MANUFACTURER'S DATA BOOK

MISSISSIPPI POWER

DEKALB, MISSISSIPPI

KEMPER COUNTY 1 – IGCC PROJECT

P.O. NO: 17497-0001

REQ. NO: MC206

ITEM NO: HX0040

LP VENT GAS COMPRESSOR PRECOOLER

1-28" x 288" AGU EXCHANGER

ENERGY JOB NO: X-7931

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 04NOV2011

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**
MM93736 0 Unit 1

ENERGY EXCHANGER COMPANY PO: MPC17497-0001
X-7931-MDB Rev: 0
IGCC - GASIFIER - MULTIPAGE - LP VENT GAS COMPRESSOR PRECOOLER -

Mississippi Power
Kemper County 1 – IGCC Project
P.O. No: 17497-0001
Req. No: MC206
Item No: HX0040
Energy Job No: X-7931

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 # 7931	Location:	TULSA, OK
Project:	KEMPER COUNTY IGCC UNIT	Supplier Ref. #:	

Item #	Description	Qty Ordered	Qty Released	Balance
01	(1) 28-288 AGU exchanger TAG # HX-0040	31	9	23

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: 10/14/11

Bill Bronaugh

IQS

SECTION 2

Energy Exchanger Company

HEAT EXCHANGER SPECIFICATION SHEET

REV				
0			P. No.: 17497-0001	
0			REV. 0 AS PURCHASED	
2	Customer	SOUTHERN COMPANY SERVICES	Job No.: X-7931 "AS BUILT"	
2	Address	BIRMINGHAM, AL	Rev.: 2	Date: 10/31/2011
	Plant Location	KEMPER COUNTY, MS	File:	10-7314
	Service of Unit	LP VENT GAS COMPRESSOR PRECOOLER	Item: HX0040	
	Size 28-288	Type AGU Horizontal	Connected In 1 Parallel	1 Series
2	Surf./Unit ☐ Gross ☑ Eff 1172 ft²; Shells/Unit 1		Surf./Shell ☐ Gross ☑ Eff. 1172 ft²	

PERFORMANCE OF ONE UNIT

REV			Shell Side				Tube Side			
	Fluid Allocation		Shell Side				Tube Side			
	Fluid Name		LP VENT GAS				COOLING WATER			
	Fluid Quantity, Total	lb/hr	23860				74092			
	Vapor (In/Out)		23860		23860					
	Liquid									
	Steam									
	Water						74092		74092	
	Noncondensable						#REF!			
	Temperature (In/Out)	°F	350.		110.0		94.		119.	
	Density (Vapor/Liquid)	Lb/Ft³	0.0390		0.0500					
	Viscosity	cP	0.0234		0.0180					
	Molecular Weight									
	Molecular Weight, Noncondensable									
	Specific Heat	Btu/lb-F	0.3277		0.3190					
	Thermal Conductivity	Btu/hr-ft-F	0.0378		0.0280					
	Latent Heat	Btu/lb								
	Inlet Pressure	psia	13.7							
1	Velocity	ft/sec	37.95				2.93			
	Pressure Drop, Allow./Calc.	psi	2.00	/	1.90		10.00	/	5.00	
	Fouling Resistance (Min.)	Hr-Ft-°F/Btu	0.002				0.001			

REV					
	Heat Exchanged	1850000	Btu/hr; M.T.D. (Corrected)	70.57	°F
	Transfer Rate, Service	22.37	Btu/hr-ft²-F; Clean	30.10	Btu/hr-ft²-F

CONSTRUCTION OF ONE SHELL

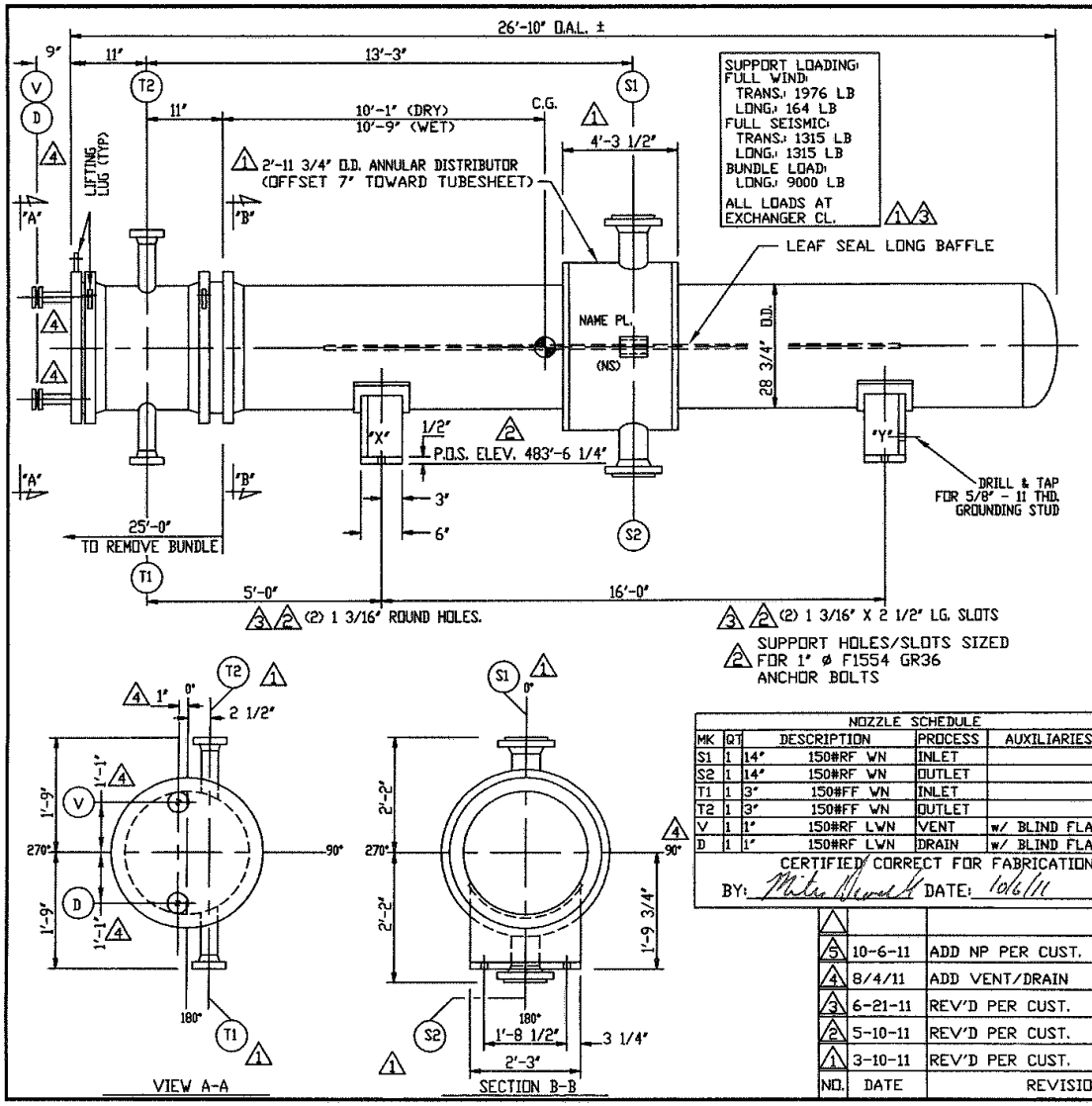
Sketch (Bundle/Nozzle Orientation)

REV				Shell Side	Tube Side
2	Design/Test Pressure		psig	15/FV/210 (5)	150/245
	Design Temperature (Max/Min)		°F	500/10	145/10
	No. Passes Per Shell			SPLIT	4
	Corrosion Allowance		inch	0.125	0.125
1	Connections	In		1 - 14" 150RF	1 - 3" 150 FF
1	Size &	Out		1 - 14" 150RF	1 - 3" 150 FF
	Rating	Intermediate			

REV		
	Tube No. 125 U'S OD 0.75 in; Thk. ☑ Min ☐ Avg 0.083 in; Length 24. ft; Pitch 1.125 in 60°	
1	Tube Type BARE U-TUBES	Material SA-214
1	Shell SA-516-70 ☑ I ☐ OD 28. in	;Shell Cover SA-516-70 ☑ Integ. ☐ Remov
1	Channel or Bonnet SA-516-70	Channel Cover SA-516-70N ☐ Integ. ☑ Remov
1	Tubesheet-Stationary SA-516-70N	Tubesheet - Floating
	Floating Head Cover	Impingement Protection (2)
1	Baffles-Cross 5 - SA-36 Type V N.T.I.W.	% Cut (☑ Di ☐ Area) 26. Spacing c/c 48.8125 Inlet in
1	Baffles-Long SA-36	Seal Type LEAF SEAL
1	Supports - Tube SA-36 U-Bend YES	Type FULL
2	Bypass Seal Arrangement DUMMY TUBES	Tube-Tubesheet Joint TWO GROOVES, EXPAND & SEAL WELD
2	Expansion Joint N/A	Type
	pv² - Inlet Nozzle Bundle Entrance	Bundle Exit
1	Gaskets - Shell Side SIDJ FLEX. GRAPHITE FILLED	Tube Side SIDJ FLEX. GRAPHITE FILLED
1	- Floating Head N/A	
1	Code Requirements ASME SECTION VIII, DIV. 1 (STAMP: YES)	TEMA Class R
1	Weight/Shell 12000# Filled With Water 18750#	Bundle 6000#

REMARKS

REV	
2	(1) DELETED.
	(2) PROVIDE ANNULAR DISTRIBUTOR AT INLET& OUTLET, 50 IN LONG, 3 " HIGH, SLOT AREA = 460 IN2.
	(3) BAFFLE SPACING CHANGED TO MATCH NUMBER OF CROSSPASSES TO SPACE AVAILABLE.
	(4) TWO INTERMEDIATE SUPPORTS PER BAFFLE SPACE CUT TOP AND BOTTOM.
1	(5) SHELL SIDE STEAM OUT AT 250°F AND 15 PSIG.



DESIGN DATA	SHELL	TUBE
DESIGN PRESSURE P.S.I.G.	15	150
VACUUM PRESSURE P.S.I.G.	FV	N/A
TEST PRESSURE P.S.I.G.	210	245
DESIGN TEMP. Deg. F.	500	145
M.D.M.T. Deg. F.	10	10
CORROSION ALLOWANCE	1/8"	1/8"
NUMBER OF PASSES	SPLIT	4
RADIOGRAPH	SPOT	SPOT
HEAT TREAT REQUIRED	NO	YES (U-BENDS: NO)
MAWP (H&C) P.S.I.G	158	185
LIMITED BY:	GIRTH FLANGE	CHANNEL COVER

ESTIMATED WEIGHTS, LBS.

DRY: 12000 BUNDLE: 6000 WET: 18750

SPECIFICATIONS

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

MATERIAL

CHANNEL:	SA-516-70
SHELL:	SA-516-70
TUBESHEETS:	SA-516-70N
BAFFLES:	SA-36
TUBES:	SA-214

(125 U) 3/4" O.D.X 0.083" (MIN) X 24'-0" LG.
TUBE PITCH 1 1/8" 60° △ SURFACE 1172 SQ. FT.

GENERAL NOTES

ALL BOLT HOLES TO STRADDLE NATURAL CENTER LINES.
INSULATION: SHELL 5" (GUARD)
CHANNEL: NONE
PAINT: SEE PAINT MAP DWG X-7931-AA
GASKETS: 1/8" THK SIDJ FLEXIBLE GRAPHITE FILLED
(1) SPARE SET OF GASKETS REQUIRED.
TUBE-TS JOINT: SEAL WELDED AND EXPANDED (2 GROOVES)
NITROGEN PURGE REQUIRED.

