DATA

1. RT DATE 5-21-12
2. MATERIAL EXAMINED:
   - (X) WELDMENT
   - ( ) CASTING
   - ( ) OTHER
3. METHODS:
   - (X) 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 B
   - SENSITIVITY LEVEL 2-T
   - LOCATION (FS) (SS)
5. FILM DATA:
   - FILM TYPE 80
   - FILM DENSITY MAX. 2-4
   - FILM DENSITY MIN. 2-4
6. SOURCE DATA:
   - ISOTOPE Ir 192 SIZE .106
   - CURIES 89 E.T.
   - S.O.D. S.S.O.F.

RADIOGRAPHER

INTERPRETER [signature] II 193332 DATE REVIEWED 5-22-12

CUSTOMER INSPECTOR [signature] DATE REVIEWED

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

readersheet(A99).doc

MM187157

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: 6-21-12

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

P.O. # 17496-0001

TAG # HX 1027

ENERGY JOB # X-7930 A

MT OF THE FOLLOWING:
LIFTING LUG WELDS
ALL TEMP ATTACHMENTS AND ARC STRIKES
ALL NOZ BACK CUTS
ALL INT. + EXT CH WELDS
BEFORE & AFTER PWHT

This certification is made to document that all Magnetic Particle Examinations have been performed on _____ **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:** 17746

MATERIAL AND THICKNESS: SA-106B X 3/8

LIGHTING: 100 FT CANDLES MIN. @ SURFACE

ENERGY EXCHANGER COMPANY

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

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE:

6/22/12

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

MM187157

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: 5-29-12

CERTIFICATION OF EXAMINATION
BY
LIQUID PENETRANT - WATER WASHABLE
(Procedure PT-1 Rev. 6)

P.O. # 17496 - 0001

TAG # HX 1027

ENERGY JOB # X-7930 A

PT TUBE TO TUBESHEET STRENGTH WELDS BEFORE AND AFTER ROLLING

This certification is made to document that all Liquid Penetrant Examinations have been performed on X-7930 A **in accordance with the requirements of ASME Section VIII, Division I, Appendix VIII, ASME Section V, Article 6, customer specifications and Energy Exchanger Company drawings.**

PENETRANT: ARDROX 906

REMOVER: WATER

DEVELOPER: ARDROX 9D1B

MATERIAL AND THICKNESS: SA-266-GR 4N X 3"

LIGHTING: 100 FT CANDLES MIN. @ SURFACE

ENERGY EXCHANGER COMPANY

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

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE: 6/12/12

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

Energy Exchanger Company

BRINELL HARDNESS REPORT

JOB NO: X-7930 A

COMPONENT	LOCATION	WELD METAL	BHN HEAT AFFECTED ZONE	BHN PLATE	WELD PROCEDURE NUMBER
FRONT CHANNEL	R1	175	171		A-1-H
	L1	165	160		A-1-H
	R2	185	177		A-1-H
	T1	187	179		M-1-H
	T2	186	180		M-1-H
SHELL	R1	186	168		A-1
	R2	173	177		A-1
	S1	174	173		M-1
	S2	175	179		M-1

Reviewed / Accepted
I.Q.S. # 3
William Branaugh
6/27/11

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE:

MM187157

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: 6-20-12

CERTIFICATE OF WELD/SUPPORT PAD AIR TEST

P.O. NO: 17496-0001

TAG NO: HX1027

ENERGY JOB NO: X-7930 A

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

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☑ DATE:

Brent Wilson
Quality Control Manager

Reviewed / Accepted
I.Q.S. #
William Bronaugh 6/22/12

MM187157

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: 5-24-12

CERTIFICATE OF TUBE TO TUBESHEET AIR TEST

P.O.# 17496 - 6001

TAG# HX1027

ENERGY JOB # X-7930 A

This is to certify that all tube to tubesheet welds on the above referenced equipment were air tested @ 15 P.S.I. and found to be satisfactory.

