MANUFACTURER'S DATA BOOK

MISSISSIPPI POWER

DEKALB, MISSISSIPPI

KEMPER COUNTY 1 – IGCC PROJECT

P.O. NO: 17497-0001

REQ. NO: MC202

ITEM NO: HX0059

MAKEUP WATER TRIM HEATER

1-29" x 288" NEU EXCHANGER

ENERGY JOB NO: X-7936

KBR

ACCEPTANCE
FOR ENGINEERING USE

THIS DOCUMENT IS:

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

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

DISCIPLINE VM BY SR
DATE 13JAN2012

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**
MM102691 0 Unit 1

ENERGY EXCHANGER COMPANY PO: MPC17497-0001
X-7936-MDB Rev: NA
IGCC - GASIFIER - MULTIPAGE - SHELL AND HEAT EXCHANGER EQUIPMENT

Mississippi Power
Kemper County 1 – IGCC Project
P.O. No: 17497-0001
Req. No: MC202
Item No: HX0059
Energy Job No: X-7936

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 05

Client:	SOUTHERN CO.	Purchase Order #:	MPC-17645; MPC17496 & MPC- 17497
EWO:	MPC9117.T61401	Supplier:	ENERGY EXCHANGERS
Shop Order #	SO # 7934, 7935, 7936	Location:	TULSA, OK
Project:	KEMPER COUNTY IGCC UNIT	Supplier Ref. #:	

Item #	Description	Qty Ordered	Qty Released	Balance
01	23-288 NEN exchanger	31	10	22
02	26-240 NFU exchanger	31	11	21
03	29-288 NEU exchanger	31	12	20

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: 12/20/11

David Hill

DWH

SECTION 2

Energy Exchanger Company

HEAT EXCHANGER SPECIFICATION SHEET

P. No.: 17497-0001 (REQ. No.: MC202)
REV. 0 AS PURCHASED

Customer	SOUTHERN COMPANY SERVICES															Job No.: X-7936 "AS BUILT"			
Address	BIRMINGHAM, AL															Rev.: 3		Date:	12/16/2011
Plant Location	KEMPER COUNTY, MS															File:		10-7314	
Service of Unit	MAKEUP WATER TRIM HEATER															Item: HX0059			
Size	29-288		Type	NEU		Horizontal								Connected In	1	Parallel	1	Series	
Surf./Unit ☐	Gross ☑	Eff	3007	ft²; Shells/Unit		1	Surf./Shell	☐	Gross ☑	Eff.	3007	ft²							
PERFORMANCE OF ONE UNIT																			
Fluid Allocation	Shell Side													Tube Side					
Fluid Name	LP STEAM													RECOVERED WATER					
Fluid Quantity, Total	lb/hr	37160 X 1.15												276227 X 1.15					
Vapor (In/Out)																			
Liquid																			
Steam		37160 X 1.15																	
Water				37160 X 1.15										276227 X 1.15		276227 X 1.15			
Noncondensable																			
Temperature (In/Out)	°F	281.				269.7								135.4				261.	
Density (Vapor/Liquid)	Lb/Ft³														61.60				58.63
Viscosity	cP														0.49				0.209
Molecular Weight																			
Molecular Weight, Noncondensable																			
Specific Heat	Btu/lb-F														0.9970				1.0140
Thermal Conductivity	Btu/hr-ft-F														0.3760				0.3960
Latent Heat	Btu/lb																		
Inlet Pressure	psia	43.												640.					
Velocity	ft/sec	61.71												5.26					
Pressure Drop, Allow./Calc.	psi	1.00	/	1.25										11.20	/	11.20			
Fouling Resistance (Min.)	Hr-Ft-°F/Btu	0.0005												0.001					
Heat Exchanged	35170000 X 1.15													Btu/hr; M.T.D. (Corrected)		45.63	°F		
Transfer Rate, Service	294.75													Btu/hr-ft²-F; Clean		695.56	Btu/hr-ft²-F		

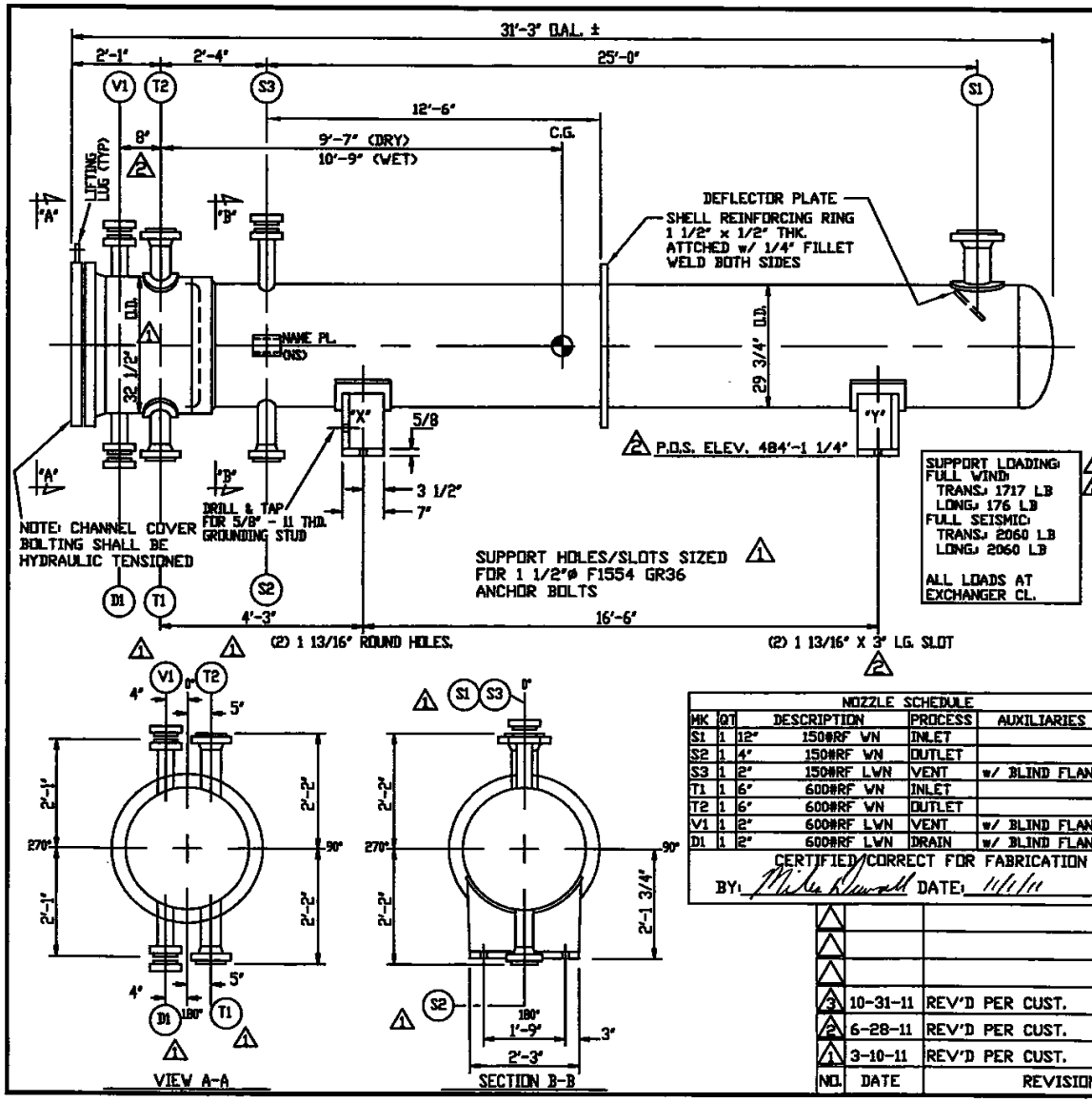
CONSTRUCTION OF ONE SHELL			
		Shell Side	Tube Side
Design/Test Pressure	psig	85 / FV / 280	1,000 / 1315
Design Temperature (Max/Min)	°F	350/10	285/10
No. Passes Per Shell		1	4
Corrosion Allowance	inch	0.125	0.125
Connections	In	1 - 12" 150RF	1 - 6" 600RF
Size &	Out	1 - 4" 150RF	1 - 6" 600RF
Rating	Intermediate		

Sketch (Bundle/Nozzle Orientation)

Tube No.	313 U'S	OD	0.75	in; Thk.	☑	Min	0.083	in; Length	24.	ft; Pitch	1	in	60°						
Tube Type	BARE							Material	SA-214										
Shell	SA-516-70				☑	ID	29.	in ;Shell Cover	SA-516-70					☑	Integ.	☐	Remov		
Channel or Bonnet	SA-516-70N							Channel Cover	SA-266-4N					☐	Integ.	☑	Remov		
Tubesheet-Stationary	SA-266-4N							Tubesheet - Floating											
Floating Head Cover								Impingement Protection	DEFLECTOR ON BENDS (SA-36).										
Baffles-Cross	15 - SA-36			Type	V D-SEG			% Cut (☑	Dia.	27.4	Spacing c/c	18.8	Inlet		in				
Baffles-Long								Seal Type											
Supports - Tube	SA-36			U-Bend	YES									Type	STRIP (3)				
Bypass Seal Arrangement								Tube-Tubesheet Joint	FULL STRENGTH WELD PER UW-20 (2)										
Expansion Joint								Type											
pv² - Inlet Nozzle				Bundle Entrance										Bundle Exit					
Gaskets - Shell Side								Tube Side	304 SS GMGC										
- Floating Head																			
Code Requirements	ASME SECTION VIII, DIV. 1 (STAMP: YES)													TEMA Class	R				
Weight/Shell	21200 #			Filled With Water			29700 #							Bundle		N/A			

REMARKS

1) ABOVE INFORMATION IS FOR "HIGH HHV" CASE WHICH IS A DESIGN CASE.
2) Fig. UW-20.1 (c) OR (d).
3) ONE STRIP SUPPORT REQUIRED AT U-BENDS



DESIGN DATA	SHELL	TUBE
DESIGN PRESSURE P.S.I.G.	85	1000
VACUUM PRESSURE P.S.I.G.	FV	N/A
TEST PRESSURE P.S.I.G.	280	1315
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
MAWP (MAC) P.S.I.G.	215	1009
LIMITED BY:	150# FLANGE RATING	CHANNEL COVER

ESTIMATED WEIGHTS, LBS.

DRY: 21200 BUNDLE: N/A WET: 29700

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-516-70
TUBESHEETS:	SA-266-4N
BAFFLES:	SA-36
TUBES:	SA-214

(313 U's) 3/4" O.D.X 0.0830" (min) X 24'-0" LG.
TUBE PITCH 1" △ SURFACE 3007 SQ. FT.

GENERAL NOTES

ALL BOLT HOLES TO STRADDLE NATURAL CENTER LINES.
INSULATION: 2" THK. (BOTH SIDES) (HC TYPE) 2
PAINT: SEE PAINT MAP DWG X-7936-AA
GASKETS: 1/8" THK 304 SS GMGC
(1) SPARE SET OF GASKETS REQUIRED.
TUBE-TS JOINT: FULL STRENGTH WELDED AND EXPANDED (2 GROOVES) 1
NITROGEN PURGE REQUIRED BOTH SIDES 3

NOZZLE SCHEDULE

MK	QT	DESCRIPTION	PROCESS	AUXILIARIES
S1	1	12" 150#RF WN	INLET	
S2	1	4" 150#RF WN	OUTLET	
S3	1	2" 150#RF LWN	VENT	w/ BLIND FLANGE
T1	1	6" 600#RF WN	INLET	
T2	1	6" 600#RF WN	OUTLET	
V1	1	2" 600#RF LWN	VENT	w/ BLIND FLANGE
D1	1	2" 600#RF LWN	DRAIN	w/ BLIND FLANGE

CERTIFIED CORRECT FOR FABRICATION
BY: Mike Dowell DATE: 11/1/11

CERTIFIED AS-BUILT
Mike Dowell 12/15/11

CUST: MISSISSIPPI POWER CO.
c/o SOUTHERN COMPANY SERVICES
P.O. NO.: 17497-0001 REQ. No.: MC202 1
ITEM NO.: HX0059
SERVICE: MAKEUP WATER TRIM HEATER
SHOP TO: KEMPER CO., MS

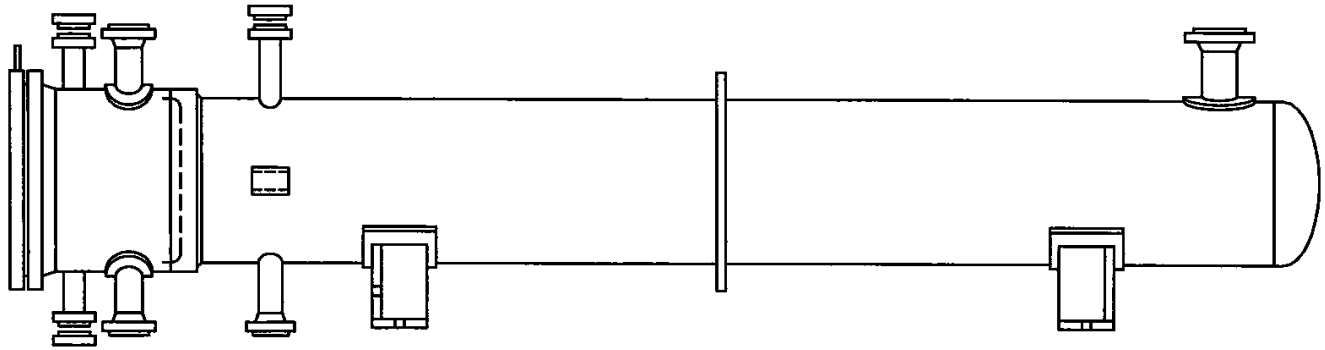
NO.	DATE	REVISIONS	DN
3	10-31-11	REV'D PER CUST.	DM/MD
2	6-28-11	REV'D PER CUST.	WE/DN
1	3-10-11	REV'D PER CUST.	DN/SG

ASSEMBLY AND SPECIFICATIONS FOR
2 ONE (1) 29-288 N E U

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

Energy Exchanger Co.

DWG. NO. X-7936-A
REV 3



COATING DATA SHEET - SYSTEM 6 APPLIES.
ABRASIVE BLAST PER SSPC-SP10 WITH AN ANCHOR PROFILE OF 2 TO 3 MILS.

FIRST COAT WITH HIGH TEMPERATURE EPOXY (4.0-5.0 MILS DFT)
SECOND COAT WITH HIGH TEMPERATURE EPOXY (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:	17497-0001 REQ No: MC202
ITEM NO:	HX0059
SERVICE:	MAKEUP WATER TRIM HEATER

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

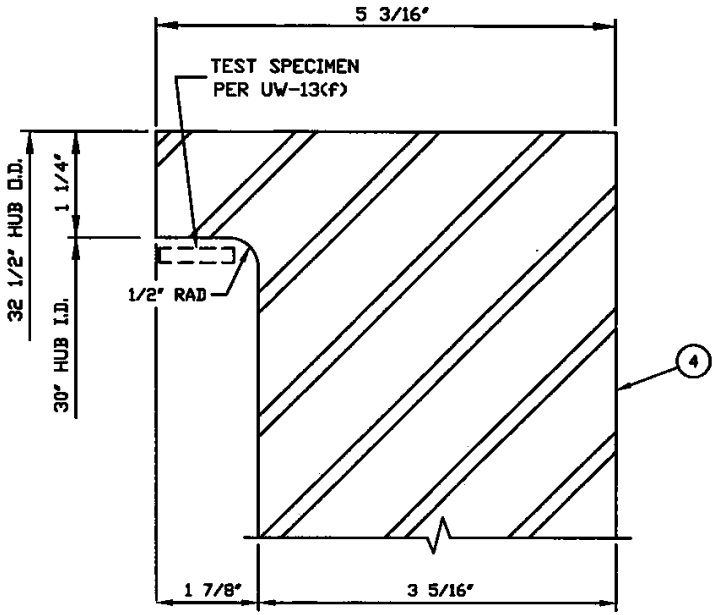
NO.	DATE	REVISIONS

PAINT MAP

DWN. BY: D.MORRISON
DATE: 3-28-11
CKD. BY:

Energy Exchanger Co.

DWG. NO. X-7936-AA
REV 0



CERTIFIED AS-BUILT

ONE

MATERIAL: SA-266-4N

CUSTOMER MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No: MC202
ITEM NO: HX0059
SERVICE: MAKEUP WATER TRIM HEATER

NO.	DATE	REVISIONS	DN
1	3-23-11	REV'D PER CUST.	DN/SG

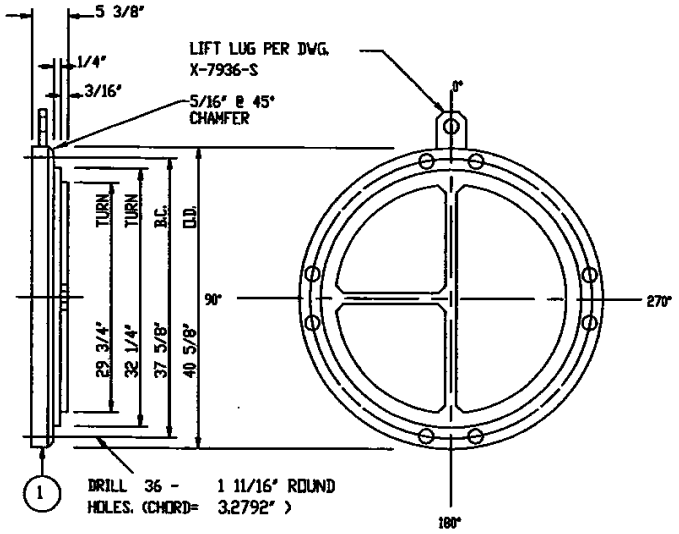
TUBESHEET FORGING DETAIL

DWN. BY: MD
DATE: 1/14/11
CKD. BY: DN

Energy Exchanger Co.

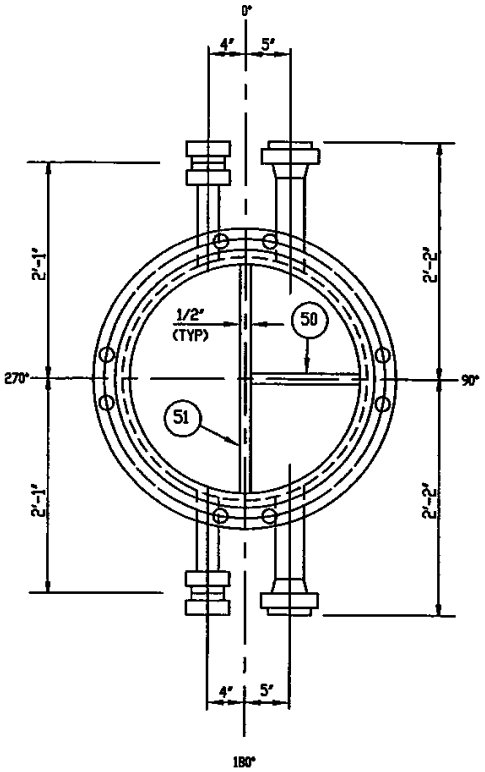
DWG. NO. X-7936-AB
REV 1

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°

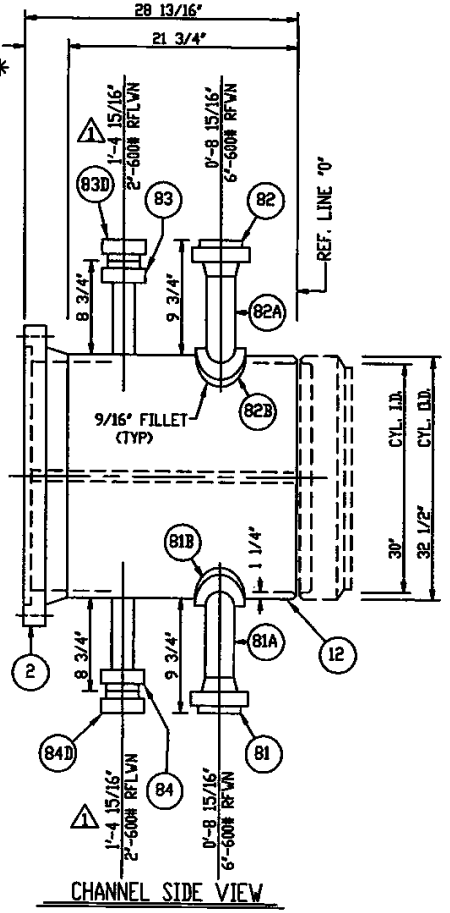


CHANNEL-COVER DETAIL

* MACHINE GASKET FACING AFTER ALL WELDING AND HEAT TREATMENT. FOR FLANGE DETAILS SEE DWG. X-7936-K



CHANNEL END VIEW



CHANNEL SIDE VIEW

CERTIFIED AS-BUILT

NOTES:
1) ALL BOLT HOLES TO STRADDLE CENTER LINES.
2) FOR WELD AND BEVEL DETAILS SEE DWG. X-7936-S
3) FOR JOB NOTES SEE DWG. X-7936-R
4) MILL PASS PLATE(S) TO 3/8"
5) NOZZLE SWING DIMENSION = 57" (2)

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No: MC202
ITEM NO: H00059
SERVICE: MAKEUP WATER TRIM HEATER

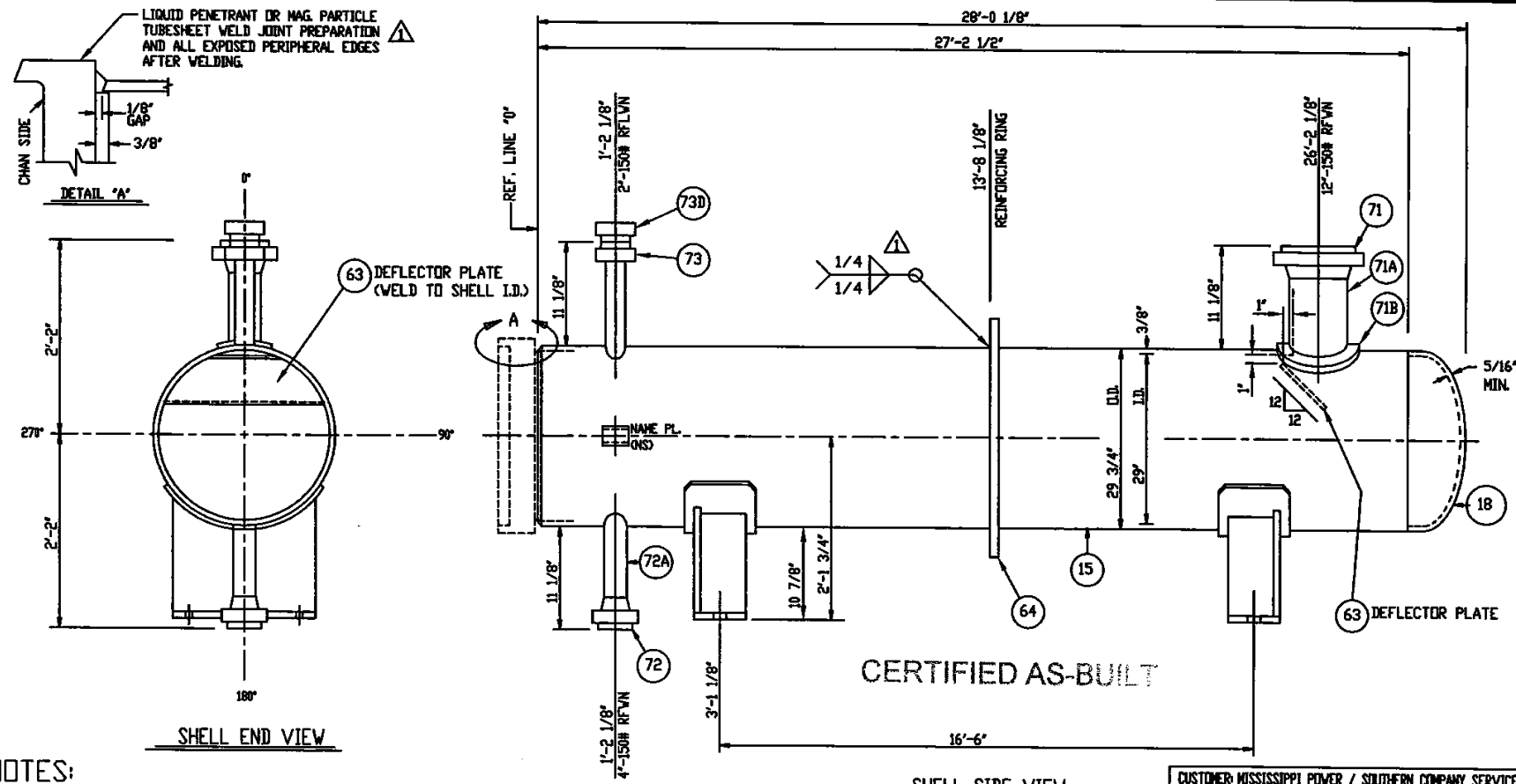
NO.	DATE	REVISIONS	
2	9-26-11	REV'D PER EEC.	KP
1	6-28-11	REV'D PER CUST.	WE/KP

FRONT CHANNEL DETAILS

DWN. BY D.MORRISON
DATE 3-28-11
CKD. BY SM

Energy Exchanger Co.

DWG. NO. X-7936-B
REV 2



NOTES:

1) ALL BOLT HOLES TO STRADDLE CENTER LINES.
2) FOR WELD AND BEVEL DETAILS SEE DWG. X-7936-S
3) FOR JOB NOTES SEE DWG. X-7936-R
4) SEE SUPPORT DETAILS FOR REFERENCE (DWG. X-7936-D). 1
5) SEE NAME PLATE DETAILS FOR REFERENCE (DWG X-7936-Q). 1
6) FOR FLANGE DETAILS SEE DWG. X-7936-K 1
7) FOR TUBESHEET DETAILS SEE DWG. X-7936-F. 1

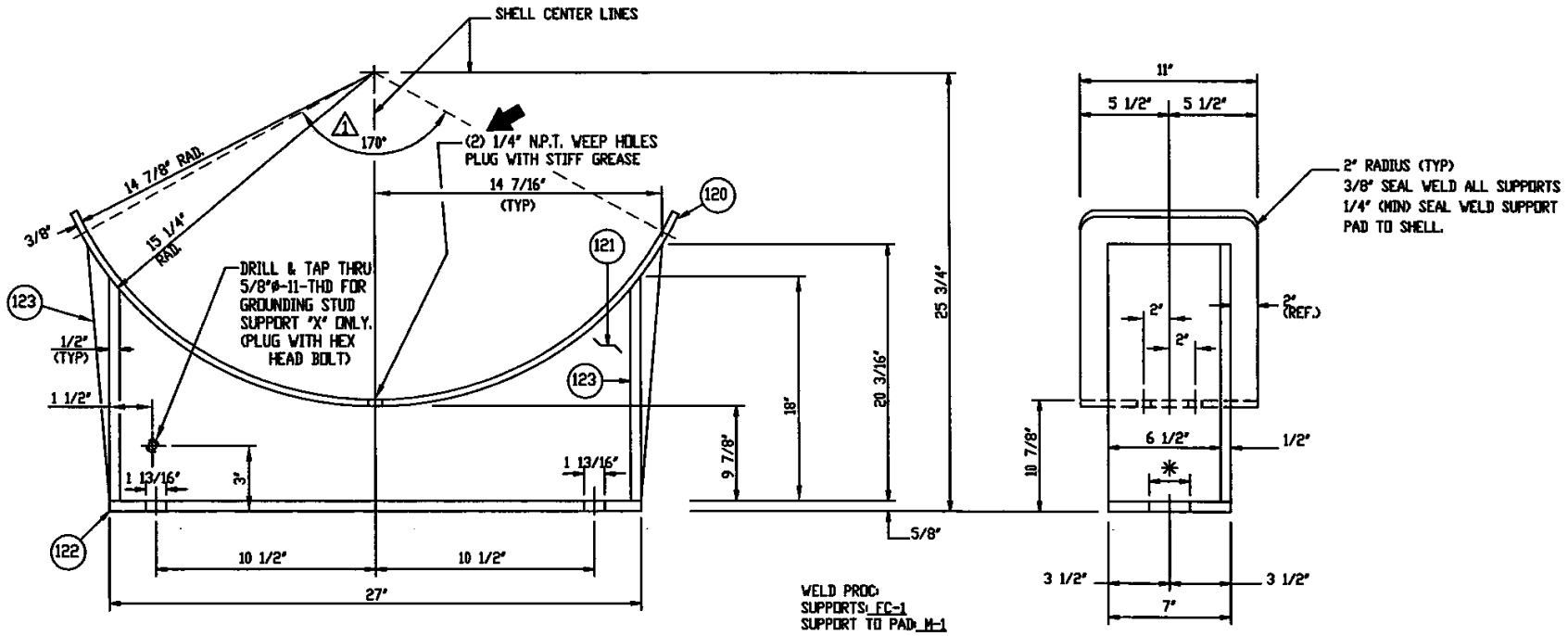
CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No: MC202
ITEM NO: HX0059
SERVICE: MAKEUP WATER TRIM HEATER

NO.	DATE	REVISIONS
1	6-28-11	REV'D PER CUST. WE/DA

SHELL DETAILS

DWN. BY: D.MORRISON
DATE: 3-28-11
CKD. BY: SM
DWG. NO.: X-7936-C
REV: 1

Energy Exchanger Co.



CERTIFIED AS-BUILT

✳ ONE REQUIRED MARKED "X" W/ (2) 1 13/16" ROUND HOLES.
ONE REQUIRED MARKED "Y" W/ (2) 1 13/16" X 3" LG. SLOTS. ⚠1
⚠1 FOR 1 1/2" DIA. F1554 GR36 ANCHOR BOLTS

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No: MC202
ITEM NO: HX0059
SERVICE: MAKEUP WATER TRIM HEATER

NO.	DATE	REVISIONS
⚠1	6-28-11	REV'D PER CUST. WE/D

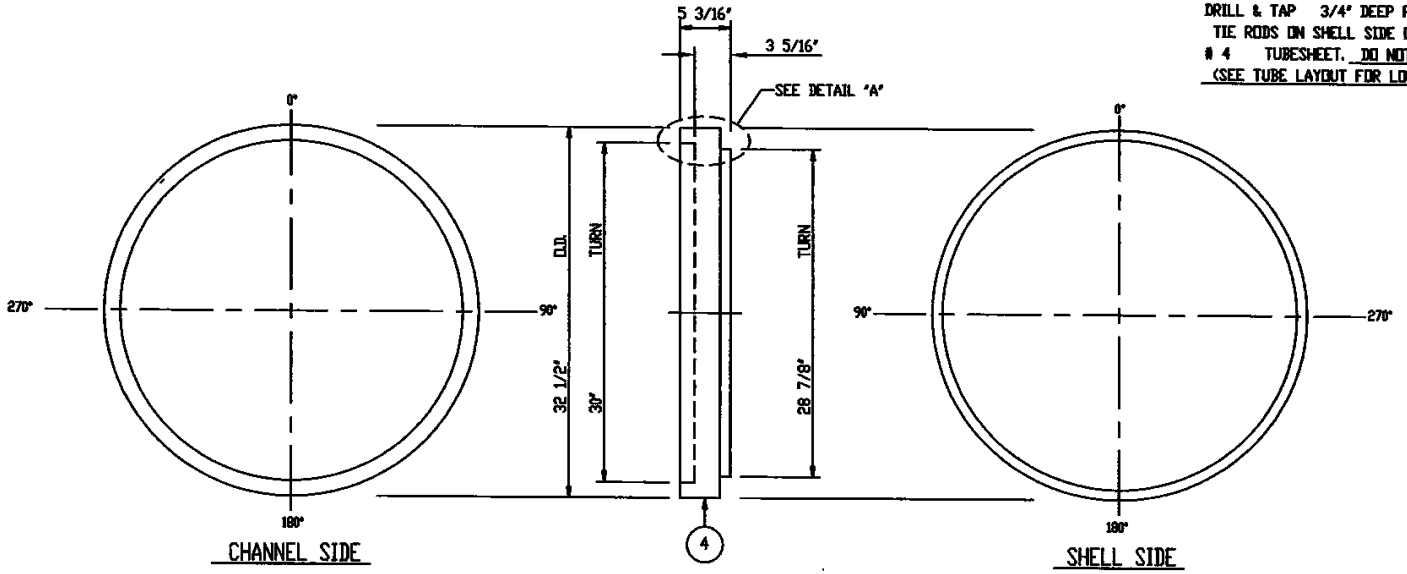
SUPPORT DETAILS

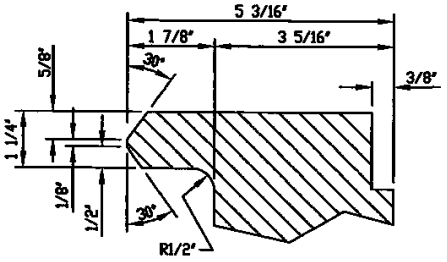
DWN. BY: D.MORRISON
DATE: 3-28-11
CKD. BY: SM
DWG. NO.: X-7936-D
REV: 1

Energy Exchanger Co.

NOTE: SEE DWG. X-7936-R FOR JOB NOTES.

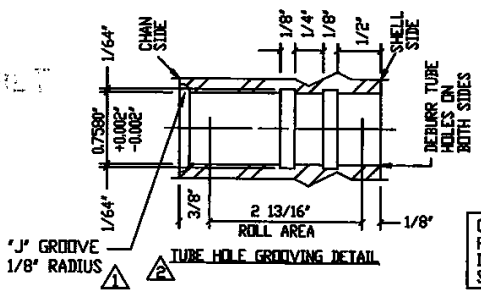
DRILL & TAP 3/4" DEEP FOR 6- 1/2" DIA. TIE RODS ON SHELL SIDE OF # 4 TUBESHEET. DO NOT DRILL THRU (SEE TUBE LAYOUT FOR LOCATIONS.)





DETAIL "A"

CERTIFIED AS-BUILT



NOTES:

1) MACHINE ALL SURFACES TO 250 Ra.
2) FOR JOB NOTES SEE DWG. X-7936-R
2

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.
DO NOT BURN TUBE ENDS
FINAL TUBE ROLLING AFTER HEAT TREAT.
BUBBLE TEST AT 15 P.S.I.G. PRIOR TO ROLLING

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No: MC202
ITEM NO: HX0059
SERVICE: MAKEUP WATER TRIM HEATER

NO.	DATE	REVISIONS
2	9-19-11	REV'D PER EEC BC/
1	6-28-11	REV'D PER CUST. WE/DN

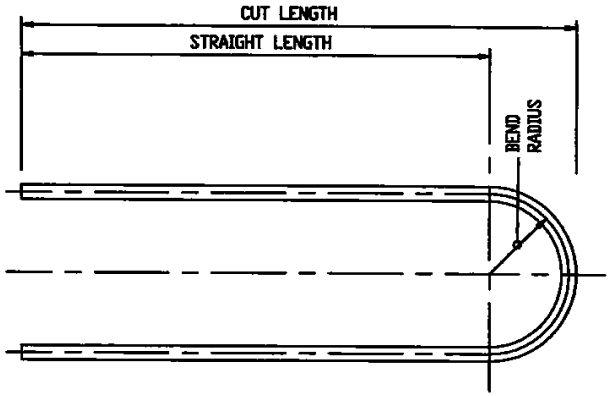
TUBESHEET DETAILS

DWN. BY: D.MORRISON
DATE: 3-28-11
CKD. BY: SM

Energy Exchanger Co.

DWG. NO. X-7936-F
REV 2

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"	24'-0"	24'-1 1/2"	48'-3 9/16"
B	15	1 5/8"	3 1/4"	0'-5 1/8"	24'-0"	24'-2"	48'-5 1/8"
C	16	2 1/8"	4 1/4"	0'-6 11/16"	24'-0"	24'-2 1/2"	48'-6 11/16"
D	14	2 5/8"	5 1/4"	0'-8 1/4"	24'-0"	24'-3"	48'-8 1/4"
E	16	3 1/8"	6 1/4"	0'-9 7/8"	24'-0"	24'-3 1/2"	48'-9 7/8"
F	14	3 5/8"	7 1/4"	0'-11 7/16"	24'-0"	24'-4"	48'-11 7/16"
G	16	4 1/8"	8 1/4"	1'-1"	24'-0"	24'-4 1/2"	49'-1"
H	14	4 5/8"	9 1/4"	1'-2 9/16"	24'-0"	24'-5"	49'-2 9/16"
J	16	5 1/8"	10 1/4"	1'-4 1/8"	24'-0"	24'-5 1/2"	49'-4 1/8"
K	14	5 5/8"	11 1/4"	1'-5 11/16"	24'-0"	24'-6"	49'-5 11/16"
L	14	6 1/8"	12 1/4"	1'-7 1/4"	24'-0"	24'-6 1/2"	49'-7 1/4"
M	12	6 5/8"	13 1/4"	1'-8 7/8"	24'-0"	24'-7"	49'-8 7/8"
N	14	7 1/8"	14 1/4"	1'-10 7/16"	24'-0"	24'-7 1/2"	49'-10 7/16"
O	12	7 5/8"	15 1/4"	2'-0"	24'-0"	24'-8"	50'-0"
P	14	8 1/8"	16 1/4"	2'-1 9/16"	24'-0"	24'-8 1/2"	50'-1 9/16"
Q	12	8 5/8"	17 1/4"	2'-3 1/8"	24'-0"	24'-9"	50'-3 1/8"
R	12	9 1/8"	18 1/4"	2'-4 11/16"	24'-0"	24'-9 1/2"	50'-4 11/16"
S	10	9 5/8"	19 1/4"	2'-6 1/4"	24'-0"	24'-10"	50'-6 1/4"
T	12	10 1/8"	20 1/4"	2'-7 13/16"	24'-0"	24'-10 1/2"	50'-7 13/16"
U	10	10 5/8"	21 1/4"	2'-9 7/16"	24'-0"	24'-11"	50'-9 7/16"
V	10	11 1/8"	22 1/4"	2'-11"	24'-0"	24'-11 1/2"	50'-11"
W	8	11 5/8"	23 1/4"	3'-0 9/16"	24'-0"	25'-0"	51'-0 9/16"
X	8	12 1/8"	24 1/4"	3'-2 1/8"	24'-0"	25'-0 1/2"	51'-2 1/8"
Y	6	12 5/8"	25 1/4"	3'-3 11/16"	24'-0"	25'-1"	51'-3 11/16"
Z	6	13 1/8"	26 1/4"	3'-5 1/4"	24'-0"	25'-1 1/2"	51'-5 1/4"
AA	2	13 5/8"	27 1/4"	3'-6 13/16"	24'-0"	25'-2"	51'-6 13/16"



TOTAL NO. REQUIRED: 313
SIZE: 3/4" O.D. x 0.083" (min) THK.
MATERIAL: SA-214

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

QUANTITIES SHOWN ARE FOR ONE SET OF U-TUBES, 1 -SET REQ'D. TOTAL.