10/29/11
CERTIFIED AS-BUILT

NOZZLE SCHEDULE

MK	QT	DESCRIPTION	PROCESS	AUXILIARIES
S1	1	14" 150#RF WN	INLET	
S2	1	14" 150#RF WN	OUTLET	
T1	1	3" 150#FF WN	INLET	
T2	1	3" 150#FF WN	OUTLET	
V	1	1" 150#RF LWN	VENT	w/ BLIND FLANGE
D	1	1" 150#RF LWN	DRAIN	w/ BLIND FLANGE

CERTIFIED CORRECT FOR FABRICATION
BY: DATE: 10/6/11

CUST: MISSISSIPPI POWER CO.
c/o SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ. No: MC206 △1
ITEM NO: HX0040
SERVICE: LP VENT GAS COMPRESSOR PRECOOLER
SHIP TO: KEMPER CO., MS

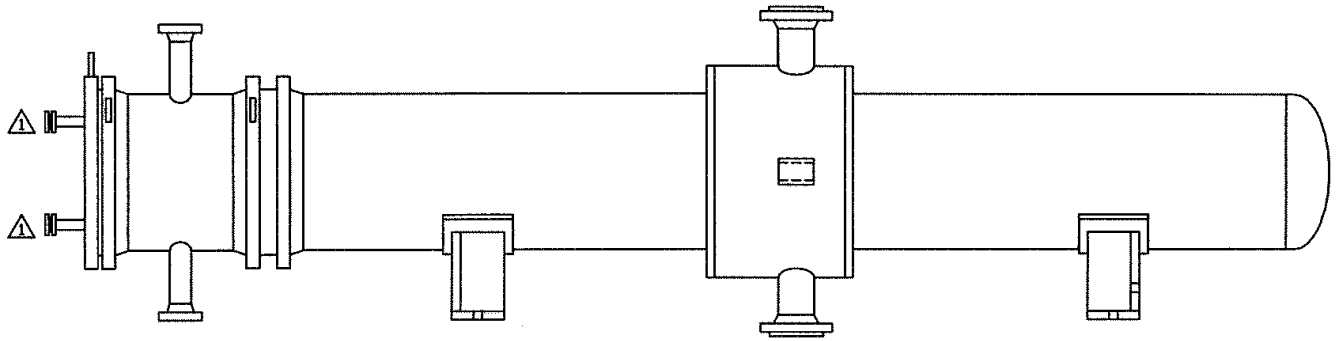
NO.	DATE	REVISIONS
△5	10-6-11	ADD NP PER CUST. WE/MM
△4	8/4/11	ADD VENT/DRAIN MD/SG
△3	6-21-11	REV'D PER CUST. SM/DN
△2	5-10-11	REV'D PER CUST. MD/SG
△1	3-10-11	REV'D PER CUST. DN/SG

ASSEMBLY AND SPECIFICATIONS FOR
△2 ONE (1) 28-288 A G U

DWN. BY DN
DATE 1- 6-11
CKD. BY MD

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

DWG. NO. X-7931-A
REV 5



CERTIFIED AS-BUILT

COATING DATA SHEET - SYSTEM 3 APPLIES.
ABRASIVE BLAST PER SSPC-SP10 WITH AN ANCHOR PROFILE OF 1 TO 2 MILS.
PRIME WITH INORGANIC ZINC (2.0-3.0 MILS DFT)
FINISH WITH MODIFIED SILICONE (1.0-2.0 MILS DFT) (COLOR: ALUMINUM)

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17497-0001 REQ No.: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO:	HX0040

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

NO.	DATE	REVISIONS
1	8/5/11	ADD CHAN VENT/DRAIN MD/SG

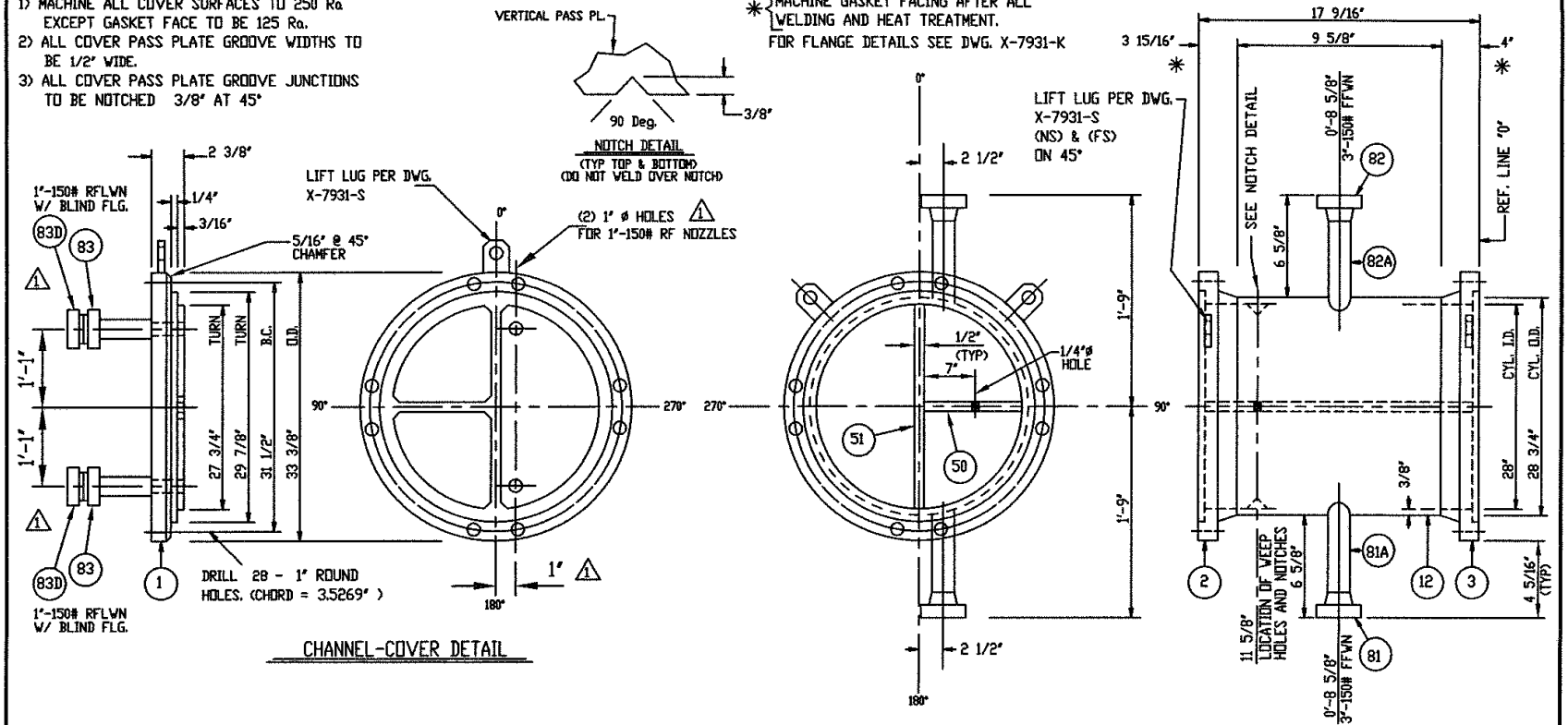
PAINT MAP

DWN. BY: D.MORRISON
DATE: 3-16-11
CKD. BY: SM

Energy Exchanger Co.

DWG. NO. X-7931-AA
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°



CERTIFIED AS-BUILT

NOTES:
1) ALL BOLT HOLES TO STRADDLE CENTER LINES.
2) FOR WELD AND BEVEL DETAILS SEE DWG. X-7931-S
3) FOR JOB NOTES SEE DWG. X-7931-R
4) MILL PASS PLATE(S) TO 3/8" (TYPICAL EACH END)
5) NOZZLE SWING DIMENSION = 42 5/8"

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17497-0001 REQ No.: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO:	HX0040

NO.	DATE	REVISIONS
1	8/5/11	ADD P/N 83/83D MD/SG

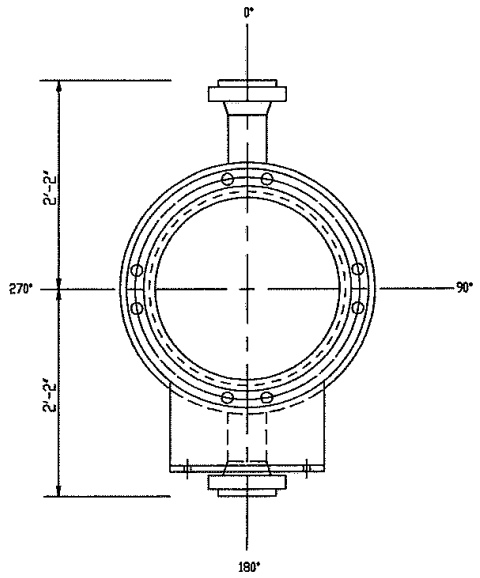
FRONT CHANNEL DETAILS

DWN. BY	D.MORRISON
DATE	3-16-11
CKD. BY	SM
DWG. NO.	X-7931-B
REV	1

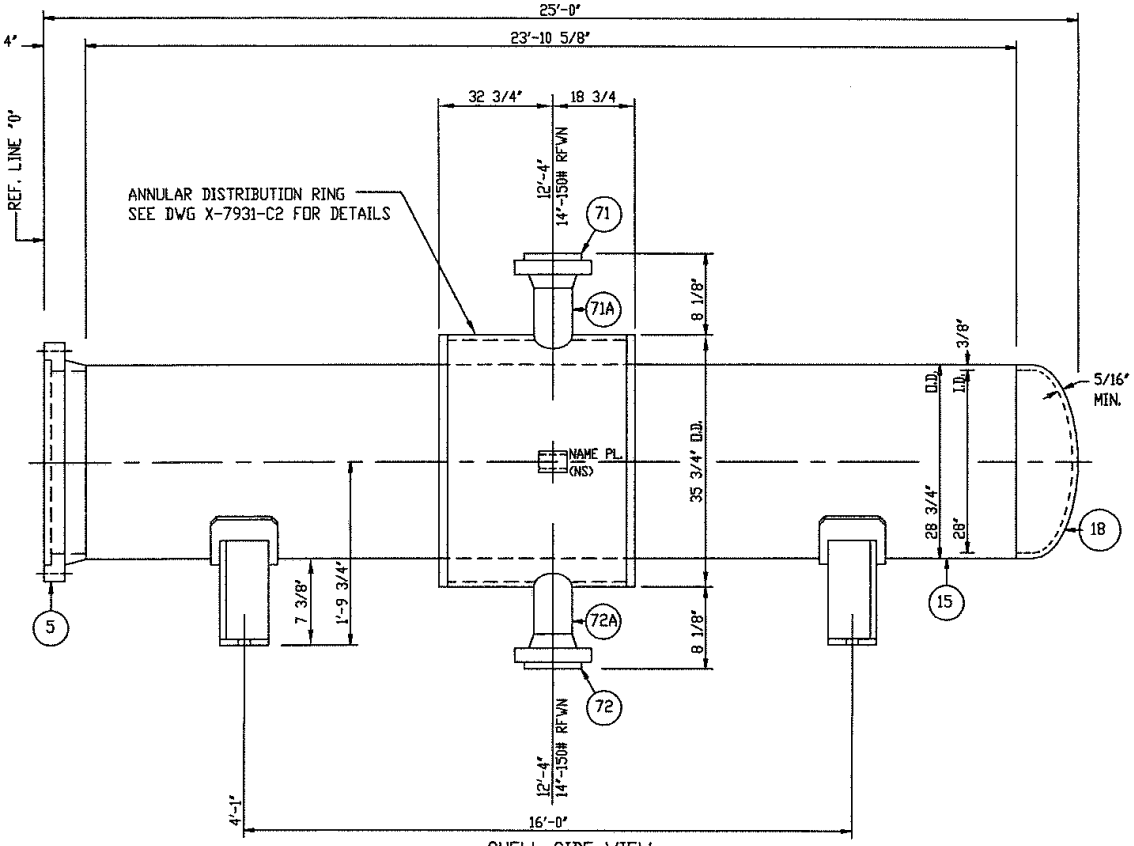
Energy Exchanger Co.