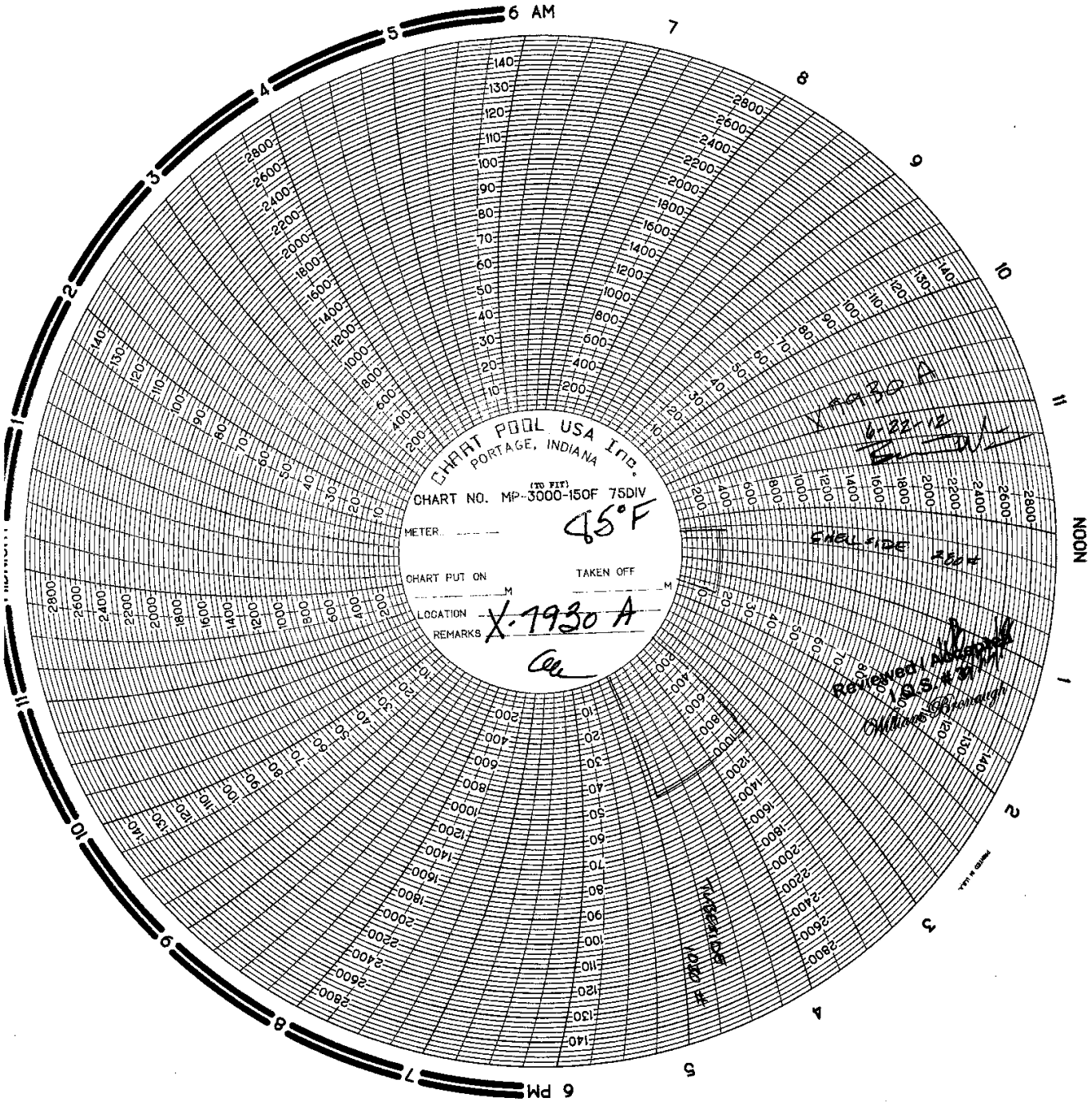
ENERGY EXCHANGER COMPANY

Brent Wilson
Quality Control Manager

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE:

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh 6/22/12

MM187157



INSPECTION DEPARTMENT
REVIEWED
WITNESSED DATE:

MM187157

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: 6-21-12

CERTIFICATE OF HYDROSTATIC TEST

P.O.# 17496-0001

TAG# Hx 1027

ENERGY JOB # X-7930 A

This is to certify the above referenced equipment was hydro tested at the following pressures:

280 **PSIG SHELL SIDE**

1030 **PSIG TUBE SIDE**

Bubble Test OK

ENERGY EXCHANGER COMPANY

INSPECTION DEPARTMENT
REVIEWED
WITNESSED ☐ DATE:

WB 6/22/12
Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

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: 6-26-12

CERTIFICATE OF NITROGEN PURGE

P.O. NO: 17496-0001

TAG NO: HX 1027

ENERGY JOB NO: X-7930A

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 Bronaugh

MM187157

ENERGY EXCHANGER COMPANY

PAINT CHECK LIST

Contractor: EATON INDUSTRIAL COATINGS

Unit Serial No: X-7930 A Customer Specification No: _____

Paint Required: 4-5 mils 450 CARBOLINE Primer; _____ mils _____ Intermediate;

4-5 mils 450 CARBOLINE Finish

Testex PRESS-O-FILM™ HT www.testextape.com X-Coarse 1.5 to 4.5 mil 38 to 115 µm Made in USA

Satisfactory Date

1. **Paint Shelf Life**
   A. **Materials in accordance with Project Specifications & Drawings**

WE	6/22/12	
	6/20/12	

2. **Notify Energy Exchanger Company**

3. **Weather Conditions:**
   93 temperature; 54% humidity; 90 substate, 74 dew point,
   EEC verify _____

WE	6/22/12	

4. **Surface Prep:**
   (Req'd) SSPC-SP- 10 2-3 mils; (Actual) SSPC-SP- 10 2.3 mils

WE	6/22/12	

5. **Surface Contamination**
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) —
12. **Dry Film Thickness:**
    (Req'd) 8-10 (Actual) 9-11
13. **Tie Down/Shipping Preparation**

WE		

WE		

2nd COAT
TEMP 98
S.TEMP 95
HUMIDITY 56%
DEWPOINT 78

Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

MM187157

SECTION 7

SPL-7930

ENERGY EXCHANGER COMPANY

SPARE PARTS LISTS

CUSTOMER: Southern Company Services (for) Mississippi Power							EEC QUOTE: 10-7314			
DESTINATION: DeKalb, Mississippi				P.O. No.: 17496-0001			EEC JOB NO.: X-7930			7/17/2012
		SPARE GASKETS								
TAG NO.	EEC JOB NUMBER	QTY. SETS	NO. GASKETS PER SET	EEC DWG. NUMBER	UNIT $ PRICE *	SHIPMENT				
HX1027	X-7930 A	**	1	X-7930-O	$ 1,175.00	2-3 Weeks				
HX2027	X-7930 B	**	1	X-7930-O	$ 1,175.00	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.

MM187157

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

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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.

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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