CERTIFIED AS-BUILT

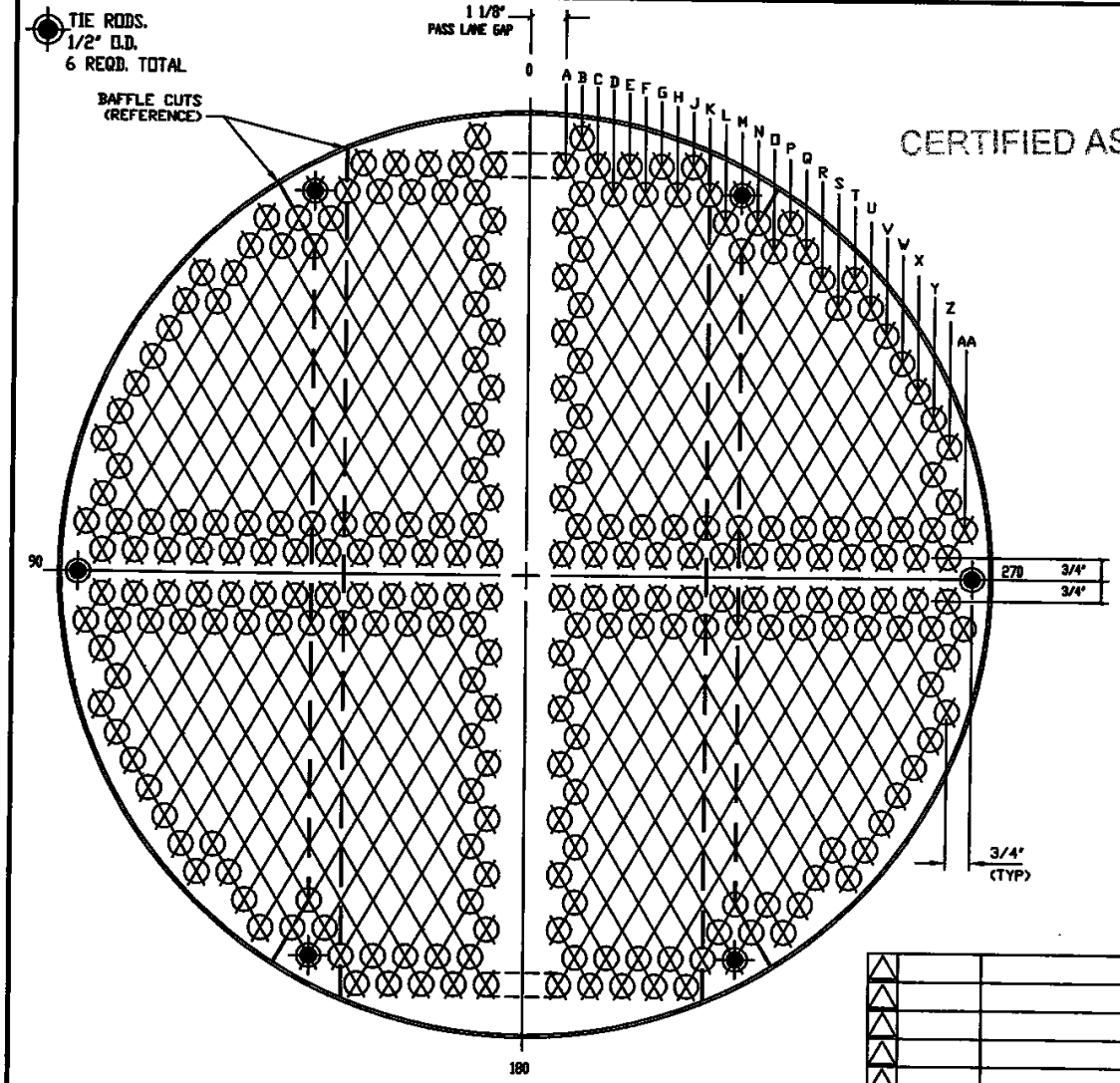
CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No: MC202 ⚠1
ITEM NO: HX0059
SERVICE: MAKEUP WATER TRIM HEATER

NO.	DATE	REVISIONS	DN/SG
⚠1	3-23-11	REV'D PER CUST.	DN/SG

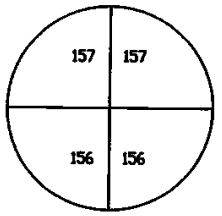
TUBE BENDING SCHEDULE

DWN. BY: MD
DATE: 1-10-11
CKD. BY: DN
DWG. NO.: X-7936-G
REV: 1

Energy Exchanger Co.



CERTIFIED AS-BUILT



TUBE DISTRIBUTION

NOTES:

1) DRILL AND REAM TUBE HOLES IN TUBESHEETS TO 0.7580" ± 0.002" DIA. FOR 313 - 3/4" O.D. U-TUBES. TOTAL HOLES = 626
2) TUBE PITCH = 1" TRIANGLE (60°). ⚠1
3) NUMBER OF PASSES = 4
4) SEE DRAWING X-7936-F FOR TUBE GROOVING DETAILS.
5) BAFFLE O.D. = 28 13/16"
6) O.T.L. = 28 1/2"

VIEW LOOKING AT SHELL SIDE OF NO. 4 TUBESHEET

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No: NC202
ITEM NO: H00059
SERVICE: MAKEUP WATER TRIN HEATER ⚠1

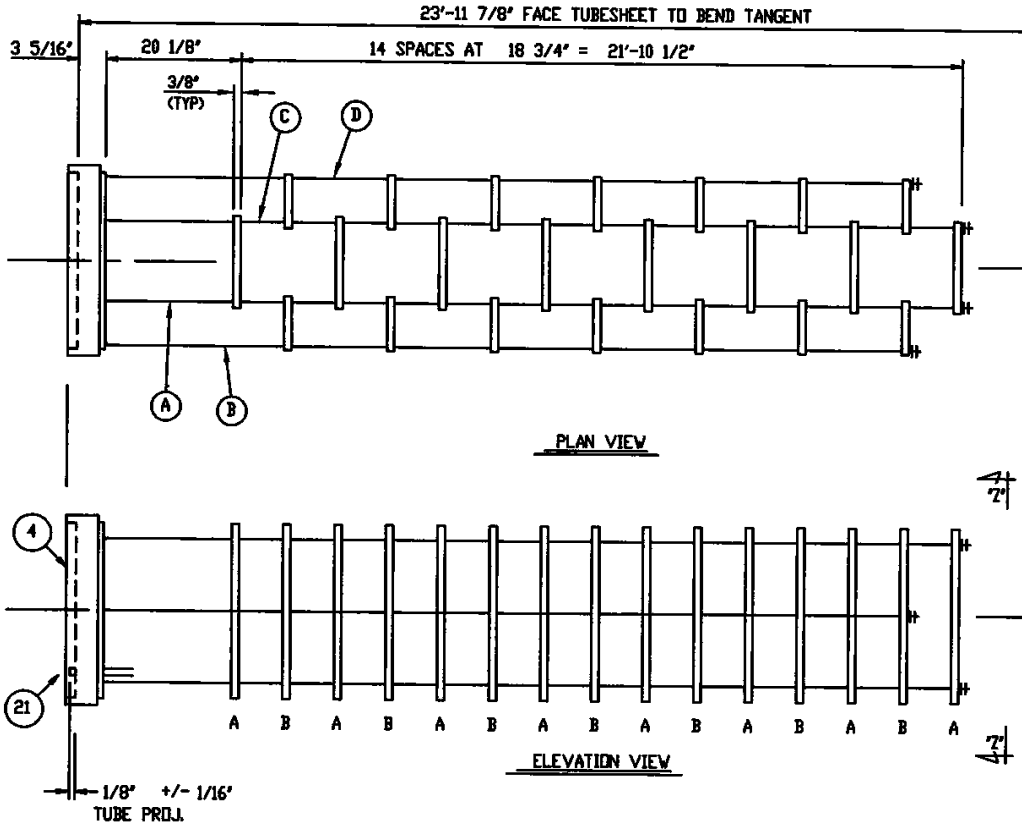
NO.	DATE	REVISIONS	
⚠1	3-23-11	REV'D PER CUST.	DN/SG

TUBE LAYOUT

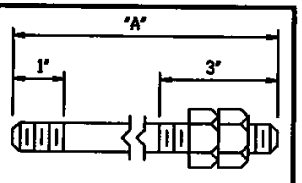
DWN. BY: MD
DATE: 1-10-11
CKD. BY: DN

Energy Exchanger Co.

DWG. NO. X-7936-H
REV 1

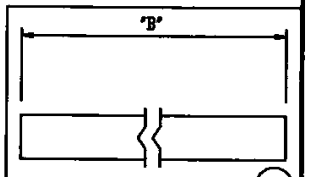


CERTIFIED AS-BUILT



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

	REQ'D.	"A"
R1	4	23'-8 3/4"
R2	2	22'-2"
R3		
R4		



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

	REQ'D.	"B"
A	4	19 3/4"
B	2	38 1/2"
C	56	18 3/8"
D	12	37 1/8"
E		
F		
G		

NOTES:
1) FOR SECTION AND VIEW DETAILS SEE DWG. X-7936-J1
2) FOR JOB NOTES SEE DWG. X-7936-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.
DO NOT BURN TUBE ENDS
FINAL TUBE ROLLING AFTER HEAT TREAT.
BUBBLE TEST AT 15 P.S.I.G. PRIOR TO ROLLING

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No: NC202
ITEM NO: H08059
SERVICE: MAKEUP WATER TRIM HEATER

NO.	DATE	REVISIONS

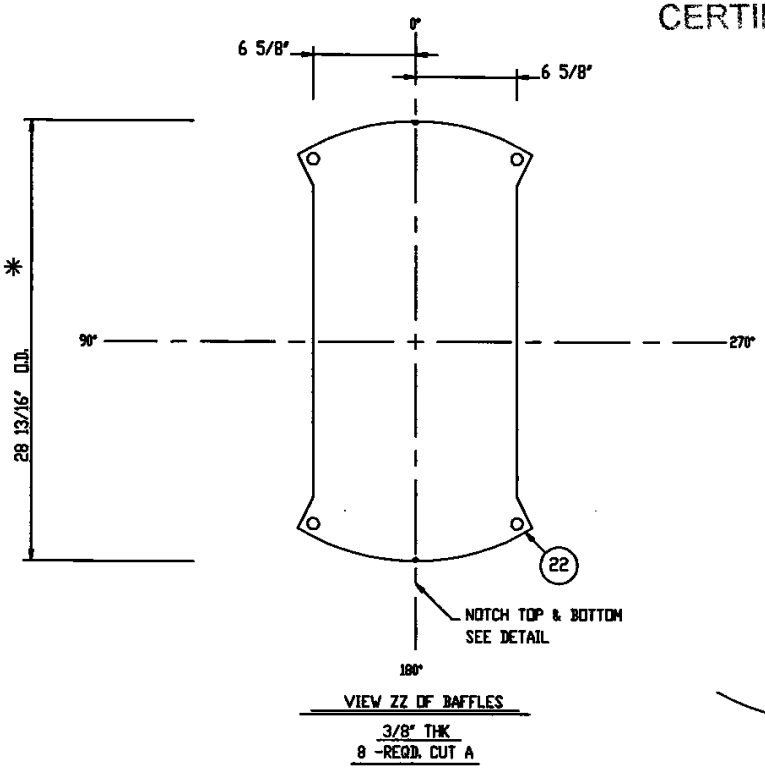
BUNDLE DETAILS

DWN. BY D.MORRISON
DATE 3-28-11
CKD. BY

Energy Exchanger Co.

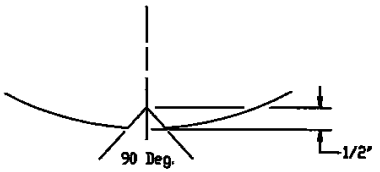
DWG. NO. X-7936-1
REV 0

CERTIFIED AS-BUILT

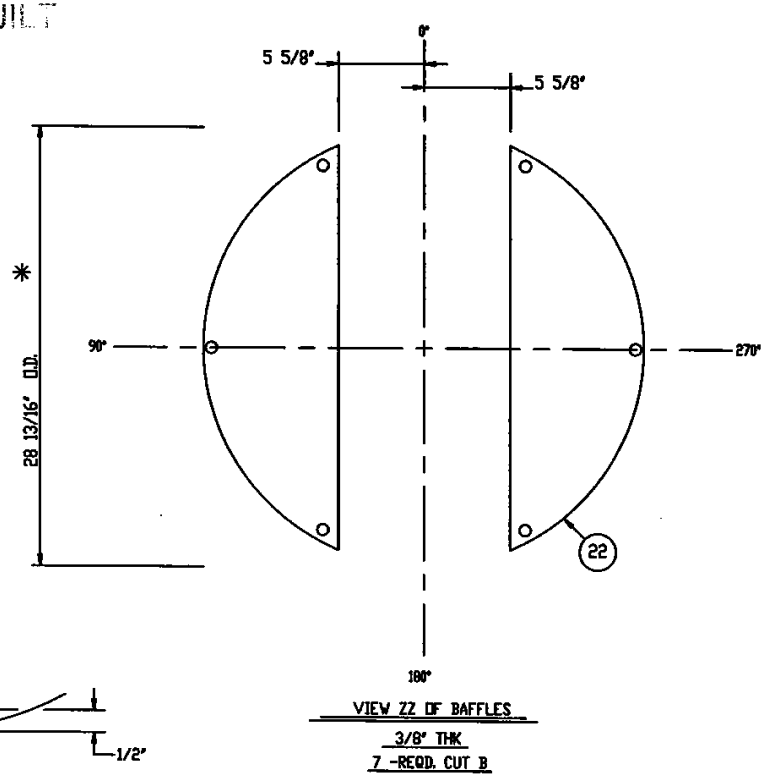


VIEW ZZ OF BAFFLES

3/8" THK
8 -REQD. CUT A



NOTCH DETAIL



VIEW ZZ OF BAFFLES

3/8" THK
7 -REQD. CUT B

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No.: MC202
ITEM NO: HX0059
SERVICE: MAKEUP WATER TRIM HEATER

NOTES:

1) FOR JOB NOTES SEE DWG. X-7936-R
2) DRILL TUBE HOLES IN BAFFLES 49/64" DIA. & DEBURR.
3) DRILL TIE ROD HOLES 9/16" DIA.
   SEE TUBE LAYOUT FOR LOCATION (DWG. X-7936-H). 1
4) RADIUS ALL CORNERS ON BAFFLE CUTS.
* 5) CHECK SHELL I.D. BEFORE MACHINING BAFFLE O.D.
6) MACHINE O.D. OF BAFFLES TO 250 Ra.
7) SEE TUBE LAYOUT FOR BAFFLE CUT LOCATIONS (DWG X-7936-H). 1

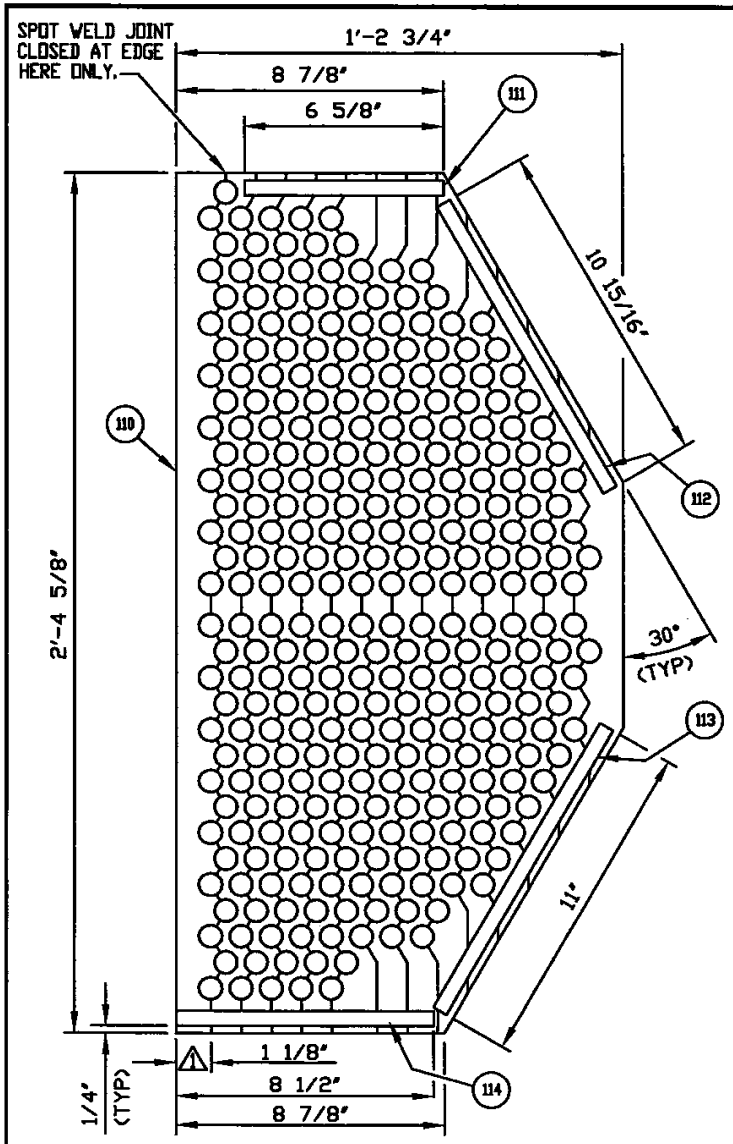
NO.	DATE	REVISIONS
1	6-28-11	REV'D PER CUST. WE/DM

BAFFLE DETAILS

DWN. BY: D.MORRISON
DATE: 3-28-11
CKD. BY: SM

Energy Exchanger Co.

DWG. NO.: X-7936-J1
REV: 1



NOTES:

1) ALL PLATE MATERIAL SHALL BE 1/2" THICK
2) SUPPORT RODS SHALL BE 1/2" DIA, ATTACHED TO PLATE WITH 1/8" FILLET WELD.
3) DRILL TUBE HOLES 13/16" DIA AND DEBURR.
4) REMOVE ALL SHARP CORNERS ON SUPPORT ASSEMBLY.
5) TUBE PITCH 1" TRI. (60°)

CERTIFIED AS-BUILT

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No.: MC202
ITEM NO: HX0059
SERVICE: MAKEUP WATER TRIM HEATER

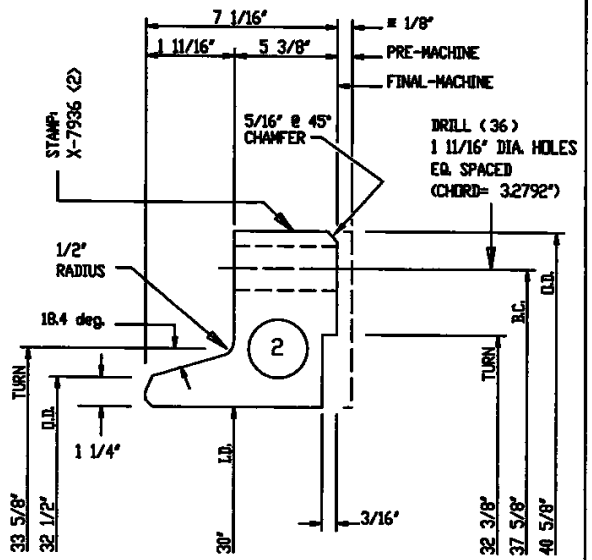
NO.	DATE	REVISIONS
1	11-22-11	REV PER EEC DM/

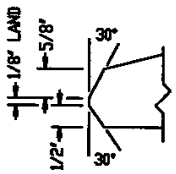
U-BEND SUPPORT DETAIL

DWN. BY: D.Morrison
DATE: 4-6-11
CKD. BY: SM

Energy Exchanger Co.

DWG. NO.: X-7936-J2
REV: 1





#2 GIRTH FLANGE (ONE) REQ'D.

CERTIFIED AS-BUILT

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No: MC282
ITEM NO: HX0059
SERVICE: MAKEUP WATER TRIM HEATER

NOTES:

1) SEE DWG. X-7936-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.

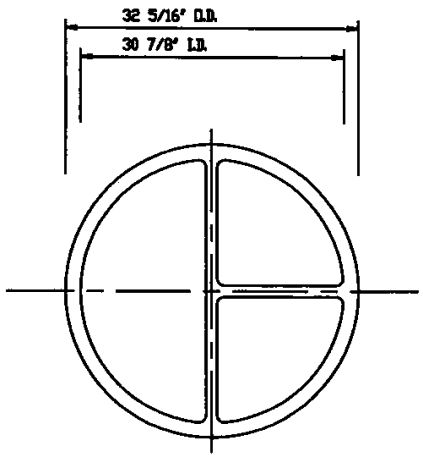
NO.	DATE	REVISIONS

GIRTH FLANGES

DWN. BY: D.MORRISON
DATE: 3-28-11
CKD. BY:

Energy Exchanger Co.

DWG. NO. X-7936-K
REV 0



(1)-REQUIRED.
CHANNEL COVER GASKET
1/8" THK 304 STN STL GMGC
RIB WIDTH TO BE 7/16" WIDE.

CERTIFIED AS-BUILT

NOTES:

1) QUANTITIES SHOWN FOR ONE SET
   (2)-SET REQUIRED TOTAL.
   ONE SET OF GASKETS TO BE USED IN EXCH. AND
   (1) SET TO BE BOXED, MARKED WITH
   P.O. & ITEM NO. & SHIPPED WITH EXCHANGER.
2) ALL RADII TO BE 1/4"
3) ALL JACKETED GASKETS TO HAVE
   LAP OF GASKET NEAR SIDE.

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No.: NC202
ITEM NO: HX0059
SERVICE: MAKEUP WATER TRIM HEATER

NO.	DATE	REVISIONS
1		
2		
3		
4		
5		
6		

GASKET DETAILS

DWN. BY: D.MORRISON
DATE: 3-28-11
CK'D. BY:

Energy Exchanger Co.

DWG. NO.: X-7936-D
REV: 0

■ SHOP TO ASSIGN AT COMPLETION OF FABRICATION

CERTIFIED BY

Energy Exchanger Company

TULSA, OKLAHOMA

U

W

RT-3

HT-T

MAWP SHELL	215	P.S.I. @	350	°F	280	TEST P.S.I.G.
MAWEP	15	P.S.I. @	350	°F		
MAWP TUBE	1009	P.S.I. @	285	°F	1315	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 @	1009	P.S.I.G.

SERIAL NO. X-7936 YEAR BUILT ■

P.O. NO. 17497-0001

SERVICE MAKEUP WATER TRIM HEATER

ITEM HX0059 SIZE 29-288 TYPE NEU

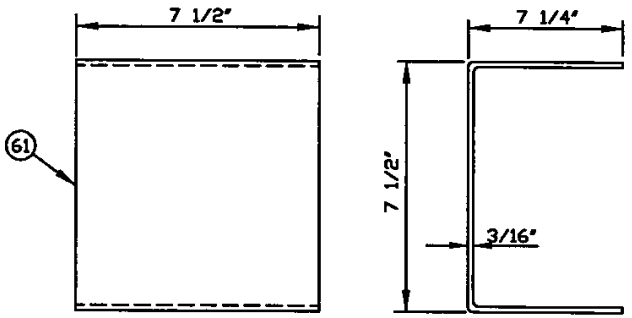
DESIGN PRESSURE: SHELL = 85 PSI; TUBE = 1000 PSI

60

CLIP CORNERS & SEAL WELD TO NAME PLATE BRACKET

NAME PLATE DETAIL

ONE - REQ'D.



NAME PLATE BRACKET DETAIL

ONE - REQ'D.

CERTIFIED AS-BUILT

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No: MC202
ITEM NO: HX0059
SERVICE: MAKEUP WATER TRIM HEATER

NO.	DATE	REVISIONS

NAME PLATE DETAILS

DWN. BY D.MORRISON

DATE 3-28-11

CKD. BY

Energy Exchanger Co.

DWG. NO. X-7936-Q

REV 0

FABRICATION REQUIREMENTS

1. ALL BOLT HOLES TO STRADDLE NATURAL CENTER LINES.
2. NOZZLES SHALL NOT PROTRUDE BEYOND THE INSIDE SURFACE OF THE CHANNEL OR SHELL.
3. CHECK SHELL FOR OUT-OF-ROUNDNESS. USE TWO DISCS EQUAL THE BAFFLE DIA. MOUNTED ON A SHAFT 18" APART.
4. FLANGE FLATNESS TOLERANCE AND SURFACE FINISH SHALL BE MEASURED AFTER THE FLANGE HAS BEEN WELDED & PWHT.
5. CHANNEL COVER AND BODY FLANGE PERIPHERAL GASKET SURFACES SHALL HAVE A FLATNESS TOLERANCE OF 1/32" AND MEASURED WITH A DIAL GAUGE. PASS PL. GROOVES AND PASS PLATE EDGES SHALL BE MEASURED WITH A STRAIGHT EDGE.
6. WELD JOINT SURFACES AND A MINIMUM OF 1 INCH OF THE INTERNAL AND EXTERNAL SURFACES OF THE ADJACENT BASE METAL SHALL BE CLEANED.
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. △1

M.T. REQUIREMENTS

1. MT ALL LIFTING LUG WELDS
2. ALL FINISHED WELDS ON TUBESIDE SHALL BE EXAMINED AFTER PWHT. △1
3. TEMPORARY ATTACHMENT WELDS SHALL BE REMOVED, THE AREAS DRESSED, AND EXAMINED.

HEAT TREAT REQUIREMENTS

CHANNEL:

A) HEAT FROM 800 deg.F TO 1150 deg.F ±25 deg. F. AT 320 deg.F PER HOUR.
B) HOLD AT 1150 deg.F ±25 deg. F. FOR 1.25 -HOUR MIND.
C) COOL FROM 1150 deg.F TO 800 deg.F AT 400 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.

HARDNESS REQUIREMENTS

1. WELD HARDNESS TESTING, SHALL BE IN ACCORDANCE WITH THE FOLLOWING:
   A) THE WELD METAL & HAZ OF PRESSURE-RETAINING WELDS IN COMPONENTS
   △1 B) BRINELL HARDNESS LIMITS SHALL BE 200 MAX.
   △1 C) DELETED
   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.

△1 I) TESTING SHALL BE DONE IN ACCESSIBLE INSIDE SURFACES.

HYDROTESTING REQUIREMENTS

1. HOLD FOR AT LEAST ONE HOUR. A HYDROTEST CHART IS REQ'D.
2. MINIMUM TEST WATER TEMP. = 40 deg.F.
3. PAINT OR OTHER COATINGS SHALL NOT BE APPLIED OVER WELDS BEFORE FINAL HYDROTEST.
4. LEAK TEST WELD PADS WITH 15 PSI AIR AND SOAP SOLUTION, OBSERVING WELDS FROM THE INSIDE AND OUTSIDE.
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 FLANGED GASKET SURFACES SHALL BE COATED WITH RUST VETO 342 RUST PREVENTIVE AND SHALL BE PROTECTED BY STEEL COVERS & A MINIMUM OF (4) FULL DIA. BOLTS. PROVIDE A 1/4" DRAIN HOLE IN BOTTOM COVERS.
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 △2 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: 17497-0001 REQ NO: MC202
ITEM NO: HX0059
SERVICE: MAKEUP WATER TRIM HEATER

NO.	DATE	REVISIONS	
△			
△			
△			
△			
2	10-31-11	REV'D PER CUST.	SM/
1	9-26-11	REV'D PER CUST.	KP/DM

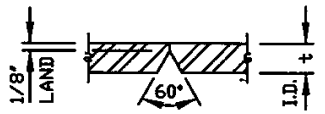
JOB NOTES

DWN. BY: D.MORRISON
DATE: 3/28/11
CKD. BY: SM

Energy Exchanger Co.

DWG. NO.: X-7936-R
REV: 2

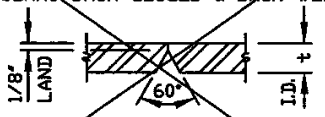
t=LESS THAN 7/16"
LOCATE LONG SEAM 15° ABOVE CL
UNLESS OTHERWISE SPECIFIED.
ALL SEAMS BACK GOUGED & BACK WELDED



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

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

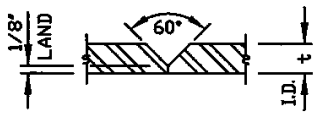
t=7/16" TO 5/8"
LOCATE LONG SEAM 15° ABOVE CL
UNLESS OTHERWISE SPECIFIED.
ALL SEAMS BACK GOUGED & BACK WELDED



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

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

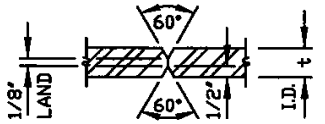
t=LESS THAN 7/16"
ALL SEAMS BACK GOUGED & BACK WELDED



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

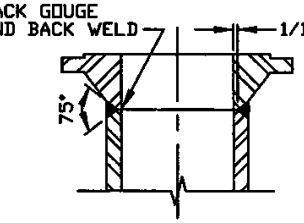
CIRC WELD BEVEL
(CYL TO HEAD)

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



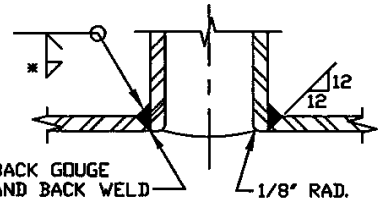
CHANNEL WELD PROC: A-1-H
SHELL WELD PROC: -----

LONG OR CIRC WELD BEVEL
(CYL TO FLG, T.S. OR CYL)



CHANNEL WELD PROC: M-6-H
SHELL WELD PROC: M-5 (4"), A-1 (12")

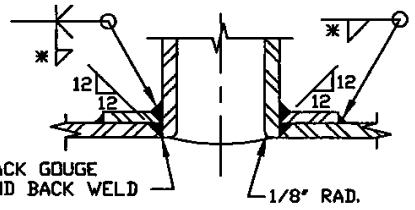
WELD-NECK FLANGE INSTALLATION



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

NOZZLE INSTALLATION WITHOUT PAD

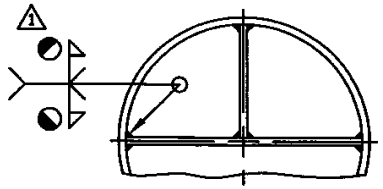
(1) 1/4" NPT IN EACH WELD PAD OR SEC. OF WELD PAD. PLUG W/ STIFF GREASE, UNLESS DETAILS SPECIFY OTHERWISE.



CHANNEL WELD PROC: M-1-H
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

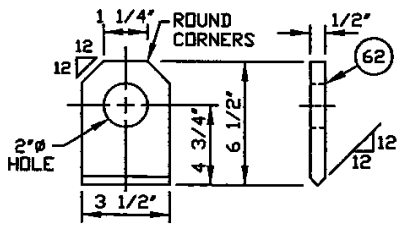


1/4" (MIN.) AT FRONT CHANNEL

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

WELD PROCEDURE: M-1-H

PASS PLATE WELDS



FULL PEN W/ 1/4" FILLET

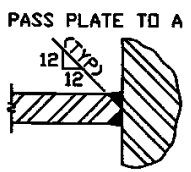
WELD PROCEDURE: M-1

LIFTING LUG DETAIL

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

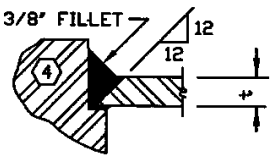
1/4" MINIMUM FILLET WELDS FOR ALL NON PRESSURE ATTACHMENTS UNLESS NOTED OTHERWISE

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



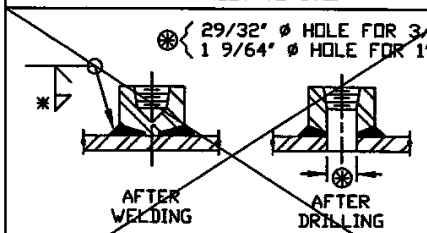
WELD PROC: M-1-H

PASS PLATE TO TUBESHEET WELD



SHELL WELD PROC: M-6

CIRCUMFERENTIAL SEAM
(TUBESHEET TO CYL)



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

COUPLING INSTALLATION (DRILLED)

CERTIFIED AS-BUILT

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No: MC202
ITEM NO: HX0059
SERVICE: MAKEUP WATER TRIM HEATER

NO.	DATE	REVISIONS	
1	6-28-11	REV'D PER CUST.	WE/DW

WELD & BEVEL DETAILS

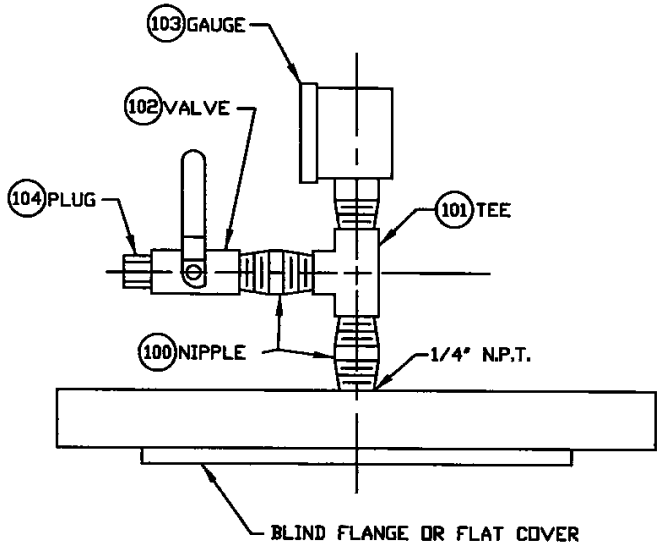
DWN. BY: D.MORRISON
DATE: 3/29/11
CKD. BY: SM

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

DWG. NO.: X-7936-S
REV: 1

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: 17497-0001 REQ No.: MC202
ITEM NO: HX0859
SERVICE: MAKEUP WATER TRIM HEATER

NO.	DATE	REVISIONS
1		
2		
3		
4		
5		
6		

NITROGEN PURGE DETAILS

DWN. BY: D.MORRISON
DATE: 10/31/11
CKD. BY:

Energy Exchanger Co.

DWG. NO.: X-7936-NP
REV: 0

BILL OF MATERIAL

PART NO	ONE REQ'D., DESCRIPTION OF ONE	MATERIAL SPEC.	QTY ONE	TOT QTY	REV	NOTE	PO NO	PROMISED	
21	TUBES 3/4" O.D.X 0.0830" (min) THK.PER BEND SCHEDULE	SA-214	313	313		2			*
	FORGED RING MATERIAL								
2	FLG 40 5/8" O.D.X 30" I.D.X 7 1/16" THK	SA-266-4N	1	1		1			*
	TUBESHEETS & COVERS								
4	TUBESHEET PER DWG. X-7936-AB	SA-266-4N	1	1		1			*
1	COVER 40 5/8" O.D.X 5 3/8" THK	SA-266-4N	1	1		1			*
	BAFFLES								
22	BAFFLES 28 13/16" O.D. X 3/8" THK	SA-36	15	15					*
	HEADS								
18	ELLIP HD. 29" I.D.X 5/16" THK(min) W/2" SF	SA-516-70	1	1					*
	CYLINDERS								
12	R&W CYL 30" I.D.X 1 1/4" THK X 1'-9 3/4" LG.	SA-516-70N	1	1					*
	(98 3/8" WRAP) X 1 1/4" THK X 22" LG.								
15	R&W CYL 29" I.D.X 3/8" THK X 27'-2 1/2" LG.	SA-516-70	1	1					*
	(92 1/2" WRAP) 2-CYL 10'-0" 1-CYL 7'-3"								

MATERIAL SHALL NOT ORIGINATE IN EITHER CHINA OR NORTH KOREA.