FOR FLANGE DETAILS SEE DWG. X-7931-K

CERTIFIED AS-BUILT



SHELL END VIEW



SHELL SIDE VIEW

NOTES:

1) ALL BOLT HOLES TO STRADDLE CENTER LINES.
2) FOR WELD AND BEVEL DETAILS SEE DWG. X-7931-S
3) FOR JOB NOTES SEE DWG. X-7931-R
4) SEE SUPPORT DETAILS FOR REFERENCE (DWG. X-7931-D). △1
5) SEE NAME PLATE DETAILS FOR REFERENCE (DWG. X-7931-Q).

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17497-0001 REQ No.: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO:	HX0040

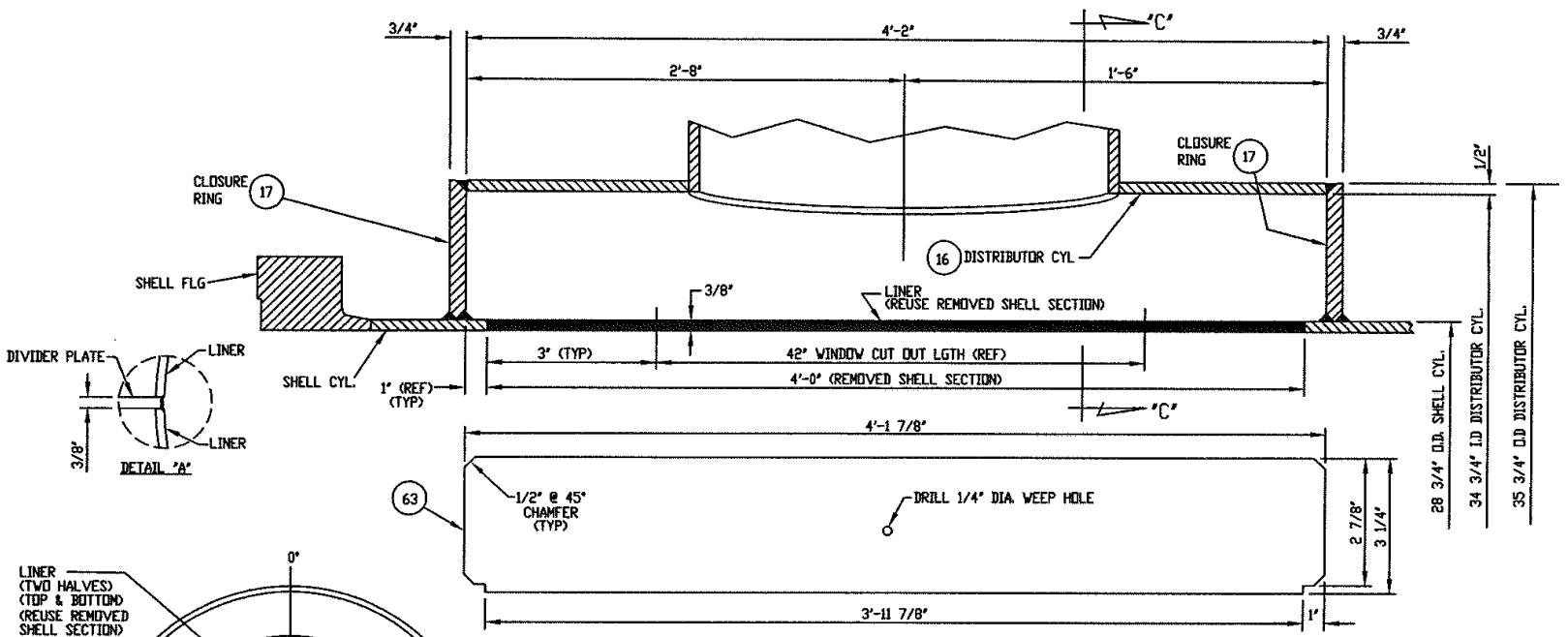
NO.	DATE	REVISIONS
△1	5/10/11	REV. PER CUSTOMER MD/SG

SHELL DETAILS

DWN. BY: D.MORRISON
DATE: 3-16-11
CKD. BY: SM

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

DWG. NO. X-7931-C1
REV 1



CERTIFIED AS-BUILT

NOTES:

1) FOR WELD AND BEVEL DETAILS SEE DWG. X-7931-S
2) FOR JOB NOTES SEE DWG. X-7931-R

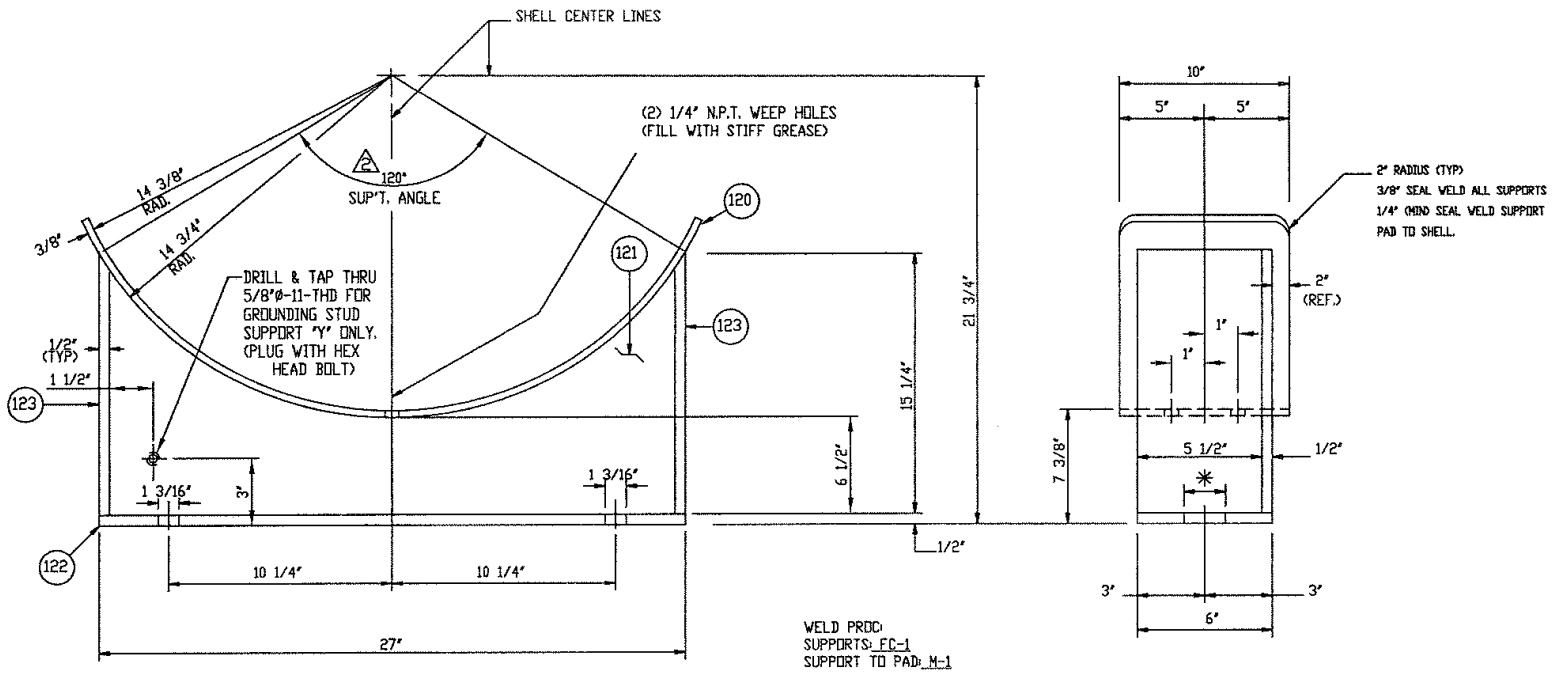
CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17497-0001 REQ No: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO:	HX0040

NO.	DATE	REVISIONS

ANNULAR DISTRIBUTOR ASSEMBLY

DWN. BY	D.MORRISON
DATE	3-16-11
CKD. BY	SM
DWG. NO.	X-7931-C2
REV	0

Energy Exchanger Co.



CERTIFIED AS-BUILT

1

2 ✳ ONE REQUIRED MARKED "Y" W/ (2) 1 3/16" X 2 1/2" LG. SLOTS.
ONE REQUIRED MARKED "X" W/ (2) 1 3/16" ROUND HOLES.

1 (1" DIA. ASTM F1554 GR 36 ANCHOR BOLTS SUPPLIED BY OTHERS)

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17497-0001 REQ No: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO:	HX0040

NO.	DATE	REVISIONS	
2	6-21-11	REV'D PER CUST.	SM/DN
1	5-10-11	REV. PER CUSTOMER	MD/SG

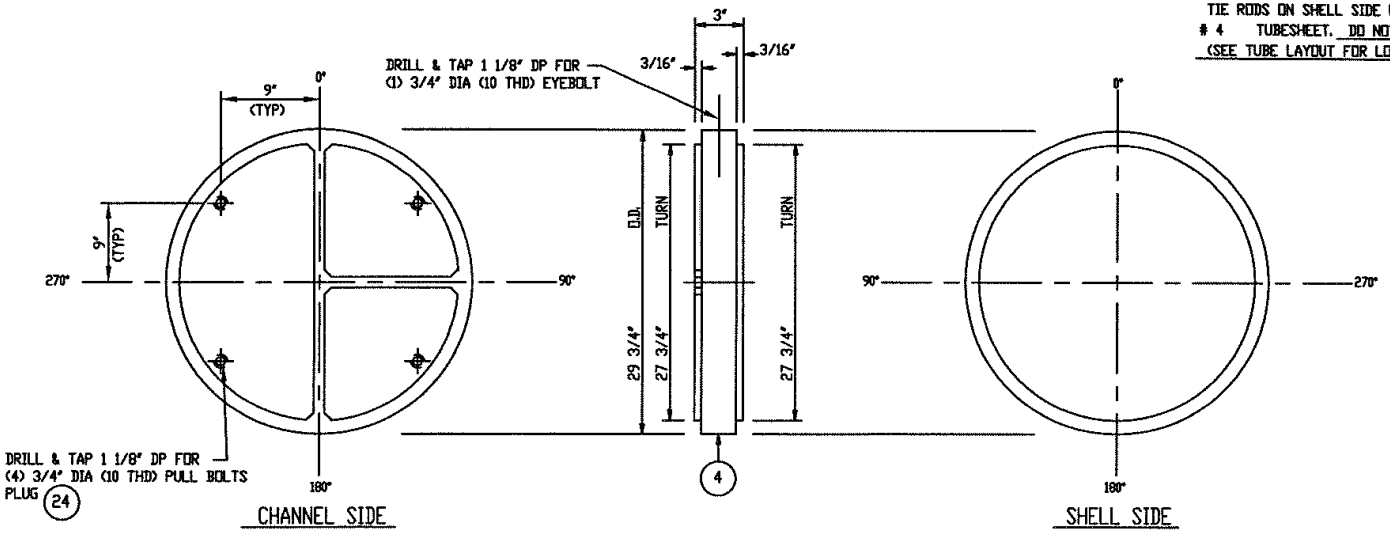
SUPPORT DETAILS

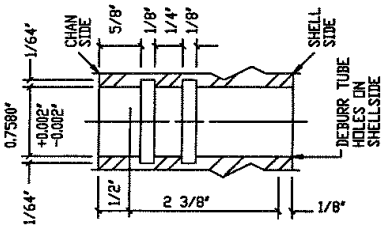
DWN. BY D.MORRISON | DATE 3-16-11 | CKD. BY SM

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

DWG. NO. X-7931-D | REV 2

NOTE: SEE DWG. X-7931-R FOR JOB NOTES.