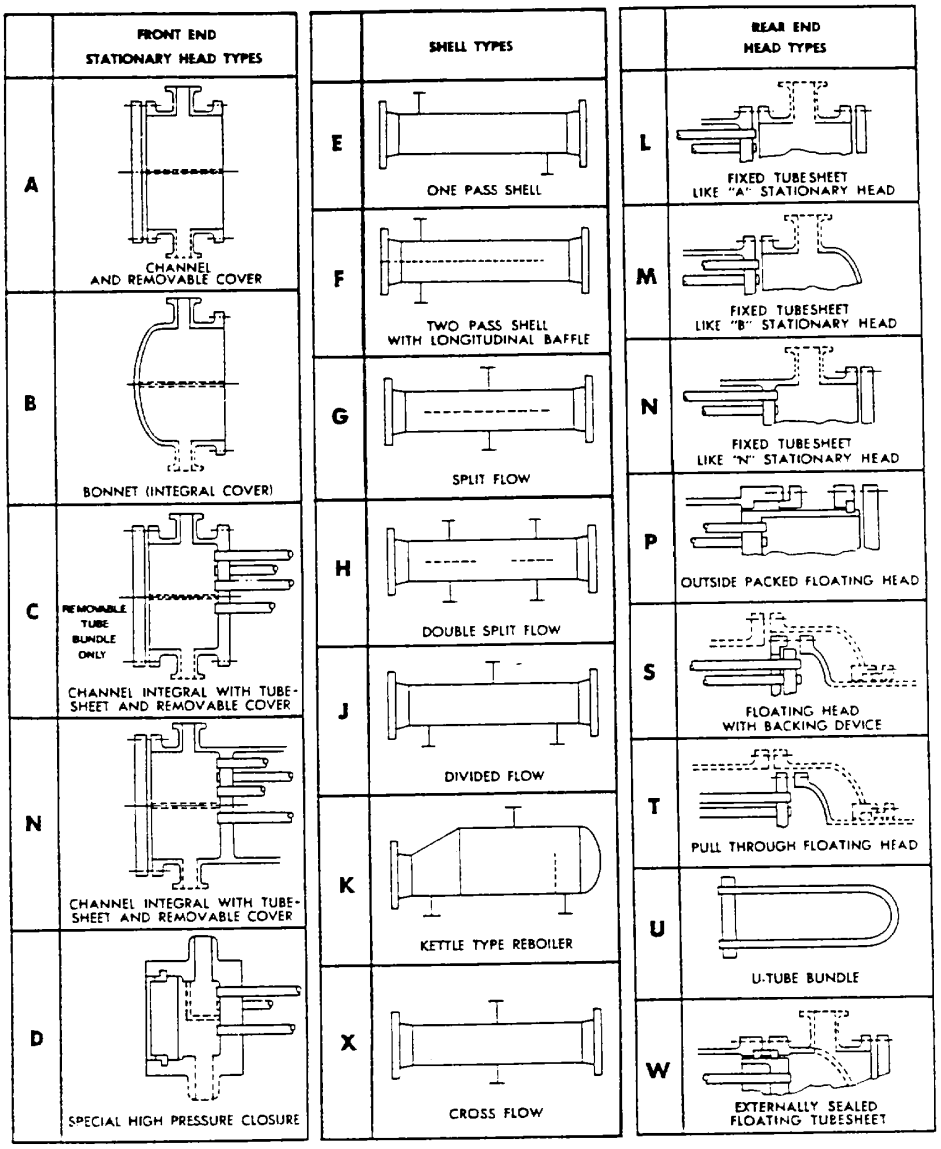
N-1 TYPE DESIGNATION-RECOMMENDED PRACTICE

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



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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