* DENOTES PRELIMINARY ORDER

1) MATERIAL SHALL BE 100% U.T. PER SA-508 SUPPLEMENTAL REQUIREMENT S2.
2) WELDED TUBE SHALL BE EDDY CURRENT TESTED PER SA-450 AFTER FINAL HEAT TREATMENT PRIOR TO BENDING. ⚠

CERTIFIED AS-BUILT

⚠ REQ No: MC202
SERVICE: MAKEUP WATER TRIM HEATER

NO.	DATE	DESCRIPTION
⚠	3/22/11	REV PER CUSTOMER DN/SG

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

CUST: MISSISSIPPI POWER c/o SOUTHERN COMPANY SERVICES
P.O.: 17497-0001 ITEM: HX0059

PB/M	DR: MD	CK: DN	DATE: 1/10/11	DWG. NO.	REV
FB/M	DR: DM	CK:	DATE: 3-29-11	X-7936-1BM	1

BILL OF MATERIAL

PART NO	ONE REQ'D. DESCRIPTION OF ONE	MATERIAL SPEC.	QTY ONE	TOT QTY	REV	NOTE	PO NO	PROMISED	
	ASME FLANGES								
71	ASME 12" - 150 # RF WN W/ (SchXH BORE)	SA-105	1	1					*
72	ASME 4" - 150 # RF WN W/ (Sch120 BORE)	SA-105	1	1					*
81	ASME 6" - 600 # RF WN W/ (SchXH BORE)	SA-105N	1	1					*
82	ASME 6" - 600 # RF WN W/ (SchXH BORE)	SA-105N	1	1					*
73	ASME 2" - 150 # RF LWN X 12" LG(2.000"BORE)	SA-105	1	1					*
83	ASME 2" - 600 # RF LWN X 12" LG(2.000"BORE)	SA-105N	1	1					*
84	ASME 2" - 600 # RF LWN X 12" LG(2.000"BORE)	SA-105N	1	1					*
71A	SMLS.PIPE 12 3/4" ODX(0.5000" SchXH)X 9" LG.	SA-106B	1	1					*
72A	SMLS.PIPE 4 1/2" ODX(0.4380" Sch120)X 9 1/4" LG.	SA-106B	1	1					*
81A	SMLS.PIPE 6 5/8" ODX(0.4320" SchXH)X 9 1/4" LG.	SA-106B	1	1					*
82A	SMLS.PIPE 6 5/8" ODX(0.4320" SchXH)X 9 1/4" LG.	SA-106B	1	1					*
71B	WELD PAD 16 3/16" O.D. x 15 3/4" O.D. x 3/8" THK	SA-516-70	1	1					*
81B	WELD PAD 10 1/16" O.D. x 9 5/8" O.D. x 3/4" THK	SA-516-70N	1	1					*
82B	WELD PAD 10 1/16" O.D. x 9 5/8" O.D. x 3/4" THK	SA-516-70N	1	1					*
73D	ASME 2" - 150 # RF BLIND FLANGE	SA-105	1	1					*
83D	ASME 2" - 600 # RF BLIND FLANGE	SA-105N	1	1					*
84D	ASME 2" - 600 # RF BLIND FLANGE	SA-105N	1	1					*
	COUPLINGS								

SEE DWG. X-7936-1BM FOR MATERIAL NOTES

* DENOTES PRELIMINARY ORDER

CERTIFIED AS-BUILT

REQ No: NC202
SERVICE: MAKEUP WATER TRIM HEATER

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

CUST: MISSISSIPPI POWER c/o SOUTHERN COMPANY SERVICES

P.O.: 17497-0001 ITEM: HX0059

NO.	DATE	DESCRIPTION					DWG. NO.	REV
1	3/22/11	REV PER CUSTOMER DN/SG	PB/M	DR: MD	CK: MD	DATE: 1/10/11	X-7936-2BM	0
			FB/M	DR: DM	CK: [illegible]	DATE: 3/29/11		

BILL OF MATERIAL

PART NO	ONE REQ'D, DESCRIPTION OF ONE	MATERIAL SPEC.	QTY ONE	TOT QTY	REV	NOTE	PO NO	PROMISED	
	BOLTING & GASKETS								
40	LOT OF GASKETS PER DWG X-7936-D		2	2					
41	1 1/2" ROUND X 8-THREAD STUDS X 16" LG. 1&2	SA-193B7	36	36					
42	1 1/2" HEAVY HEX NUTS 8-THREAD	SA-194-2H	72	72					
43	WASHERS 2 3/8" O.D. X 1 5/8" I.D. X 1/4" THK	4140HT	72	72					
44	5/8" DIA X 11 THD X 3 3/8" LG STUDS (2"-150# RF)	SA-193B7	4	4					
44A	5/8" X 11 THD HEAVY HEX NUTS (2"-150# RF)	SA-194-2H	8	8					
44B	GASKET .175" THK 304 STN STL SP. WD FLEXIBLE GRAPHITE FILLED W/								
	1/8" THK C'STL OUTER COMPRESSION RING FOR (2"-150# RF)		1	1					
45	5/8" DIA X 11 THD X 4 3/8" LG STUDS (2"-600# RF)	SA-193B7	16	16					
45A	5/8" X 11 THD HEAVY HEX NUTS (2"-600# RF)	SA-194-2H	32	32					
45B	GASKET .175" THK 304 STN STL SP. WD FLEXIBLE GRAPHITE FILLED W/								
	1/8" THK C'STL OUTER COMPRESSION RING FOR (2"-600# RF)		2	2					
	MISC. MATERIAL								
60	STD. NAME PLATE	STN.STL.	1	1					
61	STD. NAME PLATE BRK'T.	SA-516-70	1	1					
62	LIFTING LUG 3 1/2" X 1/2" X 6 1/2" LG	SA-516-70	1	1					
23	FT. 1/2" O.D. TIE RODS	C'STL	140	140					
23A	FT. 3/4" O.D. SPACER TUBING	SA-214	140	140					
23B	1/2" TIE ROD HEX NUTS	C'STL	12	12					
63	DEFLECTOR PLATE 11 1/2" X 3/8" THK X 27 1/8" LG	SA-516-70	1	1					
64	REINFORCEMENT RING 32 7/8" O.D. X 29 7/8" I.D. X 1/2" THK	SA-516-70	1	1					
50	PASS PLATES 14 11/16" X 1/2" THK X 30 7/8" LG.	SA-516-70N	1	1	1				
51	PASS PLATES 29 7/8" X 1/2" THK X 30 7/8" LG.	SA-516-70N	1	1	1				
70	NOZZLE SHIPPING COVERS PER NOZZLE COVER SKETCH								
	U-BEND SUPPORT MATERIAL								
110	PLATE 14 3/4" X 1/2" X 28 5/8" LG	SA-516-70	1	1					
111	1/2" DIA ROD X 6 5/8" LG	C'STL	1	1					
112	1/2" DIA ROD X 10 15/16" LG	C'STL	1	1					
113	1/2" DIA ROD X 11" LG	C'STL	1	1					
114	1/2" DIA ROD X 8 1/2" LG	C'STL	1	1					
	SUPPORT MATERIAL								
120	PLATE 11" X 3/8" THK X 42 1/8" LG.	SA-516-70	2	2					
121	PLATE 28 7/8" X 1/2" THK X 20 3/16" LG.	SA-516-70	2	2					
122	PLATE 7" X 5/8" THK X 27" LG.	SA-516-70	2	2					
123	PLATE 6 1/2" X 1/2" THK X 18" LG.	SA-516-70	4	4					
125	5/8" DIA X 11 THK HEX HEAD BOLT X 2" LG	C'STL	1	1					
	NITROGEN PURGE MATERIAL								
100	1/4" PIPE NIPPLE X 2" LG. (THRD. OUTSIDE EACH END)	C. STL.	4	4	2				
101	1/4" STRAIGHT TEE (THRD. INSIDE EACH END)	C. STL.	2	2	2				
102	1/4" PIPE VALVE (INSIDE THRD.) (#5X713)	BRASS	2	2	2				
103	1/4" PRESSURE GAUGE (#5X939)(P570K-60LMX0-60 PSIG)		2	2	2				
104	1/4" PIPE PLUG	C. STL.	2	2	2				

* DENOTES PRELIMINARY ORDER

CERTIFIED AS-BUILT

REQ No: MC202
SERVICE: MAKEUP WATER TRIM HEATER

NO.	DATE	DESCRIPTION
E	10-31-11	REV'D PER CUST. SM/
D	6-28-11	REV'D PER CUST. WE/DN

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

CUST: MISSISSIPPI POWER c/o SOUTHERN COMPANY SERVICES
P.O.: 17497-0001 ITEM: HX0059

FB/M	DR: ----	CK: ----	DATE: ----	DWG. NO.	REV
FB/M	DR: DM	CK: SM	DATE: 3-29-11	X-7936-3BM	2

X-7936 PACKING LIST

LINE NO	SPARE PARTS LIST	MATERIAL SPEC.	QTY ONE	TOT QTY	REV	NOTE	PO NO	PROMISED	
SP1	SPARE GASKETS PER DWG. X-7936-D		1 SET(S)	1 SET(S)					
SP2									
SP3									
SP4									
SP5									
SP6									
SP7									
SP8									
SP9									
SP10									

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

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

DO NOT ORDER FROM PACKING LIST

CERTIFIED AS-BUILT

REQ No: MC202
SERVICE: MAKEUP WATER TRIM HEATER

NO.	DATE	DESCRIPTION

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

CUST: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O.: 17497-0001 ITEM: HX0059

PB/M	DR: ——	CK: ——	DATE: ——	DWG. NO.	REV
FB/M	DR: DM	CK: GM	DATE: 3/28/11	X-7936-PL	0

Energy Exchanger Company

Mike Wurell 12/15/11
CERTIFIED AS-BUILT

DATE: 1/14/2011
PAGE: 1 OF 28 △1

MECHANICAL CALCULATIONS

CUSTOMER:	MISSISSIPPI POWER c/o SOUTHERN COMPANY SERVICES
DESTINATION:	KEMPER COUNTY, MISSISSIPPI
P.O. No.:	17497-0001 △1
ITEM No.:	HX0059
E.E.C. SERIAL No.:	X-7936
SERVICE:	MAKEUP WATER TRIM HEATER
REQ. No.:	MC202 △1

DESIGN DATA		
	SHELL SIDE	**TUBE SIDE**
DESIGN PRESSURE	85 PSIG / FV	1000 PSIG
DESIGN TEMP.	350 °F	285 °F
M.D.M.T.	10 °F	10 °F
CORR. ALLOW.	0.125"	0.125"
NO. PASSES	1	4
M.A.W.P. (H&C)	215 PSIG	1009 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 UCS-66(a,b, c & d)

REVISION LOG

DATE	PAGE	REV.	DESCRIPTION
3/22/2011	AS NOTED	1	PER CUSTOMER COMMENT

W.O. No.: X-7936

Input Echo, Component 1, Description: SHELL CYLINDER

Design Internal Pressure	P	85.00	psig
Temperature for Internal Pressure		350.00	F
User Entered Minimum Design Metal Temperature		10.00	F
Design External Pressure	PEXT	15.00	psig
Temperature for External Pressure		350.00	F
External Pressure Chart Name		CS-2	
Include Hydrostatic Head Components		NO	
Material Specification (Not Normalized)		SA-516 70	
Material UNS Number		K02700	
Material Form used		Plate	
Allowable Stress At Temperature	S	20000.00	psi
Allowable Stress At Ambient	SA	20000.00	psi
Yield Stress At Temperature	Sy	33050.00	psi
Curve Name for Chart UCS 66		B	
Joint efficiency for Shell Joint	E	0.85	
Maximum Thickness before Full Radiography		1.2500	in.
Design Length of Section	L	165.000	in.
Length of Cylinder for Volume Calcs.	CYLLEN	330.000	in.
Inside Diameter of Cylindrical Shell	D	29.000	in.
Minimum Thickness of Pipe or Plate	T	0.3750	in.
Nominal Thickness of Pipe or Plate	Tnom	0.3750	in.
Shell/Head Int. Corrosion Allowance	CA	0.1250	in.
Stiffening Ring Material Specification		SA-516 70	
Stiffening Ring Material UNS Number		K02700	
External Pressure Chart Name for Ring		CS-2	
Size of Fillet Weld Leg Ring to Shell		0.250	in.
Width of Reinforcing Ring	WRING	1.5000	in.
Thickness of Reinforcing Ring	TRING	0.5000	in.
Ring Type to Satisfy Inertia and Area Req.		NONE	
Ring Weld Attachment Style		CONTINUOUS	
Location of Reinforcing Ring		EXTERNAL	
The Angle-type Ring is rolled the "Hard Way"			
Skip UG-16(b) Min. thickness calculation		NO	
Type of Element:		Cylindrical Shell	

Internal pressure results, Shell Number 1, Desc.: SHELL CYLINDER

ASME Code, Section VIII, Division 1, 2007, A-09

Thickness Due to Internal Pressure (Tr):

```
= (P*(D/2+CA)) / (S*E-0.6*P) per UG-27 (c)(1)
= (85.00*(29.0000/2+0.1250))/(20000.00*0.85-0.6*85.00)
= 0.0733 + 0.1250 = 0.1983 in.
```

Max. All. Working Pressure at Given Thickness (MAWP):

```
= (S*E*(T-CA-CAE)) / ((D/2+CA)+0.6*(T-CA-CAE)) per UG-27 (c)(1)
= (20000.00*0.85*(0.2500))/((29.0000/2+0.1250)+0.6*0.2500)
= 287.65 psig
```

Maximum Allowable Pressure, New and Cold (MAPNC):

```
= (SA*E*T) / (D/2+0.6*T) per UG-27 (c)(1)
= (20000.00*0.85*0.3750)/(29.0000/2+0.6*0.3750)
= 432.94 psig
```

Actual stress at given pressure and thickness (Sact):

```
= (P*((D/2+CA)+0.6*(T-CA-CAE))) / (E*(T-CA-CAE))
= (85.00*((29.0000/2+0.1250)+0.6*(0.2500)))/(0.85*(0.2500))
= 5910.00 psi
```

SUMMARY OF INTERNAL PRESSURE RESULTS:

Required Thickness plus Corrosion Allowance, Trca		0.1983	in.
Actual Thickness as Given in Input		0.3750	in.
Maximum Allowable Working Pressure	MAWP	287.648	psig
Maximum Allowable Pressure, NC	MAPNC	432.937	psig
Design Pressure as Given in Input	P	85.000	psig

Hydrostatic Test Pressures (Measured at High Point):

Hydrotest per UG-99(b); 1.3 * MAWP * Sa/S	373.94	psig
Hydrotest per UG-99(c); 1.3 * MAPNC	562.82	psig
Pneumatic per UG-100 ; 1.1 * MAWP * Sa/S	316.41	psig

Percent Elongation per UCS-79 (50 * tnom/Rf * (1-Rf/Ro)) 1.277 %

Minimum Design Metal Temperature per UCS-66 Curve : B
Govrn. thk, tg = 0.375 , tr = 0.073 , c = 0.1250 in. , E* = 0.85
Stress Ratio = tr * (E*) / (tg - c) = 0.249 , Temp. Reduction = 140 F

Min. Metal Temp. w/o impact per Fig. UCS-66	-20	F
Min. Metal Temp. at Req'd thk. (UCS 66.1)	-155	F
Min. Metal Temp. w/o impact per UG-20(f)	-20	F

External Pressure Results, Shell Number 1, Desc.: SHELL CYLINDER
ASME Code, Section VIII, Division 1, 2007 A-09

External Pressure Chart CS-2	at	350.00	F
Elastic Modulus for Material		28500000.00	psi

Results for Max. Allowable External Pressure (Emawp):

Corroded Thickness of Shell	TCA	0.2500	in.
Outside Diameter of Shell	ODCA	29.750	in.
Design Length of Cylinder or Cone	SLEN	165.000	in.
Diameter / Thickness Ratio	(D/T)	119.0000	
Length / Diameter Ratio	LD	5.5462	
Geometry Factor, A f(DT,LD)	A	0.0001819	
Materials Factor, B, f(A, Chart)	B	2592.2869	psi
Maximum Allowable Working Pressure		29.05	psig

EMAWP = (4*B)/(3*(D/T)) = (4 *2592.2869)/(3 *119.0000) = 29.0452

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

Corroded Thickness of Shell	TCA	0.1920	in.
Outside Diameter of Shell	ODCA	29.750	in.
Design Length of Cylinder or Cone	SLEN	165.000	in.
Diameter / Thickness Ratio	(D/T)	154.9438	
Length / Diameter Ratio	LD	5.5462	
Geometry Factor, A f(DT,LD)	A	0.0001223	
Materials Factor, B, f(A, Chart)	B	1743.1707	psi
Maximum Allowable Working Pressure		15.00	psig

EMAWP = (4*B)/(3*(D/T)) = (4 *1743.1707)/(3 *154.9438) = 15.0005

Results for Maximum Length Between Stiffeners (Slen):

Corroded Thickness of Shell	TCA	0.2500	in.
Outside Diameter of Shell	ODCA	29.750	in.
Design Length of Cylinder or Cone	SLEN	318.331	in.
Diameter / Thickness Ratio	(D/T)	119.0000	
Length / Diameter Ratio	LD	10.7002	
Geometry Factor, A f(DT,LD)	A	0.0000940	
Materials Factor, B, f(A, Chart)	B	1338.8224	psi
Maximum Allowable Working Pressure		15.00	psig

EMAWP = (4*B)/(3*(D/T)) = (4 *1338.8224)/(3 *119.0000) = 15.0008

Effective Length of Shell			3.00	in.
	Area (in²)	Distance (in.)	Area*Dist	
Shell:	0.750	0.1250	0.094	
Ring :	0.750	1.0000	0.750	
Total:	1.500		0.844	

Centroid of Ring plus Shell		=	0.563	in.
	Inertia	Distance	A*Dist^2	
Shell:	0.004	0.4375	0.144	
Ring :	0.141	-0.4375	0.144	
Total:	0.145		0.287	
Available Moment of Inertia, Ring plus Shell			0.432	in**4

Required Stress in Ring plus Shell	BREQ	1314.84	psi
Required Strain in Ring plus Shell	AREQ	0.0000920	

Required Moment of Inertia, Ring plus Shell
= (OD^2 * SLEN * (TCA+ARING/SLEN) * AREQ)/ 10.9
= (29.7500^2*165.0000*(0.2500+0.7500/165.0000)*0.0000920)/10.9
= 0.3138 in**4

Results for Stiffening Ring Weld Calculations per UG-30

Radial Pressure Load	Pext*Slen	2475.00	lb./in.
The Radial Shear Load	V	736.31	lb.
The First Moment of the Area (Ring + Shell)	Q	0.33	in.^3
Weld Shear Flow due to Rad. Shear Load	VQ/I	559.73	lb./in
The Weld Allowable Stress	.55*S	11000.00	psi
Minimum Weld Leg Size Min(.25,TCA,Tring)	Wldmin	0.25	in.
The Weld Allowable Load	2* WLeg*.55*S	5500.00	lb./in
The Combined Weld Load SRSS of VQ/I and Pext*Slen		2537.50	lb./in

Summary of External Pressure Results:

Allowable Pressure at Corroded thickness	29.05	psig
Required Pressure as entered by User	15.00	psig
Required Thickness including Corrosion all.	0.3170	in.
Actual Thickness as entered by User	0.3750	in.
Maximum Length for Thickness and Pressure	318.331	in.
Actual Length as entered by User	165.00	in.
Required Inertia, Ring + Shell	0.314	in**4
Available Inertia, Ring + Shell	0.432	in**4

Weight and Volume Results, Original Thickness:

Volume of Shell Component	VOLMET	11420.2	in.^3
Weight of Shell Component	WMET	3231.9	lb.
Inside Volume of Component	VOLID	217971.6	in.^3
Weight of Water in Component	WWAT	7871.2	lb.

Weight and Volume Results, Corroded Thickness:

Volume of Shell Component,	Corroded	VOLMETCA	7645.8	in.^3
Weight of Shell Component,	Corroded	WMETCA	2163.8	lb.
Inside Volume of Component,	Corroded	VOLIDCA	221745.9	in.^3
Weight of Water in Component,	Corroded	WWATCA	8007.5	lb.

SHELL SIDE

NOM. SIZE	PRESS.	TEMP.	C.A.	RT	H.T.	TEMA
29.000"	85.0psig	350deg.F	0.1250"	SPOT	0deg.F	R

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

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

SHELL HEAD

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

I.D.	(min)THK.	CORR.ALLOW	EFFICIENCY	
29.0000"	0.3125"	0.1250"	0.85	
ATM.STRS	DES.STRS	STRS/STRS	MAWP N-C	MAWP CORR.
20000.0psi	20000.0psi	1.000	365.591psig	217.670psig

$$\frac{P*(R+CA)}{S*E-(.1*P)} = 0.07316" + \text{CORR. ALLOW.} = 0.19816" + \text{MTOL.} = 0.19816"$$

(P*(R+CA) = 0.0000)

****

Ellip. Head External pressure calculations:

Ext Press Chart No.=	1
Ext Press Chart....=	CS-2
OD.....=	29.75000
RO.....=	26.77500
T.....=	0.18750
Temp.....=	350.00000
Stress from MT.....=	20000.00000
Yield from MT.....=	33050.00000
A.....=	0.00088
B.....=	11134.32715
PA1.....=	77.97148
PA2.....=	152.69080
PA.....=	77.97148

```
                          FRONT CHAN.
================================================================================
 NOM.
 SIZE          PRESS.        TEMP.          C.A.        RT    H.T.          TEMA
  30.000"    1000.0psig      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 = 1000.0psig   TEMP =    285deg.F
I.D.          NOM. THK.     RW=0/PIPE=1   CORR.ALLOW   EFFICIENCY
  30.0000"      1.2500"         0           0.1250"       0.85
ATM.STRS      DES.STRS      STRS/STRS      MAWP N-C      MAWP CORR.
  20000.0psi    20000.0psi  1.000        1349.206psig   1210.443psig

 P*(R+CA)
---------- =  0.92226"   + CORR. ALLOW. =  1.04726"   + MTOL. =  1.04726"
S*E-(.6*P)
********************************************************************************
ASME CODE SEC.VIII DIV.I UG-27                                    [ CYLINDER ]
====DESIGN CONDITIONS==============CYLINDER CALCULATIONS ON I.D. FORMULA====
TUBESHEET HUB
MATERIAL: SA-266-4N        PRESS = 1000.0psig   TEMP =    285deg.F
I.D.          NOM. THK.     RW=0/PIPE=1   CORR.ALLOW   EFFICIENCY
  30.0000"      1.2500"         0           0.1250"       0.85
ATM.STRS      DES.STRS      STRS/STRS      MAWP N-C      MAWP CORR.
  20000.0psi    20000.0psi  1.000        1349.206psig   1210.443psig

 P*(R+CA)
---------- =  0.92226"   + CORR. ALLOW. =  1.04726"   + MTOL. =  1.04726"
S*E-(.6*P)
********************************************************************************
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```
NOZZLE REINFORCEMENT CALCULATIONS/ ASME SEC.VIII DIV.I UG-37 & UG-16
NOZ NO= S1     12.00"     150 LB RF  WN
[INLET] SHELL SIDE
PRESSURE =   85.0psig   TEMP =  350.0deg.F

-------CYLINDER-----------------------NOZZLE-------
SA-516-70                          SA-106B
OPER STRS=    20000.0 psi          OPER STRS=    17100.0 psi
ATM STRS =    20000.0 psi          ATM STRS =    17100.0 psi
C.A.     =    0.12500"             C.A.     =    0.12500"
I.D.     =   29.00000"             I.D.     =   11.75000"
O.D.     =   29.75000"             O.D.     =   12.75000"
THK.     =    0.37500"             THK.   XH=    0.50000"
T        =    0.25000"             TN       =    0.37500"
TR       =    0.06232"             TRN      =    0.03163"
ET       =    0.18768"             ETN      =    0.34337"

MIN STD. WT. PIPE+C.A.=  0.45312"   TR+C.A.=  0.18732"
LIMITS=  24.00000"
fr1= 0.8550 fr2= 0.8550 fr3= 0.8550 fr4= 1.0000      F=   1.00000
Min weld sizes:NS=  0.0000" NP=  0.3536" PS=  0.1768" IF=  0.0000"

AREA REQD.                 A =    0.75456in^2
EXCESS IN CYL.             A1=    2.23181in^2
EXCESS IN NOZ.(OUTSIDE)    A2=    0.36698in^2  H =    0.62500"
AREA OF FILLETS              =    0.26086in^2
AREA AVAILABLE               =    2.85965in^2

NOZ. NECK WELD= 0.37500"  AREA=    0.12023in^2

PAD MATL.= SA-516-70      S=  20000.psi
PAD O.D.=  15.75000"     THK.=    0.37500"     AREA=    1.12500in^2
PAD TO CYL. WELD=    0.37500"     AREA=    0.14062in^2
ARC=  13.177"
PAD RET. DIM.=  15.750"  X   16.188"

< AREA REQD-AREA AVAILABLE >  =    -3.23009in^2

MAWP N-C=    366.0psig  LIMITED BY AR
MAWP COR=    263.0psig  LIMITED BY AR

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


 NOZTYP[ 0.0] X-7936         12.00"- 150# RF  WN    PRESS= -15 TEMP= 350  INLET
<<<<<< CYLINDER >>>>  <<<<<< NOZZLE >>>>>>
      SA-516-70              SA-106B
OPER STRS=20000.0000  OPER STRS=17100.0000  Area reqd.      A=  1.2121
ATM STRS =20000.0000  ATM STRS =17100.0000  Excess in cyl A1=  0.5922
C.A.      =   0.12500 C.A.      =   0.12500 Excess in noz A2=  0.3608 H= 0.6250
I.D.      =  29.00000 I.D.      =  11.75000 Excess in noz A3=  0.0000 H= 0.0000
O.D.      =  29.75000 O.D.      =  12.75000 Area fillets     =  0.2609
THK.      =   0.37500 THK.   XH=   0.50000 Area avail.      =  1.2139
T         =   0.25000 TN        =   0.37500 Noz neck weld   =  0.3750 A= 0.1202
TR        =   0.20020 TRN       =   0.03740 Pad weld        =  0.3750 A= 0.1406
ET        =   0.04980 ETN       =   0.33760 Internal weld   =  0.0000 A= 0.0000
PIPE F=1.0000 E1=1.0000  SHELL TOL=0.8750 (Min USED)  NOZ TOL=1.0000 (Nom USED)
MIN STD. WT. PIPE+C.A.=0.45312   TR[using abs(P)]+C.A.=0.13597   CHORD=  0.0000
LIMITS=  24.00000    fr1= 0.8550 fr2= 0.8550 fr3= 0.8550 fr4= 1.0000
Min weld sizes: NS= 0.0000 NP= 0.3536 PS= 0.1768 IF= 0.0000
PAD MATL.= SA-516-70    O.D.=15.75000 THK.= 0.37500 AREA= 1.12500 S= 20000.
Area reqd-Area avail =<< -1.12677>>
```

```
NOZZLE REINFORCEMENT CALCULATIONS/ ASME SEC.VIII DIV.I UG-37 & UG-16
NOZ NO= S2      4.00"    150 LB RF  WN
[OUTLET] SHELL SIDE
PRESSURE =   85.0psig   TEMP =  350.0deg.F

-------CYLINDER-----------------------NOZZLE-------
SA-516-70                          SA-106B
OPER STRS=   20000.0 psi           OPER STRS=   17100.0 psi
ATM STRS =   20000.0 psi           ATM STRS =   17100.0 psi
C.A.     =   0.12500"              C.A.     =   0.12500"
I.D.     =  29.00000"              I.D.     =   3.62400"
O.D.     =  29.75000"              O.D.     =   4.50000"
THK.     =   0.37500"              THK.sc120=   0.43800"
T        =   0.25000"              TN       =   0.31300"
TR       =   0.06232"              TRN      =   0.01116"
ET       =   0.18768"              ETN      =   0.30184"

MIN STD. WT. PIPE+C.A.=  0.33237"   TR+C.A.=  0.18732"
LIMITS=   7.74800"
fr1= 0.8550 fr2= 0.8550 fr3= 0.0000 fr4= 0.0000     F=   1.00000
Min weld sizes:NS=  0.2475" NP=  0.0000" PS=  0.0000" IF=  0.0000"

AREA REQD.                A =   0.24707in^2
EXCESS IN CYL.            A1=   0.71005in^2
EXCESS IN NOZ.(OUTSIDE)   A2=   0.32259in^2  H =   0.62500"
AREA OF FILLETS             =   0.12023in^2
AREA AVAILABLE              =   1.15288in^2

NOZ. NECK WELD= 0.37500"  AREA=   0.12023in^2

< AREA REQD-AREA AVAILABLE >  =   -0.90581in^2

MAWP N-C=   386.0psig  LIMITED BY AR
MAWP COR=   239.0psig  LIMITED BY AR


NOZTYP[ 0.0] X-7936          4.00"- 150# RF  WN   PRESS= -15 TEMP= 350  INLET
<<<<<< CYLINDER >>>>  <<<<<< NOZZLE >>>>>>
      SA-516-70              SA-106B
OPER STRS=20000.0000  OPER STRS=17100.0000  Area reqd.      A=  0.3969
ATM STRS =20000.0000  ATM STRS =17100.0000  Excess in cyl A1=  0.1884
C.A.      =   0.12500 C.A.      =   0.12500 Excess in noz A2=  0.3127 H= 0.6250
I.D.      =  29.00000 I.D.      =   3.62400 Excess in noz A3=  0.0000 H= 0.0000
O.D.      =  29.75000 O.D.      =   4.50000 Area fillets    =  0.1202
THK.      =   0.37500 THK.sc120=   0.43800 Area avail.     =  0.6214
T         =   0.25000 TN        =   0.31300 Noz neck weld   =  0.3750 A= 0.1202
TR        =   0.20020 TRN       =   0.02040 Pad weld        =  0.0000 A= 0.0000
ET        =   0.04980 ETN       =   0.29260 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.=0.33237   TR[using abs(P)]+C.A.=0.13597   CHORD=  0.0000
LIMITS=   7.74800    fr1= 0.8550 fr2= 0.8550 fr3= 0.0000 fr4= 0.0000
Min weld sizes: NS= 0.2475 NP= 0.0000 PS= 0.0000 IF= 0.0000
Area reqd-Area avail =<< -0.22448>>
```

```
NOZZLE REINFORCEMENT CALCULATIONS/ ASME SEC.VIII DIV.I UG-37 & UG-16
NOZ NO= T1 & T2      6.00"    600 LB RF  WN
[INLET & OUTLET] FRONT CHANNEL SIDE
PRESSURE = 1000.0psig   TEMP =  285.0deg.F
OFFSET VERTICAL NOZZLE: OFFSET =   5.00000"

-------CYLINDER----------------------NOZZLE-------
SA-516-70N                        SA-106B
OPER STRS=   20000.0 psi          OPER STRS=   17100.0 psi
ATM STRS =   20000.0 psi          ATM STRS =   17100.0 psi
C.A.     =   0.12500"             C.A.     =   0.12500"
I.D.     =  30.00000"             I.D.     =   5.76100"
O.D.     =  32.50000"             O.D.     =   6.62500"
THK.     =   1.25000"             THK.   XH=   0.43200"
T        =   1.12500"             TN       =   0.30700"
TR       =   0.77964"             TRN      =   0.18929"
ET       =   0.34536"             ETN      =   0.11771"

MIN STD. WT. PIPE+C.A.=  0.37000"   TR+C.A.=  0.90464"
LIMITS=  12.02200"
fr1= 0.8550 fr2= 0.8550 fr3= 0.8550 fr4= 1.0000     F=   1.00000
Min weld sizes:NS=  0.0000" NP=  0.3039" PS=  0.5303" IF=  0.0000"

AREA REQD.              A =   4.75582in^2
EXCESS IN CYL.          A1=   2.04522in^2
EXCESS IN NOZ.(OUTSIDE) A2=   0.30546in^2  H =   1.51750"
AREA OF FILLETS           =   0.43664in^2
AREA AVAILABLE            =   2.78732in^2

NOZ. NECK WELD= 0.37500"  AREA=   0.12023in^2

PAD MATL.= SA-516-70N     S=  20000.psi
PAD O.D.=   9.62500"    THK.=   0.75000"    AREA=   2.25000in^2
PAD TO CYL. WELD=   0.56250"    AREA=   0.31641in^2
ARC=   7.035"
PAD RET. DIM.=   9.625"  X   10.062"

< AREA REQD-AREA AVAILABLE >  =   -0.28149in^2

MAWP N-C=  1161.0psig  LIMITED BY AR
MAWP COR=  1027.0psig  LIMITED BY AR

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

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

DESIGN CONDITIONS		GASKET and BOLTING CALCULATIONS			TABLE	
Design Pres=	1000.0 psig	Eff.Gsk OD=	32.2500"		No.Passes=	4
Neg. Pres=	None	Eff.Gsk ID=	30.8750"		N=	0.688"
Design Temp=	285 deg.F	THK= 0.1250"		col.=1	b=	0.293
Flg Matl=SA-266-4N	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=	493322 #	Am =	48.1042in^2
Flange Desn	Sfo 20000.0 psi	Hp =	415172 #	Ab =	50.5800in^2
Atm.	Sfa 20000.0 psi	H =	787431 #	W =	1233552 #
Bolting Desn	Sb 25000.0 psi	Wm1=	1202604 #	Wm1=	1202604 #
Atm.	Sa 25000.0 psi	Gasket Width Check		Nmin =	0.6293"

CONDITION	LOAD	x	LEVER ARM =	MOMENT	
	HD =	718687 #	hD= 2.84375"	MD=	2043768 in#
Operating	HG =	415172 #	hG= 2.98065"	MG=	1237484 in#
	HT =	68743 #	hT= 3.33408"	MT=	229196 in#
				Mo=	3510449 in#
Gasket Seating	HG =	1233552 #	hG= 2.98065"	mo=	3676788 in#

Allow.Stress-STRESS CALCULATIONS-Operating		SHAPE CONSTANTS			
1.5 Sfo Long Hub,SH	24663.3 psi	K = 1.3430	h/ho=	0.2893	
Sfo Radial Flg,SR	4502.0 psi	T = 1.7789	F =	0.8807	
Sfo Tang Flg,ST	13359.5 psi	Z = 3.4889	V =	0.3744	
Sfo .5(SH+SR)or.5(SH+ST)	19011.4 psi	Y = 6.7402	f =	1.1851	
J(APP.2-14)= 0.5608		U = 7.4068	e =	0.1510in^-1	

Allow.Stress-STRESS CALCULATIONS-Gsk.Seating		g1/go= 1.5000 d = 146.061In^3
1.5 Sfa Long Hub,SH	25832.0 psi	ho = 5.8336"
Sfa Radial Flg,SR	4715.4 psi	
Sfa Tang Flg,ST	13992.5 psi	
Sfa .5(SH+SR)or.5(SH+ST)	19912.3 psi	
J(APP.2-14)= 0.5668		

OTHER STRESS FORMULA FACTORS	
t	5.1875"
Alpha	1.7832
Beta	2.0442
Gamma	1.0024
Delta	0.9557
Lambda	1.9581
M	116047 #
m	121546 #

O.D.	40.6250"	THK.	=	5.3750"	
I.D.	30.0000"	T-Adder	=	0.0000"	
GO	1.2500"	G1	=	1.8125"	
HUB O.D.	33.6250"	HUB LEN	=	1.6875"	
HUB ANG	18.4350deg	RIB LENGTH	=	52.4875"	
G(MEAN)	31.5625"	G(CALC)	=	31.6637"	
G(MIN.)	30.9375"	G(MAX.)	=	34.8125"	
B.C.	37.6250"	B.S.C.F.	=	1.0000	
No. BOLTS	36	BOLT DIAMETER	=	1.5000"	
R	2.0000"	E	=	1.5000"	
BOLT SPAC	3.2792"	TORQUE	=	1202ft#	
MIN. SPAC	3.2500"	TEMA MAX. SPAC	=	9.5526"	
FLG TURN	0.1875"	FACING	=	RECESS	
BPRIME	0.0000"	BG1	=	0.0000"	
FLG RWT	1180Lbs	FLG FWT	=	928Lbs	

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

EXCHANGER TYPE....=	C E U	MATERIAL.....=	SA-266-4N
PRESSURE.....=	1000.0 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.....=	50.5800 in^2
d.....=	31.6637"	C.....=	0.3000
W.....=	1233552 #	Wm1.....=	1202604 #
hG (ASME).....=	2.9807"	hG (TEMA).....=	2.9807"
G (TEMA).....=	31.6637"	E (MOD.) x (10)-6..=	28.2 psi
COVER THK SET HOLD=	[NO]		

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

$$THK = d \sqrt{\frac{C\,P}{S\,E} + \frac{1.9\,Wm1\,hG}{S\,E\,d^3}} = 5.0787"$$

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

$$THK = d \sqrt{\frac{1.9\,W\,hG}{S\,E\,d^3}} = 3.3214"$$

[PER TEMA RCB-9.2 FLAT CHANNEL COVER]
MAXIMUM DEFLECTION = 30.0000" x 0.00125 = 0.0375"
DEFLECTION at 4.6083" THICK = 0.0375"

$$Y = \frac{G}{E\left(\frac{5.188}{\left|0.0435\,G^3\,P + 0.5\,Sb\,Ab\,hG\right|}\right)^3} = 0.0263"$$

[COV THK Min] TEMA Deflection	=	4.6083" +	0.1875" =	4.7958"
[COV THK Min] CODE Operating	=	5.0787" +	0.1875" =	5.2662"
[COV THK Min] CODE Gasket Seating	=	3.3214" +	0.1875" =	3.5089"

ACTUAL COVER THICKNESS USED (SET HOLD[NO])= 5.3750"

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

/// INDIVIDUAL COMPONENTS ///
MAWP CORR. MAIN FLG = 1009.0 Limited by: Flange stress.
MAWP CORR. COVER = 1009.0

MAWP N-C MAIN FLG = 1051.0 Limited by: Minimum bolting area Am.
MAWP N-C COVER = 1043.0

ASME SEC.VIII DIV.1 UHX-12

```
(U-Tube)  Configuration a
No or EPC=Elastic-Plastic Calcs SSC=Simply Supported Calcs       =EPC
MT Tubes                  =SA-214       MT Tubesheets            =SA-266-4N
MT Channel                =SA-516-70N   MT Shell                 =SA-516-70
Diameter (Do)             =  28.3478"   Pass Lane Area (AL)      =  100.445in^2
Perimeter of layout (CP)  =   0.0000"   Area enclosed by CP (AP) =    0.000in^2
Tubesheet thickness (h)   =   3.3125"   Tubesheet thickness HOLD =   NO
Tube Pitch (p)            =   1.0000"   Pitch type =  Triangle     (60 Deg)
Diameter of tube (dt)     =   0.7500"   Tube thickness (tt)       =   0.0830"
Exp length of tube (ltx)  =   0.0000"   Exp depth ratio (Rho)     =   0.9500
Groove channel side (hg)  =   0.0000"   Groove shell side         =   0.0000"
Channel I.D. (Dc)         =  30.0000"   Channel thickness (Tc)   =   1.2500"
Shell I.D. (Ds)           =  29.0000"   Shell thickness (Ts)     =   0.3750"
TS outside diameter (A)   =  37.8750"   Bolt circle (C)          =   0.0000"
G Channel side (Gc or G1) =   0.0000"   G Shell side (Gs or G1)  =   0.0000"
Bolt load Chan side (Wc)  =      0.0#   Bolt load Sh side (Ws)   =      0.0#
1.8*Sqrt(Dc*Tc)           =  11.0227"   1.8*Sqrt(Ds*(Ts or Ts1)) =  0.0000"
Thickness at Top TS (tr)  =   3.3125"   Outer Tube Circle        =  28.3478"
hr Ch Op=  0.0000"  Ch Atm=  0.0000"    Sh Op=  0.0000"   Sh Atm =   0.0000"
Tubes welded Backside TS  =NO           Hole Size in Tubesheet   =   0.0000"

Design Press Chan (Pt)    =   1000.0psigDesign Press Shell (Ps)  =     85.0psig
Design Temp  Chan         =    285.0deg.Design Temp  Shell       =    350.0deg.
Corr Chan                 =  0.12500"   Corr Shell               =  0.12500"
Corr Chan side TS (ct)    =  0.12500"   Corr Shell side TS (cs)  =  0.12500"
```

ASME SEC.VIII DIV.1 UW-20

```
 Tube Joint=     Full Strength Welds Per FIG. UW-20.1(d)

Tube O.D. do ..................................................=0.750000"
Tube Thickness t ..............................................=0.083000"
Stress Tubes Sa ...............................................=13411.76psi
St = Stress Tubesheet or Base if Clad .........................=20000.00psi
Sw = Stress Weld = Lesser of Sa or St .........................=13411.76psi
fw = Weld strength factor = Sa/Sw ..............................=1.000000
af = Fillet Weld leg ..........................................=0.062500"
ag = Groove Weld leg ..........................................=0.125000"
ac = Length of the combined weld legs = af + ag ...............=0.187500"
Weld throat ...................................................=0.088388"
Ft = Axial tube strength = Phi*t*(do-t)*Sa .....................=2332.597#
Fd = Design strength, but not greater than Ft .................=2332.597#
fd = Ratio of design strength to tube strength
fd = 1.0 for Full strength welds
fd = Fd/Ft for Partial strength welds ..........................=1.000000
Fg = Groove weld strength, but not > Ft, = 0.85*Phi*ag*(do+0.67*ag)Sw .....=2332.597#
Ff = Fillet weld strength, but not > Ft, = 0.55*Phi*af*(do+0.67*af)Sw .....=1146.925#
ff = Ratio of fillet weld strength to design strength = 1.0-Fg/(fd*Ft) .....=     0.0
ar = Sqrt((0.75*do)^2+2.73*t*(do-t)fw*fd*ff) -0.75*do .....................=     0.0"
Lmax = Ft .....................................................=2332.597#