TUBE HOLE GROOVING DETAIL

SEAL WELD TUBE TO TUBESHEET USING TIG WITH NO FILLER WIRE. REMOVE OIL & GREASE OR OTHER FOREIGN MATTER FROM TUBESHEET, TUBEHOLES & TUBE ENDS PRIOR TO WELDING OF TUBES.
WELD PROCEDURE = SLW-1
DYE CHECK TUBE TO TUBESHEET WELDS BEFORE AND AFTER TUBE ROLLING.
PREHEAT TO 200 deg.F. PRIOR TO WELDING.
BUBBLE TEST @ 15 PSIG PRIOR TO ROLLING.

NOTES:

1) MACHINE ALL SURFACES TO 250 Ra. EXCEPT GASKET FACE TO BE 125 Ra.
2) ALL PASS PLATE GROOVE WIDTHS TO BE 1/2" WIDE.
3) ALL PASS PLATE GROOVE JUNCTIONS TO BE NOTCHED 3/8" AT 45°
4) FOR JOB NOTES SEE DWG. X-7931-R

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17497-0001 REQ No.: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO:	HX0040

CERTIFIED AS-BUILT

NO.	DATE	REVISIONS

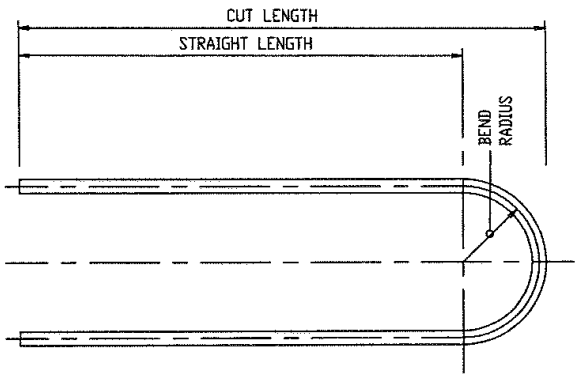
TUBESHEET DETAILS

DWN. BY: D.MORRISON
DATE: 3-16-11
CKD. BY: SM

Energy Exchanger Co.

DWG. NO.: X-7931-F
REV: 0

ROW	NO.OF TUBES	BEND RADIUS	BEND DIAMETER	BEND LENGTH	STRAIGHT LENGTH	CUT LENGTH	DEVELOPED LENGTH
A	13	1 1/8"	2 1/4"	0'-3 9/16"	24'-0"	24'-1 1/2"	48'-3 9/16"
B	14	1 11/16"	3 3/8"	0'-5 5/16"	24'-0"	24'-2 1/16"	48'-5 5/16"
C	12	2 1/4"	4 1/2"	0'-7 1/8"	24'-0"	24'-2 5/8"	48'-7 1/8"
D	14	2 13/16"	5 5/8"	0'-8 7/8"	24'-0"	24'-3 3/16"	48'-8 7/8"
E	12	3 3/8"	6 3/4"	0'-10 5/8"	24'-0"	24'-3 3/4"	48'-10 5/8"
F	14	3 15/16"	7 7/8"	1'-0 3/8"	24'-0"	24'-4 5/16"	49'-0 3/8"
G	12	4 1/2"	9"	1'-2 3/16"	24'-0"	24'-4 7/8"	49'-2 3/16"
H	12	5 1/16"	10 1/8"	1'-3 15/16"	24'-0"	24'-5 7/16"	49'-3 15/16"
J	12	5 5/8"	11 1/4"	1'-5 11/16"	24'-0"	24'-6"	49'-5 11/16"
K	10	6 3/16"	12 3/8"	1'-7 1/2"	24'-0"	24'-6 9/16"	49'-7 1/2"



TOTAL NO. REQUIRED: 125
SIZE: 3/4" O.D. X 0.083" (MIN)
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.: MC206
SERVICE: LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO: HX0040

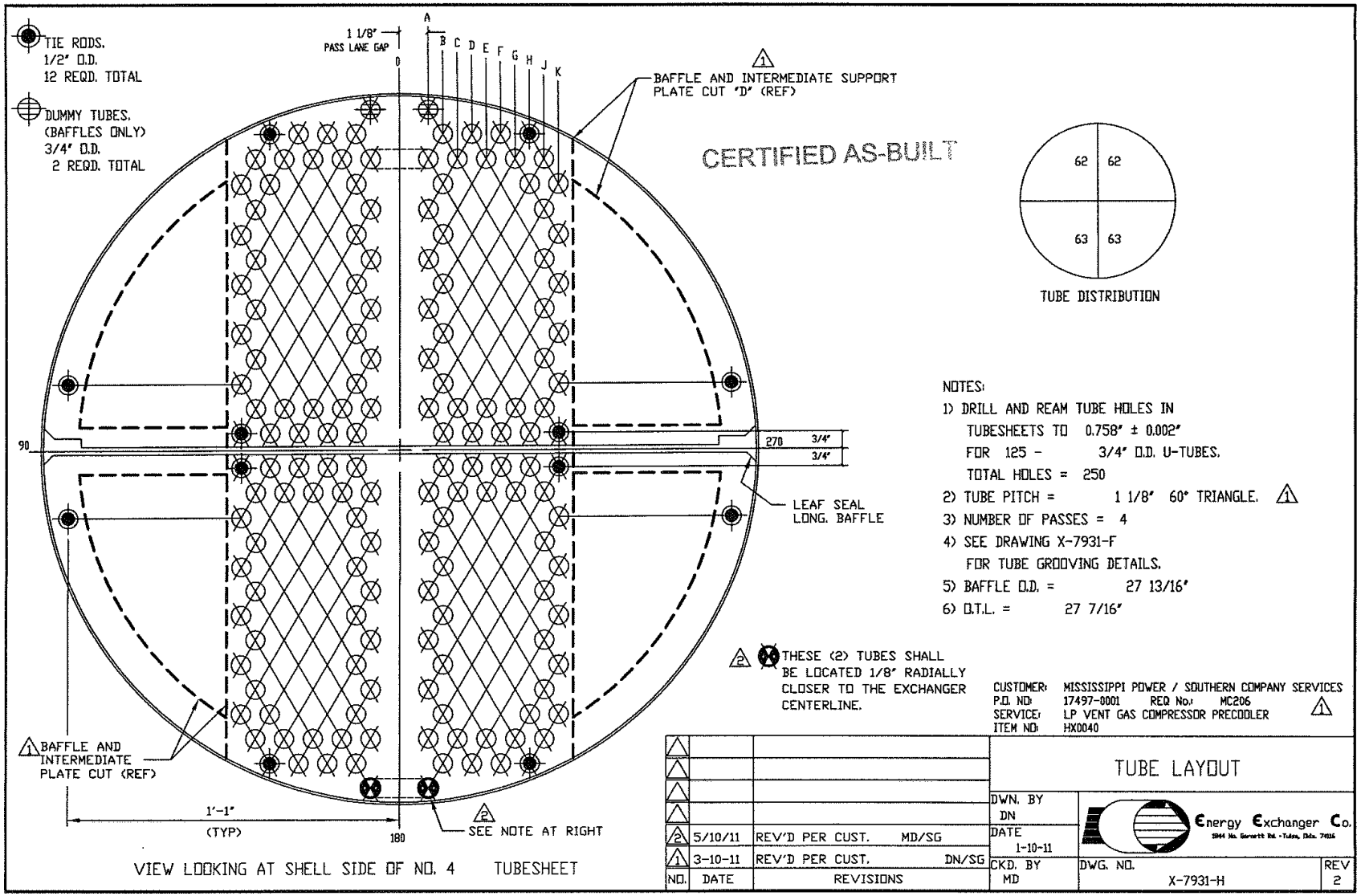
NO.	DATE	REVISIONS
1	3-10-11	REV'D PER CUST. DN/SG

TUBE BENDING SCHEDULE

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

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

DWG. NO. X-7931-G
REV 1



NOTES:

1) DRILL AND REAM TUBE HOLES IN
   TUBESHEETS TO 0.758" ± 0.002"
   FOR 125 - 3/4" O.D. U-TUBES.
   TOTAL HOLES = 250
2) TUBE PITCH = 1 1/8" 60° TRIANGLE. △1
3) NUMBER OF PASSES = 4
4) SEE DRAWING X-7931-F
   FOR TUBE GROOVING DETAILS.
5) BAFFLE O.D. = 27 13/16"
6) O.T.L. = 27 7/16"

△2 THESE (2) TUBES SHALL BE LOCATED 1/8" RADIALLY CLOSER TO THE EXCHANGER CENTERLINE.

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No.: MC206 △1
SERVICE: LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO: HX0040