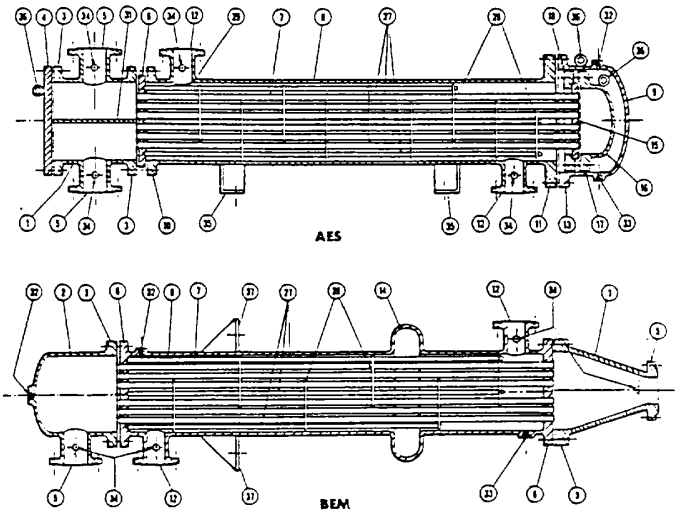

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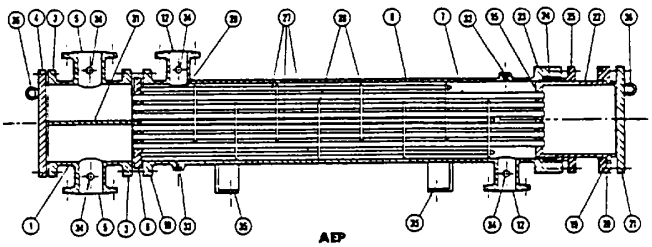
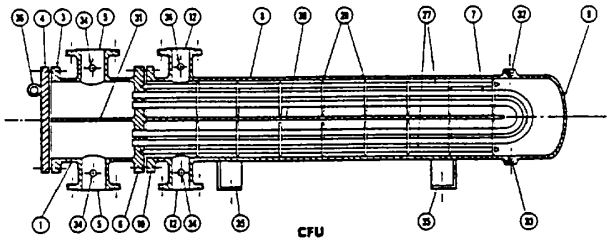
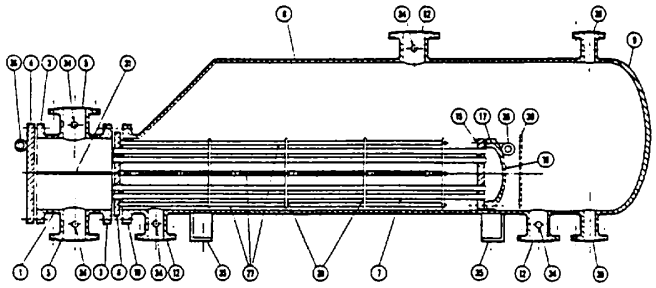
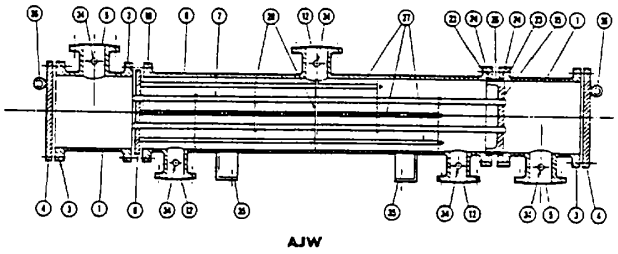
Figure N-2 (Continued)









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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.

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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.

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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.

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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.

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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.

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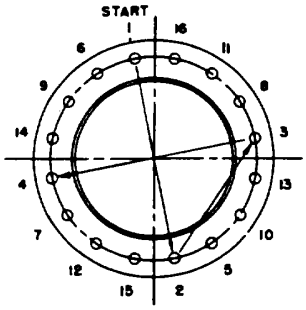
E-4.42 RECOMMENDED BOLT TIGHTENING PROCEDURE

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



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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.

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E-5.14 LOCATING LEAKS IN TUBES

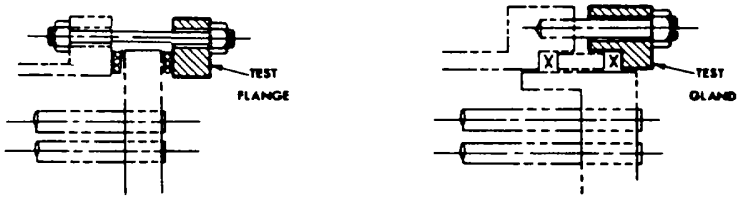
The following procedures may be used to locate perforated or split tubes and leaking joints between tubes and tubesheets. In most cases, the entire front face of each tubesheet will be accessible for inspection. The point where water escapes indicates a defective tube or tube-to-tubesheet joint.

(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

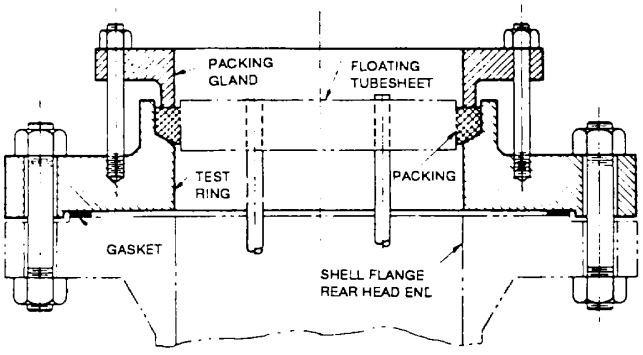


(3) Units with type S or T floating head:
Remove channel cover or bonnet, shell cover and floating head cover. Install test ring and bolt in place with gasket and packing. Apply hydraulic pressure in the shell. A typical test ring is shown in Figure E-5.14-2. When a test ring is not available it is possible 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



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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.

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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.

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(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.

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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.

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