--- Weld Size Check ---
ac shall not be less than the greater of [ar+ag or t]   0.188"       >= 0.125"
```

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

(U-Tube) Configuration a

Tubesheet Thickness (h) =	3.0625"		
Exp length of tube (ltx) =	2.9094"	Exp depth ratio (Rho) =	0.9500"
Channel I.D. (Dc) =	30.2500"	Channel thickness (Tc) =	1.1250"
Shell I.D. (Ds) =	29.2500"	Shell thickness (Ts) =	0.2500"
Press Chan (Pt) =	1000.0psi	Press Shell (Ps) =	0.0psi
Corr Chan =	0.12500"	Corr Shell =	0.12500"
Corr Chan side TS (ct) =	0.12500"	Corr Shell side TS (cs) =	0.12500"

	Temp	Stress	Yield	Modulus x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 350deg.F	S = 20000psi	Sy = 0psi	E =27.9000	V =.000	Sps =	0psi
Temp TBS	Tt= 350deg.F	St = 13411psi	Syt= 0psi	Et =27.9000	Vt=.000		
Temp CH	Tc= 285deg.F	Sc = 20000psi	Syc= 33780psi	Ec =28.1750	Vc=.300	Spsc=	67560psi
Temp SH	Ts= 350deg.F	Ss = 20000psi	Sys= 33050psi	Es =27.9000	Vs=.300	Spss=	66100psi

Mu= 0.2500 d*= 0.6442" P*= 1.0905" Mu*= 0.4092 hg'= 0.0000" hgs'= 0.0000"

Wmax =	0.0#	Rho s =	1.031826854		
Rho c =	1.067102909	Mts =	-7207.938965In-Lb/In	h/p =	3.062500000
E* =	11873542.00psi	v* =	0.308818936	Beta s =	0.669382930in^-1
Kappa s =	53444.89844#	Lambda s =	1682146.875psi	Delta s =	0.000026070In^3/Lb
Delta c =	0.000006130In^3/Lb	Beta c =	0.305976123in^-1	Kappa c =	1557313.875#
Lambda c =	23382258.00psi	Omega s =	2.934619904in^2	Omega c =	8.722574234in^2
K =	1.336083412	F =	1.929619908	M* =	1514.635254In-Lb/In
Mp =	17057.50781In-Lb/In	Mo =	-24488.67578In-Lb/In	M =	24488.67578In-Lb/In
Sigma s,m=	0.0psi	Sigma s,b=	-23918.52148psi	Sigma s =	23918.52148psi
Sigma c,m=	6481.186523psi	Sigma c,b=	56036.33203psi	Sigma c =	62517.51953psi

Es*Sqrt(1.5Ss/Sigma s)= 27900002.00psi Ec*Sqrt(1.5Sc/Sigma c)= 19517478.00psi

Sigma	38281 psi	<= 2S	40000 psi	[OK	]
Tau	9256 psi	<= .8S	16000 psi	[OK	]
Sigma s	23918 psi	<= 1.5Ss	30000 psi	[OK	]
Sigma c	62517 psi	<= 1.5Sc	30000 psi	[OK Per El.Pl.Calc]	

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

(U-Tube) Configuration a

Tubesheet Thickness (h)	= 3.0625"		
Exp length of tube (ltx)	= 2.9094"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 30.2500"	Channel thickness (Tc)	= 1.1250"
Shell I.D. (Ds)	= 29.2500"	Shell thickness (Ts)	= 0.2500"
Press Chan (Pt)	= 0.0psi	Press Shell (Ps)	= 85.0psi
Corr Chan	= 0.12500"	Corr Shell	= 0.12500"
Corr Chan side TS (ct)	= 0.12500"	Corr Shell side TS (cs)	= 0.12500"

	Temp	Stress	Yield	Modulus x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 350deg.F	S = 20000psi	Sy = 0psi	E =27.9000	V =.000	Sps =	0psi
Temp TBS	Tt= 350deg.F	St = 13411psi	Syt= 0psi	Et =27.9000	Vt=.000		
Temp CH	Tc= 285deg.F	Sc = 20000psi	Syc= 33780psi	Ec =28.1750	Vc=.300	Spsc=	67560psi
Temp SH	Ts= 350deg.F	Ss = 20000psi	Sys= 33050psi	Es =27.9000	Vs=.300	Spss=	66100psi

Mu= 0.2500 d*= 0.6442" P*= 1.0905" Mu*= 0.4092 hg'= 0.0000" hgs'= 0.0000"

Wmax = 0.0#	Rho s = 1.031826854				
Rho c = 1.067102909	Mts = 280.5309143In-Lb/In	h/p = 3.062500000			
E* = 11873542.00psi	v* = 0.308818936	Beta s = 0.669382930in^-1			
Kappa s = 53444.89844#	Lambda s = 1682146.875psi	Delta s = 0.000026070In^3/Lb			
Delta c = 0.000006130In^3/Lb	Beta c = 0.305976123in^-1	Kappa c = 2248104.000#			
Lambda c = 33754112.00psi	Omega s = 2.934619904in^2	Omega c = 8.722574234in^2			
K = 1.336083412	F = 2.533384800	M* = 31.08822250In-Lb/In			
Mp =-1521.645020In-Lb/In	Mo = 2009.780640In-Lb/In	M = 2009.780640In-Lb/In			
Sigma s,m= 2465.180176psi	Sigma s,b= 9804.251953psi	Sigma s = 12269.43164psi			
Sigma c,m= 0.0psi	Sigma c,b=-3306.689941psi	Sigma c = 3306.689941psi			
Es*Sqrt(1.5Ss/Sigma s)= 0.0psi		Ec*Sqrt(1.5Sc/Sigma c)= 0.0psi			

Sigma	3141 psi	<= 2S	40000 psi	[OK	]
Tau	786 psi	<= .8S	16000 psi	[OK	]
Sigma s	12269 psi	<= 1.5Ss	30000 psi	[OK	]
Sigma c	3306 psi	<= 1.5Sc	30000 psi	[OK	]

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

(U-Tube) Configuration a

Tubesheet Thickness (h)	= 3.0625"		
Exp length of tube (ltx)	= 2.9094"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 30.2500"	Channel thickness (Tc)	= 1.1250"
Shell I.D. (Ds)	= 29.2500"	Shell thickness (Ts)	= 0.2500"
Press Chan (Pt)	= 1000.0psi	Press Shell (Ps)	= 85.0psi
Corr Chan	= 0.12500"	Corr Shell	= 0.12500"
Corr Chan side TS (ct)	= 0.12500"	Corr Shell side TS (cs)	= 0.12500"

	Temp	Stress	Yield	Modulus x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 350deg.F	S = 20000psi	Sy = 0psi	E =27.9000	V =.000	Sps =	0psi
Temp TBS	Tt= 350deg.F	St = 13411psi	Syt= 0psi	Et =27.9000	Vt=.000		
Temp CH	Tc= 285deg.F	Sc = 20000psi	Syc= 33780psi	Ec =28.1750	Vc=.300	Spsc=	67560psi
Temp SH	Ts= 350deg.F	Ss = 20000psi	Sys= 33050psi	Es =27.9000	Vs=.300	Spss=	66100psi

Mu= 0.2500 d*= 0.6442" P*= 1.0905" Mu*= 0.4092 hg'= 0.0000" hgs'= 0.0000"

Wmax	= 0.0#	Rho s	= 1.031826854		
Rho c	= 1.067102909	Mts	=-6927.408203In-Lb/In	h/p	= 3.062500000
E*	= 11873542.00psi	v*	= 0.308818936	Beta s	= 0.669382930in^-1
Kappa s	= 53444.89844#	Lambda s	= 1682146.875psi	Delta s	= 0.000026070In^3/Lb
Delta c	= 0.000006130In^3/Lb	Beta c	= 0.305976123in^-1	Kappa c	= 1600208.250#
Lambda c	= 24026296.00psi	Omega s	= 2.934619904in^2	Omega c	= 8.722574234in^2
K	= 1.336083412	F	= 1.967110515	M*	= 1545.723389In-Lb/In
Mp	= 15754.61230In-Lb/In	Mo	=-22260.14648In-Lb/In	M	= 22260.14648In-Lb/In
Sigma s,m	= 2465.180176psi	Sigma s,b	=-14114.26855psi	Sigma s	= 16579.44922psi
Sigma c,m	= 6481.186523psi	Sigma c,b	= 52729.63672psi	Sigma c	= 59210.82422psi

Es*Sqrt(1.5Ss/Sigma s)= 27900002.00psi Ec*Sqrt(1.5Sc/Sigma c)= 20055064.00psi

Sigma	34797 psi	<= 2S	40000 psi	[OK	]
Tau	8469 psi	<= .8S	16000 psi	[OK	]
Sigma s	16579 psi	<= 1.5Ss	30000 psi	[OK	]
Sigma c	59210 psi	<= 1.5Sc	30000 psi	[OK Per El.Pl.Calc]	

ASME SEC.VIII DIV.1 UHX-12 Case 4

(U-Tube) Configuration a

Tubesheet Thickness (h)	= 3.0625"		
Exp length of tube (ltx)	= 2.9094"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 30.2500"	Channel thickness (Tc)	= 1.1250"
Shell I.D. (Ds)	= 29.2500"	Shell thickness (Ts)	= 0.2500"
Press Chan (Pt)	= 1000.0psi	Press Shell (Ps)	= -15.0psi
Corr Chan	= 0.12500"	Corr Shell	= 0.12500"
Corr Chan side TS (ct)	= 0.12500"	Corr Shell side TS (cs)	= 0.12500"

	Temp	Stress	Yield	Modulus x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 350deg.F	S = 20000psi	Sy = 0psi	E =27.9000	V =.000	Sps =	0psi
Temp TBS	Tt= 350deg.F	St = 13411psi	Syt= 0psi	Et =27.9000	Vt=.000		
Temp CH	Tc= 285deg.F	Sc = 20000psi	Syc= 33780psi	Ec =28.1750	Vc=.300	Spsc=	67560psi
Temp SH	Ts= 350deg.F	Ss = 20000psi	Sys= 33050psi	Es =27.9000	Vs=.300	Spss=	66100psi

Mu= 0.2500 d*= 0.6442" P*= 1.0905" Mu*= 0.4092 hg'= 0.0000" hgs'= 0.0000"

Wmax = 0.0#	Rho s = 1.031826854				
Rho c = 1.067102909	Mts = -7257.444336In-Lb/In	h/p = 3.062500000			
E* = 11873542.00psi	v* = 0.308818936	Beta s = 0.669382930in^-1			
Kappa s = 53444.89844#	Lambda s = 1682146.875psi	Delta s = 0.000026070In^3/Lb			
Delta c = 0.000006130In^3/Lb	Beta c = 0.305976123in^-1	Kappa c = 1550096.500#			
Lambda c = 23273894.00psi	Omega s = 2.934619904in^2	Omega c = 8.722574234in^2			
K = 1.336083412	F = 1.923311830	M* = 1509.149170In-Lb/In			
Mp = 17286.08008In-Lb/In	Mo = -24883.29688In-Lb/In	M = 24883.29688In-Lb/In			
Sigma s,m=-435.0317688psi	Sigma s,b=-25648.68555psi	Sigma s = 26083.71680psi			
Sigma c,m= 6481.186523psi	Sigma c,b= 56619.86328psi	Sigma c = 63101.05078psi			
Es*Sqrt(1.5Ss/Sigma s)= 27900002.00psi		Ec*Sqrt(1.5Sc/Sigma c)= 19427024.00psi			

Sigma	38898 psi	<= 2S	40000 psi	[OK	]
Tau	9395 psi	<= .8S	16000 psi	[OK	]
Sigma s	26083 psi	<= 1.5Ss	30000 psi	[OK	]
Sigma c	63101 psi	<= 1.5Sc	30000 psi	[OK Per El.Pl.Calc]	

ASME SEC.VIII DIV.1 UHX-12 Case 5

(U-Tube) Configuration a

Tubesheet Thickness (h)	= 3.0625"		
Exp length of tube (ltx)	= 2.9094"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 30.2500"	Channel thickness (Tc)	= 1.1250"
Shell I.D. (Ds)	= 29.2500"	Shell thickness (Ts)	= 0.2500"
Press Chan (Pt)	= 1009.0psi	Press Shell (Ps)	= 0.0psi
Corr Chan	= 0.12500"	Corr Shell	= 0.12500"
Corr Chan side TS (ct)	= 0.12500"	Corr Shell side TS (cs)	= 0.12500"

	Temp	Stress	Yield	Modulus x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 350deg.F	S = 20000psi	Sy = 0psi	E =27.9000		V =.000	Sps = 0psi
Temp TBS	Tt= 350deg.F	St = 13411psi	Syt= 0psi	Et =27.9000		Vt=.000	
Temp CH	Tc= 285deg.F	Sc = 20000psi	Syc= 33780psi	Ec =28.1750		Vc=.300	Spsc= 67560psi
Temp SH	Ts= 350deg.F	Ss = 20000psi	Sys= 33050psi	Es =27.9000		Vs=.300	Spss= 66100psi

Mu= 0.2500 d*= 0.6442" P*= 1.0893" Mu*= 0.4086 hg'= 0.0000" hgs'= 0.0000"

Wmax = 0.0#	Rho s = 1.027476668		
Rho c = 1.062604070	Mts =-6812.134766In-Lb/In	h/p = 3.062500000	
E* = 11849292.00psi	v* = 0.308948517	Beta s = 0.669382930in^-1	
Kappa s = 53444.89844#	Lambda s = 1682146.875psi	Delta s = 0.000026070In^3/Lb	
Delta c = 0.000006130In^3/Lb	Beta c = 0.305976123in^-1	Kappa c = 1551292.375#	
Lambda c = 23291848.00psi	Omega s = 2.922247648in^2	Omega c = 8.685800552in^2	
K = 1.330450535	F = 1.921059251	M* = 1951.838013In-Lb/In	
Mp = 17473.61719In-Lb/In	Mo =-24803.85547In-Lb/In	M = 24803.85547In-Lb/In	
Sigma s,m= 0.0psi	Sigma s,b=-24083.08984psi	Sigma s = 24083.08984psi	
Sigma c,m= 6539.517090psi	Sigma c,b= 56464.28516psi	Sigma c = 63003.80078psi	

Es*Sqrt(1.5Ss/Sigma s)= 27900002.00psi Ec*Sqrt(1.5Sc/Sigma c)= 19442012.00psi

Sigma	38836 psi	<= 2S	40000 psi	[OK]
Tau	9379 psi	<= .8S	16000 psi	[OK]
Sigma s	24083 psi	<= 1.5Ss	30000 psi	[OK]
Sigma c	63003 psi	<= 1.5Sc	30000 psi	[OK Per El.Pl.Calc]

ASME SEC.VIII DIV.1 UHX-12 Case 6

(U-Tube) Configuration a

Tubesheet Thickness (h)	= 3.0625"		
Exp length of tube (ltx)	= 2.9094"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 30.2500"	Channel thickness (Tc)	= 1.1250"
Shell I.D. (Ds)	= 29.2500"	Shell thickness (Ts)	= 0.2500"
Press Chan (Pt)	= 0.0psi	Press Shell (Ps)	= 215.0psi
Corr Chan	= 0.12500"	Corr Shell	= 0.12500"
Corr Chan side TS (ct)	= 0.12500"	Corr Shell side TS (cs)	= 0.12500"

	Temp	Stress	Yield	Modulus x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 350deg.F	S = 20000psi	Sy = 0psi	E =27.9000	V =.000	Sps =	0psi
Temp TBS	Tt= 350deg.F	St = 13411psi	Syt= 0psi	Et =27.9000	Vt=.000		
Temp CH	Tc= 285deg.F	Sc = 20000psi	Syc= 33780psi	Ec =28.1750	Vc=.300	Spsc=	67560psi
Temp SH	Ts= 350deg.F	Ss = 20000psi	Sys= 33050psi	Es =27.9000	Vs=.300	Spss=	66100psi

Mu= 0.2500 d*= 0.6442" P*= 1.0893" Mu*= 0.4086 hg'= 0.0000" hgs'= 0.0000"

Wmax = 0.0#	Rho s = 1.027476668		
Rho c = 1.062604070	Mts = 615.1087036In-Lb/In	h/p = 3.062500000	
E* = 11849292.00psi	v* = 0.308948517	Beta s = 0.669382930in^-1	
Kappa s = 52554.78906#	Lambda s = 1654131.250psi	Delta s = 0.000026070In^3/Lb	
Delta c = 0.000006130In^3/Lb	Beta c = 0.305976123in^-1	Kappa c = 2248104.000#	
Lambda c = 33754112.00psi	Omega s = 2.922247648in^2	Omega c = 8.685800552in^2	
K = 1.330450535	F = 2.529585361	M* = -13.17454052In-Lb/In	
Mp = -3906.044189In-Lb/In	Mo = 5102.535156In-Lb/In	M = 5102.535156In-Lb/In	
Sigma s,m= 6235.455566psi	Sigma s,b= 24789.35547psi	Sigma s = 31024.81055psi	
Sigma c,m= 0.0psi	Sigma c,b=-8349.463867psi	Sigma c = 8349.463867psi	

Es*Sqrt(1.5Ss/Sigma s)= 27435336.00psi Ec*Sqrt(1.5Sc/Sigma c)= 28175002.00psi

Sigma	7989 psi	<= 2S	40000 psi	[OK]
Tau	1998 psi	<= .8S	16000 psi	[OK]
Sigma s	31024 psi	<= 1.5Ss	30000 psi	[OK Per El.Pl.Calc]
Sigma c	8349 psi	<= 1.5Sc	30000 psi	[OK]

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

Tube size.....=	0.75000"	Straight or U-Tube.=	U-Tube
Internal Press...=	1015.00000psig	External press.....=	85.00000psig
Temperature used.=	350.00000deg.	Tube Matl MT# 61...=	SA-214
Stress Oper.....=	11400.00000psi	Stress Atm.....=	11400.00000psi
Yield.....=	22600.00000psi	Inside Radius.....=	0.29200"
Joint Eff.....=	1.00000	Mill tol...= 0.00% =	0.00000"
Wall Thk. t.....=	0.08300"	Tube gauge.....=	
Mean Rad., R.....=	1.12500"	Tube Length.....=	288.00000"
Corrosion ID.....=	0.00000"	Corrosion OD.....=	0.00000"
Thinning factor..=	1.16667		
tr = PR/SE - .6P =	0.02747"	(tr*TF)+MT+CA.....=	0.03204"
MAWP Internal H/C=	2423.25439psig	MAWP Internal N/C..=	2423.25439psig
MAWP External H/C=	1685.60413psig	MAWP External N/C..=	1745.37158psig

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

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

TUBE SIDE PRESSURE DROP q = 17.00000

FRONT PASS PLATE THK..... = 0.50000
MATERIAL..... = SA-516-70
STRESS OPER..... = 20000.00
FRONT Chan ID..... = 30.00000
FRONT Chan OAL..... = 28.87500
a..... = 15.00000
b..... = 23.75000
TABLE RCB-9.132..... = Three sides fixed
a/b..... = 0.63158
B..... = 0.12942
t..... = 0.20339
Min fillet leg [both sides] = 3/4t = .75 x 0.20339 = 0.15254

Energy Exchanger Company

Customer :	SOUTHERN / MISS. POWER CO.	Item No.	HX0059	W.O. :	X-7936
Subject :	Seismic and Wind Loading Factors	Date	3/23/2011	By :	MD/DN

Wind Loading

Given Data: From Customer Spec

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

Seismic Loading

Given Data: From Customer Spec

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

SNOW LOADS

Pg	5	psf
CAT	C	
Ct	1.2	
I	1.1	
Pf = 0.7*Ct*I	6.6	psf
SNOW LOAD AREA	95	sf
ADDITIONAL WEIGHT	627	lbs

Input Echo, Horizontal Vessel Item 1, Description: EXCH. SUPPORTS

Design Internal Pressure		85.00	psig
Design Temperature		350.00	F
Corrosion Allowance for Vessel		0.1250	in.
Shell Material		SA-516 70	
Shell Material UNS Number		K02700	
Shell Operating Allowable Stress		20000.00	psi
Shell Ambient Allowable Stress		20000.00	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		64.6980	lb./ft³
Liquid Height in Vessel		29.2500	in.

NOTE: Liquid Height is not entered, it is being set equal to the vessel ID.

Extra Weight		18430.340	lb.	Note: Snow load is included in Extra Weight.
Saddle Reaction Force Factor	ftr	3.00		
Distance from Center of Vessel to Support	B	25.75	in.	
Baseplate Length		27.0000	in.	
Baseplate Thickness		0.6250	in.	
Baseplate Width		7.0000	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		9.5000	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		0.0679 ⚠1		
Diameter Basis for Vessel		ID		
Shell Diameter		29.000	in.	
Shell Length Tangent to Tangent		27.354	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		93.375	in.	
Saddle Width		7.000	in.	
Saddle Bearing Angle		170.0000	degrees	
Wear Pad Thickness		0.3750	in.	
Wear Pad Extension above Horn of Saddle		2.0000	in.	
Wear Pad Width		11.000	in.	
Stiffening Ring Present		N		

Results for Horizontal Vessel Number 1, Description: EXCH. SUPPORTS

Vessel Stress Summary

Shell Allowable Stress used in Calculation		20000.00	psi
Shell Compressive Yield used in Calculation		33050.00	psi
Head Allowable Stress used in Calculation		20000.00	psi
Volume of Vessel		131.38	ft.**3
Weight of Vessel, Empty		21827.00	lb.
Weight of Vessel, Full		30327.00	lb.
Shell Thk. + CA, Reqd. vs. Actual	0.199	0.375	in.
Head Thk. + CA, Reqd. vs. Actual	0.199	0.312	in.
Shell M.A.W.P. , Reqd. vs. Actual	85.00	287.65	psig
Head M.A.W.P. , Reqd. vs. Actual	85.00	217.67	psig

	Actual	Allowable		
Long. Stress at Top of Saddles	17140.36	20400.00	psi	← INCREASED BY 1.2x AS PER UG-23(d). WITH NO WIND OR SEISMIC, STRESS IN SHELL IS 14950 PSI w/ 17000 PSI ALLOWABLE.
Long. Stress at Bottom of Saddles	-12201.86	-14296.88	psi	
Long. Stress at Top of Midspan	3896.13	17000.00	psi	
Long. Stress at Bottom of Midspan	1042.37	17000.00	psi	
Tangential Shear in Shell	1247.83	16000.00	psi	
Circ. Stress at Horn of Saddle	-11197.06	-29745.00	psi	
Circ. Stress at Tip of Wear Plate	-9058.07	-29745.00	psi	
Circ. Compressive Stress in Shell	-1652.55	-16525.00	psi	

Wind(ASCE #7) and Seismic Results :

Transverse Wind Load Component, Ftw:

```
Ftw = ( AFT * Cf * QZ * Cnv_Fac) * 0.5
Ftw = ( 15311.971 * 1.000 * 16.1440 * 0.00694 )* 0.5
Ftw = 858.321 lb.
```

Longitudinal Wind Load Component, Flw:

```
Flw = ( AFL * QZ * Cnv_fac)
Flw = ( 1564.035 * 16.1440 * 0.00694 )
Flw = 175.346 lb.
```

Transverse Earthquake Load Component, Fte:

```
Fte = ( Cs * Wo ) * 0.5
Fte = ( 0.0679 * 30327.00 ) * 0.5
Fte = 1029.602 lb.
```

Longitudinal Earthquake Load Component, Fle:

```
Fle = Cs * Wo
Fle = 0.0679 * 30327.00
Fle = 2059.203 lb.
```

Saddle Reaction Force due to Transverse Forces, Qr:

```
Qr = ftr * Max( Ftw, Fte ) * B / E
Qr = 3.0 * Max( 858.32 , 1029.60 ) * 25.7500 / 29.8858
Qr = 2661.352 lb.
```

Saddle Reaction Force due to Longitudinal forces, Ql:

```
Ql = Max( Flw, Fle, Flf, Flu ) * B / Ls
Ql = Max( 175.35 , 2059.20 , 0.00 , 0.00 ) * 25.7500 / 141.5004
Ql = 374.730 lb.
```

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

```
Q = Wo/2 + Max( Qr, Ql )
Q = 15163.50 + Max( 2661.35 , 374.73 )
Q = 17824.852 lb.
```

Summary of Loads on this Saddle Support:

Vertical Load on this Saddle	17824.85	lb.
Transverse Shear Load on this Saddle	1029.60	lb.
Longitudinal Shear Load on this Saddle	2059.20	lb.

OPTIMUM WEAR PLATE THICKNESS RESULTS :

	WELDED	UNWELDED	
Optimum Thickness (Ext. = 5 deg.)	0.1875	0.1875	in.
Optimum Thickness (Ext. = 10 deg.)	0.3750	0.3125	in.
Optimum Thickness (Ext. = 15 deg.)	0.4375	0.4375	in.

Formulae and substitutions for ZICK Analysis

Shell and Head Required Thickness and MAWP :

Shell:

Thickness Due to Internal Pressure:

= (P*(D/2+CA)) / (S*E-0.6*P) per UG-27 (c)(1)
= (86.10*(29.0000/2+0.1250))/(20000.00*0.85-0.6*86.10)
= 0.0743 + 0.1250 = 0.1993 in.

Max. All. Working Pressure at Given Thickness (MAWP):
Less Operating Hydrostatic Head Pressure of 1.10 psig

= (S*E*(T-CA-CAE)) / ((D/2+CA)+0.6*(T-CA-CAE)) per UG-27 (c)(1)
= (20000.00*0.85*(0.2500))/((29.0000/2+0.1250)+0.6*0.2500)
= 287.65 - 1.10 = 286.55 psig

Maximum Allowable Pressure, New and Cold (MAPNC):

= (SA*E*T) / (D/2+0.6*T) per UG-27 (c)(1)
= (20000.00*0.85*0.3750)/(29.0000/2+0.6*0.3750)
= 432.94 psig

Actual stress at given pressure and thickness (Sact):

= (P*((D/2+CA)+0.6*(T-CA-CAE))) / (E*(T-CA-CAE))
= (86.10*((29.0000/2+0.1250)+0.6*(0.2500)))/(0.85*(0.2500))
= 5986.14 psi

Elliptical Head:

Thickness Due to Internal Pressure:

= (P*(D+2*CA)*K) / (2*S*E-0.2*P) Appendix 1-4(c)
= (86.10*(29.0000+2*0.1250)*1.00)/(2*20000.00*0.85-0.2*86.10)
= 0.0741 + 0.1250 = 0.1991 in.

Max. All. Working Pressure at Given Thickness (MAWP):
Less Operating Hydrostatic Head Pressure of 1.10 psig

= (2*S*E*(T-CA-CAE)) / (K*(D+2*CA)+0.2*(T-CA-CAE)) per Appendix 1-4(c)
= (2*20000.00*0.85*(0.1875))/(1.00*(29.0000+2*0.1250)+0.2*(0.1875))
= 217.67 - 1.10 = 216.57 psig

Maximum Allowable Pressure, New and Cold (MAPNC):

= (2*SA*E*T) / (K*D+0.2*T) per Appendix 1-4 (c)
= (2*20000.00*0.85*0.3125)/(1.00*29.0000+0.2*0.3125)
= 365.59 psig

Actual stress at given pressure and thickness (Sact):

= (P*(K*(D+2*CA)+0.2*(T-CA-CAE))) / (2*E*(T-CA-CAE))
= (86.10*(1.00*(29.0000+2*0.1250)+0.2*(0.1875)))/(2*0.85*(0.1875))
= 7910.62 psi

Longitudinal Bending (+-) at Midspan

= (3 * Q * L * K.2 / (PI * R^2 * (T - CA)))
= (3 * 17824 * 27.35 * -0.1639) /
(PI * 14.6250 * 14.6250 * (0.3750 - 0.1250)))
= -1426.88 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(1.760) / 1.760 - Cos(1.760)) / (1.760 + Sin(1.760) *
Cos(1.760) - 2 * Sin(1.760) * Sin(1.760)/ 1.760)
= 4.8934

Compute the moment fraction [X]:

```
= (1 - (1 - A/L + ( R² - H² )/(2 * A*L ) )/(1 + (4*H )/( 3 * L ) ) )
= (1 - (1 - 7.781 /27.354 + (1.219² - 0.611²)/( 2 * 7.781 * 27.354 ) ) /
  (1 + (4 * 0.611 )/(3 * 27.354 ) ) )
= 0.3026
```

Intermediate Product [K.1]:

```
= K * X  * 4 * A / L
= 4.893 * 0.303 * 4 * 7.781 / 27.354 = 1.6849
```

Longitudinal Bending (+-) at Saddle

```
= ( 3 * Q * L * K.1 / ( PI * R^2 * ( T - CA )))
= ( 3 * 17824 * 27.35 * 1.6849 ) /
  ( PI * 14.6250 * 14.6250 * ( 0.3750 - 0.1250 )))
= 14671.11 psi
```

Longitudinal Pressure Stress

```
= DP*((SID/2+CA)-0.4*(T-CA))/(2.0*(T-CA))
= 85.0 * (( 29.00 / 2 + 0.1250 - 0.4 * ( 0.375 - 0.1250 )) /
  ( 2.0 * ( 0.375 - 0.1250 ))
= 2469.25 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))
= 17824 * 0.6402 * (( 27.35 - 0.61 - 2 * 7.78 )/
  ( 27.35 + 0.61 ))/( 14.6250 * ( 0.3750 - 0.1250 ))
= 1247.83 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)
= -17824 /( 4 * 0.2500 * (7.00 + 1.56*SQRT(14.6250 *0.2500 )))
  -3 * 17824 * 0.0170 / ( 2 * 0.2500 ^2 )
= -9058.07 psi
```

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

Saddle-Tangent Distance A (93.4) is > R/2 (7.3 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)
= -17824 /( 4 * 0.2500 * (7.00 + 1.56*SQRT(14.6250 *0.2500 )))
  -3 * 17824 * 0.0220 / ( 2 * 0.0625 )
= -11197.06 psi
```

Circumferential Compression at Bottom of Shell

```
= (Q*( K.9/( TEM9 * WPDWTH ) ) )
= ( 17824 *( 0.6374 /( 0.6250 * 11.000 ) ) )
= -1652.55 psi
```

RESULTS for VESSEL RIBS, WEB and BASE

Moment of Inertia of Saddle - Lateral Direction

	Y	A	AY	Ay^2	Io
Shell	0.1250	3.4957	0.4370	0.0546	0.0182
Wearplate	0.4375	4.1250	1.8047	0.7896	0.0483
Web	4.7500	4.1250	19.5938	93.0703	23.3965
BasePlate	9.1875	4.3750	40.1953	369.2944	0.1424
Totals	14.5000	16.1207	62.0307	463.2089	23.6054

```
Value  C1 = Sumof(Ay)/Sumof(A)                          =     3.8479  in.
Value   I = Sumof(Ay²) + Sumof(Io) - C1*Sumof(Ay)      =   248.1273  in**4
Value  As = Sumof(A) - Ashell                          =    12.6250  in²
```

K1 = (1+Cos(b)-.5*Sin(b)^2)/(pi-b+Sin(b)*Cos(b)) = 0.2983

Fh = K1 * Q = 0.2983 * 17824.852 = 5317.216 lb.

Tension Str., St = (Fh/As) =	421.1656	psi
Allowed Str., Sa = .6 * Yield Stress =	22800.0000	psi
d = B - R*Sin(theta) / theta =	14.3043	in.
Bending Moment, M = Fh * d =	6338.2407	ft.lb.
Bending Stress, Sbnd = (M * C1 / I) =	1179.4985	psi
Allowed Str., Sa = .66 * Yield Str. =	25080.0020	psi

Minimum Thickness of Baseplate

= (3 * Q * BasePlateWidth / (2 * BasePlateLength * AllStress))½
= (3 * 17824 * 7.00 / (2 * 27.000 * 25080.002))½
= 0.526 in.

Calculation of Axial Load, Intermediate Values and Compressive Stress:

Effective Baseplate Length (e)
= (Bplen - Clearance) / (Nribs - 1)
= (27.0000 - 1.0) / (2 - 1) = 26.0000 in.

Baseplate Pressure Area (Ap)
= e * Bpwid / 2
= 26.0000 * 7.0000 / 2 = 91.0000 in²

Axial Load (P)
= Ap * Bp
= 91.00 * 94.31 = 8582.34 lb.

Area of the Rib and Web (Ar)
= (Bpwid - Clearance - Webtk) * Ribtk + e/2 * Webtk
= (7.000 - 1.0 - 0.500) * 0.500 + 26.0000 /2 * 0.500
= 9.250 in²

Compressive Stress (Sc)
= P/Ar
= 8582.34 / 9.2500 = 927.8201 psi

Check of Outside Ribs
Inertia of Saddle, Outer Ribs - Axial Direction

	Y	A	AY	Ay^2	Io
Rib	3.2500	3.0000	9.7500	12.6399	11.4427
Web	0.2500	6.5000	1.6250	5.8338	0.2708
Values	1.1974	9.5000	11.3750	18.4737	11.7135

KL/R < Cc (12.6368 < 123.2882) per AISC E2-1 9th Edition
Sca = (1-(Klr)²/(2*Cc²))*Fy/(5/3+3*(Klr)/(8*Cc)-(Klr³)/(8*Cc³)
Sca = (1-(12.64)²/(2 * 123.29²)) * 38000 /
(5/3+3*(12.64)/(8* 123.29)-(12.64³)/(8*123.29³)
Sca = 22170.72 psi

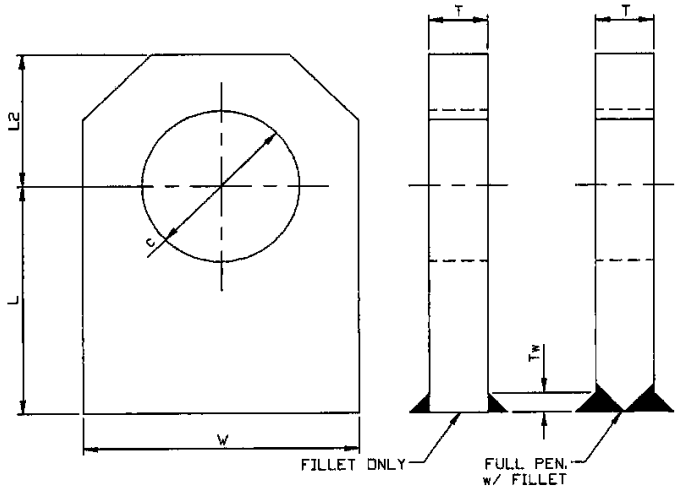
AISC Unity Check on Outside Ribs (must be <= 1.0)
Check = Sc/Sca + (Rm/Z)/Sba
Check = 927.82 / 22170.72 + (11316.90 /6.286) / 25080.00
Check = 0.11

Energy Exchanger Company

Customer :	MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES	Item No	HX0059	W.O. :	X-7936
Subject :	LIFTING LUG CALCULATION	Date	3/23/2011	By :	MD/DN

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

Material	SA-516-70
Yield Strength	38000 psi
T =	1/2 in
Tw =	1/4 in
W=	3 1/2 in
L =	4 3/4 in
L2=	1 3/4 in
OAL =	6 1/2 in
C=	2 in
Analysis Type	Full Pen w/ Fillet (1)
Impact Factor	1.500
Occasional Load Factor	1.125
Heaviest Lug Load	1850 #
	(CHANNEL COVER)
Weld Group Area (Aw)	2.651 in^2
Weld Group Inertia (Iw)	3.067 in^4
Shear Area (As)	0.375 in^2
Lug Inertia (I)	1.786 in^4



Allowable Loading

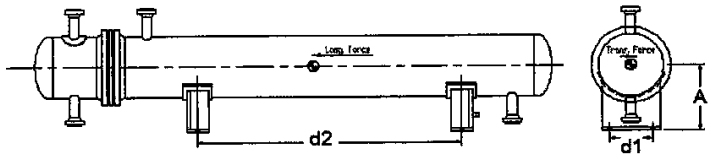
Shear Stress	17100 psi
0.4 * Yield * Occ Factor	
Bearing Stress	32062.5 psi
MIN(0.75*Yield*Occ Factor, 0.9*Yield)	
Combined	28215 psi
MIN(.66*Yield*Occ Factor, 0.75*Yield)	

Calculated Loads

Primary Shear in Welds	1046.68 psi
Load*Impact/(Aw)	
Bending Shear Stress in Welds	1809.38 psi
Load*Impact*(W+2*Tw)/2/(Iw)	
Total Combined Shear	2856.06 psi
Shear in Lug Above Hole	4933.33 psi
Load*Impact/(As)	
Pin Hole Bearing Stress	2775.00 psi
Load*Impact/(T*C)	
Bending Stress @ Lug Base	12912.24 psi
Load*Impact*L/(W^2*T/6)	
Tensile @ Lug Base	1585.71 psi
Load*Impact/(W*T)	
Total Combined Stress @ lug Base	14497.96 psi

Energy Exchanger Company

Customer :	MISSISSIPPI POWER c/o SOUTHERN COMPANY SERVICES	Item Nc	HX0059	W.O. :	X-7936
Subject :	ANCHOR BOLTING CALC	Date	3/23/2011	By :	DN/MD



Static Balance

Near Saddle Ref Dimension:	51 in
Far Saddle Ref Dimension:	249 in
COG Ref Dimension:	129 in
Weight	29700 lb
Dim A	25.75 in
Dim d1	21 in
Dim d2	198 in

Reaction Forces	
Near Saddle (Rfn)	18000 lb
Far Saddle (Rff)	11700 lb
Rf = 0 or Rff if COG outside saddles	0 lb
Transverse Shear Calculation:	
Ss = Ft/(total bolts*bolt area) =	183 psi
Longitudinal Shear Calculation:	
Sl = Fl/(fixed bolts*bolt area) =	733 psi
Transverse Overturning Moment Calc	
Stm = (48*(Ft*A/12)/(d1*total bolts)-(Weight/total bolts))/Ab	
Stm =	-4386 psi
Longitudinal Overturning Moment Calc	
Slm = (48*(Fl*A/12)/(d2*total bolts)-(Weight/total bolts))/Ab	
Slm =	-5094 psi

Number of Bolts (Fixed only)*	2
Bolt Diam.	1.5 in
Bolt Area (Ab)	1.405 in^2
Bolting Material	F1554(Gr. 36)
Allowable Stress Shear	11880 psi
Allowable Stress Tension	11880 psi
Greatest Transverse Load (Ft)	1030 lb
Greatest Longitudinal Load (Fl)	2060 lb

* Longitudinal shear foces countered by bolting in stationary support only.
transverse forces counter by full bolting (fixed support bolts * 2)

All calcualted stresses are less than allowable
Anchor bolting design is accebtale.