NO.	DATE	REVISIONS
△		
△		
△		
△		
△2	5/10/11	REV'D PER CUST. MD/SG
△1	3-10-11	REV'D PER CUST. DN/SG

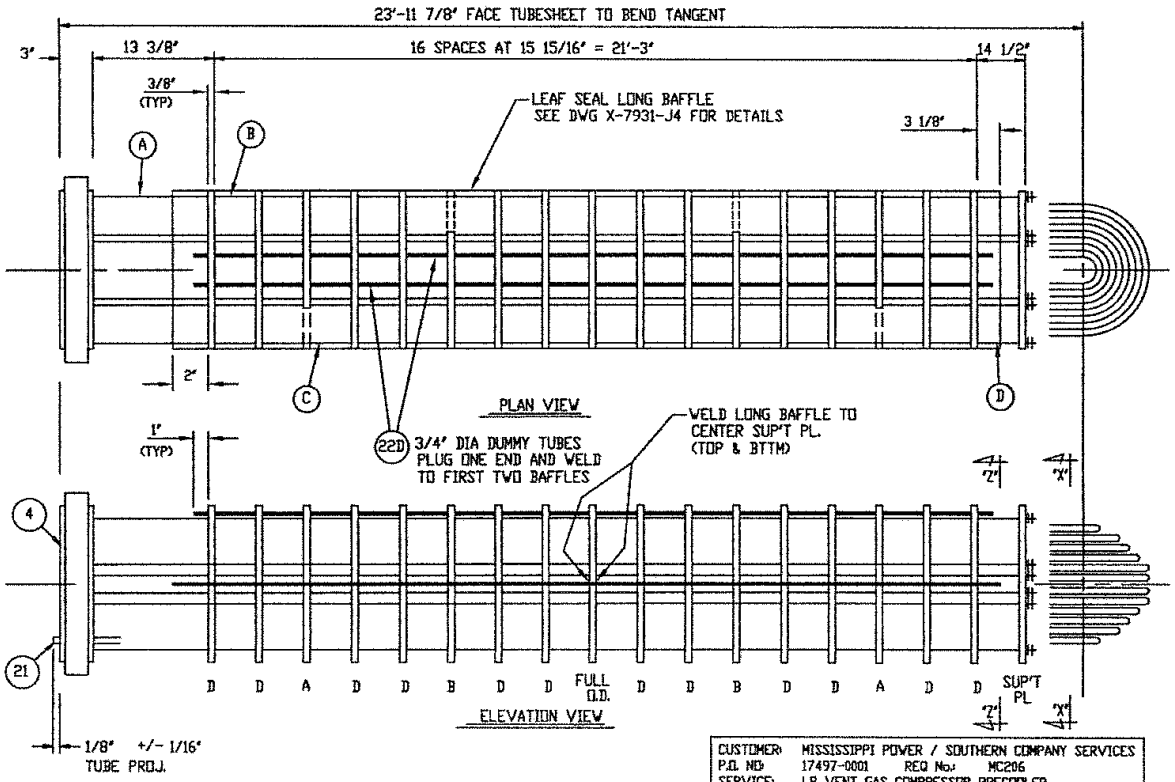
TUBE LAYOUT

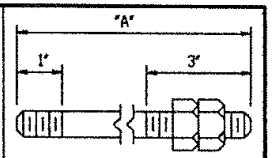
DWN. BY: DN
DATE: 1-10-11
CKD. BY: MD

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

DWG. NO. X-7931-H
REV 2

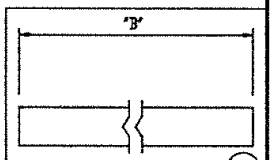
CERTIFIED AS-BUILT





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

REQ'D.	"A"
R1 12	23'-9"
R2	
R3	
R4	



3/4" O.D. SPACER TUBING

REQ'D.	"B"
A 12	13"
B 176	15 9/16"
C 8	31 1/2"
D 12	14 1/8"
E	
F	
G	

NOTES:
1) FOR SECTION AND VIEW DETAILS SEE DWG. X-7931-J1, J2 & J3
2) FOR JOB NOTES SEE DWG. X-7931-R

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17497-0001 REQ No.: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO:	HX0040

SEAL WELD TUBE TO TUBESHEET USING TIG WITH NO FILLER WIRE. REMOVE OIL & GREASE OR OTHER FOREIGN MATTER FROM TUBESHEET, TUBEHOLES & TUBE ENDS PRIOR TO WELDING OF TUBES.
WELD PROCEDURE = SLW-1
DYE CHECK TUBE TO TUBESHEET WELDS BEFORE AND AFTER TUBE ROLLING.
PREHEAT TO 200 deg.F. PRIOR TO WELDING.
BUBBLE TEST @ 15 PSIG PRIOR TO ROLLING.

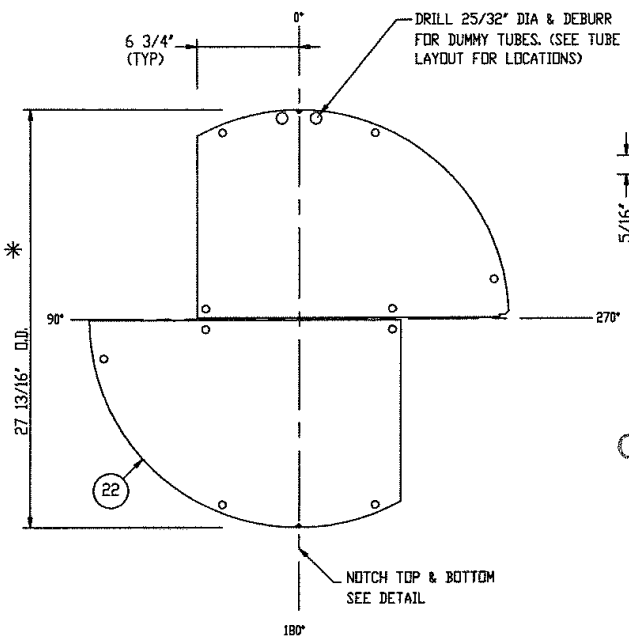
NO.	DATE	REVISIONS

BUNDLE DETAILS

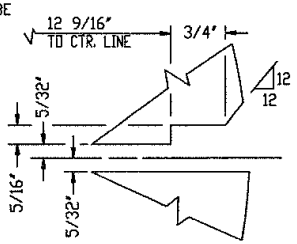
DWN. BY D.MORRISON
DATE 3-16-11
CKD. BY

Energy Exchanger Co.

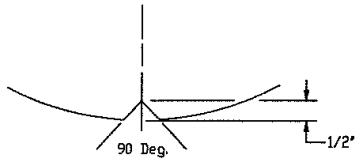
DWG. NO. X-7931-1
REV 0



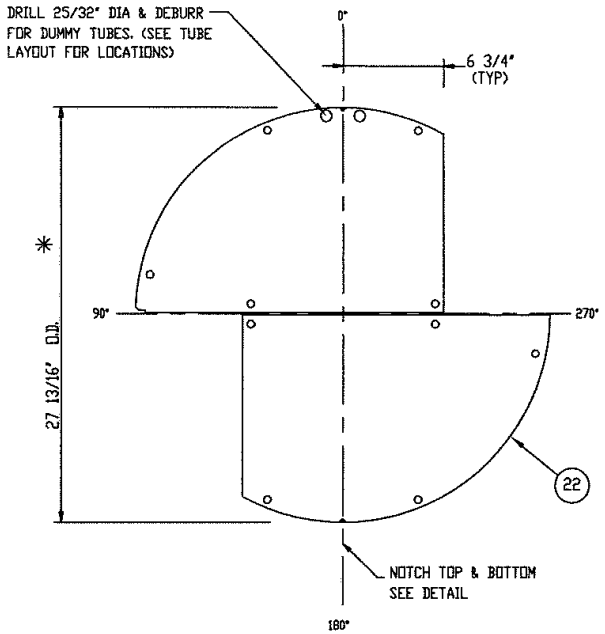
VIEW ZZ OF BAFFLES
3/8" THK.
2-REQD. CUT A



CERTIFIED AS-BUILT



NOTCH DETAIL



VIEW ZZ OF BAFFLES
3/8" THK.
2-REQD. CUT B

NOTES:

1) FOR JOB NOTES SEE DWG. X-7931-R
2) DRILL TUBE HOLES IN BAFFLES 25/32 DIA. & DEBURR. △1
3) DRILL TIE ROD HOLES 9/16" DIA.
   SEE TUBE LAYOUT (DWG. X-7931-H) FOR LOCATION. △1
4) RADIUS ALL CORNERS ON BAFFLE CUTS.
✳ 5) CHECK SHELL I.D. BEFORE MACHINING BAFFLE O.D.
6) MACHINE O.D. OF BAFFLES TO 250 Ra.
7) SEE TUBE LAYOUT (DWG. X-7931-H) FOR BAFFLE CUT LOCATIONS. △1

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17497-0001 REQ No.: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO:	HX0040

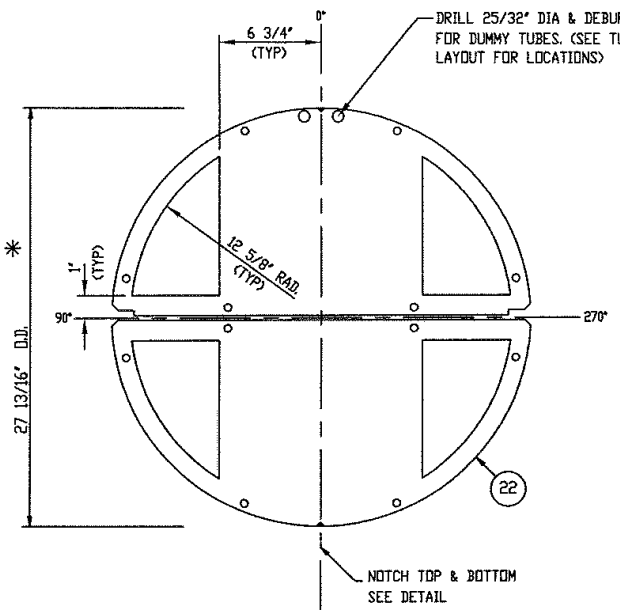
NO.	DATE	REVISIONS
△1	5/10/11	REV. PER CUSTOMER MD/SG

BAFFLE DETAILS

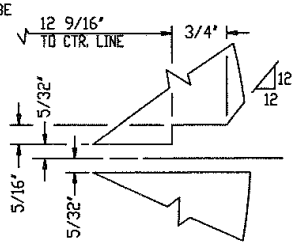
DWN. BY	D.MORRISON
DATE	3-16-11
CKD. BY	SM

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

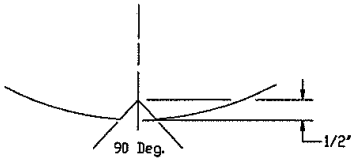
DWG. NO.	REV
X-7931-J1	1



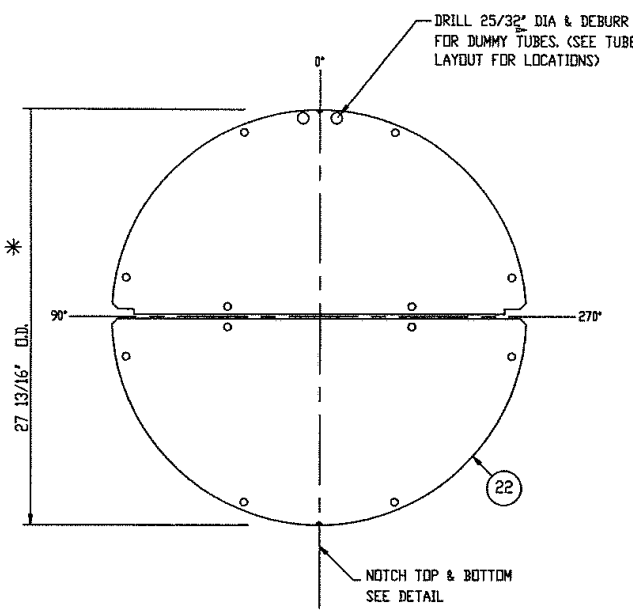
VIEW ZZ OF BAFFLES
3/8" THK.
12-REQD. CUT D



CERTIFIED AS-BUILT



NOTCH DETAIL



VIEW ZZ OF FULL O.D. BAFFLE
3/8" THK
1-REQD

NOTES:

1) FOR JOB NOTES SEE DWG. X-7931-R
2) DRILL TUBE HOLES IN BAFFLES 25/32" DIA. & DEBURR. 1
3) DRILL TIE ROD HOLES 9/16" DIA.
   SEE TUBE LAYOUT (DWG. X-7931-H) FOR LOCATION. 1
4) RADIUS ALL CORNERS ON BAFFLE CUTS.
* 5) CHECK SHELL I.D. BEFORE MACHINING BAFFLE O.D.
6) MACHINE O.D. OF BAFFLES TO 250 Ra.
7) SEE TUBE LAYOUT (DWG. X-7931-H) FOR BAFFLE CUT LOCATIONS. 1

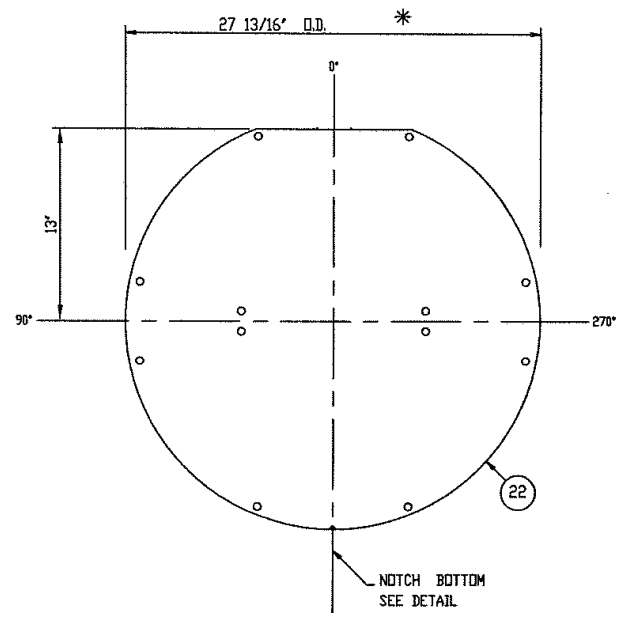
CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17497-0001 REQ No.: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO:	HX0040

NO.	DATE	REVISIONS
1	5/10/11	REV. PER CSUTOMER MD/SG

BAFFLE DETAILS

DWN. BY	D.MORRISON
DATE	3-16-11
CKD. BY	SM
DWG. NO.	X-7931-J2
REV	1

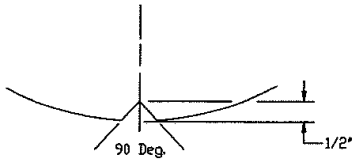
Energy Exchanger Co.
1844 No. Garnett Rd. - Tulsa, Okla. 74116



VIEW XX OF SUP'T PL.

3/8" THK

1-REQD



NOTCH DETAIL

CERTIFIED AS-BUILT

NOTES:

1) FOR JOB NOTES SEE DWG. X-7931-R
2) DRILL TUBE HOLES IN BAFFLES 25/32" DIA. & DEBURR. 1
3) DRILL TIE ROD HOLES 9/16" DIA.
   SEE TUBE LAYOUT (DWG. X-7931-H) FOR LOCATION. 1
4) RADIUS ALL CORNERS ON BAFFLE CUTS.
* 5) CHECK SHELL I.D. BEFORE MACHINING BAFFLE O.D.
6) MACHINE O.D. OF BAFFLES TO 250 Ra.
7) SEE TUBE LAYOUT (DWG. X-7931-H) FOR SUPPORT PLATE CUT LOCATIONS. 1

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17497-0001 REQ No.: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO:	HX0040

NO.	DATE	
1	5/10/11	REV. PER CSUTOMER MD/SG

BAFFLE DETAILS

DWN. BY D.MORRISON

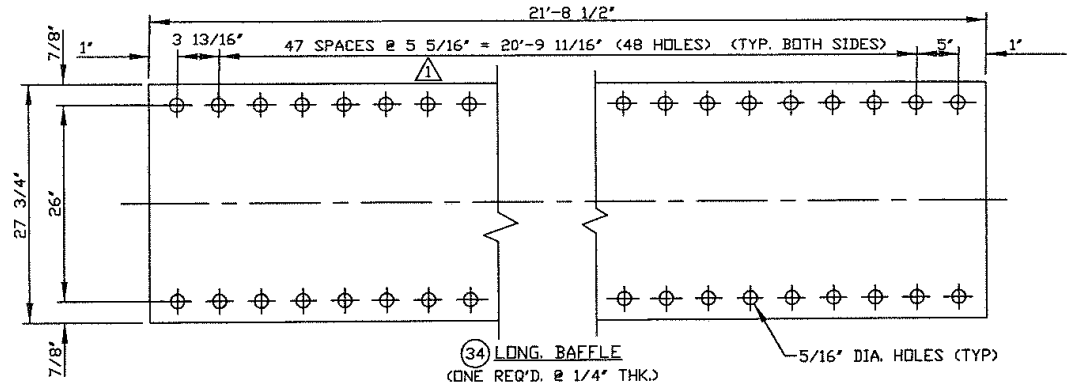
DATE 3-16-11

CKD. BY SM

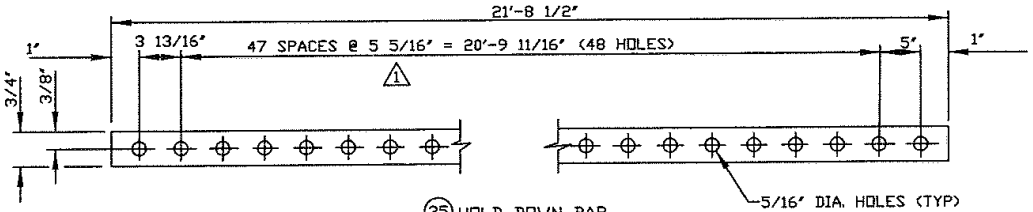
Energy Exchanger Co.

DWG. NO. X-7931-J3

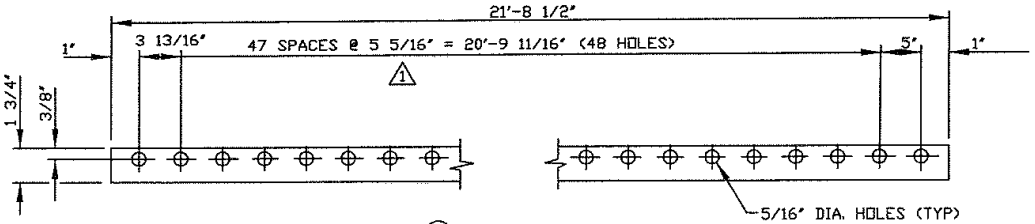
REV 1



(34) LONG. BAFFLE
(ONE REQ'D. @ 1/4" THK.)

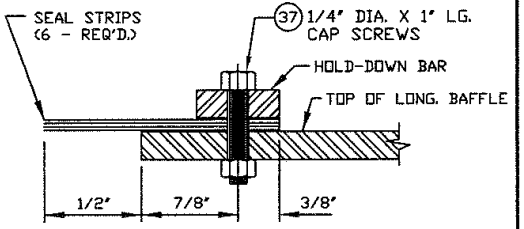


(35) HOLD-DOWN BAR
(TWO REQ'D. @ 1/4" THK.)



(36) SEAL STRIPS
(TWELVE REQ'D. @ 0.004" THK.)

CERTIFIED AS-BUILT



NOTE:
SEAL STRIPS, BOLTS AND HOLD DOWN BARS SHALL BE ASSEMBLED TO LONG. BAFFLE AFTER BUNDLE IS TUBED.

ASSEMBLY DETAIL

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17497-0001 REQ No.: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO:	HX0040

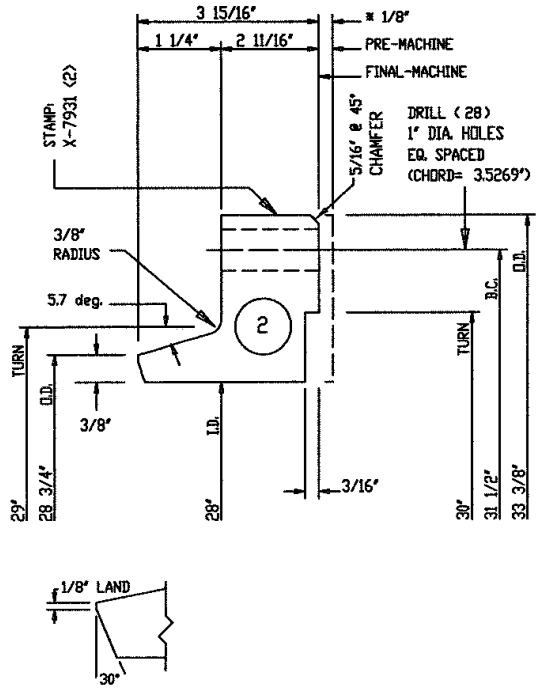
NO.	DATE	REVISIONS
1	5/10/11	REV. PER CUSTOMER MD/SG

LONG BAFFLE DETAILS

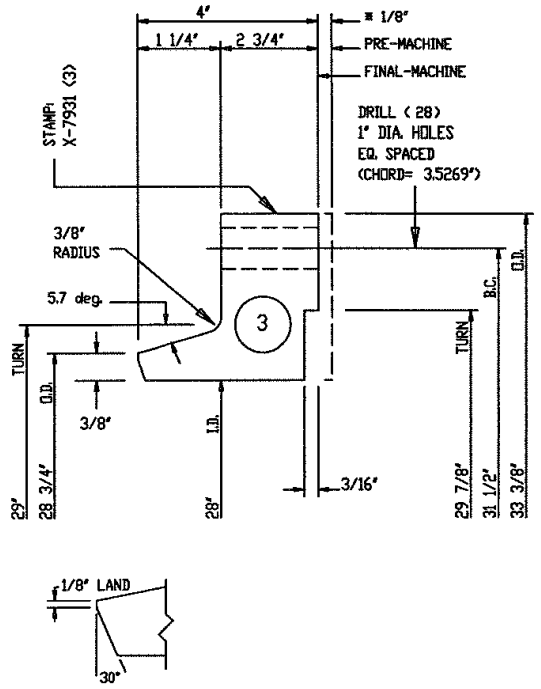
DWN. BY: D.MORRISON
DATE: 3-16-11
CKD. BY: SM

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

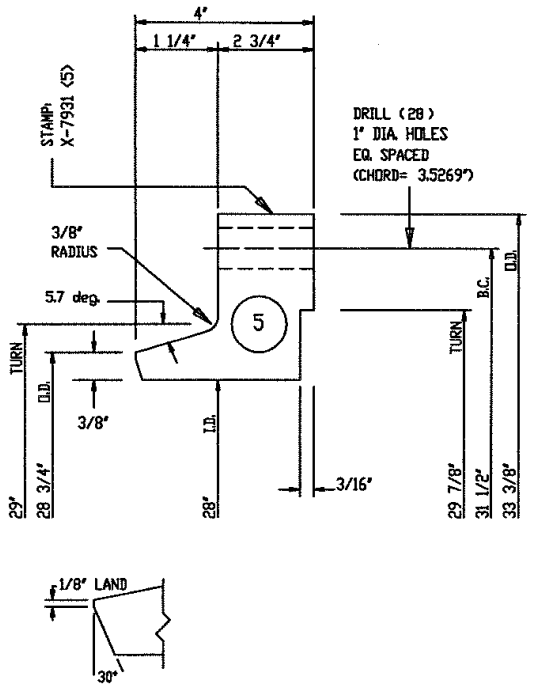
DWG. NO.: X-7931-J4
REV: 1



#2 GIRTH FLANGE (ONE) REQ'D.



#3 GIRTH FLANGE (ONE) REQ'D.



CERTIFIED AS-BUILT

#5 GIRTH FLANGE (ONE) REQ'D.

NOTES:
1) SEE DWG. X-7931-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.