CALCULATION IS FOR SIZING OF SUPPORT HOLES & SLOTS. THIS CALCULATION DOES NOT REPLACE OR RELIEVE THE 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 CO. DEKALB MS. (Name and address)
4. Type: HORIZ. (Horiz., vert., or sphere) | HEAT EXCHANGER (Tank, separator, jkt. vessel, heat exh., etc.) | X-7936 (Mfg's serial No.)
   (CRN) | X-7936-A REV. 3 (Drawing No.) | 5925 (Nat'l Bd. No.) | 2011 (Year built)
5. ASME Code, Section VIII, Div. 1 2007 EDITION (2009 ADDENDA) [Edition and Addenda (date)] | (Code Case No.) | [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): 3 (b) Overall length (ft & in.): 27'-2 1/2"

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
2	29" I.D.	10'-0"	SA-516-70	3/8"	1/8"	1	SPOT	0.85	1 *(1)*	SPOT	0.85	---	---
1	29" I.D.	7'-2 1/2"	SA-516-70	3/8"	1/8"	1	SPOT	0.85	1 *(1)*	SPOT	0.85	---	---

7. Heads: (a) SA-516-70 (Mat'l Spec. No., Grade or Type) (H.T. - Time & Temp.) (b) (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) (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 UCS-66(a,b,c,d), [indicate *yes* or *no* and the component(s) impact tested] at test temperature of — °F.
11. Hydro., ~~pneu., or comb.~~ Test press. 280 P.S.I.G. Proof test

Items 12 and 13 to be completed for tube sections.

12. Tubesheet: SA-266-4N [Stationary (Mat'l Spec. No.)] | 29 3/4" [Dia., in. (subject to press.)] | 3 5/16" (Nom. thk., in.) | 1/4" (Corr. Allow., in.) | WELDED [Attachment (welded or bolted)]
    [Floating (Mat'l Spec. No.)] | (Dia., in.) | (Nom. thk., in.) | (Corr. Allow., in.) | (Attachment)
13. Tubes: SA-214 (Mat'l Spec. No., Grade or Type) | 3/4" (O.D., in.) | 0.0830" (min) THK. (Nom. thk., in. or gauge) | 313 (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`-9 3/4"

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B, & C)			Heat Treatment	
No.	Diameter, in.	Length (ft & in.)	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time
1	30" I.D.	1'-9 3/4"	SA-516-70N	1 1/4"	1/8"	1	SPOT	0.85	1 *(1)*	SPOT	0.85	1150° F.	1 1/4 HR.

15. Heads: (a) SA-266-4N (Mat'l Spec. No., Grade or Type) (H.T. - Time & Temp.) (b) (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 3/8"	3/16"						31.6637"					
(b)														

If removable, bolts used (describe other fastening) a)SA-193B7; 1 1/2" DIA; 36 (Mat'l Spec. No., Grade, size, No.)

FORM U-1 (Back)

16. MAWP 1009 (internal) — (external) psi at max. temp. 285 (internal) — (external) °F Min. design metal temp. 10 °F at 1009 psi.

17. Impact test NO, EXEMPT PER UCS-66(a,b,c,d), (Indicate yes or no and the component(s) impact tested) at test temperature of — °F.

18. Hydro., ~~pneu., or comb.~~ Test press. 1315 P.S.I.G. Proof test

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	12"-150#	RF-WN	SA-106B	SA-105	0.5000"	1/8"	SA-516-70	WELDED	WELDED	SHELL
OUTLET	1	4"-150#	RF-WN	SA-106B	SA-105	0.4380"	1/8"	WELD	WELDED	WELDED	SHELL
VENT	1	2"-150#	RF-LWN	SA-105	—	0.5300"	1/8"	WELD	WELDED	—	SHELL
INLET	1	6"-600#	RF-WN	SA-106B	SA-105N	0.4320"	1/8"	SA-516-70N	WELDED	WELDED	CHANNEL
OUTLET	1	6"-600#	RF-WN	SA-106B	SA-105N	0.4320"	1/8"	SA-516-70N	WELDED	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 — (Describe) (2)Saddles 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: MAKEUP WATER TRIM HEATER; ITEM NO.: HX0059; P.O. NO: 17497-0001; SIZE: 29-288; TYPE: NEU
TUBES DESIGNED W/ 0" C.A., SAFETY RELIEF DEVICES BY OTHERS
(1) Tubesheet to cylinder circumferential seams are type 7 joints with efficiency of 1.0
LINES 14-18 INCLUDES (1) 40 5/8" O.D. X 30" I.D. X 7 1/16 " THK., SA-266-4N, RING

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 12-14-11 Name ENERGY EXCHANGER COMPANY (Manufacturer) Signed (Representative)

CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commision issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of OKLAHOMA and employed by ONEBEACON AMERICA INSURANCE COMPANY of LYNN, MA have inspected the pressure vessel described in this Manufacturer's Data Report on 12-14-2011, 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 12-14-11 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

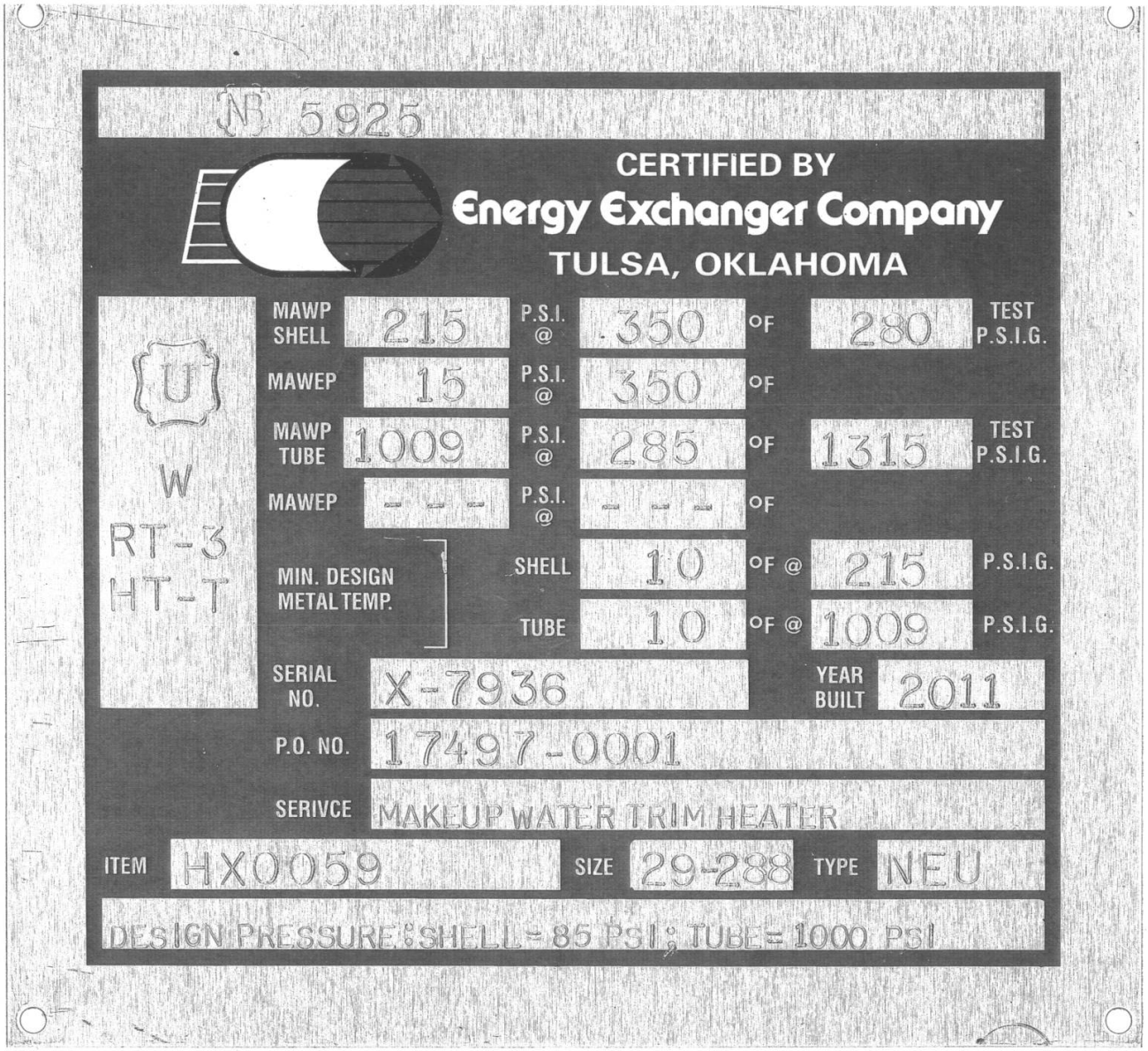
Date Name (Assembler) Signed (Representative)

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

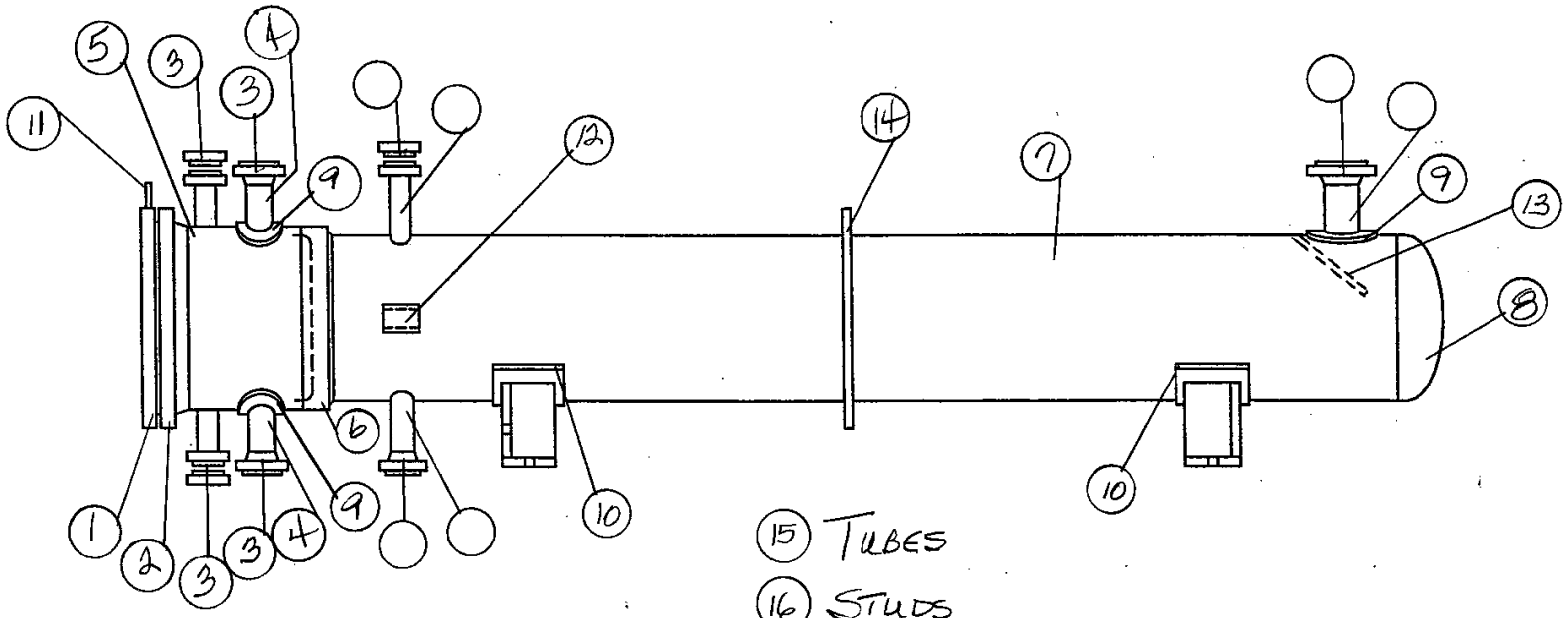
I, the undersigned, holding a valid commision issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of and employed by of , have compared the statements in this Manufacturer's Data Report with the described pressure vessel and state that parts referred to 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.)


NB 5925
CERTIFIED BY
Energy Exchanger Company
TULSA, OKLAHOMA
U
W
RT-3
HT-T
MAWP SHELL 215 P.S.I. @ 350 °F 280 TEST P.S.I.G.
MAWEP 15 P.S.I. @ 350 °F
MAWP TUBE 1009 P.S.I. @ 285 °F 1315 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 @ 1009 P.S.I.G.
SERIAL NO. X-7936
YEAR BUILT 2011
P.O. NO. 17497-0001
SERIVCE MAKEUP WATER TRIM HEATER
ITEM HX0059
SIZE 29-288
TYPE NEU
DESIGN PRESSURE: SHELL = 85 PSI; TUBE = 1000 PSI

SECTION 4



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

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No.: MC202
ITEM NO: HX0059
SERVICE: MAKEUP WATER TRIM HEATER

NO.	DATE	REVISIONS

HEAT NUMBER LOCATION MAP

DWN. BY: D.MORRISON
DATE: 3-28-11
CKD. BY:

Energy Exchanger Co.

DWG. NO.: X-7936

ENERGY EXCHANGER COMPANY

MATERIAL HEAT NUMBER INDEX

Project: Kemper County 1 - IGCC

CUSTOMER:	**Southern Company Services (for) Mississippi Power**	**ITEM NO:**	**HX0059**	**PAGE:**	**1 of 3**
DESTINATION:	**DeKalb, Mississippi**	**SERVICE:**	**Makeup Water Trim Heater**	**DATE:**	**December 6, 2011**
P.O. No:	**17497-0001**	**DESCRIPTION:**	**1-29" x 288" NEU**	**JOB NO:**	**X-7936**
REQ. NO:	**MC202**				

PART NO.	HEAT NO.	SLAB NO.	STEEL PRODUCER	GRADE	DESCRIPTION	PCS	SIZE
1	Y5655		Ellwood City	SA-266-4N	**(#1 Channel Cover)**	1	40 5/8" OD x 5 3/8" thk.
2	110695		Nucor	SA-266-4N	**(#2 Channel Flange)**	1	40 5/8" OD x 30" ID x 7 1/16" thk.
3	101728N/02		Galperti	SA-105-N	**(Nozzle Flange T-1 & 2)**	2	6" 600# RF WN Sch X-Hvy. Bore
3	Z526		FCI	SA-105-N	**(Nozzle Flange V1 & D1)**	2	2" 600# RF LWN x 12" lg.
3	3021551		Galperti	SA-105-N	**(Nozzle Flange V1 & D1)**	2	2" 600# RF Blind
3	10336W/02		Galperti	SA-105-N	**(Nozzle Flange S-1)**	1	12" 150# RF WN Sch X-Hvy. Bore
3	3024415		Galperti	SA-105-N	**(Nozzle Flange S-2)**	1	4" 150# RFWN Sch 120 Bore
3	C859AF		FVC	SA-105	**(Nozzle Flange S-3)**	1	2" 150# RF LWN x 12" lg.
3	3023067		Galperti	SA-105-N	**(Nozzle Flange S-3)**	1	2" 150# RF Blind
4	X22424		U.S.S.	SA-106-B	**(Nozzle Pipe T-1 & 2)**	2	6" Sch X-Hvy. X 9 1/4"lg.
4	A02133		U.S.S.	SA-106-B	**(Nozzle Pipe S-1)**	1	12" Sch X-Hvy. X 9" lg.
4	HA0196		U.S.S.	SA-106-B	**(Nozzle Pipe S-2)**	1	4" Sch 120 x 9 1/4" lg.
5	E0K165	C09	SSAB	SA-516-70N	**(Channel Cylinder)**	1	30" ID x 1 1/4" thk. x 1'-9 3/4" lg.

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

ENERGY EXCHANGER COMPANY

By: Lynda Patterson

ENERGY EXCHANGER COMPANY
MATERIAL HEAT NUMBER INDEX

Project: Kemper County 1 - IGCC

CUSTOMER:	**Southern Company Services (for) Mississippi Power**	**ITEM NO:**	**HX0059**	**PAGE:**	**2 of 3**
DESTINATION:	**DeKalb, Mississippi**	**SERVICE:**	**Makeup Water Trim Heater**	**DATE:**	**December 6, 2011**
P.O. No:	**17497-0001**	**DESCRIPTION:**	**1-29" x 288" NEU**	**JOB NO:**	**X-7936**
REQ. NO:	**MC202**				

PART NO.	HEAT NO.	SLAB NO.	STEEL PRODUCER	GRADE	DESCRIPTION	PCS.	SIZE
6	207A724		Bethlehem	SA-266-4N	**(#4 Tubesheet)**	1	32 1/2" OD x 5 3/16" thk.
7	1506168	06	Nucor	SA-516-70	**(Shell Cylinder) "Courses 1 & 3"**	2	29" ID x 3/8" thk.
7	B1S6882	01	Nucor	SA-516-70	**(Shell Cylinder) "Course 2"**	1	29" ID x 3/8" thk.
8	2B026 1500668	01	Nucor	SA-516-70	**(Shell Head)**	1	29" ID x 5/16" (min) thk. 2:1 Ellip. w/2" S.F.
9	W7F517	A18	Ipsco	SA-516-70N	**(Channel Weld Pads)**	2	10 1/16" OD x 9 5/8" OD x 3/4" thk.
9	1506168	06	Nucor	SA-516-70	**(Shell Weld Pad)**	1	16 3/16" OD x 15 3/4" OD x 3/8" thk.
10	1502825	09	Nucor	SA-516-70	**(Support Pads)**	2	11" x 3/8" thk. x 42 1/8" lg.
11	1500676	09	Nucor	SA-516-70	**(Lifting Lugs)**	1	3 1/2" x 1/2" x 6 1/2" lg.
12	W0H543	0024	SSAB	SA-516-70	**(Name Plate Bracket)**	1	7 1/2" x 3/16" thk. x 22" lg.
13	1502456	03	Nucor	SA-516-70	**(Deflector Plate)**	1	11 1/2" x 3/8" thk. x 27 1/8" lg.
14	E0J010	63	SSAB	SA-516-70	**(Reinforcement Ring)**	1	32 7/8" OD x 29 7/8" ID x 1/2" thk.

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

ENERGY EXCHANGER COMPANY

By: Lynda Jatterson

ENERGY EXCHANGER COMPANY
MATERIAL HEAT NUMBER INDEX

Project: Kemper County 1 - IGCC

CUSTOMER:	**Southern Company Services (for) Mississippi Power**	**ITEM NO:**	**HX0059**	**PAGE:**	**3 of 3**
DESTINATION:	**DeKalb, Mississippi**	**SERVICE:**	**Makeup Water Trim Heater**	**DATE:**	**December 6, 2011**
P.O. No:	**17497-0001**	**DESCRIPTION:**	**1-29" x 288" NEU**	**JOB NO:**	**X-7936**
REQ. NO:	**MC202**				

PART NO.	HEAT NO.	SLAB NO.	STEEL PRODUCER	GRADE	DESCRIPTION	PCS.	SIZE
15	WA102708		Webco	SA-179	**(Tubes)**	270	3/4" OD x .083" (min) x V/L
15	GC52765		Webco	SA-179		7	3/4" OD x .083" (min) x V/L
15	WA013327		Webco	SA-179		6	3/4" OD x .083" (min) x V/L
15	WA101432		Webco	SA-179		30	3/4" OD x .083" (min) x V/L
16	108584		Vulcan Thrd. Prod.	SA-193-B7	**(Studs)**	36	1 1/2" (8 Thd) x 16" lg.
17	NC361		Unytite	SA-194-2H	**(Nuts)**	72	1 1/2" (8 Thd)
18	821E02630	B030887	ArcelorMittal	SA-516-70N	**(Pass Plate)**	1	14 11/16" x 1/2" thk. x 30 7/8" lg.
18	821E02630	B030887	ArcelorMittal	SA-516-70N	**(Pass Plate)**	1	29 7/8" x 1/2" thk. x 30 7/8" lg.

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

ENERGY EXCHANGER COMPANY

By: Lynda Patterson

Part #1+2

OKLAHOMA FORGE, INC.
Certification of Analysis and Tests

INVOICE NUMBER: 111-67455

Date: 7/20/11

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

Sold To	Your Purchase Order		Sales Order	
ENERGY EXCHANGER COMPANY	Number	1275	Number	111-52240
1844 N. GARNETT ROAD	By	JIM ELDER	Shipped Via	DELIVERY
TULSA, OK 74116 USA	Date	6/09/2011	Ship Date	7/20/2011

PART DESCRIPTION

Your Part Number | Shop Order Number | Shape | Dimensions
Supplier | Heat Number | Made to Specification
Chemical Analysis
Item | Physical Properties | Sharpy Impact (Ft-Lbs) | Quantity

Item	Your Part Number	Shop Order Number	Shape	Dimensions	Quantity
7	X-7936-2	111-52240-07	RING	40.625"OD x 30.000"ID x 7.063"TH	1
		NUCOR	110695	SA266-10 GR4 NORMALIZED	

Part #2

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.17	1.22	.011	.004	.20	.06	.11	.15	.02	.021	.003	.025		.42	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
50,500	74,500	34	73	150			FINE	CVN	-50F	85	61	102	92

Item	Your Part Number	Shop Order Number	Shape	Dimensions	Quantity
11	X-7936-1	111-52240-11	DISC	40.625"OD x 5.375"TH	1
		ELLWOOD CITY	Y5655	SA266-10 GR4 NORMALIZED	

Part #1

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.18	1.16	.008	.001	.21	.13	.12	.18	.05	.016	.0143	.020		.43	N-.019

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
54,500	80,000	32	70	163			FINE	CVN	-50F	38	48	35	32

VERIFIED BY
JUL 22 2011
EEC QC DEPT
L. Patterson

Notes: UT REPORT ATTACHED

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

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.

DW

ADVANCED INSPECTION TECHNOLOGIES

3820 Charles Page Blvd.
Tulsa, Oklahoma 74127-8033
Phone: 918-584-4677

ULTRASONIC INSPECTION AND CALIBRATION REPORT

CUSTOMER DATA

NAME Oklahoma Forge
ADDRESS Sapulpa, ok
PURCHASE ORDER # SO. 533 Part # 1+2
ATTENTION
DAY Wednesday DATE 7-20-11

JOB NUMBER:
APPLICABLE CODE: SA 508 ; S2
PROCEDURE # UT1B REVISION # REV. DATE:

EQUIPMENT DATA

EQUIPMENT MANUFACTURER: Sonotest MODEL# SS240 S/N Tool70
SEARCH UNIT CABLES: #1 TYPE single LENGTH 6' S/N
SEARCH UNIT CABLES: #2 TYPE LENGTH S/N
LONGITUDINAL SEARCH UNIT MFG. #1 Krautkramer ANGLE Ø FREQ. 2.25 MHz SIZE 3/4" S/N
LONGITUDINAL SEARCH UNIT MFG. #2 ANGLE FREQ. MHz SIZE S/N
SHEAR WAVE SEARCH UNIT MFG #1 Krautkramer ANGLE 45 FREQ. 1.0 MHz SIZE 1.0 S/N
SHEAR WAVE SEARCH UNIT MFG #2 ANGLE FREQ. MHz SIZE S/N
SHEAR WAVE SEARCH UNIT MFG #3 ANGLE FREQ. MHz SIZE S/N
COUPLANT BRAND NAME: Sonotech UT-X TYPE: Cellulose
SPECIAL EQUIPMENT: (IF USED)
CALIBRATION BLOCK TYPE: 4in Type I
SIMULATION BLOCK TYPE:

CALIBRATION DATA

LONGITUDINAL - #1 REFERENCE LEVEL 46 (db) SCANNING LEVEL 52 (db)
LONGITUDINAL - #2 REFERENCE LEVEL (db) SCANNING LEVEL (db)
SHEAR WAVE - ANGLE #1 REFERENCE LEVEL 61 (db) SCANNING LEVEL 67 (db)
SHEAR WAVE - ANGLE #2 REFERENCE LEVEL (db) SCANNING LEVEL (db)
SHEAR WAVE - ANGLE #3 REFERENCE LEVEL (db) SCANNING LEVEL (db)
Initial Cal. Time Cal. Check Ending Cal. Time

TEST CONDITIONS

PART CONDITION: machined Smooth
SIMULATION BLOCK TEMP: 90 F PART TEMP. 90 F
SCANNING TYPE: CONTACT ✓ IMMERSION MANUAL ✓ AUTOMATIC
SCANNING SPEED 46" per Second.
SCANNING SURFACE: INSIDE OUTSIDE ✓ VERTICAL ✓ HORIZONTAL ✓
SCANNING DIRECTIONS: PARALLEL ✓ PERPENDICULAR ✓ OPPOSING ✓

PART IDENTIFICATION: So# 52240-07
1- 40.625 x 30.000 X 7.063
HT# 110695
material: SA266

So # 52240-11
1- 40.625 x 5.375
material: SA266
HT# 45655

RESULTS UT acceptable per SA 508, S2
no indications found.

TECHNICIAN HRS. ASST. HRS. TRAVEL HRS. MILEAGE PERDIEM

TECHNICIAN: Blaine Sampson LEVEL II
ASSISTANT: LEVEL
CUSTOMER REPRESENTATIVE: TOTAL TIME 2 pieces

Part #2

GALPERTI, INC.
160 Southbelt Industrial Drive
Houston, Texas 77047
PH. 713-433-0700 - FAX 713-433-6580
Email: galpmail@galperti-am.com

Noz. 1-1+2

TEST/CERTIFICATE	EN 10204	INTERNAL JOB
3.1B		110699

PROGRESSIVE SUPPLY
P. O. BOX 470748
TULSA OK 74145

This MTR applies to your PO# 1438

M.T.CERTIFICATE N.	DATE	YOUR P.O.	DATE
002919/B	04/01/2011	119502 X-7936-81+82	02/23/2011

ITEM	DESCRIPTION	QUANTITY	B/P	MATERIAL	HEAT N°	#
002/002	24" 150 WN RF STD A105 B1 F	1	B	ASTM A/SA105 03c	154776L/02	A
004/004	14" 150 WN RF XS A105 B1 F	3	B	ASTM A/SA105 03c	10321W/02	B
007/007	3" 150 WN RF 160 A105 B1 F	10	B	ASTM A/SA105 03c	3021864	C
020/020	6" 600 WN RF XS A105 B1 F	10	B	ASTM A/SA105 03c	101728N/02	D

CHEMICAL ANALYSIS

#		C %	MN %	SI %	P %	S %	CR %	NI %	MO %	CU %	V %	SN %	AL %	NB %	TI %	N %	CB%	FL%
A		0.160	1.300	0.270	0.017	0.009	0.160	0.040	0.020	0.050	0.017		0.020	0.002			0.002	0.42
A	C	0.150	1.320	0.250	0.020	0.006	0.170	0.050	0.030	0.060	0.012		0.030	0.002			0.002	0.41
B		0.210	0.860	0.200	0.013	0.008	0.070	0.100	0.020	0.290	0.002		0.022	0.001			0.001	0.39
B	C	0.200	0.880	0.180	0.016	0.011	0.060	0.090	0.030	0.300	0.002		0.024	0.001			0.001	0.39
C		0.190	1.050	0.220	0.016	0.017	0.120	0.080	0.020	0.290	0.003		0.002	0.0001			0.0001	0.41
C	C	0.180	1.070	0.240	0.019	0.020	0.130	0.090	0.030	0.280	0.003		0.010	0.0001			0.0001	0.41
D		0.180	1.240	0.200	0.011	0.006	0.090	0.070	0.020	0.200	0.023		0.017	0.0030			0.0030	0.43
D	C	0.170	1.260	0.180	0.014	0.003	0.100	0.080	0.030	0.210	0.018		0.031	0.0030			0.0030	0.42

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	78,504	49,089	27.0	66.0				159
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	76,978	50,399	30.7	66.2				154
C	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
C	O		12.50	122.70	50.00	68	76,652	49,366	30.0	67.0				164
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	76,303	49,483	30.6	68.6				151

NOTES

O = OBTAINED
S = STANDARD

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

GENERAL NOTES

ROUGHNESS
F =STOCK FINISH 125-250 microinch

VERIFIED BY
STANDARD
B1 = ASME B16.5 4 2011
OCT
EEC QC DEPT

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

TRADE MARK / LOGO	INT. INSPECT DATE	INT. INSPECTOR
Stamped on product	04/01/2011	D.RUZICKA

INSPECTION AUTHORITY

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

101728N6P33BX.max

Part #3

FCI FORGED COMPONENTS INC.

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

REPORT NUMBER 52779
DATE 9/2/2011
FCI ORDER NUMBER 53175
Processed I.A.W. EN10204 3.1

CUSTOMER ORDER NUMBER 119682-ADD
SOLD/SHIPPED TO PROGRESSIVE SUPPLY
P.O. BOX 470748
TULSA OK 74147 USA

This MTR applies to your PO# 1438

Item	Quantity	Description
5	10	2" X 600 X 12" LG RF LWN

X. 7936. 82 + 84 Noz. V1 + D1

HEAT NUMBER:	MATERIAL TYPE:	Material Origin:	Manufactured in
Z526	SA105	USA ✓	USA ✓

I.A.W. ASME 2010 ED.

CHEMICAL ANALYSIS

C	.170 ✓
Mn	1.150 ✓
P	.0060 ✓
S	.0020 ✓
Si	.200 ✓
Cr	.160 ✓
Mo	.030 ✓
V	.041 ✓
Cu	.150 ✓
Ni	.060 ✓
Cb	.000 ✓
N	.0100
Sn	.013
As	.003
Sb	.002
Ti	.0010
Al	.025
B	.0000
C E	.42

PHYSICAL PROPERTIES

Yield PSI	49,600 ✓
Tensile PSI	75,800 ✓
Elongation	30 ✓
Reduction of Area	75 ✓
Hardness	149 HBW ✓

VERIFIED BY
[illegible]
EEC QC DEPT

L. Patterson

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

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

Prepared by V.H.

Name: Veronica Hernandez Title: QA Representative

Z5262X12P173.max

GALPERTI, INC.
160 Southbelt Industrial Drive
Houston, Texas 77047
PH. 713-433-0700 – FAX 713-433-6560
Email: galpmail@galperti-am.com

Noz. V1+D1

TEST/CERTIFICATE EN 10204: 3.1B

INTERNAL JOB: 111106

PROGRESSIVE SUPPLY
P. O. BOX 470748
TULSA OK 74145

Part #3

This MTR applies to your PO# 14138

M.T.CERTIFICATE N.	DATE	YOUR P.O.	DATE
002929/B	04/01/2011	119520 X-7936-83D+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	3019/86		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

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

GENERAL NOTES

ROUGHNESS
F =STOCK FINISH 125-250 microinch

STANDARD
B1 = ASME B16.5

VERIFIED BY

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

EEC QC DEPT

TRADE MARK / LOGO	INT. INSPECT DATE	INT. INSPECTOR
Stamped on product	04/01/2011	D.RUZICKA

INSPECTION AUTHORITY

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

30215512P73.max

Part #3

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

Noz. S1

TEST/CERTIFICATE EN 10204 3.1B

INTERNAL JOB 093141

PROGRESSIVE SUPPLY
P. O. BOX 470748
TULSA OK 74145

This MTR applies to your PO# 1438

M.T.CERTIFICATE N.	DATE	YOUR P.O.	DATE
000999/B	01/27/2010	099052 X-7936-71	10/07/2009

ITEM	DESCRIPTION	QUANTITY	B/P	MATERIAL	HEAT N°		#
005/005	12" 150 WN RF XS A105 B1 F	10	B	ASTM A/SA105 03c	10336W/02		A

CHEMICAL ANALYSIS

#		C %	MN %	SI %	P %	S %	CR %	NI %	MO %	CU %	V %	SN %	AL %	NB %	TI %	N %	CB%		FL%
A		0.180	1.150	0.210	0.013	0.006	0.060	0.080	0.020	0.190	0.020		0.020	0.0008	0.015		0.0008		0.40
A	C	0.170	1.170	0.190	0.016	0.009	0.050	0.090	0.030	0.180	0.015		0.030	0.0008	0.015		0.0008		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	78,403	46,941	28.4	70.0				161

NOTES
COUNTRY OF ORIGIN USA ✓

O = OBTAINED
S = STANDARD

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

GENERAL NOTES
ROUGHNESS
F -STOCK FINISH 125-250 microinch

VERIFIED BY
STANDARD
B1 - ASME B16.5

NOTES
Material I.A.W. Nace MR-0175-2003

EEC QC DEPT
L Patterson

TRADE MARK / LOGO
Stamped on product

INT. INSPECT DATE 01/27/2010

INT. INSPECTOR D.RUZICKA

INSPECTION AUTHORITY

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

10336W12P30BX.max

Part #3

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

Noz. 52

TEST/CERTIFICATE EN 10204: 3.1B

INTERNAL JOB: 112429

PROGRESSIVE SUPPLY
P. O. BOX 470748
TULSA OK 74145

This MTR applies to your PO# 1438

M.T.CERTIFICATE N.	DATE	YOUR P.O.	DATE
007993/B	08/26/2011	119676 X-7936-72	07/18/2011

ITEM	DESCRIPTION	QUANTITY	B/P	MATERIAL	HEAT N°		#
017/017	4" 150 WN RF 120 A105 B1 F	10	B	ASTM A/SA105 03c	3024415		A
029/029	3" 1500 WN RF XS A105 B1 F	10	B	ASTM A/SA105 03c	112268N/02		B

CHEMICAL ANALYSIS

#		C %	MN %	SI %	P %	S %	CR %	NI %	MO %	CU %	V %	SN %	AL %	NB %	TI %	N %	CB%	B %	FL%
A		0.200	1.030	0.210	0.010	0.022	0.090	0.080	0.022	0.240	0.004		0.002	0.001			0.001		0.41
A	C	0.190	1.050	0.190	0.013	0.019	0.100	0.070	0.012	0.250	0.004		0.011	0.001			0.001		0.40
B		0.170	1.170	0.200	0.012	0.005	0.110	0.060	0.020	0.170	0.018		0.024	0.002	0.001		0.002	0.0002	0.40
B	C	0.160	1.190	0.220	0.009	0.008	0.120	0.050	0.010	0.160	0.013		0.025	0.002	0.001		0.002	0.0002	0.40

NOTES
FL=Carbon Equivalent Long Formula

C = CHECK ANALISYS

MECHANICAL PROPERTIES

#		TENSILE TYPE	ø DIAMETER mm.	AREA mmq.	LENGHT mm.	TEMP. F	TENSILE PSI	YIELD PSI	ELONG %	REDUCT. %	CHARPY TEST TYPE	TEMP.	VALUES	HB HARDNESS (AVERAGE)
A	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
A	O		12.50	122.70	50.00	68	76,449	49,826	28.0	68.0				155
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	77,765	47,461	30.8	68.8				152

NOTES

O = OBTAINED
S = STANDARD

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

GENERAL NOTES

ROUGHNESS
F =STOCK FINISH 125-250 microinch

VERIFIED BY
OCT 04 2011
EEC QC DEPT

STANDARD
B1 = ASME B16.5

NOTES
Material I.A.W. Nace MR-0175/ISO 15156-2-09

COUNTRY OF ORIGIN: USA

L Patterson

TRADE MARK / LOGO
Stamped on product

INT. INSPECT DATE: 08/26/2011

INT. INSPECTOR: D.Ruzicka

INSPECTION AUTHORITY
D. Ruzicka

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

30244154P30S120.max

X-7936-73 Part #3 This MTR applies to your PO# 1438

Material Test Report

Heat Code: C859AF

Noz 53

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: 119550	Sales Order: 95626 Line: 6
Attn: Accounts Payable	Item Code: LWN020150120A001A1	Qty Shipped: 5
P.O. Box 470748	Item Desc: LWN,SA105,150#,2"x12",RF	
Tulsa, OK 74147	Supplier: STEEL DYNAMICS	Supplier Heat: A110109
Spec: ASME SA105, 2007 Edition, 2009 Addenda		

Element	(%wt)	Ladle	Product	EPCRA	CAS#
C	Carbon	0.20			
Mn	Manganese	1.14		✓	7439-96-5
P	Phosphorous	0.005			
S	Sulphur	0.004			
Si	Silicon	0.24			
Cu	Copper	0.14		✓	7440-50-8
Ni	Nickel	0.06		✓	7440-02-0
Cr	Chromium	0.09		✓	7440-47-3
Mo	Molybdenum	0.02			
V	Vanadium	0.03			
Cb	Columbium	0.001			
Sn	Tin	0.009			

Element	(%wt)	Ladle	Product	EPCRA	CAS#
Ti	Titanium	0.001		✓	7440-02-0
Al	Aluminum	0.024			
Ca	Calcium	0.0020			
N	Nitrogen	0.0079			
O					
As	Arsenic	0.004		✓	7440-38-2
Sb	Antimony	0.002		✓	7440-36-0
CE	C+Mn/6+(Cr+Mo+V)/5	0.43			
Cu+Ni+Cr+Mo		0.31			
Cr+Mo		0.11			
H % wt		0.0001			

Mechanical Testing

Test Lab	AMF 49959
HBW	183
Elg (%)	32
RA (%)	71
Tensile (ksi)	90.073
Yield (ksi)	75.427

Heat Treat

Heat Treatment	As forged

Other

Country of Origin	USA
Manufactured In	USA
Production Method	EAF/VTD
Reduction Ratio (Mill) x:1	14.9
Gr.Sz.	7
Calcium Treated	Y

VERIFIED BY
OCT 04 2011
EEC QC DEPT

NACE MR0175 & MR0103 (hardness only), CE=C+(Mn/6)+((Cr+Mo+V)/5)+((Ni+Cu)/15), Elongation in 2" round
FVC STANDARD MANUFACTURING PRACTICES:
1) FLANGE DIMENSIONS & BOLTING COMPLY - ASME B16.5
2) SELF-REINFORCING NOZZLES COMPLY WITH SPECIFICATION OF SECTION VIII DIV. 1 OR DIV. 2 PER CUSTOMER DESIGN/FVC DESIGN
3) MATERIAL SPECIFICATION COMPLIES WITH ASME SECT. II PART A
4) ALL FVC MATERIAL MANUFACTURED PER FINE GRAIN PRACTICE
5) ALL FVC MATERIAL CERTIFIED PER EN 1020, 3.1.B UNLESS OTHERWISE SPECIFIED
6) CERTIFICATE OF INSURANCE AVAILABLE UPON REQUEST

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

Certification No.: 1004972
Certification Date: 6/21/2011
Issued By: Ana Robles
This report is issued in compliance with the requirements of EN10204 3.1 / ISO 104/4 3.1.B

Puneet Saggar - Plant Metallurgist

C859AF2X12P170.max

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

Noz. 53

Part #3

TEST/CERTIFICATE EN 10204 — 3.1B

INTERNAL JOB — 110548

PROGRESSIVE SUPPLY
P. O. BOX 470748
TULSA OK 74145

This MTR applies to your PO# 1438

M.T.CERTIFICATE N.	DATE	YOUR P.O.	DATE
003380/B	04/14/2011	119497 X-7936-73D	02/14/2011

ITEM	DESCRIPTION	QUANTITY	B/P	MATERIAL	HEAT N°		#
028/028	2" 150 BL RF A105 B1 F	100	B	ASTM A/SA105 03c	3023067		A
031/031	18" 150 BL RF A105 B1 F	3	B	ASTM A/SA105 03c	11134W/02		B

CHEMICAL ANALYSIS

#		C %	MN %	SI %	P %	S %	CR %	NI %	MO %	CU %	V %	SN %	AL %	NB %	TI %	N %	CB %	B %	FL %
A		0.200	1.040	0.230	0.008	0.016	0.080	0.080	0.020	0.200	0.003			0.001			0.001		0.41
A	C	0.190	1.060	0.250	0.011	0.013	0.090	0.090	0.030	0.210	0.003			0.001			0.001		0.41
B		0.180	1.170	0.200	0.018	0.004	0.080	0.090	0.030	0.200	0.020		0.022	0.0001	0.002	0.002	0.0001	0.0001	0.42
B	C	0.170	1.190	0.220	0.015	0.007	0.090	0.080	0.020	0.210	0.015		0.034	0.0001	0.002	0.002	0.0001	0.0001	0.41

NOTES
FL=Carbon Equivalent Long Formula

C = CHECK ANALISYS

MECHANICAL PROPERTIES

TENSILE

#		TYPE	Ø DIAMETER mm.	AREA mm².	LENGHT mm.	TEMP. F	TENSILE PSI	YIELD PSI	ELONG %	REDUCT. %
A	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0
A	O		12.50	122.70	50.00	68	77,256	48,071	27.6	69.2
B	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0
B	O		12.50	122.70	50.00	68	77,939	46,678	26.0	69.0

CHARPY TEST

TYPE	TEMP.	VALUES	HB HARDNESS (AVERAGE)
			187
			152
			187
			165

NOTES

O = OBTAINED
S = STANDARD

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

GENERAL NOTES

ROUGHNESS
F =STOCK FINISH 125-250 microinch

VERIFIED BY
STANDARD
B1 – ASME B16.5
OCT 04 2011
EEC QC DEPT

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

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

INSPECTION AUTHORITY

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

30230672P70.max

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

NOZ. T-1,2

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-7926-81A+82A

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

Part #4

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: F0052922

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

**

Part #1

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

UNITED STATES STEEL

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

TIME: 12:17:26

MILL ORDER/ITEM NO.	SHIPPERS NO.	P.O. NUMBER	VEHICLE I.D.
DR30241 02		C2539000	

SOLD TO ADDRESS

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

MAIL TO ADDRESS

This MTR applies to your
PO# 0274

VENDOR

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

#96

SPECIFICATION AND GRADE

PIPE CARBON SMLS STD PIPE API 5L-*43RD EDITION DATED 3/04 PSL-1 GRADE B ASTM A53-*02 GRADE B ASME SA53-*2001 EDITION 2003 ADDENDA GRADE B ASTM A106-*02A GRADE B/C ASME SA106-*2001 EDITION 2003 ADDENDA GRADE B/C BLK REG MILL COAT PE BEV 30 DEG MEETING ALL THE APPLICABLE REQUIREMENTS OF NACE STANDARD MR-01-75 *2002

X.7936.71A

STOCK Noz. 51 SCH X.HVY

MATERIAL COND: AS ROLLED | O.D.: 12.750(323.850) in (mm) | WALL: 0.500 (12.700) in (mm)

PRODUCT IDENTIFICATION	TENSILE TEST TYPE/ ORIENTATION	TEST COND.	GAUGE WIDTH	YIELD PSI	EXT % .50	TENSILE PSI	Y/T	ELONG % (IN 2')	HARDNESS SCALE: HRB	MIN HYDRO PSI	DWELL (SEC)
			IN	MIN: 40000 MAX:		MIN: 70000 MAX:	MAX:	MIN: 29.5	MIN: MAX: 99.0	2060	5
A02133	STRIP/L/B	AR	1.500	45300	.50	72500	0.63	44.0	B 80.7	2060	5
		**	END OF DATA THIS	SHEET	**						

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

PRODUCT IDENTIFICATION	TYPE	C	MN	P	S	SI	CU	NI	CR	MO	AL	N	V	B	TI	CB	CO	C.E.*
																		MAX .50
A02133	HEAT	.19	1.06	.007	.005	.17	.03	.02	.10	.02	.031		.001			.001		.40
A02133	PROD	.20	1.07	.005	.007	.16	.03	.02	.10	.03	.030		.002			.001		.41
A02133	PROD	.20	1.07	.005	.007	.16	.03	.02	.10	.03	.030		.002			.001		.41
		**	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 POSITIONS FOR ELEMENTS ARE INDICATED BY THE LEFT MARGIN, VERTICAL DOTTED LINE OR DECIMAL POINT.