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17497-0001 REQ No.: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO:	HX0040

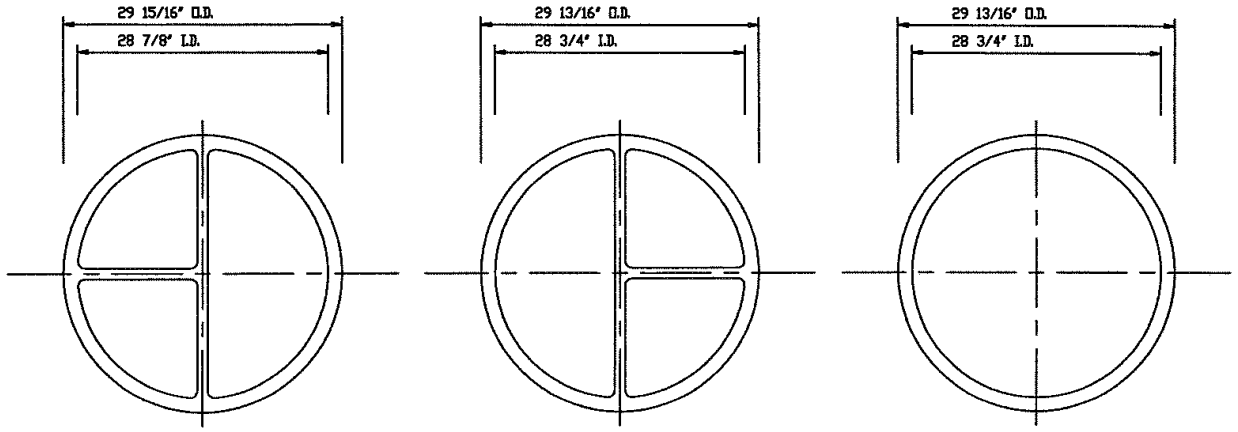
NO.	DATE	REVISIONS

GIRTH FLANGES

DWN. BY	D.MORRISON
DATE	3-16-11
CKD. BY	

Energy Exchanger Co.

DWG. NO.	REV
X-7931-K	0



(1)-REQUIRED.
CHANNEL COVER GASKET
1/8" THK SOFT IRON DBL JKTD
FLEXIBLE GRAPHITE FILLED
RIB WIDTH TO BE 7/16" WIDE.

(1)-REQUIRED.
CHANNEL GASKET
1/8" THK SOFT IRON DBL JKTD
FLEXIBLE GRAPHITE FILLED
RIB WIDTH TO BE 7/16" WIDE.

(1)-REQUIRED.
SHELL GASKET
1/8" THK SOFT IRON DBL JKTD
FLEXIBLE GRAPHITE FILLED

CERTIFIED AS-BUILT

NOTES:

1) QUANTITIES SHOWN FOR ONE SET
(2)-SETS REQUIRED TOTAL.
ONE SET OF GASKETS TO BE USED IN EXCH. AND
(1) SET TO BE BOXED, MARKED WITH
P.O. & ITEM NO. & SHIPPED WITH EXCHANGER.
2) ALL 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.: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO:	HX0040

NO.	DATE	REVISIONS
1		
2		
3		
4		
5		
6		

GASKET DETAILS

DWN. BY: D.MORRISON
DATE: 3-16-11
CKD. BY:

Energy Exchanger Co.

DWG. NO.: X-7931-0
REV: 0

■ SHOP TO ASSIGN AT COMPLETION OF FABRICATION

NB ■

CERTIFIED BY

Energy Exchanger Company

TULSA, OKLAHOMA

U

W

RT-3

HT-T

MAWP SHELL	158	P.S.I. @	500	°F	210	TEST P.S.I.G.
MAWEP	15	P.S.I. @	500	°F		
MAWP TUBE	185	P.S.I. @	145	°F	245	TEST P.S.I.G.
MAWEP	---	P.S.I. @	---	°F		
MIN. DESIGN METAL TEMP. SHELL	10	°F @	158	P.S.I.G.		
MIN. DESIGN METAL TEMP. TUBE	10	°F @	185	P.S.I.G.		

SERIAL NO. X-7931 YEAR BUILT ■

P.O. NO. 17497-0001

SERVICE LP VENT GAS COMPRESSOR PRE COOLER

ITEM HX0040 SIZE 28-288 TYPE AGU

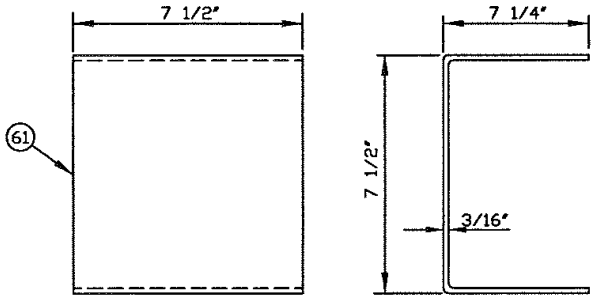
DESIGN PRESSURE: SHELL = 15 PSI, TUBE = 150 PSI

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.: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO:	HX0040

NO.	DATE	REVISIONS

NAME PLATE DETAILS

DWN. BY D.MORRISON

DATE 3-16-11

CKD. BY

Energy Exchanger Co.

DWG. NO. X-7931-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 GUAGE. PASS PL. GROOVES AND PASS PLATE EDGES SHALL BE MEASURED WITH A STRAIGHT EDGE.
6. FLATNESS OF TUBESHEET GASKET-CONTACT SURFACES SHALL BE MEASURED AFTER THE TUBE-TO-TUBESHEET JOINTS HAVE BEEN COMPLETED.
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
13. WELD JOINT SURFACES AND A MINIMUM OF 1" OF THE INTERNAL AND EXTERNAL SURFACES OF THE ADJACENT BASE METAL SHALL BE CLEAN AND FREE FROM PAINT, OIL, DIRT, SCALE, OXIDES, AND OTHER FORIEGN MATERIAL DETRIMENTAL TO THE INTEGRITY OF THE WELD.

M.T. REQUIREMENTS

△1

△1 2. MT ALL LIFTING LUG WELDS

△1 4. 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 400 deg.F PER HOUR.
B) HOLD AT 1150 deg.F ±25 deg. F. FOR 1.00 -HOUR (MIN).
C) COOL FROM 1150 deg.F TO 800 deg.F AT 500 deg.F PER HOUR.
D) FURTHER COOLING MAY BE IN STILL AIR.

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

R.T. REQUIREMENTS

1. TUBESIDE & SHELLSIDE: SPOT RADIOGRAPHED.
   AS A MINIMUM, SPOT RADIOGRAPH SHALL BE AS FOLLOWS:
   A) ONE SPOT AT EACH CATEGORY A AND B WELDED JOINT. (NOZZLE WELDS EXEMPT)
   B) AT EACH START AND STOP OF WELDS MADE BY AUTOMATIC SUBMERGED-ARC PROCESS.
   C) SPOTS SHALL BE AT LEAST 10" LG. OR FULL LENGTH IF WELD IS LESS THAN 10".
   D) WELD POROSITY LIMITS FOR SPOT RADIOGRAPHS SHALL BE SAME AS LIMITS FOR FULL RADIOGRAPHED JOINTS.
   E) RT EACH WELD PROCEDURE, WELDER/OPERATOR, & SHIFT.

2. RT FILM SHALL BE FINE GRAIN, HD, HIGH CONTRAST FILM (KODAK TYPE AA OR EQUAL) FILM DENSITY OF 2.0-3.5 DETERMINED BY SPECIMEN OR DENSITOMETER.

HARDNESS REQUIREMENTS

1. WELD HARDNESS TESTING, SHALL BE IN ACCORDANCE WITH THE FOLLOWING:
   A) THE WELD METAL & HAZ OF PRESSURE-RETAINING WELDS IN COMPONENTS
   B) BRINELL HARDNESS LIMITS SHALL BE 200 MAX.
   C) BRINELL HARDNESS LIMITS SHALL BE 225 MAX. IN WELD OR HAZ OF STRENGTH WELDED TUBE-TO-TUBESHEET JOINTS. THESE WELDS ARE MACRO HARDNESS TESTED ON THE TUBE MOCK-UP MOCK-UP AND RESULTS INCLUDED WITH THE MOCK-UP.
   D) HARDNESS SHALL BE DETERMINED USING A 10mm DIA. BALL UNLESS OTHERWISE SPECIFIED.
   E) ONE READING IN THE WELD METAL OF EACH LONG. SEAM AND ONE READING IN EACH HEAT AFFECTED ZONE.
   F) ONE READING IN THE WELD METAL OF EACH CIRC. SEAM AND ONE READING IN EACH HEAT AFFECTED ZONE.
   G) ONE READING IN THE WELD METAL OF NOZZLE TO EXCHANGER WELDS AND ONE READING IN EACH HEAT AFFECTED ZONE IN 50% OF THE NOZZLES.
   H) TESTING SHALL BE DONE ON ACCESSIBLE INSIDE SURFACES.

CERTIFIED AS-BUILT

HYDROTESTING REQUIREMENTS

1. HOLD FOR AT LEAST ONE HOUR, A HYDROTEST CHART IS REQ'D.
2. MINIMUM TEST WATER TEMP. = 40 deg.F.
3. PAINT OR OTHER COATINGS SHALL NOT BE APPLIED OVER WELDS BEFORE FINAL HYDROTEST.
4. LEAK TEST WELD PADS WITH 15 PSIG 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 & FULL DIA. BOLTS. PROVIDE A 1/4" DRAIN HOLE IN BOTTOM COVERS. △2
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-L-G (DRY) WITH A 3" CIRCLE ON HORZ. & VERTICLE CENTERLINES.
7. △2 NITROGEN PURGE REQUIRED FOR SHIPPING AND STORAGE.

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO:	17497-0001 REQ No.: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO:	HX0040

NO.	DATE	REVISIONS
△		
△		
△		
△		
△2	10-6-11	ADD NP PER CUST. WE
△1	8/5/11	REVISED PER EEC MD/SG

JOB NOTES

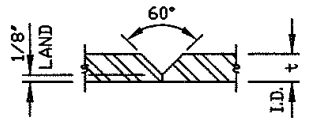
DWN. BY: D.MORRISON
DATE: 3/16/11
CKD. BY: SM

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

DWG. NO.: X-7931-R
REV: 2

CERTIFIED AS-BUILT

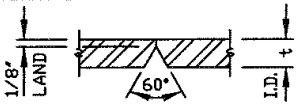
t=LESS THAN 7/16"
LOCATE LONG SEAM 15° ABOVE CL
UNLESS OTHERWISE SPECIFIED.
ALL SEAMS BACK GOUGED & BACK WELDED



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

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

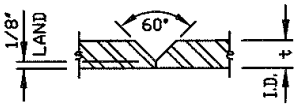
t=7/16" TO 5/8"
LOCATE LONG SEAM 15° ABOVE CL
UNLESS OTHERWISE SPECIFIED.
ALL SEAMS BACK GOUGED & BACK WELDED



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

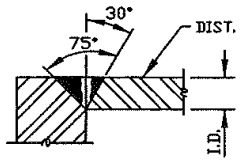
LONG OR CIRC WELD BEVEL
(CYL TO FLG, OR CYL)

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



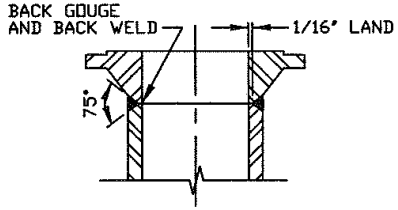
CHANNEL HEAD WELD PROC: -----
SHELL HEAD WELD PROC: M-6

CIRC WELD BEVEL
(CYL TO HEAD)



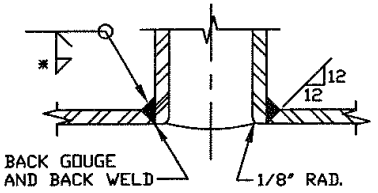
SHELL WELD PROC: A-1, M-6

CIRC WELD BEVEL
(DISTRIBUTOR CYL TO CLOSURE RING)



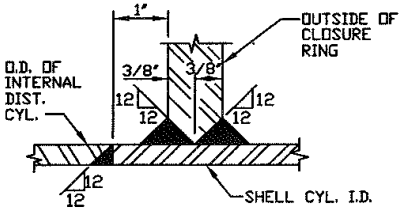
CHANNEL WELD PROC: M-5-H
SHELL WELD PROC: A-1

WELD-NECK FLANGE INSTALLATION



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

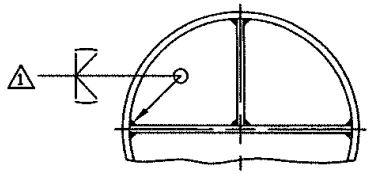
NOZZLE INSTALLATION WITHOUT PAD



SHELL WELD PROC: A-1, M-6

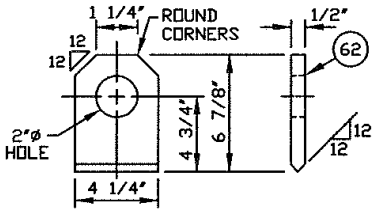
CIRC WELD BEVEL
(SHELL CYL TO CLOSURE RING & INTERNAL CYL.)