CHECKED APR 29 2010
L Patterson

Part #4

UNITED STATES STEEL

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

TIME: 12:17:26

MILL ORDER/ITEM NO.	SHIPPERS NO.	P.O. NUMBER	
DR30241 02		C2539000	

MATERIAL COND: AS ROLLED

O.D.: 12.750(323.850) in (mm) | WALL: 0.500 (12.700) in (mm)

PRODUCT IDENTIFICATION	FLAT	BEND	GRAIN SIZE	MIN COLLAPSE	CHARPY V-NOTCH IMPACT TESTING												
					DIR	TEST LOC.	TEMP	SIZE	TEST COND.	FT-LBS 1	FT-LBS 2	FT-LBS 3	FT-LBS AVG	% SHEAR 1	% SHEAR 2	% SHEAR 3	% SHEAR AVG
							DEG										
A02133	OK		** 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 ____ L/T X 10.0% NOTCH
FULL LENGTH MPI		
FULL LENGTH UT		OD ____ OD/ID ____ L ____ L/T ____
END AREA INSPECTION (PLAIN END)	X	MPI X UT ____
SPECIAL END AREA (SEA) INSP.		MPI ____ UT ____
FULL LENGTH DRIFT		DRIFT MANDREL SIZE:

ADDITIONAL NOTES/COMMENTS

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

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

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

DATE 06/14/05

UNITED STATES STEEL

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

DATE: 04/13/10
TIME: 10:16:57
SERIAL NO: L0031508

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	VEHICLE I.D
DR48372 03		D0653000	

SOLD TO ADDRESS

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

MAIL TO ADDRESS

This MTR applies to your
PO# 0897

VENDOR

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

Noz. 5-2

SPECIFICATION AND GRADE

PIPE CARBON SMLS STD PIPE API 5L-*44TH ED DTD OCT 2007 AND ISO 3183:2007 MOD PSL-1 GRADE B AND GRADE X42 R N OR Q ASTM A53-*07 ASTM A106-*08 GRADE B QUAD STENCIL ASME SA53-*2007 EDITION ASME SA106-*2007 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-7926-72A STOCK #72 Ch 120

MATERIAL COND: AS ROLLED | O.D.: 4.500 (114.300) In (mm) | WALL: 0.438 (11.125) In (mm)

PRODUCT IDENTIFICATION	TENSILE TEST TYPE/ ORIENTATION	TEST COND.	GAUGE WIDTH	YIELD PSI / EXT % .50	TENSILE PSI	Y/T	ELONG % (IN 2")	HARDNESS SCALE: HRB	MIN HYDRO PSI	DWELL(SEC)
			IN	MIN: 42100	MIN: 60200		MIN:	MIN:		
				MAX:	MAX:	MAX:	25.0	MAX: 99.0	2970	5
HA0196	STRIP/L/B	AR	0.750	51000 .50	82500	0.62	34.0	B 81.9	2970	5
		**	END OF DATA THIS SHEET **							

LEGEND: L - LONGITUDINAL, T - TRANSVERSE, U - UPSET, 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 .50
HA0196	HEAT	22	99	010	003	24	14	10	16	02	031		00	0000	002	001		.44
HA0196	PROD	22	99	011	005	22	15	10	16	04	033		00	0000	002	002		.44
HA0196	PROD	23	100	011	005	23	15	10	17	03	034		00	0000	002	002		.46
			** 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 POSITIONS FOR ELEMENTS ARE INDICATED BY THE LEFT MARGIN, VERTICAL DOTTED LINE OR DECIMAL POINT.

CHECKED JAN 28 2011
L. Patterson

Part #4

UNITED STATES STEEL

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

DATE: 04/13/10
TIME: 10:16:57
SERIAL NO: L0031508

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	
DR48372 03		D0653000	

MATERIAL COND: AS ROLLED

O.D.: 4.500(114.300) In (mm)

WALL: 0.438 (11.125) In (mm)

PRODUCT IDENTIFICATION	FLAT	BEND	GRAIN SIZE	MIN COLLAPSE	CHARPY V-NOTCH IMPACT TESTING												
					DIR	TEST LOC.	TEMP	SIZE	TEST COND.	FT-LBS				% SHEAR			
										1	2	3	AVG	1	2	3	AVG
							DEG										
HA0196	OK		**	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		OD ____ OD/ID ____ L ____ L/T ____
FULL LENGTH MPI		
FULL LENGTH UT		ID ____ OD/ID ____ L ____ L/T ____
END AREA INSPECTION (PLAIN END)		MPI ____ 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

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 04/13/10

Part #4

**

SSAB

Test Certificate

Form TC1: Revision 1: Date 31 Oct 2000

12400 Highway 43 North, Axis, Alabama 36505

Customer: METALS USA PLATES & SHAPES SOU P.O. BOX 3528 101 EAST ILLINOIS ENID OK 73702 X.7936-12	**Customer P.O. No.:** MUS-232504	**Mill Order No.:** 41-285661-04	**Shipping Manifest :** AR105229
	Product Description: ASME SA516-70/SA516-65/SA516-60(09A) ASTM A516-70/A516-65/A516-60(06) LCVN 15/12 FT.LBS @ -50F/A673-P NORMALIZED ✓	**Ship Date:** 19 Nov 10 **Cert Date:** 19 Nov 10	**Cert No:** 081252335 (Page 1 of 1)
	Size: 1.250 X 96.00 X 200.0 (IN)	SSAB 289	

Tested Pieces				Tensiles						Charpy Impact Tests									
Heat Id	Piece Id	Piece Dimensions	Tst Loc	YS (PSI)	UTS (PSI)	%RA	Elong % 2in	Elong % 8in	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
E0K165	C09	1.260 X 96.00 (DISCRT)	L	51000	72000			28	T		38	54	71	54.3					-60F	L	10.	

Heat Id	Chemical Analysis C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	CEV	ORGN
E0K165	.17	1.11	.011	.001	.20	.025	.023	.29	.15	.14	.05	.002	.004	.015	.43	USA

MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED
DURING THE MANUFACTURE OF THIS PRODUCT
CEV (IIW) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15
MTR DIN EN10204:2004 TYPE 3.1 COMPLIANT
100% MELTED AND MANUFACTURED IN THE USA.
NORMALIZED PLATES. HEATED AT 1650F FOR 50 MINUTES.
PRODUCTS SHIPPED:
E0K165 C09 6200416 PCES: 2, WGT: 13800

CHECKED DEC 0 8 2010

L. Patterson

(P) Cust Part # :

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

Jason Thomas
SENIOR METALLURGIST

Part #5

Gulf Coast Machine & Supply Co.

General Offices & Plant
6817 Industrial Road
Beaumont, TX 77705
(409) 842-1311

MATERIAL MAIN TEST REPORT

Reference #: 79272 **Item #:** 004 **Job Order #:** 79272-0000 **Heat #:** 207A724

Quantity Ordered: 1 **Quantity Shipped:** 1 **Sold To:** ENERGY EXCHANGERS

Description: ASME SA266-07 GR 4 NORMALIZE **Date:** 8/15/2011
R/M FOR UT 22 MAX RC (237 HB MAX) DOMESTIC MATERIAL ONLY **P/O #:** 1277
PT# X-7936 LN 4 LINE ITEM 4
32.5 OD X 5.188 LG
Gulfco Job Nr. and S/N 79272

CHEMICAL ANALYSIS:

Steel Mill: BETHLEHEM

	C	Mn	P	S	Si	Ni	Cr	Mo	Cu	V	Cb	N	Al
Mill	0.15	1.25	0.007	.005	0.23	0.06	0.12	0.012	0.14	0.084	.001	.0090	.020
PA													

	Sn	As	Sb	Ti	B	Ca	Co	H (ppm)	O (ppm)	Ta
Mill	0.007	.004	.005	.002	.0003	.0022	TRACE	2.1	24	.001
PA										

MECHANICAL PROPERTIES:

Diameter Test Specimen: .503

Tensile Lb/Sq Ins	.2% Yield Lbs/Sq Ins	Elongation in 2 Ins	Reduction in Area %	Type Test*
72,500	47,700	36	73	P

Actual Impact Results	Type Sample	Ft/Lbs	% Shear	MLE	Type Test*

Degrees Fahrenheit

I HEREBY CERTIFY THIS REPORT TO BE TRUE AND CORRECT ACCORDING TO THE RECORDS IN POSSESSION OF THIS COMPANY.

* P = Production Prolongation R = Representative Test Block

Jennifer Higgins

Jennifer Higgins 8/15/2011

Q.A. Representative Date

STEEL MADE IN THE U.S.A. UNLESS OTHERWISE NOTED

Part #6

VERIFIED BY

EEC QC DEPT

L. Patterson

Gulf Coast Machine & Supply Co.

General Offices & Plant
6817 Industrial Road
Beaumont, TX 77705
(409) 842-1311

HEAT TREAT REPORT

REFERENCE #: 79272 **ITEM #:** 004 **JOB ORDER #:** 79272-0000 **HEAT #:** 207A724
QTY ORDERED: 1 **QTY SHIPPED:** 1 **DATE:** 8/15/2011 **SOLD TO:** ENERGY EXCHANGERS
DESCRIPTION: ASME SA266-07 GR 4 NORMALIZE R/M FOR UT 22 MAX RC (237 HB MAX) DOMESTIC MATERIAL ONLY
PT# X-7936 LN 4 LINE ITEM 4
32.5 OD X 5.188 LG
Gulfco Job Nr. and S/N 79272
P/O #: 1277

HB: 143 ✓ **HB:** 146 ✓

	Deg. F	ACTUAL TIME(HOURS)	COOLANT
Normalize	1650	9.5	AIR

Result Notes:

I HEREBY CERTIFY THIS REPORT TO BE TRUE AND CORRECT ACCORDING TO THE RECORDS IN POSSESSION OF THIS COMPANY.

Jennifer Higgins
Jennifer Higgins 8/15/2011
Q.A. Representative Date

Part #6

Gulf Coast Machine & Supply Co.

General Offices & Plant
6817 Industrial Road
Beaumont, TX 77705
(409) 842-1311

ULTRASONIC TEST REPORT

REFERENCE #: 79272 **ITEM #:** 004 **JOB ORDER #:** 79272-0000 **HEAT #:** 207A724
QTY ORDERED: 1 **QTY ACCEPTED:** 1 **DATE:** 8/15/2011 **SOLD TO:** ENERGY EXCHANGERS
DESCRIPTION: ASME SA266-07 GR 4 NORMALIZE **P/O #:** 1277
R/M FOR UT 22 MAX RC (237 HB MAX) DOMESTIC MATERIAL ONLY
PT# X-7936 LN 4 LINE ITEM 4
32.5 OD X 5.188 LG
Gulfco Job Nr. and S/N 79272

REPORT NUMBER: UT- 79272

SPECIFICATION NUMBER: ASME SA-508 S2 **WITNESS:**

PROCEDURE NUMBER: WI 1003-01 **SCOPE** 100%

INSTRUMENT TYPE & MODEL #: USN-60 S/N:203MXH **TYPE COUPLANT:** SONOTECH UT-X POWDER

LONG. FREQ: 2.25 MHz **SIZE OF TRANSDUCER:** 1" **TYPE OF TRANSDUCER:** GAMMA S/N:01WDHD

SHEAR FREQ: **SIZE OF TRANSDUCER:** **TYPE OF TRANSDUCER:**

REFERENCE LEVEL (Longitudinal): 40 DB **SCAN LEVEL(Longitudinal):** 46 DB
REFERENCE LEVEL (Shear): **SCAN LEVEL(Shear):**

SHEAR WAVE WEDGE MEDIUM & SIZE: **ESTIMATED RMS SURFACE:** 250

TECHNICIAN: Brent LaFleur **TECH LEVEL:** II Brent LaFleur

Jennifer Higgins

I HEREBY CERTIFY THIS REPORT TO BE TRUE AND CORRECT ACCORDING TO THE RECORDS IN POSSESSION OF THIS COMPANY.

Jennifer Higgins 8/15/2011
Q.A. Representative Date

Part #6

Gulf Coast Machine & Supply Co.

General Offices & Plant
6817 Industrial Road
Beaumont, TX 77705
(409) 842-1311

ADDITIONAL COMMENTS

REFERENCE #:	79272	**ITEM #:**	004	**JOB ORDER #:**	79272-0000	**HEAT #:**	207A724
QTY Ordered:	1	**QTY Shipped:**	1	**DATE:**	8/15/2011	**Sold To:**	ENERGY EXCHANGERS
Description:	ASME SA266-07 GR 4 NORMALIZE					**P/O #:**	1277
	R/M FOR UT 22 MAX RC (237 HB MAX) DOMESTIC MATERIAL ONLY						
	PT# X-7936 LN 4 LINE ITEM 4						
	32.5 OD X 5.188 LG						
	Gulfco Job Nr. and S/N 79272						

NOTES: UW13 TENSILE TEST: TS - 72,700 YS - 48,400 EL - 35 RA - 71

I HEREBY CERTIFY THIS REPORT TO BE TRUE AND CORRECT ACCORDING TO THE RECORDS IN POSSESSION OF THIS COMPANY.

Jennifer Higgins

Jennifer Higgins — 8/15/2011

Q.A. Representative — **Date**

Part #6

NUCOR
NUCOR STEEL TUSCALOOSA, INC.

MILL TEST CERTIFICATE

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

NL 334

Load Number	Tally	Mill Order Number	P.O. Number	Part Number	Certificate Number	Date
387949	00000000413236	N-105831-011	33756		L328808-1	06/12/2011 05:36

Grade

Customer:

Order Description:
A516 70, 0.3750 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 (1pc.) X-7936-15

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
1E3285E	B1S6882-01 ***	B1S6882	0.22	1.12	0.009	0.007	0.20	0.17	0.07	0.08	0.021	0.001	0.001	0.039	0.001	0.008	0.0001	0.0030	0.008	0.44
1E3285F	B1S6882-01 ***	B1S6882	0.22	1.12	0.009	0.007	0.20	0.17	0.07	0.08	0.021	0.001	0.001	0.039	0.001	0.008	0.0001	0.0030	0.008	0.44

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
1E3285E	S1E3285BTT	B1S6882 ***	52.5	73.9	71.0	32.6													
1E3285E	S1E3285FTT	B1S6882 ***	53.1	79.9	66.5	31.6													
1E3285E	S1E3285MTT	B1S6882 ***	52.7	73.9	71.3	35.4													
1E3285F	S1E3285BTT	B1S6882 ***	52.5	73.9	71.0	32.6													
1E3285F	S1E3285FTT	B1S6882 ***	53.1	79.9	66.5	31.6													
1E3285F	S1E3285MTT	B1S6882 ***	52.7	73.9	71.3	35.4													

VERIFIED BY
OCT 13 2011
EEC QC DEPT
L. Patterson

Energy Exch.
PO # 1585
4pc 3/8 x 96 x 240 A516-70

Items: 2 PCS: 8 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

Part #1

333

NUCOR
PLATE MILL

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

Mill Test Report

Page 1

NUCOR
It's our Nature.

Issuing Date : 08/26/2011 B/L No. : 303546 Load No. : 305186 Our Order No. : 94009/12 Cust. Order No. : MUS-234121

Vehicle No: NOKL 725344

Specification : 0.3750" x 120.000" x 480.000"
ASTM A516 70-10/ASME SA516 70 PVQ 2011 Addenda 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-7936-15 (2pcs.) + (1pc) - 71B

	Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
*	1506168	0.19	1.02	0.012	0.002	0.20	0.33	0.08	0.10	0.02	0.032	0.004	0.001	0.002		0.0009	0.0003	0.012	0.41	0.27
	1506169	0.19	1.08	0.014	0.002	0.20	0.27	0.08	0.12	0.02	0.033	0.005	0.001	0.002		0.0008	0.0003	0.011	0.43	0.28

	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.
*	1506168-06	6	18.37	T	56,000	81,200		19.5												
	1506168-07	3	9.18	T	68,000	82,700		23.2												
	1506168-06	6	18.37	T	52,200	75,300		22.5	N											
	1506168-07	3	9.18	T	51,100	75,900		24.5	N											
	1506169-01	4	12.25	T	55,400	78,700		18.3												
	1506169-02	6	18.37	T	56,900	81,500		18.3												
	1506169-01	4	12.25	T	63,600	77,000		21.6	N											
	1506169-02	6	18.37	T	53,200	75,500		20.8	N											

VERIFIED BY
SEP 2 1 2011
EEC QC DEPT
L Jatterson

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 (#008063) 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. B Depretis

T. A. Depretis, Metallurgist

09/02/2011 6:50:00 AM

Part # 7149

Tank Head Manufacturing Complex
10703 Sheldon Road
Houston, TX 77044

UNI-FORM COMPONENTS CO.

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

Part #8

X-7936-18

Packlist No.	Customer ID
PL-53271	ENEEXC

MATERIAL CERTIFICATION

Customer PO No.	UCC Job No.	Date Cert. Originated
1305	98194	7/18/2011

Sold To:
ENERGY EXCHANGER COMPANY
1844 N GARNETT RD

WILL NOT RECEIVE ON FRIDAYS
TULSA OK 74116

Ship To:
ENERGY EXCHANGER COMPANY
1844 N GARNETT RD

WILL NOT RECEIVE ON FRIDAYS
TULSA OK 74116

Ln	Order Qty	Ship Qty	B/O Qty	Part Description	
1	1	1	0	**HEAD 2:1 ELLIP, 29 ID X 1/2 SA516-70** **Unit of Measure: EA**	**.3125" MIN** ✓

Code: 2B-026 **HEAT/SLAB:** 1500668/01 **GRADE:** SA516-70 **MILL:** NUCOR

VERIFIED BY
JUL 27 2011
EEC QC DEPT
K. Patterson

MILL TEST REPORTS ATTACHED

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

1. We hereby certify that these heads were hot formed at the required normalizing temperature and air cooled, in accordance with all applicable specifications.

2. We hereby certify that these heads comply with tolerances of UG-81 of ASME Section VIII, Div. 1.

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

Stephen Cobb

Quality Control

2B026

NUCOR PLATE MILL
P.O.Box 279
Winton, NC 27986
(252) 358-3700

Mill Test Report

Page 2

NUCOR It's our Nature.

Issuing Date : 01/28/2011 B/L No. : 283977 Load No. : 285784 Our Order No. : 88271/4 Cust. Order No. : 9987

Vehicle No: TTPX 811251

Specification : 0.5000" x 120.000" x 488.000"
ASTM A516 70-10/ASME SA516 70 PVQ 2009 Addenda Cu .15 Max, Sn .020 Max Normalized Test Coupons at 1650 F

Sold To : RANGER STEEL SERVICES LP
1225 NORTH LOOP W. STE 850
HOUSTON,TX 77008

Ship To : RANGER STEEL
C/O KINDERMORTEX
9649 CLINTON DRIVE
ZONE 23 TRACK 415
HOUSTON,TX 77245

Marking : X-7926-18

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
1500668	0.19	1.02	0.010	0.000	0.20	0.12	0.12	0.08	0.01	0.027	0.005	0.002	0.002		0.0014	0.0002	0.007	0.40	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.
1500668-01	6	24.50	T	50,000	78,200		25.3													
1500668-05	6	24.50	T	48,100	76,300		21.5													
1500668-01	6	24.50	T	49,500	75,300		28.5	N												
1500668-05	6	24.50	T	44,900	71,200		25.3	N												

VERIFIED BY

JUL 27 2011

EEC QC DEPT

L. Patterson

RANGER STEEL
Q.C. APPROVED

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 (#008063) 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-548

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

01/31/2011 9:52:58 AM

Part #8

Test Certificate

IPSCO
12400 Highway 43 North, Axis, Alabama 36505

Form TC1: Revision 1: Date 31 Oct 2000

Customer: METALS USA PLATES & SHAPES SOU P.O. BOX 3528 101 EAST ILLINOIS ENID OK 73702 X-7936-81B, 82B	**Customer P.O. No.:** MUS-225181	**Mill Order No.:** 41-179952-04	**Shipping Manifest :** AR039599
	Product Description: ASME SA516-70/SA516-65/SA516-60(04ED.) ASTM A516-70/A516-65/A516-60(06) LCVN 15/12 FT.LBS @ -60F/A673-P NORMALIZED ✓ **Size:** 0.750 X 120.0 X 480.0 (IN)	**Ship Date:** 30 Jun 07 **Cert Date:** 30 Jun 07	**Cert No:** 081089960 (Page 1 of 1) IPS 215

Tested Pieces			Tensiles						Charpy Impact Tests									
Heat Id	Piece Id	Piece Dimensions	YS (PSI)	UTS (PSI)	%RA	Elong % 2in	Elong % 8in	Bnd Tst	Average Hardness	Abs. Energy(FTLB) 1	2	3	Avg	% Shear 1	2	3	Avg	Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
W7F517	A18	0.749 X 120.0 (DISCRT) L	50000	73000			28			68	78	48	64.7					-60F	L	10.	

Heat Id	Chemical Analysis C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	CEV	ORGN
W7F517	.18	1.11	.007	.004	.21	.026	.023	.24	.16	.08	.05	.004	.011	.020	.42	USA

MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED
DURING THE MANUFACTURE OF THIS PRODUCT
CEV (IIW) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15
100% MELTED AND MANUFACTURED IN THE USA. MTR DIN EN10204 TYPE 3.1 COMPLIANT.
NORMALIZED PLATES. HEATED AT 1650F FOR 32 MINUTES.

W7F517 A18 6031030 PCES: 1, WGT: 12259 W7F517 A18 6031031 PCES: 1, WGT: 12259
W7F517 A18 6031032 PCES: 1, WGT: 12256 W7F517 A18 6031033 PCES: 1, WGT: 12256

MTR Verified
L Patterson 7/31/07
ENERGY FABRICATORS CORP.

(P) Cust Part # :

WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH THE APPROPRIATE SPECIFICATION

Jason Thomas
SENIOR METALLURGIST

Part #s
Energy Fabricators
55895

321

NUCOR PLATE MILL

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

Mill Test Report

Page 3

NUCOR It's our Nature.

Issuing Date : 05/01/2011 B/L No. : 292311 Load No. : 294273 Our Order No. : 90537/10 Cust. Order No. : MUS-233263

Vehicle No: TTPX 82223

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-7936-120

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
1502825	0.19	1.02	0.013	0.002	0.19	0.21	0.07	0.10	0.01	0.025	0.005	0.002	0.002		0.0016	0.0002	0.009	0.40	0.26

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.
1502825-08	5	12.25	T	53,500	79,600		24.4													
1502825-09	5	12.25	T	51,000	76,100		24.8													
1502825-10	5	12.25	T	51,800	78,300		25.8													
1502825-08	5	12.25	T	55,800	76,400		25.8	N												
1502825-09	5	12.25	T	60,600	72,800		25.0	N												
1502825-10	5	12.25	T	49,800	75,800		24.9	N												

VERIFIED BY
JUN 20 2011
EEC QC DEPT

NACE MR0175 ANNEX 2.1.2 COMPLIANT

L Patterson

Test coupons only, normalized 60 minutes per inch of thickness at 1650 F ± 25 F. Hold 30 minutes minimum. ;

Part #10

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 (#008063) 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

05/12/2011 12:52:48 PM

0983-1

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 : 01/26/2011 B/L No. : 284003 Load No. : 285802 Our Order No. : 88286/3 Cust. Order No. : 9989

Vehicle No: TTPX 805406

Specification : 0.5000" x 96.000" x 480.000"
ASTM A516 70-10/ASME SA516 70 PVQ 2009 Addenda Cu .15 Max, Sn .020 Max Normalized Test Coupons at 1650 F

Sold To : STEEL SERVICE CLAREMORE OKLAHOMA

Ship To : STEEL SERVICE CLAREMORE OKLAHOMA

X-7936-62

Cut to 6½" Lg.

Marking : STOCK LIFTING LUGS 3½ x ½" THK x 8¾" Lg.

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
1500676	0.18	1.00	0.014	0.000	0.20	0.12	0.13	0.07	0.01	0.020	0.005	0.001	0.002		0.0018	0.0002	0.008	0.38	0.25

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.
1500676-04	5	16.33	T	47,800	76,200		24.4													
1500676-09	6	19.60	T	47,000	76,500		23.9													
1500676-10	3	9.80	T	45,700	74,500		25.1													
1500676-04	5	16.33	T	49,000	74,600		25.8	N												
1500676-09	6	19.60	T	49,300	74,800		26.9	N												
1500676-10	3	9.80	T	47,200	71,900		25.1	N												

VERIFIED BY
AUG 12 2011
EEC QC DEPT
L. Latterson

PIONEER STEEL INC.
DATE 8-8-11 QTY. 100
PO# 1408
PART# STOCK
BY

Pioneer
PO# 914544
1pc ½x96x240
1 A516-70

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 (#008063) 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

01/31/2011 9:51:41 AM

Part #11

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 : HT864418

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

STOCK NB BRACKETS

Size: 0.188 X 96.00 X 480.0 (IN)

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

Cert No: 831110772
(Page 1 of 1)

V-7936-61

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

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

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

ENERGY EXCHANGER
PO#1462
SO#203277

HT#W0H543 SL#0024
ITEM#1 65PCS

VERIFIED BY
SEP 19 2011
EEC QC DEPT

(*) Cust Part # :

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

Jason Thomas
SENIOR METALLURGIST

Part #13

323

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

Mill Test Report

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-7926-63

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												

VERIFIED BY
JUN 20 2011
EEC QC DEPT
R. Patterson

Post #13

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 (#008053) 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, Metallurgist

04/26/2011 10:32:37 AM

SSAB

Test Certificate

318

13609 Industrial Road, Houston, TX 77015

Form TC1: Revision 1: Date 31 Oct 2000

Customer:	Customer P.O. No.: MUS-232724	Mill Order No.: 41-289050-03	Shipping Manifest : HT067336
METALS USA PLATES & SHAPES SOU P.O. BOX 3528 101 EAST ILLINOIS ENID OK 73702	Product Description: ASTM A516-70(06)/ASME SA516-70(09A) AS-ROLLED, TEST COUPON NORM. 1650F+/-25F 1HR/";NACE MR0175 ANNEX A2.1.2 COMPLIANT	Ship Date: 21 Jan 11 Cert Date: 21 Jan 11	Cert No: 031116185 (Page 1 of 1)
	Size: 0.500 X 96.00 X 480.0 (IN)	X-7936-64	

Tested Pieces				Tensiles						Charpy Impact Tests								
Heat Id	Piece Id	Piece Dimensions	Tst Loc	YS (PSI)	UTS (PSI)	%RA	Elong % 2in / 8in	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
E0J010	0063	0.506 X 96.00 (T.L.C)	L	61000	77000		31	T							
			C	64000	81000		32	T							
			T	65000	84000		30	T							
E0J010	0063*	0.506 X 96.00 (T.L.C)	L	52000	76000		34	T							
			C	52000	74000		35	T							
			T	52000	75000		34	T							

Heat Id	Chemical Analysis C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	CEV	ORGN
E0J010	.16	1.17	.014	.002	.20	.027	.024	.27	.14	.15	.05	.002	.006	.016	.43	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
RESULTS OF TENSILE TESTS PERFORMED ON NORMALIZED TEST COUPONS ARE LABELED WITH *
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:
* E0J010 0063 PCES: 4, WGT: 26137

VERIFIED BY

JUN 20 2011

EEC QC DEPT

L. Patterson

(P) Cust Part # : 1271

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

Jason Thomas
SENIOR METALLURGIST

Part #14

MATERIAL TEST REPORT

Part # 15

Sold To: 3010000	Ship To: 3010000
ENERGY EXCHANGER	ENERGY EXCHANGER
1844 N. GARNETT	1844 N. GARNETT
TULSA OK 74116	TULSA OK 74116

X-7936

Purchase Order: 1070 / X-7931 X-7935 X-7936
Sales Order: 132889
Material: BA13007500830M A/SA214/178-A ERW 0750 OD 083M
Delivery: 80221504

(313 pcs.)

Description: ASTM/ASME A/SA 214-96(05) 178-A-02(07) ERW

Test: FLATTENING TEST PASSED. REVERSE FLATTENING TEST PASSED. FLANGE TEST PASSED. NDT ELECTRIC TESTED TO ASTM A450 & E309.

Heat Number:		GC52765 % (7 pcs)	WA013327 % (6 pcs.)	WA101432 % (30 pcs.)	WA102708 % (270 pcs.)
CARBON	LDL	0.060	0.061	0.063	0.063
MANGANESE	LDL	0.450	0.370	0.356	0.358
PHOSPHORUS	LDL	0.007	0.011	0.013	0.011
SULFUR	LDL	0.005	0.002	0.004	0.004
SILICON	LDL	0.030	0.030	0.020	0.010
NICKEL	LDL	0.050	0.040	0.050	0.050
CHROMIUM	LDL	0.040	0.060	0.070	0.060
MOLYBDENUM	LDL	0.010	0.010	0.010	0.010
COPPER	LDL	0.080	0.090	0.130	0.160
ALUMINUM	LDL	0.034	0.033	0.027	0.027
R-EACH	LDL	0.000	0.000	0.000	0.000
R-TOTAL	LDL	0.000	0.000	0.000	0.000
BORON	LDL	0.0001	0.0002	0.0001	0.0001
CALCIUM	LDL	0.002	0.002	0.002	0.002
COLUMBIUM	LDL	0.001	0.000	0.000	0.000
NITROGEN	LDL	0.008	0.006	0.008	0.006
TIN	LDL	0.009	0.006	0.006	0.007
TITANIUM	LDL	0.001	0.002	0.001	0.001
VANADIUM	LDL	0.001	0.002	0.002	0.003
Ultimate (PSI)					
Yield (PSI)					
Elongation (%)					
Hardness (RB)		50 / 56	49 / 51	56 / 56	53 / 58

Webco Industries, Inc. certifies that the material described was manufactured and tested and/or inspected in accordance with the specification and fulfills requirements in such respect.
This document conforms to the requirements ofSpecification EN 10204 Inspection Document Type 3.1.
This document was prepared by means of electronic processing and is valid without signature.

Date: 11/14/2011

Tim Benear
Quality Manager

VERIFIED BY

EEC QC DEPT

L Patterson

DATE: 11/16/11

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

Part #16

CERTIFIED MATERIAL TEST REPORT

ENERGY EXCHANGERS
1844 N. GARNETT RD.
TULSA OK 74116

LOT # 108584
HEAT # 108584
STOCK # B7S150C1600
1-1/2-8 X 16 ASTM A-193 B-7
CUS PO# 1618
ORDER # 280518

X.7936.41

SPECIFICATIONS:

ASTM A193 B7 ALL THREAD ROD
REV 2007

VENDOR: VULCAN THREADED PRODUCTS, INC. QTY SOLD 36

- CHEMICAL COMPOSITION -

C %	MN %	P %	S %	SI %	NI %	CR %
00.4200	00.8900	00.0140	00.0230	00.2300	00.1110	00.9640
MO %	**CU %**	**CO %**	**V %**	**AL %**	**FE %**	**TA %**
00.1590	00.2800		00.0050	00.0010		
TI %	**ZN %**	**SE %**	**CB %**	**W %**	**N %**	**SN %**
						00.0130

- CHARPY IMPACT -

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

- MECHANCIAL PROPERTIES -

TENSILE STRENGTH: 132,600 Psi
YIELD : 117,400
ELON : 20.00
RA : 58.00

HARDNESS : 26 HRC
PROOF STRESS: 0 Psi

COMMENTS:

COUNTRY OF ORIGIN USA
TEMPERING TEMP 1380 F
MACRO ETCH S1/R2/C1

VERIFIED BY
NOV 17 2011
EEC QC DEPT
K. Jatterson

W.M. HEITGRAS COMPANY
QUALITY CONTROL MANAGER

DATE: 11/16/11

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

Part #17

CERTIFIED MATERIAL TEST REPORT

ENERGY EXCHANGERS
1844 N. GARNETT RD.
TULSA OK 74116

LOT # NC361
HEAT # 806425
STOCK # H2HHN150-8
1-1/2-8 ASTM A-194 2-H HEAVY
CUS PO# 1618
ORDER # 280518

SPECIFICATIONS:

X-7936-42

ASTM A-194 GR.2H HEAVY HEX NUT

VENDOR: UNYTITE, INC.

QTY SOLD 72

- CHEMICAL COMPOSITION -

C %	MN %	P %	S %	SI %	NI %	CR %
00.4600	00.7600	00.0080	00.0290	00.2200	00.0800	00.0800

MO %	CU %	CO %	V %	AL %	FE %	TA %
00.0200	00.2000					

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 : 28.4 HRC
PROOF STRESS: 261,100 Psi

COMMENTS:

TEMPERING TEMP 1157 F
HARDNESS AFTER 24HR=104.2 HB
COUNTRY OF ORIGIN USA
NUTS ARE HOT FORGED

VERIFIED BY
NOV 17 2011
EEC QC DEPT

W.M. HEITGRAS COMPANY

R Patterson

QUALITY CONTROL MANAGER

ArcelorMittal Burns Harbor Plate

Part #18

QUALITY ASSURANCE
REPORT OF TEST AND ANAYLSES

SHIPMENT NO.	DATE SHIPPED	CAR OR VEHICLE NO.		PAGE
803-04983	03-27-09	IHB-MCCOO-BNSF	LMIC 036335	3

SOLD TO
STEEL SERVICE CO
24412 AMAH PKWY
CLAREMORE OK 74017

SHIP TO
STEEL SERVICE CO
C/O TULOMA STEVEDORING INC ,
TULSA PORT AUTHORITY OK
X-7936-50+51

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 2007 EDITION 2008 ADD,
CH-V A20S5 PLT L 15/12 FTLBS AT
-50F --- PLT NORMALIZED & COOLED IN
STILL AIR
NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)
MFST - MFST MILL SERIAL# LIFT MAX 10 TON UNLDG
OH-CHAIN
CO# 26298 GH 816-2424E
PLATES HEAT TREATED - TEST SPECIMENS ATTACHED & YIELD STRENGTH @ .5% EUL ✓

B030598	811E02630	2	1/2	120	480	16336	50800	73100	8	24		
			N	1650 DEG F -	26 MIN							
(M55)MFST REF#:06												
B030888	813E62230	1	1/2	120	480	8168	52900	75200	8	27		
			N	1650 DEG F -	26 MIN							
(M55)MFST REF#:06												
* B030887	821E02630	1	1/2	120	480	8168	49800	72400	8	26		
			N	1650 DEG F -	26 MIN							
(M55)MFST REF#:06												

Q-QUENCH TEMPERATURE

Company Name: ENERGY EXCHANGERS
PO#: 0033
Quantity: 1
Size: 1/2 X 120 X 240 NORM
Heat#: 821E02630 B030887

N-NORMALIZE TEMPERATURE

SERIAL NUMBER	PAT NO.	HEAT NUMBER	HARD 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
B030598		811E02630			.500	V	FULL	L	-50	219	193	196						
B030888		813E62230			.500	V	FULL	L	-50	119	194	194						
B030887		821E02630			.500	V	FULL	L	-50	128	128	194						

HEAT NUMBER	CHEMICAL ANALYSIS C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti	Al	B	Cb	N	Sn	MOUAD GRAIN SIZE
811E02630	.16	1.04	.009	.004	.333	.269	.17	.04	.004	.001	.002	.041	.0002	.002	.005	.002	
813E62230	.16	1.04	.009	.004	.328	.256	.17	.04	.008	.001	.002	.038	.0002	.002	.006	.002	
* 821E02630	.16	1.04	.009	.004	.333	.269	.17	.04	.004	.001	.002	.041	.0002	.002	.005	.002	

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.

D. W. ELWOOD PER WNK

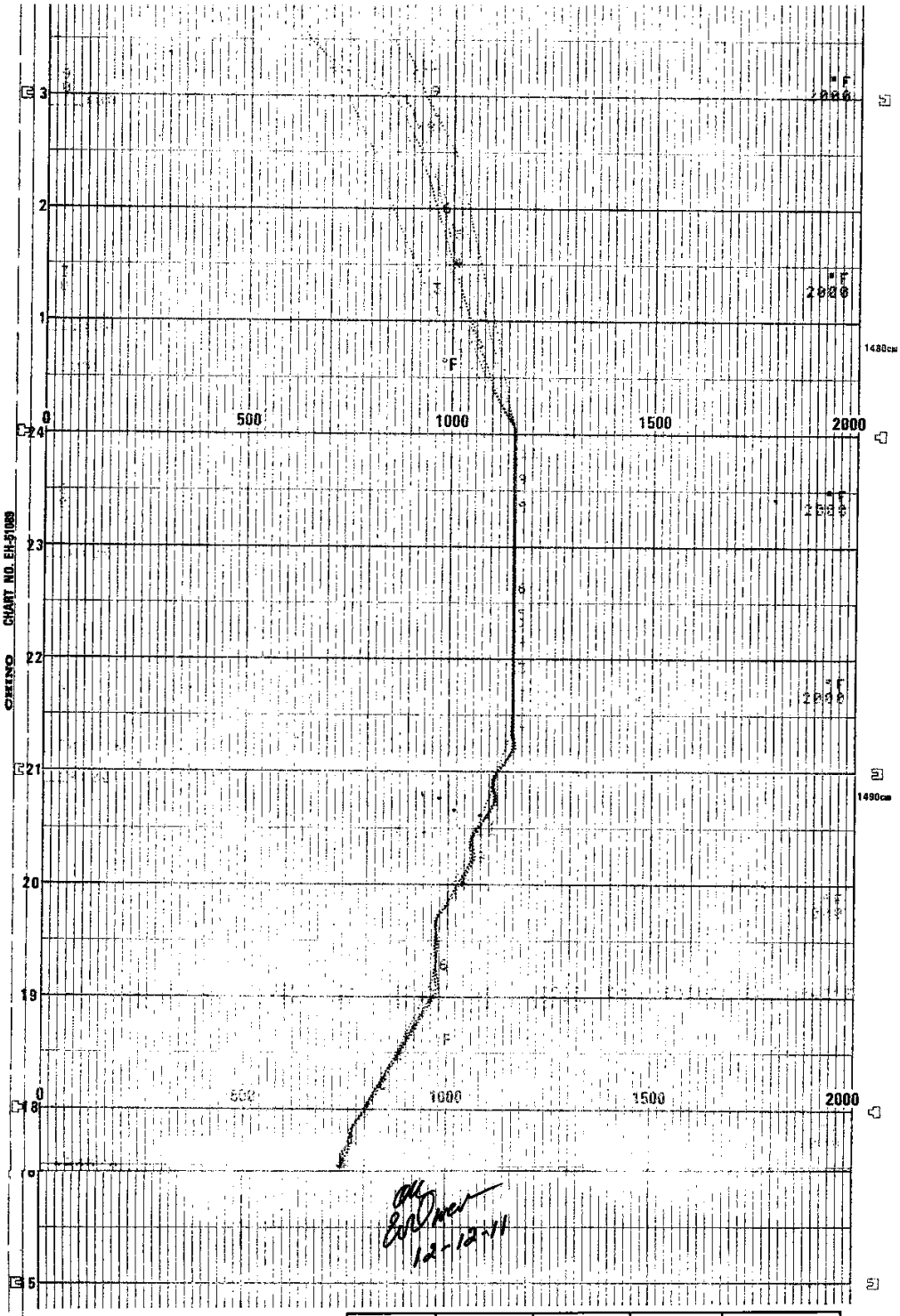
BHPLTRPT.TIF

SUPV. QUALITY ASSURANCE

CHECKED FEB 04 2010

K. Patterson

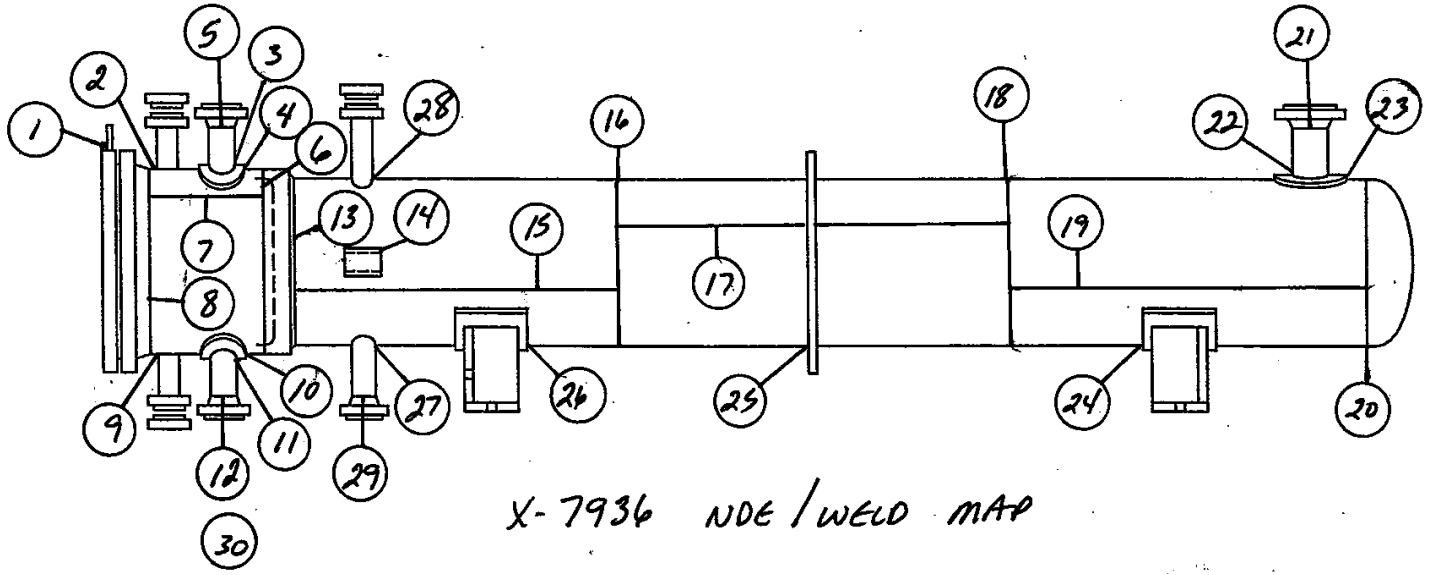
SECTION 5



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

Customer: Energy Exchanger
Location: Tulsa
Job No: X 7936
Date: 12-11-11
Chart Speed: 50mm
Technician: SHAT
HTS or Chart ID: 18211

Rec. No.	Weld No.	Weld Size	Schedule	Material
1,2,3	CHAN TO TS			Carbon
6	CHAN TO Bottom			
11	CHAN TO			
[redacted]				
5,4	NOZZ NEAR FA			
9	CHAN TO Flange			
7,8	CHAN Flange			
	End			



X-7936 NOE / WELD MAP

TUBE TO TUBESHEET WELDS

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No: MC202
ITEM NO: H00059
SERVICE: MAKEUP WATER TRIM HEATER

NO.	DATE	REVISIONS

DWN. BY D.MORRISON
DATE 3-28-11
CKD. BY

Energy Exchanger Co.

DWG. NO. X-7936

ENERGY EXCHANGER COMPANY

CUSTOMER: Schlumberger Co. P.O.#: 17497-0001

TAG: HX0059 ENERGY JOB # X-7936

NDE/WELD INDEX

Part #	Consumable	WPS	Weld Stamp	NDE Procedure	NDE Technician
1	E-7018-1	M-1-H	H	MT	M. Wells + E. Lopez
2	"	"	G	"	"
3	"	"	Z	"	"
4	"	"	Z	"	"
5	"	M-6-H	Y	"	"
6	L-61	A-1-H	K	RT	"
7	"	"	U	RT	"
8	"	"	J	RT	"
9	E-7018-1	M-1-H	G	"	"
10	"	"	G	"	"
11	"	"	G	"	"
12	"	M-6-H	Y	"	"
13	"	M-6	K	RT	"
14	"	M-1	S	"	"
15	L-61	A-1	J	RT	"
16	"	"	J	RT	"
17	"	"	K	RT	"
18	"	"	J	RT	"
19	"	"	J	RT	"
20	"	A-1	J	RT	"
21	"	A-1	Y	RT	"
22	E-7018-1	M-1	S	MT	"
23	"	M-1	S	"	"
24	"	"	Z	"	"
25	"	"	S	"	"
26	"	"	S	"	"
27	"	"	S	MT	"
28	"	"	S	MT	"
29	"	M-5	D	"	"
30	EL-70S-2	SW-1	H/L	PT	"

ENERGY EXCHANGER COMPANY

JOB # X-7934

P.O.# 17497-0001

PART IDENTIFICATION CHANNEL Spot UWSI APWHT

TYPE OF MATERIAL SA-516-70N MATERIAL THICKNESS 32½" OD x 1¼"

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

FILM IDENTIFICATION	ACCEPTABLE	REJECTED	FILM ARTIFACTS	SURFACE INDICATIONS	POROSITY	SLAG INCLUSIONS	CRACKS	INCOMPLETE FUSION	INADEQUATE PENETRATION	UNDERCUT	BURN THROUGH	REMARKS
CH												
R1												
1-2	X											
L1												
1-2	X											
R2												
1-2	X											

RADIOGRAPHIC DATA

1. RT DATE 12-11-11
2. MATERIAL EXAMINED:
   - (X) WELDMENT
   - ( ) CASTING
   - ( ) OTHER _____
3. METHODS:
   - (X) SINGLE EXPOSURE
   - ( ) MULTIPLE EXPOSURE
   - ( ) DOUBLE WALL TECHNIQUE
   - (X) SINGLE WALL TECHNIQUE
   - ( ) DOUBLE WALL VIEWING
   - (X) SINGLE WALL VIEWING
   - (X) SINGLE FILM LOADING
   - ( ) DOUBLE FILM LOADING
4. IQI (PENETRAMETER) DATA:
   - DESIGNATION B
   - SENSITIVITY LEVEL 0.25
   - LOCATION (FS) (~~BS~~)
5. FILM DATA:
   - FILM TYPE 1BB
   - FILM DENSITY MAX. 3.5
   - FILM DENSITY MIN. 2.0
6. SOURCE DATA:
   - ISOTOPE Ir192 SIZE 0.106
   - CURIES 60 E.T. 2:10
   - S.O.D. 15" S.S.O.F. 1¼

RADIOGRAPHER M. KAKE Lev II

INTERPRETER E.E. Dwyer ASNT Lev III #68771 DATE REVIEWED 12-12-11

CUSTOMER INSPECTOR David Hill DATE REVIEWED 12-15-11

readersheet(A99).doc

ENERGY EXCHANGER COMPANY

JOB # X-7936

P.O.# 17497-0001

PART IDENTIFICATION SHELL Spot UW51

TYPE OF MATERIAL SA-516-70 MATERIAL THICKNESS 29 3/4" OD x 3/8"

SPECIFICATION NO: Q.C. WELDMENT CODE/STANDARD: ASME SEC. VIII, DIV. 1, A-10

FILM IDENTIFICATION	ACCEPTABLE	REJECTED	FILM ARTIFACTS	SURFACE INDICATIONS	POROSITY	SLAG INCLUSIONS	CRACKS	INCOMPLETE FUSION	INADEQUATE PENETRATION	UNDERCUT	BURN THROUGH	REMARKS
SH												
L1												
1-2	X											
3-4	X											
R2												
1-2	X											
L2												
1-2	X											
3-4	X											
R3												
1-2	X											
L3												
1-2	X											

RADIOGRAPHIC DATA

1. RT DATE 12-2-11
2. MATERIAL EXAMINED:
   - (X) WELDMENT
   - ( ) CASTING
   - ( ) OTHER _____
3. METHODS:
   - (X) SINGLE EXPOSURE
   - ( ) MULTIPLE EXPOSURE
   - ( ) DOUBLE WALL TECHNIQUE
   - (X) SINGLE WALL TECHNIQUE
   - ( ) DOUBLE WALL VIEWING
   - (X) SINGLE WALL VIEWING
   - (X) SINGLE FILM LOADING
   - ( ) DOUBLE FILM LOADING
4. IQI (PENETRAMETER) DATA:
   - DESIGNATION B
   - SENSITIVITY LEVEL 013
   - LOCATION (FS) (SS)
5. FILM DATA:
   - FILM TYPE 80
   - FILM DENSITY MAX. 3.5
   - FILM DENSITY MIN. 2.0
6. SOURCE DATA:
   - ISOTOPE Ir192 SIZE .1 x 1
   - CURIES 75 E.T. 1:00
   - S.O.D. 18 S.S.O.F. 3/8

RADIOGRAPHER R. Stubb R II

INTERPRETER Ed Dwan ASNT Level III #68771 DATE REVIEWED 12-4-11

CUSTOMER INSPECTOR David Hall DATE REVIEWED 12/15/11

readersheet(A99).doc

ENERGY EXCHANGER COMPANY

JOB # X-7936

P.O.# 17497-0001

PART IDENTIFICATION SHELL Spot UW51

TYPE OF MATERIAL SA-516-70 MATERIAL THICKNESS 29 3/4" OD x 3/8"

SPECIFICATION NO: Q.C. WELDMENT CODE/STANDARD: ASME SEC. VIII, DIV. 1, A-10

FILM IDENTIFICATION	ACCEPTABLE	REJECTED	FILM ARTIFACTS	SURFACE INDICATIONS	POROSITY	SLAG INCLUSIONS	CRACKS	INCOMPLETE FUSION	INADEQUATE PENETRATION	UNDERCUT	BURN THROUGH	REMARKS
SH												
R4												
1-2	X											

RADIOGRAPHIC DATA

1. RT DATE 12-3-11
2. MATERIAL EXAMINED:
   - (X) WELDMENT
   - ( ) CASTING
   - ( ) OTHER _____
3. METHODS:
   - (X) SINGLE EXPOSURE
   - ( ) MULTIPLE EXPOSURE
   - ( ) DOUBLE WALL TECHNIQUE
   - (X) SINGLE WALL TECHNIQUE
   - ( ) DOUBLE WALL VIEWING
   - (X) SINGLE WALL VIEWING
   - (X) SINGLE FILM LOADING
   - ( ) DOUBLE FILM LOADING
4. IQI (PENETRAMETER) DATA:
   - DESIGNATION B
   - SENSITIVITY LEVEL .013
   - LOCATION (FS) (SS)
5. FILM DATA:
   - FILM TYPE Fuji 80
   - FILM DENSITY MAX. 3.5
   - FILM DENSITY MIN. 2.0
6. SOURCE DATA:
   - ISOTOPE Ir192 SIZE .1X.1
   - CURIES 98 u E.T. :50
   - S.O.D. 17 5/8" S.S.O.F. 3/8"

RADIOGRAPHER M. RAKE II

INTERPRETER Ed Owen ASNT Lev III #68771 DATE REVIEWED 12-5-11

CUSTOMER INSPECTOR David Hall DATE REVIEWED 12/14/11

ENERGY EXCHANGER COMPANY

JOB # X-7936

P.O.# 17497-0001

PART IDENTIFICATION SHELL NOZZLE Spot UW51

TYPE OF MATERIAL SA-106-B MATERIAL THICKNESS 12 3/4" OD x 1/2"

SPECIFICATION NO: Q.C. WELDMENT CODE/STANDARD: ASME SEC. VIII, DIV. 1, A- 10

FILM IDENTIFICATION SH/102	ACCEPTABLE	REJECTED	FILM ARTIFACTS	SURFACE INDICATIONS	POROSITY	SLAG INCLUSIONS	CRACKS	INCOMPLETE FUSION	INADEQUATE PENETRATION	UNDERCUT	BURN THROUGH	REMARKS
S1-R1												
1-2	X											

RADIOGRAPHIC DATA

1. RT DATE 11-16-11

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

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

4. IQI (PENETRAMETER) DATA:
   - DESIGNATION B
   - SENSITIVITY LEVEL 013
   - LOCATION (FS) (SS)

5. FILM DATA:
   - FILM TYPE 80
   - FILM DENSITY MAX. 3.5
   - FILM DENSITY MIN. 2.0

6. SOURCE DATA:
   - ISOTOPE IR192 SIZE 1 x 1
   - CURIES 45 E.T. :12
   - S.O.D. 6 3/8 S.S.O.F. 1/2

RADIOGRAPHER R. Stahl R. T.

INTERPRETER E.D. Owen SNT-TC-1A Level II DATE REVIEWED 11-17-11

CUSTOMER INSPECTOR David Neff DATE REVIEWED 11-29-11

readersheet(A99).doc

Energy Exchanger Company

DATE: 9-17-11

CERTIFICATION OF EXAMINATION
BY
MAGNETIC PARTICLE (DRY POWDER METHOD)

P.O. # 17497-0001 CHANNEL COVER LIFTING LUG

TAG # HX 0059

ENERGY JOB # X-7936

This certification is made to document that all Magnetic Particle Examinations have been performed on X-7936 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: 17527

MATERIAL AND THICKNESS: SA-516-70N / ½"

LIGHTING: 100 FT CANDLES MIN. @ SURFACE

ENERGY EXCHANGER COMPANY

Edgar O Owen

Edgar O. Owen
Quality Control Manager
SNT-TC-1A Level II

Energy Industrial Park 1844 North Garnett Road Tulsa, Oklahoma 74116-1612
Phone: 918 437-3000 Fax: 918 437-7144

DH

Energy Exchanger Company

DATE: 12-2-11

CERTIFICATION OF EXAMINATION
BY
MAGNETIC PARTICLE (DRY POWDER METHOD)

P.O. # 17497-0001 CHANNEL NOZZLE BACK-CUTS.

TAG # HX 0059

ENERGY JOB # X-7936

This certification is made to document that all Magnetic Particle Examinations have been performed on X-7936 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: 17527

MATERIAL AND THICKNESS: SA-516-70 N / 1¼"

LIGHTING: 100 FT CANDLES MIN. @ SURFACE

ENERGY EXCHANGER COMPANY

Edgar O. Owen
Quality Control Manager
SNT-TC-1A Level II

Energy Industrial Park 1844 North Garnett Road Tulsa, Oklahoma 74116-1612
Phone: 918 437-3000 Fax: 918 437-7144

DK

Energy Exchanger Company

DATE: 12-12-11

CERTIFICATION OF EXAMINATION
BY
MAGNETIC PARTICLE (DRY POWDER METHOD)

P.O. # 17497-0001

TAG # HX 0059

ENERGY JOB # X-7936

CHANNEL (APWHT)
ALL TEMP ATTACHMENT WELDS
ALL ARC-STRIKES
ALL WELDS

This certification is made to document that all Magnetic Particle Examinations have been performed on X-7936 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: 17527

MATERIAL AND THICKNESS: SA-516-70N / 1¼"

LIGHTING: 100 FT CANDLES MIN. @ SURFACE

ENERGY EXCHANGER COMPANY

Edgar O Owen

Edgar O. Owen
Quality Control Manager
SNT-TC-1A Level II

Energy Industrial Park 1844 North Garnett Road Tulsa, Oklahoma 74116-1612
Phone: 918 437-3000 Fax: 918 437-7144

DK

Energy Exchanger Company

DATE: 11-28-11

CERTIFICATION OF EXAMINATION
BY
MAGNETIC PARTICLE (DRY POWDER METHOD)

P.O. # 17497 - 0001 SHELL NOZZLE BACK-CUTS

TAG # HX 0059

ENERGY JOB # X-7936

This certification is made to document that all Magnetic Particle Examinations have been performed on X-7936 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: 17527

MATERIAL AND THICKNESS: SA-516-70 / 3/8"

LIGHTING: 100 FT CANDLES MIN. @ SURFACE

ENERGY EXCHANGER COMPANY

Edgar O. Owen
Quality Control Manager
SNT-TC-1A Level II

Energy Industrial Park 1844 North Garnett Road Tulsa, Oklahoma 74116-1612
Phone: 918 437-3000 Fax: 918 437-7144

OK

Energy Exchanger Company

DATE: 12-5-11

CERTIFICATION OF EXAMINATION
BY
MAGNETIC PARTICLE (DRY POWDER METHOD)

P.O. # 17497-0001 — SHELL

TAG # HX0059 — ALL TEMP ATTACHMENT WELDS

ENERGY JOB # X-7936 — ALL ARC-STRIKES

ALL WELDS

This certification is made to document that all Magnetic Particle Examinations have been performed on X-7936 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: 17527

MATERIAL AND THICKNESS: SA-516-70 / 3/8"

LIGHTING: 100 FT CANDLES MIN. @ SURFACE

ENERGY EXCHANGER COMPANY

Edgar O. Owen
Quality Control Manager
SNT-TC-1A Level II

Energy Industrial Park 1844 North Garnett Road Tulsa, Oklahoma 74116-1612
Phone: 918 437-3000 Fax: 918 437-7144

DM

Energy Exchanger Company

DATE: 12-13-11

CERTIFICATION OF EXAMINATION
BY
LIQUID PENETRANT - WATER WASHABLE

P.O. # 17497-0001

TAG # HX0059

ENERGY JOB # X-7936

This certification is made to document that all Liquid Penetrant Examinations have been performed on X-7936 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-214 / 3/4" OD X .083"

LIGHTING: 100 FT CANDLES MIN. @ SURFACE

ENERGY EXCHANGER COMPANY

Edgar O. Owen
Quality Control Manager

Energy Industrial Park 1844 North Garnett Road Tulsa, Oklahoma 74116-1612
Phone: 918 437-3000 Fax: 918 437-7144

DM

Energy Exchanger Company

BRINELL HARDNESS REPORT

JOB NO: X-7936

COMPONENT	LOCATION	WELD METAL	BHN HEAT AFFECTED ZONE	BHN PLATE	WELD PROCEDURE NUMBER
CHANNEL	R1	195	190		A-1-H
	L1	188	176		〃
	R2	181	177		〃
	T1	185	187		M-1-H
	T2	182	175		〃
SHELL	R1	190	187		A-1
	L1	180	177		〃
	R2	178	176		〃
	L2	190	182		〃
	R3	183	181		〃
	L3	188	180		〃
	R4	189	191		〃
	S1	193	180		M-1
	S2	184	181		〃
	S3	188	184		〃
					Ed Dhe
					12-13-11

DH

SECTION 6

Energy Exchanger Company

DATE: 12-5-11

CERTIFICATE OF WELD/SUPPORT PAD AIR TEST

P.O.# 17497-0001

TAG# HX0059

ENERGY JOB # X-7936

This is to certify all weld/support pads on the above referenced equipment were air tested @ 25 P.S.I. and found to be satisfactory.

ENERGY EXCHANGER COMPANY

Edgar O. Owen
Quality Control Manager

Energy Industrial Park / 1844 North Garnett Road / Tulsa, Oklahoma 74116-1612
918 437-3000 / FAX 918 437-7144

DH

Energy Exchanger Company

DATE: 12-13-11

CERTIFICATE OF TUBE TO TUBESHEET AIR TEST

P.O.# 17497-0001

TAG# HX 0059

ENERGY JOB # X-7936

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

Edgar O Owen

Edgar O. Owen
Quality Control Manager

Energy Industrial Park / 1844 North Garnett Road / Tulsa, Oklahoma 74116-1612
918 437-3000 / FAX 918 437-7144 / E-MAIL: eec@energyexchanger.com

DW

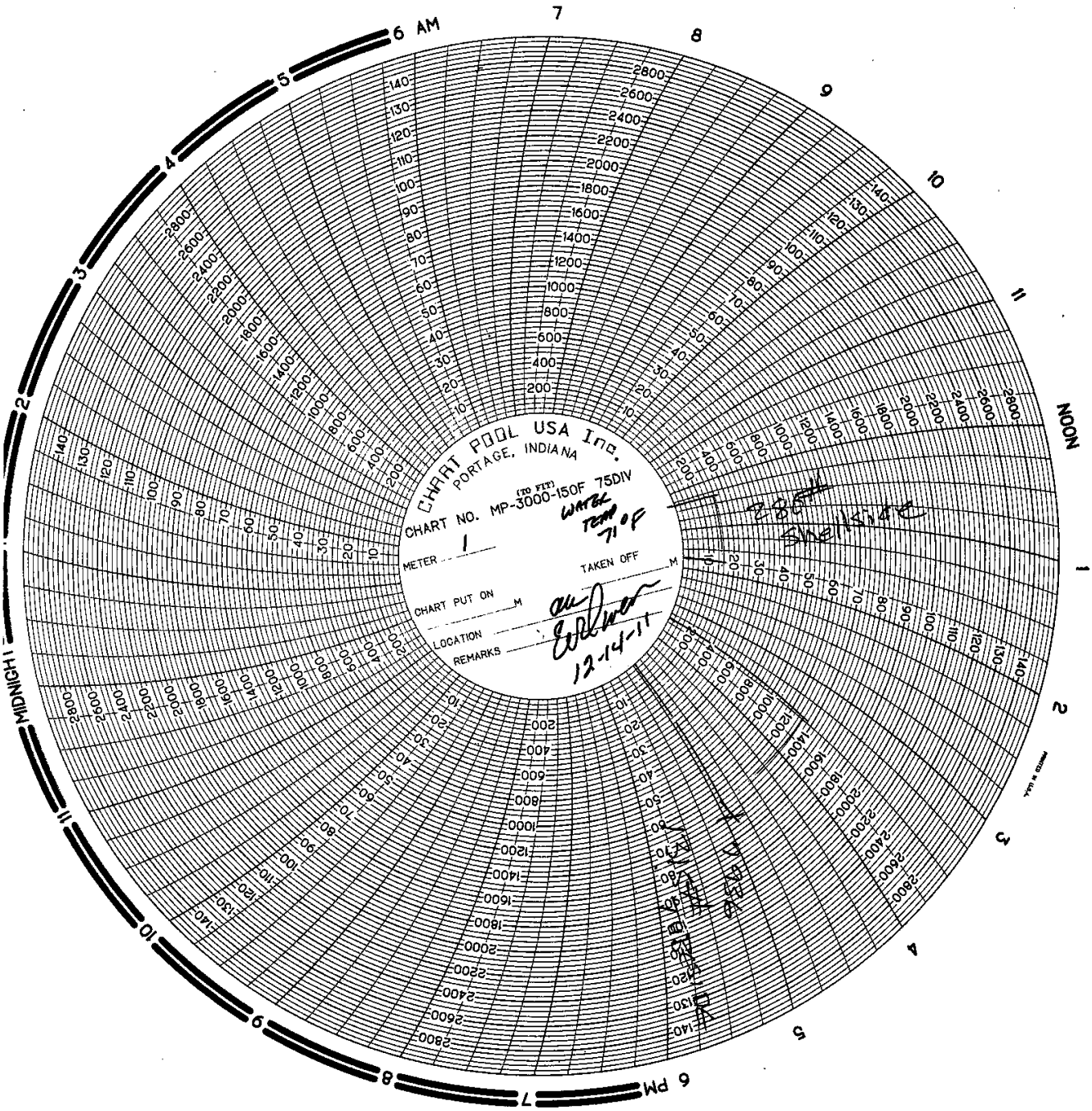


CHART POOL USA Inc.
PORTAGE, INDIANA
CHART NO. MP-3000-150F 75DIV
(100 FEET)
METER 1
CHART PUT ON M
TAKEN OFF M
LOCATION
REMARKS
WATER TEMP 71°F
12-14-11
6 AM
NOON
6 PM
MIDNIGHT

Energy Exchanger Company

DATE: 12-14-11

CERTIFICATE OF HYDROSTATIC TEST

P.O.# 17497-0001

TAG# HX0059

ENERGY JOB # X-7936

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

280 PSI SHELL SIDE

1315 PSI TUBE SIDE

BUBBLE TEST OK EVP

ENERGY EXCHANGER COMPANY

Edgar O. Owen
Quality Control Manager

/lt

Energy Industrial Park / 1844 North Garnett Road / Tulsa, Oklahoma 74116-1612
918 437-3000 / FAX 918 437-7144 / E-MAIL: eec@energyexchanger.com

DH

CITY OF Tulsa
A New Kind of Energy.

AB Jewell Treatment Plant: Oolagah Finished Water
Lab Analysis Summary
Concentrations in parts per million (ppm or mg/L) unless otherwise noted

	Jan-09	Apr-09	Jul-09	Oct-09	Jan-10	Apr-10	Jul-10	Oct-10	Jan-11	Apr-11	Jul-11	Oct-11**	MCL/ SMCL*	Max	Min	Avg
Inorganics																
Chloride (Cl^-)	15	20	14	11	14	21	12	14	13	15	18	17	250*	21	11	15
MBAS	0.040	0.049	0.023	0.040	0.032	0.031	0.029	n/a	n/a	n/a	n/a	n/a	0.5*	0.049	0.023	0.035
Nitrate (N)	0.000	0.000	0.260	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.0	0.260	0.000	0.022
Nitrite (N)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**	1.0	0.000	0.000	0.000
Phosphate (PO_4-Ortho)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.120	0.000	0.000	0.000	0.000	NR	0.120	0.000	0.010
Solids Total Dis.	190	250	190	140	51.0	190	320	170	180	190	220	240	500*	320	51.0	194
Sulfate	28	42	26	16	30	43	5.9	19	19	27	47	60	250*	60	5.9	30
Metals																
Aluminum (Al)	0.000	0.040	0.052	0.110	0.049	0.140	0.000	0.042	0.000	0.000	0.000	0.034	0.05-0.2*	0.140	0.000	0.039
Antimony (Sb)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.000
Arsenic (As)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.000
Barium (Ba)	0.052	0.063	0.052	0.042	0.046	0.061	0.059	0.053	0.048	0.056	0.061	0.067	2.0	0.067	0.042	0.055
Beryllium (Be)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000
Cadmium (Cd)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000
Calcium (Ca)	42.1	51.6	38.8	29.2	42.9	56.4	47.5	37.2	40.0	44.2	45.0	51.4	NR	56.4	29.2	43.9
Chromium (Cr)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.10	0.000	0.000	0.000
Copper (Cu)	0.000	0.000	0.062	0.000	0.000	0.031	0.000	0.009	0.000	0.017	0.016	0.000	TT 1.3	0.062	0.000	0.011
Cyanide	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.20	0.000	0.000	0.000
Iron (Fe)	0.000	0.017	0.000	0.013	0.015	0.000	0.000	0.028	0.000	0.016	0.000	0.000	0.3*	0.028	0.000	0.007
Lead (Pb)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	TT 0.015	0.000	0.000	0.000
Magnesium (Mg)	6.91	8.80	7.42	5.45	7.26	9.14	9.64	6.32	7.40	7.74	9.31	10.6	NR	10.60	5.45	8.00
Manganese (Mn)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.05*	0.000	0.000	0.000
Mercury (Hg)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.002	0.000	0.000	0.000
Nickel (Ni)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	NR	0.000	0.000	0.000
Potassium (K)	3.25	3.16	2.44	2.75	3.14	2.81	3.09	2.86	4.20	2.86	3.31	3.53	NR	4.20	2.44	3.12
Selenium (Se)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.05	0.000	0.000	0.000
Silicon (Si)	2.16	0.22	2.72	1.30	1.50	1.60	1.25	1.75	0.79	0.19	2.50	1.00	NR	2.72	0.190	1.42
Silver (Ag)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.10*	0.000	0.000	0.000
Sodium (Na)	10.0	13.6	12.1	9.24	10.2	16.4	19.7	11.5	12.0	13.3	15.9	15.9	NR	19.7	9.24	13.3
Thallium (Tl)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000
Zinc (Zn)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023	0.000	0.000	5.0*	0.023	0.000	0.002

	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	MCL/ SMCL*	Max	Min	Avg
General																
Alkalinity (Avg)	116	119	121	121	122	125	122	110	105	107	111	116	NR	125	105	116
Total Hardness	125	128	132	133	132	140	146	142	146	153	160	169	NR	169	125	142
Fluoride (F^-)	0.90	0.87	0.76	0.70	0.47	0.55	0.52	0.56	0.68	0.71	0.73	0.83	4.0	0.90	0.47	0.69
Spec. Conductance	258	258	261	264	275	292	301	305	302	314	319	335	NR	335	258	290
Chlorine Residual	2.22	2.24	2.26	2.37	2.29	2.34	2.31	2.33	2.33	2.07	2.17	2.21	4.0	2.37	2.07	2.26
Avg Water Temp.(°F)	60	47	42	42	53	61	67	79	85	85	76	69	NR	85	42	64
Turbidity (NTU)	0.03	0.03	0.02	0.02	0.04	0.08	0.03	0.04	0.14	0.12	0.10	0.09	TT 0.3	0.14	0.02	0.06
pH	7.9	8.0	8.1	8.0	8.1	8.1	8.0	7.9	7.8	7.9	8.1	8.2	6.5-8.5*	8.2	7.8	8.0

MCL - Maxmium Contaminant Level (40 CFR 141) - Primary levels are enforced by the state and the federal government.
SMCL - Secondary Maximum Contaminant Level (40 CFR 143)- Secondary levels are considered guidelines that only pertain to the aesthetic quality of drinking water. Secondary levels are not federally enforced.
SMCL is indicated by an (*) next to the level.
(**) Nitrate value reported is as Nitrate-Nitrite, with no result for Nitrite
NR - Not Regulated
TT - Treatment Technique
(#) - Indicates Below Detectable Level (less than zero)

ABJ Hardness	High	Low	Average
(grains/gallon)	9.88	7.31	8.31

CITY OF Tulsa
A New Kind of Energy.

Mohawk Treatment Plant: Spavinaw/Eucha Finished Water
Lab Analysis Summary
Concentrations in parts per million (ppm or mg/L) unless otherwise noted

	Jan-09	Apr-09	Jul-09	Oct-09	Jan-10	Apr-10	Jul-10	Oct-10	Jan-11	Apr-11	Jul-11	Oct-11**	MCL/ SMCL*	Max	Min	Avg
Inorganics																
Chloride (Cl^-)	9.4	11	12	9.4	9.2	9.9	12	12	12	12	11	9.8	250*	12	9.2	11
MBAS	0.027	0.021	0.000	0.040	0.026	0.020	0.023	n/a	n/a	n/a	n/a	n/a	0.5*	0.040	0.000	0.022
Nitrate (N)	0.000	0.290	0.000	0.000	0.830	1.30	0.000	0.220	0.000	0.000	0.220	0.340	10.0	1.30	0.000	0.267
Nitrite (N)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**	1.0	0.000	0.000	0.000
Phosphate (PO_4-Ortho)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	NR	0.000	0.000	0.000
Solids Total Dis.	89	150.00	120	120	41	130	120	120	180	140	99	140	500*	180	41	121
Sulfate	5.4	6.20	6.2	3.9	5.7	6.3	6.1	5.5	5.5	6.0	4.8	4.5	250*	6.3	3.9	5.5
Metals																
Aluminum (Al)	0.000	0.000	0.000	0.000	0.025	0.150	0.000	0.000	0.000	0.000	0.017	0.000	0.05-0.2*	0.150	0.000	0.016
Antimony (Sb)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.000
Arsenic (As)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.000
Barium (Ba)	0.042	0.045	0.034	0.036	0.029	0.045	0.034	0.031	0.052	0.051	0.033	0.035	2.0	0.052	0.029	0.039
Beryllium (Be)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000
Cadmium (Cd)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000
Calcium (Ca)	33.4	38.6	28.3	27.4	37.8	42.5	31.8	29.8	34.0	43.1	25.8	30.3	NR	43.1	25.8	33.6
Chromium (Cr)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.10	0.000	0.000	0.000
Copper (Cu)	0.000	0.000	0.024	0.000	0.000	0.020	0.000	0.007	0.000	0.000	0.000	0.011	TT 1.3	0.024	0.000	0.005
Cyanide	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.20	0.000	0.000	0.000
Iron (Fe)	0.000	0.005	0.000	0.000	0.010	0.000	0.000	0.024	0.000	0.015	0.000	0.000	0.3*	0.024	0.00	0.004
Lead (Pb)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	TT 0.015	0.000	0.000	0.000
Magnesium (Mg)	1.80	1.81	1.97	1.55	1.92	1.63	1.96	1.82	2.10	2.07	1.74	1.79	NR	2.10	1.55	1.85
Manganese (Mn)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.05*	0.000	0.000	0.000
Mercury (Hg)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.002	0.0000	0.0000	0.0000
Nickel (Ni)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	NR	0.000	0.000	0.0000
Potassium (K)	2.30	2.17	2.02	2.22	2.30	2.00	2.29	2.29	2.90	2.24	2.57	2.83	NR	2.90	2.00	2.34
Selenium (Se)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.05	0.000	0.000	0.000
Silicon (Si)	0.76	0.22	1.88	3.63	0.32	0.64	2.22	2.50	0.53	0.43	1.40	4.20	NR	4.20	0.22	1.56
Silver (Ag)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.10*	0.000	0.000	0.000
Sodium (Na)	7.30	6.29	8.06	7.77	5.69	7.72	8.87	9.78	8.20	7.24	8.01	9.35	NR	9.78	5.69	7.86
Thallium (Tl)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000
Zinc (Zn)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.0*	0.000	0.000	0.000

	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	MCL/ SMCL*	Max	Min	Avg
General																
Alkalinity (Avg)	90	89	97	102	103	101	89	86	65	66	71	80	NR	103	65	87
Total Hardness	87	88	96	102	106	112	99	86	69	67	72	82	NR	112	67	89
Fluoride (F^-)	1.00	0.95	0.80	0.70	0.65	0.61	0.06	0.90	0.60	0.71	0.67	0.68	4.0	1.00	0.06	0.69
Spec. Conductance	224	218	231	238	243	262	231	206	184	187	194	203	NR	262	184	218
Chlorine Residual	2.2	2.19	2.18	2.11	2.23	2.2	2.22	2.22	2.19	2.17	2.21	2.19	4.0	2.23	2.11	2.19
Avg Water Temp.(°F)	52	52	47	47	53	66	73	82	91	90	81	74	NR	91	47	67
Turbidity (NTU)	0.02	0.02	0.02	0.02	0.02	0.04	0.05	0.05	0.05	0.06	0.06	0.03	TT 0.3	0.06	0.02	0.04
pH	7.8	8.1	8.0	8.0	7.9	7.8	7.7	7.7	7.7	7.7	7.7	7.8	6.5-8.5*	8.1	7.7	7.8

MCL - Maxmium Contaminant Level (40 CFR 141)- Primary levels are enforced by the state and the federal government.
SMCL - Secondary Maximum Contaminant Level (40 CFR 143)- Secondary levels are considered guidelines that only pertain to the aesthetic quality of drinking water. Secondary levels are not federally enforced.
SMCL is indicated by an (*) next to the level.
(**) Nitrate value reported is as Nitrate-Nitrite, with no result for Nitrite
NR - Not Regulated
TT - Treatment Technique
(#) - Indicates Below Detectable Level (less than zero)

Mohawk Hardness	High	Low	Average
(grains/gallon)	6.55	3.92	5.19

Energy Exchanger Company

DATE: 12-21-12

CERTIFICATE OF NITROGEN PURGE

P.O.# 17497-0001

TAG# HX0059

ENERGY JOB # X-7936

This is to certify the above referenced equipment was purged with

15 **PSI dry nitrogen after hydro test.**

ENERGY EXCHANGER COMPANY

Edgar O. Owen
Quality Control Manager

Energy Industrial Park / 1844 North Garnett Road / Tulsa, Oklahoma 74116-1612
918 437-3000 / FAX 918 437-7144

DK

ENERGY EXCHANGER COMPANY

PAINT CHECK LIST

Contractor: EATON INDUSTRIAL COATINGS

Unit Serial No: X-7936 Customer Specification No: _____

Paint Required: 4-6 mils 450 CARBOLINE Primer; _____ mils _____ Intermediate;

4-5 mils 450 CARBOLINE Finish

Testex PRESS-O-FILM™ HT Coarse 0.8 to 2.5 mil 20 to 64 µm

Satisfactory Date

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

WC	12/15/11	

2. **Notify Energy Exchanger Company**

3. **Weather Conditions:**
   60 temperature; 53% humidity; 55 substate, 42 dew point,
   EEC verify 20

WC	12/15/11	

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

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**

WC	12/15/11	

11. **Wet Film Thickness:**
    (Req'd) — (Actual) —

12. **Dry Film Thickness:**
    (Req'd) 8-10 (Actual) 10

EO MC	12-17-11	

13. **Tie Down/Shipping Preparation**

2nd COAT
TEMP 56
S. TEMP 52
HUMIDITY 50%
DEW POINT 40

SECTION 7

SPL-7936

ENERGY EXCHANGER COMPANY

SPARE PARTS LISTS

CUSTOMER: Southern Company Services (for) Mississippi Power							EEC QUOTE: 10-7314			
DESTINATION: DeKalb, Mississippi				P.O. No.: 17497-0001			EEC JOB NO.: X-7936			1/5/2012
		SPARE GASKETS								
TAG NO.	EEC JOB NUMBER	QTY. SETS	NO. GASKETS PER SET	EEC DWG. NUMBER	UNIT $ PRICE *	SHIPMENT				
HX0059	X-7936	**	1	X-7936-O	$1,450.00	2-3 Weeks				

* 1) PRICES ARE F.C.A. ENERGY SHOPS, TULSA, OK.
* 2) SHIPPING TERMS ARE PREPAY AND CHARGE.
* 3) PRICE ARE VALID FOR TWELVE (12) MONTHS.
* 4) UNIT PRICES ARE PER SET OF SPARE GASKETS.

** 1) ENERGY EXCHANGER COMPANY RECOMMENDS ONE SET OF SPARE GASKETS PER EXCHANGER PER YEAR OF OPERATION.

Energy Exchanger Company

Installation, Operation and Maintenance Manual for SHELL AND TUBE HEAT EXCHANGERS

A Member of the
Tubular Exchanger
Manufacturers Association

Energy Industrial Park/1844 North Garnett/Tulsa, Oklahoma 74116-1698
918 437-3000 / FAX 918 437-7144

FOREWORD

Included in this manual are Tables and Figures which are reprinted in their entirety from the Standards of the Tubular Exchanger Manufacturers Association Seventh Edition (1988). Pages containing such material contain a citation to that publication.

Additionally, there are extensive extracts of text reprinted from the 7th Edition TEMA Standards. Pages containing such excerpts contain a footnote to that effect.

The information in this publication is based on the collective experience of industry engineers and technicians. While the information is intended to be comprehensive and thorough, it is subject to change based on particular applications, field experience and technological developments. The Tubular Exchanger Manufacturers Association expressly disclaims any warranty of fitness for a particular application, as well as any claims for compensatory, consequential or other damages arising out of or related to the use of this publication.

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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

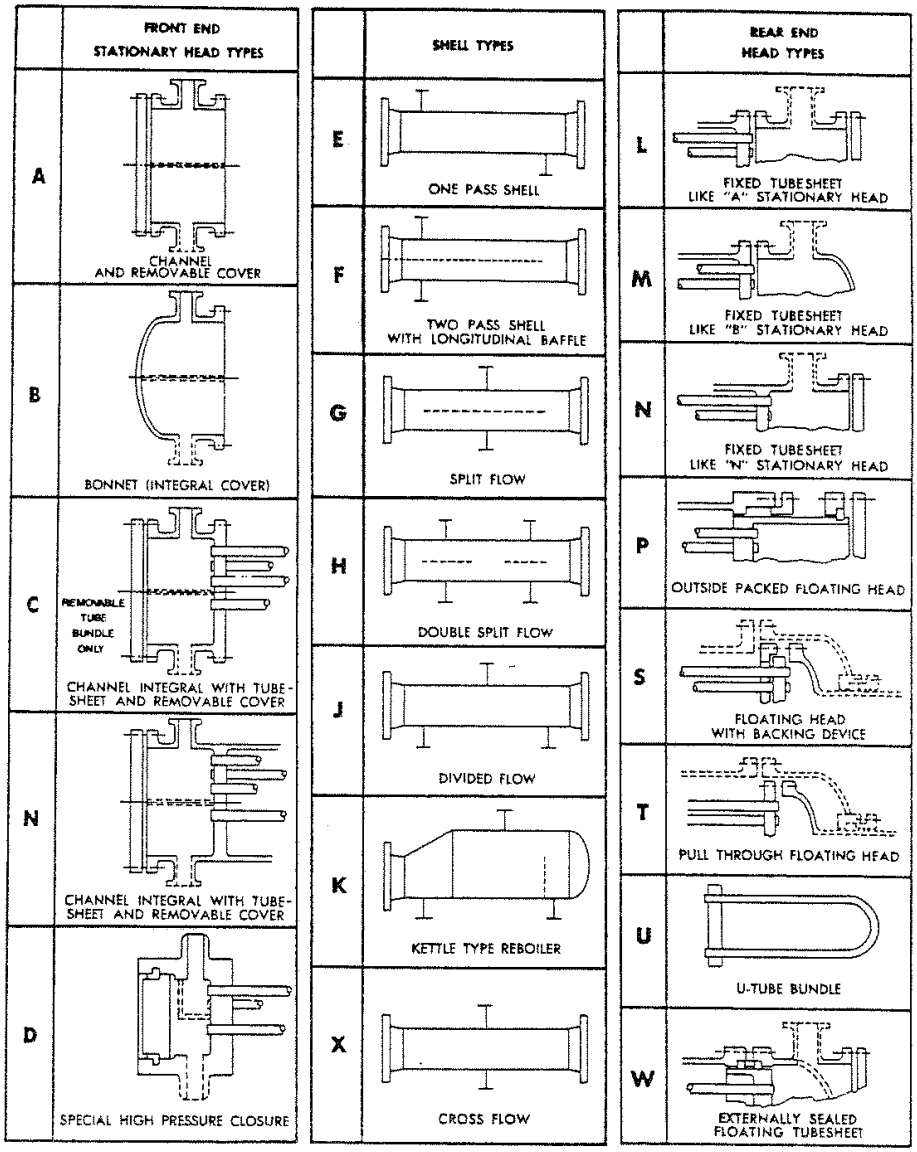
N-1 TYPE DESIGNATION-RECOMMENDED PRACTICE

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



N-2 **NOMENCLATURE OF HEAT EXCHANGER COMPONENTS**

For the purpose of establishing standard terminology, Figure N-2 illustrates various types of heat exchangers. Typical parts and connections, for illustrative purposes only, are numbered for identification in Table N-2. (See Note)

Table N-2

1. Stationary Head — Channel
2. Stationary Head — Bonnet
3. Stationary Head Flange — Channel or Bonnet
4. Channel Cover
5. Stationary Head Nozzle
6. Stationary Tubesheet
7. Tubes
8. Shell
9. Shell Cover
10. Shell Flange — Stationary Head End
11. Shell Flange — Rear Head End
12. Shell Nozzle
13. Shell Cover Flange
14. Expansion Joint
15. Floating Tubesheet
16. Floating Head Cover
17. Floating Head Flange
18. Floating Head Backing Device
19. Split Shear Ring
20. Slip-on Backing Flange
21. Floating Head Cover — External
22. Floating Tubesheet Skirt
23. Packing Box
24. Packing
25. Packing Gland
26. Lantern Ring
27. Tierods and Spacers
28. Transverse Baffles or Support Plates
29. Impingement Plate
30. Longitudinal Baffle
31. Pass Partition
32. Vent Connection
33. Drain Connection
34. Instrument Connection
35. Support Saddle
36. Lifting Lug
37. Support Bracket
38. Weir
39. Liquid Level Connection

NOTE: Manufacturers may identify corresponding parts using numbers differing from the above.

Figure N-2

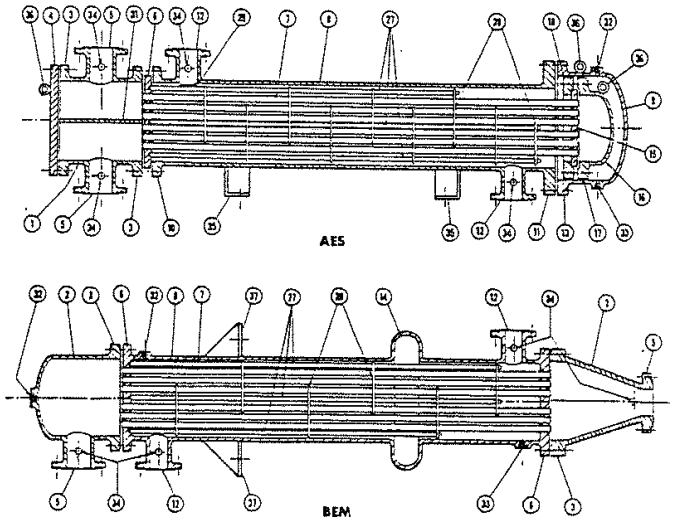
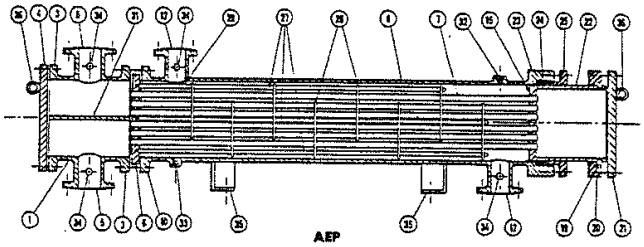
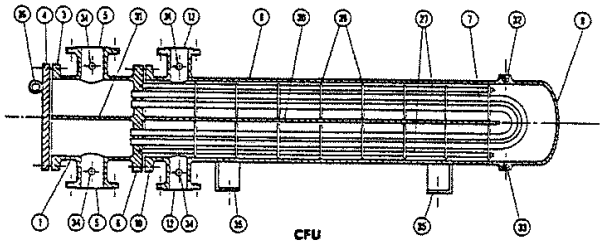


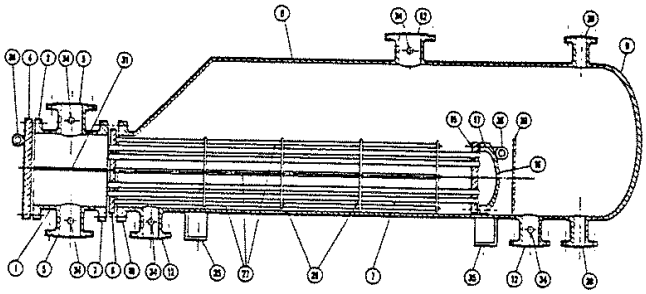
Figure N-2 (Continued)



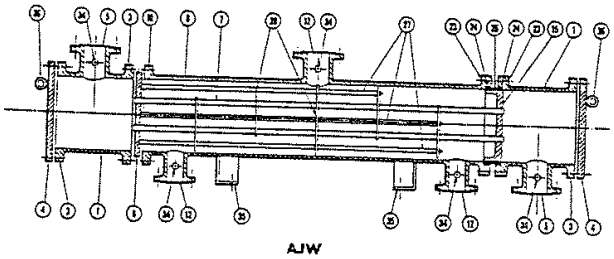
AEP



CFU



AKT



AJW

SECTION 2
HEAT EXCHANGER IDENTIFICATION AND DEFINITIONS

D-2.1 EXCHANGER IDENTIFICATION

D-2.11 COMPLETE EXCHANGER

Manufacturers normally assign a serial number which is unique and permanently identifies each exchanger. Inquiries to the manufacturer should reference this number when it is shown on the nameplate and manufacturer's drawings. Additional useful information normally shown includes size, type, and item number.

D-2.12 EXCHANGER PARTS

Exchanger parts should be identified by the exchanger serial number and by the name and part number corresponding to those shown in Section 1, Table N-2, or as shown on the manufacturer's drawings.

D-2.2 DEFINITIONS

D-2.21 EXCHANGER UNIT

One or more exchangers designed for a specific service.

D-2.22 ITEM NUMBER

The purchaser's identification number for an exchanger unit.

D-2.23 NORMAL OPERATING CONDITIONS

The thermal and hydraulic performance requirements generally specified for designing the heat exchanger.

D-2.24 UPSET CONDITIONS

A departure from specified operating conditions.

D-2.25 PULSATING FLUID CONDITIONS

Conditions of flow generally characterized by rapid fluctuations in pressure and flow rate resulting from sources outside of the heat exchanger such as: pumps, compressors, blowers, etc.

D-2.26 START-UP CONDITIONS

The conditions of operation which exist from the time that flow of either or both process streams is initiated to the time that steady-state operating conditions are achieved.

D-2.27 SHUT-DOWN CONDITIONS

The conditions of operation which exist from the time of steady-state operating conditions to the time that flow of both process streams has ceased.

D-2.28 CODE

All references to Code herein mean the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Pressure Vessels.

SECTION 3
INSTALLATION OF HEAT EXCHANGERS

E-3 INSTALLATION

E-3.1 INSTALLATION PLANNING

E-3.11 CLEARANCE FOR DISMANTLING

For straight tube exchangers fitted with removable bundles, provide sufficient clearance at the stationary head end to permit removal of the bundle from the shell and provide adequate space beyond the rear head end to permit removal of the shell cover and/or floating head cover.

For fixed tubesheet exchangers, provide sufficient clearance at one end to permit withdrawal and replacement of the tubes and enough space beyond the head at the opposite end to permit removal of the bonnet or channel cover.

For U-tube heat exchangers, provide sufficient clearance at the stationary head end to permit withdrawal of the tube bundle, or at the opposite end to permit removal of the shell.

E-3.12 FOUNDATIONS

Foundations must be adequate so that exchangers will not settle and impose excessive strains on the exchanger. Foundation bolts should be set to allow for setting inaccuracies. In concrete footings, pipe sleeves at least one size larger than bolt diameter slipped over the bolt and cast in place are best for this purpose, as they allow the bolt center to be adjusted after the foundation has set.

E-3.13 PIPING

E-3.131 THERMAL EXPANSION

It is essential that adequate provisions be made in the connecting piping to allow for thermal expansion without imposing unspecified piping loads on the exchanger. This is particularly important for single pass internal floating head designs, outside packed floating heads, and fixed tubesheet types with shell expansion joints. Unless precautions are taken, leakage or damage may result.

E-3.132 PULSATION AND VIBRATION

In all installations, care must be taken to eliminate or minimize transmission of fluid pulsations and mechanical vibrations to the heat exchangers.

E-3.14 CLEANING

Convenient means should be provided for cleaning the unit as suggested under "Maintenance." (Section 5)

E-3.15 LEVELING

Exchangers must be installed so that pipe connections are made without forcing, disassembling or loosening of flanged assemblies.

E-3.16 STACKED HEAT EXCHANGERS

The manufacturer normally stacks exchangers prior to completion of fabrication to insure proper alignment of interconnecting nozzles. Shims separating the intermediate shell supports are normally used. Therefore, it is important that shims, if used, match the thicknesses and locations used by the manufacturer.

E-3.17 CONNECTION PROTECTORS

Remove shipping covers and plugs immediately prior to installation. Before connecting to piping, inspect all openings in the heat exchanger for foreign material. The entire system should be clean and free of foreign objects before starting operation. Do not expose heat exchanger internals to moisture or harmful contaminants.

E-3.18 PIPE CONNECTIONS

Pipe connections must be in accordance with the manufacturer's dimensional outline drawing.

E-3.19 FOUNDATION BOLTS

Foundation bolts should be loosened at one end of unit to allow free expansion of shells. Slotted holes in supports are provided for this purpose.

E-3.20 If the heat exchanger is equipped with a bellows type expansion joint, the expansion joint must be adequately protected during shipping and setting. Shipping supports must be removed in accordance with instructions.

E-3.3 HEAT EXCHANGER STORAGE

Heat exchangers normally are not protected for storage. If storage is necessary, a covered location at uniform temperature is preferable and provisions must be made to protect the heat exchanger interior from moisture, freezing, or harmful contaminants.

SECTION 4
OPERATION OF HEAT EXCHANGERS

E-4. OPERATION

E-4.1 PERFORMANCE OF HEAT EXCHANGERS

Satisfactory performance and service life can be expected only from heat exchangers which are properly installed, operated in accordance with design conditions, and receive preventive maintenance and cleaning on an appropriate schedule. These requirements are the responsibility of the user.

E-4.11 PERFORMANCE FAILURES

The failure of heat exchanger equipment to perform satisfactorily may be caused by one or more factors, such as:

(1) Excessive fouling.
(2) Air or gas binding resulting from improper piping installation or lack of suitable vents.
(3) Operating conditions differing from design conditions.
(4) Maldistribution of flow in the unit.
(5) Excessive clearances between the baffles and shell and/or tubes, due to corrosion.
(6) Improper thermal design.
(7) Flooding resulting from inadequate drainage of condensate.

E-4.2 OPERATION OF HEAT EXCHANGERS

E-4.21 OPERATING PROCEDURES — NORMAL

Before placing any exchanger in operation, reference should be made to the exchanger drawings, specification sheet(s), and name plate(s) for any special instructions. Local safety and health regulations must be considered. Improper start-up or shut-down sequences, particularly of fixed tubesheet units, may cause leaking of tube-to-tubesheet and/or bolted flanged joints.

E-4.22 START-UP OPERATION

Most exchangers with removable tube bundles may be placed in service by first establishing circulation of the cold medium, followed by the gradual introduction of the hot medium. During start-up all vent valves should be opened and left open until all passages have been purged of air and are completely filled with fluid. For fixed tubesheet exchangers, fluids must be introduced in a manner to minimize differential expansion between the shell and tubes. (Refer E-4.24)

E-4.23 SHUT-DOWN OPERATION

For exchangers with removable bundles, the units may be shut down by first gradually stopping the flow of the hot medium and then stopping the flow of the cold medium. If it is necessary to stop the flow of cold medium, the circulation of hot medium through the exchanger should also be stopped. For fixed tubesheet exchangers the unit must be shut down in a manner to minimize differential expansion between shell and tubes, (Refer E-4.24). When shutting down the system, all units should be drained completely when there is the possibility of freezing or corrosion damage. To guard against water hammer, condensate should be drained from steam heaters and similar apparatus during start-up or shut-down. To reduce water retention after drainage, the tube side of water cooled exchangers should be blown out with air.

E-4.24 START-UP AND SHUT-DOWN PROCEDURES FOR FIXED TUBESHEET EXCHANGERS

When start-up and shut-down instructions are furnished, they must be followed. When specific instructions are not supplied, the recommended procedure is to start, or stop, the circulation of both shell and tube side fluids gradually and at the same time.

E-4.3 OPERATING LIMITATIONS

E-4.31 NORMAL OPERATING CONDITIONS

Equipment must not be operated at conditions more severe than those specified on the heat exchanger specification sheet, and/or name plates. A change in service or deviation from the specified operating conditions may require that a mechanical design check be made in order to avoid possible damage to the heat exchanger.

E-4.32 SUPPLEMENTAL NAME PLATE DATA

The manufacturer may supply supplemental data where it is pertinent to the operation or testing of the exchanger. This may include information pertaining to differential design and test pressure conditions, restrictions on operating conditions for fixed tubesheet type exchangers, or other restrictive conditions applicable to the design and/or operation of the unit or its components. Such information may be noted on the standard name plate or on a supplemental plate attached to the exchanger at the name plate location.

E-4.33 FLOW RATE

Heat exchangers are not to be operated at flow rates greater than those shown on the heat exchanger specification sheet. Excessive flow rates can cause vibration and/or erosion and severely damage the heat exchanger.

E-4.34 HYDRAULIC HAMMER

Exchangers should not be subjected to pulsating, slugging, or unstable flow conditions which may impair performance or result in destructive hydraulic hammer. Adequate condensate drainage is essential for steam heaters and similar apparatus.

E-4.35 TEMPERATURE SHOCKS

Exchangers normally should not be subjected to abrupt temperature fluctuations. Hot fluid must not be suddenly introduced when the unit is cold, nor cold fluid when the unit is hot.

E-4.36 FLUID TEMPERATURE LIMITS

E-4.361 Heat exchangers are not to be operated at fluid temperatures more severe than those shown on the heat exchanger specification sheet.

E-4.362 For fixed tubesheet exchangers fluid inlet temperatures may be severely limited when there is no fluid on the opposite side. Operation with fluid circulation on one side only should be avoided, unless specifically provided for in the design of the heat exchanger.

E-4.4 BOLTED JOINTS

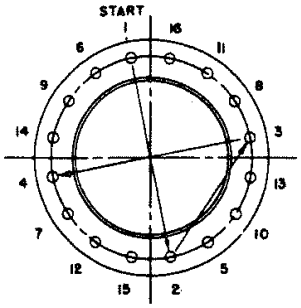
E-4.41 RECOMMENDATIONS FOR RETIGHTENING

Heat exchangers are pressure tested before leaving the manufacturer's shop in accordance with ASME Code requirements. However, normal yielding of gasket joints may occur in the interval between testing in the manufacturer's shop and installation at the job site. Therefore, all external bolted joints may require retightening after installation and, if necessary, after the exchanger has reached operating temperature.

E-4.42 RECOMMENDED BOLT TIGHTENING PROCEDURE

It is important that all bolted joints be tightened uniformly and in a diametrically staggered pattern as illustrated in Figure E-4.42 except for special high pressure closures when the instructions of the manufacturer should be followed.

Figure E-4.42



SECTION 5
MAINTENANCE OF HEAT EXCHANGERS

E-5. MAINTENANCE

E-5.1 INSPECTION OF UNIT

At regular intervals and as frequently as experience indicates, an examination should be made of the interior and exterior condition of the unit. Neglect in keeping all tubes clean may result in complete stoppage of flow through some tubes which could cause severe thermal strains, leaking tube joints, or structural damage to other components. Sacrificial anodes, when provided, should be inspected to determine whether they should be cleaned or replaced.

E-5.11 INDICATIONS OF FOULING

Exchangers subject to fouling or scaling should be cleaned periodically. A light sludge or scale coating on the tube greatly reduces its efficiency. A marked increase in pressure drop and/or reduction in performance usually indicates cleaning is necessary. The unit should first be checked for air or vapor binding to confirm that this is not the cause for the reduction in performance. Since the difficulty of cleaning increases rapidly as the scale thickness or deposit increases, the intervals between cleanings should not be excessive.

E-5.12 PREVENTIVE MAINTENANCE

Additional important reasons for inspections include:

(1) Corrosion and erosion may weaken various parts of an exchanger and may eventually cause mechanical failure, or impaired performance.

(2) Determination of fouling and corrosion rates for prediction of service life and scheduling down-time.

(3) Implementation of preventive maintenance procedures which reduce rates of fouling and general deterioration, or eliminate leaks.

E-5.13 ACCESS TO TUBES

Before disassembly, the user must assure himself that the unit has been depressurized, vented and drained, neutralized and/or purged of hazardous materials.

To inspect the inside of the tubes and also make them accessible for cleaning, the following procedures should be used:

(1) Stationary Head End

(a) Type A, C, & D, remove cover only.
(b) Type B, remove bonnet.

(2) Rear Head End

(a) Type L, N, & P, remove cover only.
(b) Type M, remove bonnet.
(c) Type S & T, remove shell cover and floating head cover.
(d) Type W, remove channel cover or bonnet.

E-5.14 LOCATING LEAKS IN TUBES

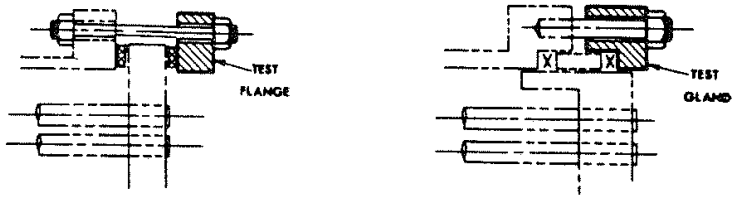
The following procedures may be used to locate perforated or split tubes and leaking joints between tubes and tubesheets. In most cases, the entire front face of each tubesheet will be accessible for inspection. The point where water escapes indicates a defective tube or tube-to-tubesheet joint.

(1) Units with removable channel cover:
Remove channel cover and apply hydraulic pressure in the shell.

(2) Units with bonnet type head:
(a) On fixed tubesheet units where tubesheets are an integral part of the shell, remove bonnet and apply hydraulic pressure in the shell.
(b) On fixed tubesheet units where tubesheets are not an integral part of the shell and on units with removable bundles, remove bonnet, re-bolt tubesheet to shell or install test flange or gland, whichever is applicable, and apply hydraulic pressure in the shell.
See Figure E-5.14-1 for typical test flange and test gland.

CAUTION: Bolting directly to the edges of the tubesheets may result in overstress unless it was considered in the design of the tubesheets.

Figure E-5.14-1

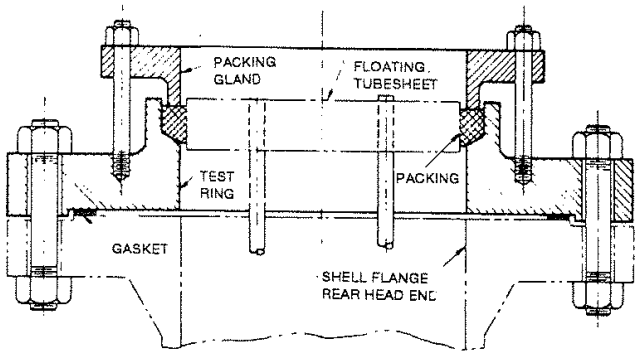


(3) Units with type S or T floating head:
Remove channel cover or bonnet, shell cover and floating head cover. Install test ring and bolt in place with gasket and packing. Apply hydraulic pressure in the shell. A typical test ring is shown in Figure E-5.14-2. When a test ring is not available it is possible to locate leaks in the floating head end by removing the shell cover and applying hydraulic pressure in the tubes. Leaking tube joints may then be located by sighting through the tube lanes.

NOTE: Care must be exercised when testing partially assembled exchangers to prevent over extension of expansion joints or overloading of tubes and/or tube-to-tubesheet joints.

Hydrostatic test should be performed so that the temperature of the metal is at least 30°F above the minimum design metal temperature, MDMT.

Figure E-5.14-2



E-5.2 TUBE BUNDLE REMOVAL

Bundles must be withdrawn from the stationary end as noted on the drawing. All parts such as glands, retainer rings, split shear rings and closure packing must be removed before attempting to remove bundle. Threaded eyebolts may be attached to the stationary tubesheet when tapped holes have been provided for this purpose. When eyebolt tappings are not provided, rods may be passed through two or more tubes and attached to a steel bearing plate over the floating tubesheet. Provide a protective spacer between the bearing plate and tubesheet to protect the tube ends.

E-5.21 HANDLING TUBE BUNDLES

Tube bundles should not be handled with hooks or other devices which might damage the tubes. Bundles should be supported on cradles or skids. Horizontal tube bundles should be lifted by means of suitable slings. Baffles can be bent and damaged by dragging a bundle over a rough surface. All gasket and packing contact surfaces should be protected from accidental damage since these areas are generally difficult to repair.

E-5.3 CLEANING TUBE BUNDLES

E-5.31 CLEANING METHODS

The heat transfer surfaces of heat exchangers should be kept reasonably clean to assure satisfactory performance. Convenient means for cleaning should be made available.

Heat exchangers may be cleaned by either chemical or mechanical methods. The method selected must be the choice of the operator of the plant and will depend on the type of deposit and the facilities available in the plant. Following are several cleaning procedures that may be considered:

(1) Circulating hot wash oil or light distillate through tubes or shell at high velocity may effectively remove sludge or similar soft deposits.

(2) Some salt deposits may be washed out by circulating hot fresh water.

(3) Commercial cleaning compounds are available for removing sludge or scale provided hot wash oil or water is not available or does not give satisfactory results.

(4) High pressure water jet cleaning.

(5) Scrapers, rotating wire brushes, and other mechanical means for removing hard scale, coke, or other deposits.

(6) Employ services of a qualified organization that provides cleaning services. These organizations will check the nature of the deposits to be removed, furnish proper solvents and/or acid solutions containing inhibitors, and provide equipment and personnel for a complete cleaning job.

E-5.32 CLEANING PRECAUTIONS

(1) Tubes should not be cleaned by blowing steam through individual tubes since this heats the tube and may result in severe expansion strain, deformation of the tube, or loosening of the tube-to-tube sheet joint.

(2) When mechanically cleaning a tube bundle, care should be exercised to avoid damaging the tubes.

(3) Cleaning compounds must be compatible with the metallurgy of the exchanger.

(4) Cleaning procedures, especially those which circulate hot fluids through the tubes, can cause significant temperature differentials between the shell and tubes. Such cleaning procedures can cause damage to fixed tubesheet heat exchangers and should be avoided unless specifically provided for in the design of the heat exchanger.

E-5.4 GASKET REPLACEMENT

Gasket and gasket surfaces should be thoroughly cleaned and should be free of scratches and other defects. Gaskets should be properly positioned before attempting to retighten bolts. It is recommended that when a heat exchanger is dismantled for any cause, it be reassembled with new gaskets. This will tend to prevent future leaks and/or damage to the gasket seating surfaces of the heat exchanger. Composition gaskets become dried out and brittle so that they do not always provide an effective seal when reused. Metal or metal jacketed gaskets, when compressed initially, flow to match their contact surfaces. In so doing they are work hardened and, if reused, may provide an imperfect seal or result in deformation and damage to the gasket contact surfaces of the exchanger.

Bolted joints and flanges are designed for use with the particular type of gasket specified. Substitution of a gasket of different construction or improper dimensions may result in leakage and damage to gasket surfaces. Therefore, any gasket substitutions should be of compatible design.

Any leakage at a gasketed joint should be rectified and not permitted to persist as it may result in damage to the gasket surfaces.

When metal jacketed filled type gaskets are used with a tongue and groove joint without a nubbin, the gasket should be installed so that the tongue bears on the seamless side of the gasket jacket. When a nubbin is used, the nubbin should bear on the seamless side.

E-5.5 SPARE AND REPLACEMENT PARTS

The procurement of spare or replacement parts from the manufacturer will be facilitated if the correct name for the part, as shown in Section 1, Table N-2, of this manual is given, together with the serial number, type, size, and other information from the nameplate. Replacement parts should be purchased from the original manufacturer.

E-5.6 EXPANDED TUBE JOINTS

E-5.61 TUBE HOLE FINISH

Tube hole finish affects the mechanical strength and leak tightness of an expanded tube-to-tubesheet joint. In general:

(1) A rough tube hole provides more mechanical strength than a smooth tube hole. This is influenced by a complex relationship of modulus of elasticity, yield strength, and hardness of the materials being used.

(2) A smooth tube hole does not provide the mechanical strength that a rough tube hole does, but it can provide a pressure tight joint at a lower level of tube wall reduction.

(3) Very light wall tubes require a smoother tube hole finish than heavier wall tubes.

(4) Significant longitudinal scratches can provide leak paths through an expanded tube-to-tubesheet joint and should therefore be removed.

E-5.62 TUBE WALL REDUCTION

The optimum tube wall reduction for an expanded tube-to-tubesheet joint depends on a number of factors, some of which are:

(1) Tube hole finish.

(2) The presence or absence of the tube hole serrations (grooves).

(3) The tube hole size and tolerance.

(4) Tubesheet ligament width and its relation to tube diameter and thickness.

(5) Tube wall thickness.

(6) Tube hardness and change in hardness during cold working.

(7) Tube O.D. tolerance.

(8) Type of expander used.

(9) Type of torque control or final tube thickness control.

(10) Function of tube joint, i.e., strength in resistance to pulling out, minimum cold work for corrosion purposes, freedom from leaks, ease of replacement, etc.

(11) Length of expanded joint.

(12) Compatibility of tube and tubesheet materials.

E-5.63 TUBE EXPANDING

A suitable tube expander should be used to tighten a leaking tube joint. Care should be taken to insure that tubes are not over expanded. Do not re-expand tubes which are not leaking. Do not expand tubes beyond 1/8" from the back face of the tubesheet.

E-5.64 TYPICAL COMPUTATION OF TUBE WALL REDUCTION

EXAMPLE OF DETERMINING THE EXPANDED TUBE INSIDE DIAMETER FOR A SPECIFIED AMOUNT OF WALL REDUCTION

GIVEN:	TUBE DIAMETER	= 0.750
	TUBE HOLE DIAMETER	= 0.760
	TUBE WALL THICKNESS	= 0.065
	SPECIFIED WALL REDUCTION	= 5%
SOLUTION:	WALL REDUCTION	= 0.065 x 0.05 = 0.00325
	FINAL WALL THICKNESS	= 0.065 – 0.00325 = 0.06175
	FINAL EXPANDED TUBE I.D.	= 0.760 – 2(0.06175) = 0.6365

CAUTION: *THE USE OF NOMINAL DIMENSIONS, WITHOUT ATTENTION TO PERMISSIBLE TOLERANCES CAN LEAD TO INCORRECT CONCLUSIONS.*

EXPANDING PROCEDURES SHOULD BE BASED ON MEASURED DIMENSIONS, NOT NOMINAL DIMENSIONS.

E-5.65 PLUGGING TUBES IN TUBE BUNDLES

In U-tube heat exchangers, and other exchangers of special design, it may not be feasible to remove and replace defective tubes. Defective tubes may be plugged using commercially available tapered plugs with ferrules or tapered only plugs which may or may not be seal welded. Excessive tube plugging may result in reduced thermal performance, higher pressure drop, and/or mechanical damage.

E-5.7 WELDED TUBE JOINTS

Welding procedure and testing techniques for either seal welded or strength welded tube joints normally are by agreement between manufacturer and purchaser and therefore should be considered prior to repairs to welded tube joints or tube replacements.

E-5.8 END FLANGES AND BOLTING

The purpose of this section is to alert the users, and provide basic data for consideration in assembly and maintenance of bolted flanged joints. Controlling the torque applied in tightening threaded bolts is the most economical and commonly used method for the control of initial tension. There are several factors which affect the relationship between torque and tension of threaded bolts. A few of the factors are the type of lubricant and/or plating, if any, used on the threads and the materials from which the bolt and nut are manufactured.

In assembling gasketed joints it is essential that the gasket first be seated uniformly by initial tightening of studs using a staggered quarterly pattern. After the gasket is seated, torquing may be completed stepwise to the final desired value, following a staggered or sequential pattern.

The following may be used as references and aids when assembling bolted flanged joints:

1. Recommended assembly and maintenance of flanged joints as shown in the Crane Company Catalog #60, Engineering Data Section.

2. Torque Control, Sixth Edition, Sturtevant Company.

3. ASME Code, Appendix S.

E-5.9 SPECIAL HIGH PRESSURE CLOSURES

The instructions of the heat exchanger manufacturer should be followed when provided.

E-5.10 REPAIRS, ALTERATION, RERATING, AND REPLACEMENT PARTS.

In order to maintain the Code integrity of the vessel, any repairs by welding, subsequent heat treating, alterations, replacement pressure parts, or rerating must be done in accordance with the National Board Inspection Code.

Potentially toxic or harmful contaminants must be neutralized prior to repairs.

Following repair by welding, post weld heat treatment may be a requirement for preservation of resistance to corrosion.