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: -----



WELD PROCEDURE: M-1-H

PASS PLATE WELDS



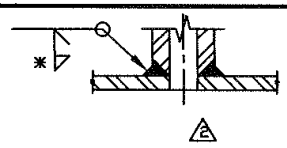
FULL PEN WELD & 1/4" FILLET
WELD PROCEDURE: M-1, M-1-H

LIFTING LUG DETAIL

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

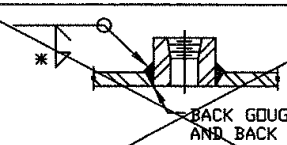
1/4" MINIMUM FILLET WELDS FOR ALL NON PRESSURE ATTACHMENTS UNLESS NOTED OTHERWISE

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



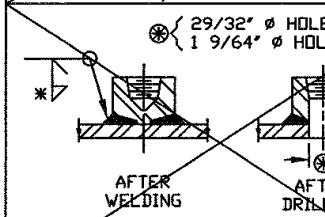
CHANNEL WELD PROC: M-5-H
SHELL WELD PROC: -----

AUXILLARY NOZZLE INSTALLATION
(TO CHANNEL COVER)



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

COUPLING INSTALLATION (WELD-IN)
(TO PIPE, CYLINDER OR HEAD)



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

COUPLING INSTALLATION (DRILLED)

CUSTOMER:	MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES	
P.O. NO:	17497-0001	REQ No.: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER	
ITEM NO:	HX0040	

NO.	DATE	REVISIONS
3		
2		
1		
0		
2	8/5/11	ADD AUXILIARY DETAIL MD/SG
1	5/10/11	REV. PER CUSTOMER MD/SG

WELD & BEVEL DETAILS

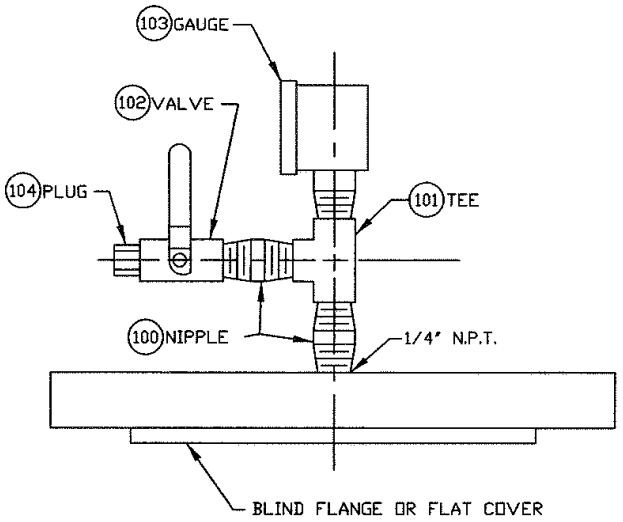
DWN. BY: D.MORRISON
DATE: 3/19/11
CKD. BY: SM

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

DWG. NO.: X-7931-S
REV: 2

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.: MC206
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO:	HX0040

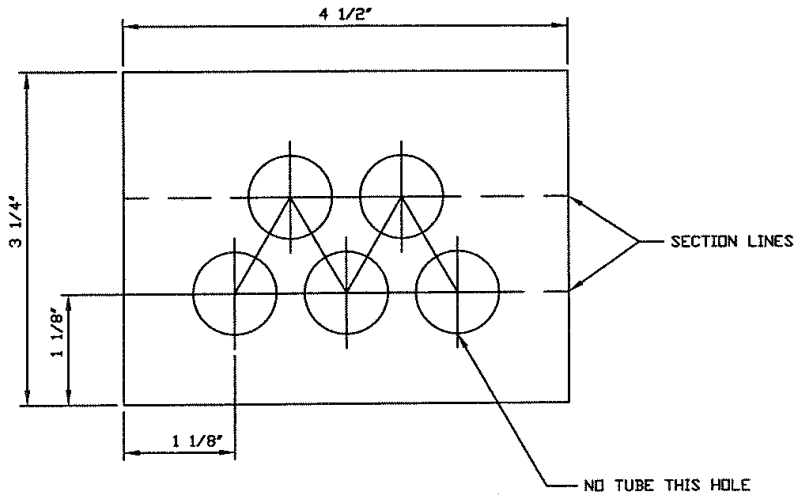
NO.	DATE	REVISIONS
1		
2		
3		
4		
5		
6		

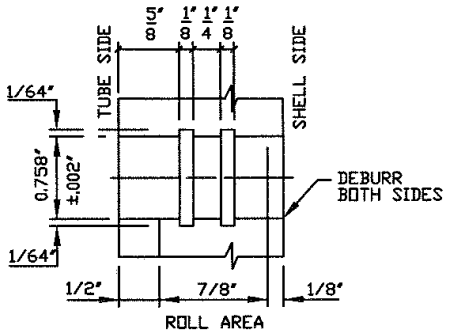
NITROGEN PURGE

DWN. BY: W. ECHOLS
DATE: 10-6-11
CKD. BY: DM

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

DWG. NO. X-7931-X
REV 0





TUBE HOLE GROOVING DETAIL

NOTES:

1.) DRILL & REAM (5) 0.758"ø (±.002") HOLES ON 1 1/8" TRIANGLE PITCH.
2.) SEE TUBE GROOVING DETAIL.
3.) (WELD PROCEDURE PER ASME SECTION IX QW-193)
SEAL WELD TUBE TO TUBESHEET. REMOVE OIL & GREASE OR OTHER FOREIGN MATTER FROM TUBESHEET, TUBEHOLES & TUBE ENDS PRIOR TO WELDING OF TUBES. PREHEAT TO 200°F. TIG WITH NO FILLER METAL. WELD EACH TUBE INDIVIDUALLY.
W.P.= SLW-1
DYE CHECK TUBE TO TUBESHEET WELDS BEFORE & AFTER TUBE ROLLING.
4.) CROSS SECTION & ETCH ALL TUBES.
5.) TRAVERSE HARDNESS TEST REQ'D ON THE WELD, TUBE, TUBESHEET & HAZ
MAX HARDNESS OF 248 VICKERS 10kg

CERTIFIED AS-BUILT

ITEM	DESCRIPTION	MATERIAL	QTY
TUBE	3/4" OD x 0.083" THK (MIN) x 6' LG	SA-214	4
PLATE	3 1/4" x 1 1/2" THK x 4 1/2" LG	SA-516-70N	1

NO.	DATE	REVISIONS
1	3-10-11	REV'D PER CUST. DN/SG

CUSTOMER: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O. NO: 17497-0001 REQ No: MC206
SERVICE: LP VENT GAS COMPRESSOR PRECOOLER
ITEM NO: HX0040

MOCK-UP DETAIL

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

Energy Exchanger Co.
3944 N. Garnett Rd. • Tulsa, Okla. 74116

DWG. NO. X-7931-MU
REV 1

BILL OF MATERIAL

PART NO	ONE REQ'D., DESCRIPTION OF ONE	MATERIAL SPEC.	QTY ONE	TOT QTY	REV	NOTE	PO NO	PROMISED	
21	TUBES 3/4" O.D.X 0.083" THK (MIN) PER BEND SCHEDULE	SA-214	125	125		1			*
	FORGED RING MATERIAL								
2	FLG 33 3/8" O.D.X 28" I.D.X 3 15/16" THK	SA-266-2or4	1	1					*
3	FLG 33 3/8" O.D.X 28" I.D.X 4" THK	SA-266-2or4	1	1					*
5	FLG 33 3/8" O.D.X 28" I.D.X 4" THK	SA-266-2or4	1	1					*
17	CLOSURE RINGS: 35 3/4" O.D. X 28 7/8" I.D. X 3/4" THK.	SA-516-70	2	2					*
	TUBESHEETS & COVERS								
4	TUBESHEET 29 3/4" O.D.X 3" THK	SA-516-70N	1	1					*
1	COVER 33 3/8" O.D.X 2 3/8" THK	SA-516-70N	1	1					*
	BAFFLES								
22	BAFFLES & SUPPORT PLATES 27 13/16" O.D.X 3/8" THK	SA-36	18	18					*
	HEADS								
18	ELLIP HD. 28" I.D.X 5/16" THK(min) W/2" SF	SA-516-70	1	1					*
	CYLINDERS								
12	R&W CYL 28" I.D.X 3/8" THK X 9 5/8" LG.	SA-516-70	1	1					*
	(89 3/8" WRAP) X 3/8" THK X 9 7/8" LG.								
15	R&W CYL 28" I.D.X 3/8" THK X 23'-10 5/8" LG.	SA-516-70	1	1					*
	(89 3/8" WRAP) 2-CYL 8'-0" 1-CYL 7'-11 1/8"								
16	R&W CYL 34 3/4" I.D.X 1/2" THK X 4'-2" LG.	SA-516-70	1	1					*
	(110 15/16" WRAP) X 1/2" THK X 4'-2 1/4" LG.								
99	TUBE TO TUBESHEET MOCK-UP PER DWG. X-7931-MU			1	1				*

NOTES: NO MATERIAL OF ORIGIN REQUIREMENTS WERE PROVIDED.
1) TUBES SHALL BE EDDY CURRENT TESTED PER SA-450.
TESTING PERFORMED AFTER FINAL HEAT TREATMENT PRIOR TO BENDING.

* DENOTES PRELIMINARY ORDER

CERTIFIED AS-BUILT

REQ. No.: MC206
SERVICE: LP VENT GAS COMPRESSOR PRECOOLER

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

CUST: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O.: 17497-0001 ITEM: HX0040

PB/M	DR: DN	CK: MD	DATE: 1/10/11	DWG. NO.	REV
FB/M	DR: DM	CK: SM	DATE: 3-16-11	X-7931-1BM	0

BILL OF MATERIAL

1

PART NO	ONE REQ'D, DESCRIPTION OF ONE	MATERIAL SPEC.	QTY ONE	TOT QTY	REV	NOTE	PO NO	PROMISED	
	ASME FLANGES								
71	ASME 14" - 150 # RF WN W/ (SchXH BORE)	SA-105	1	1					*
72	ASME 14" - 150 # RF WN W/ (SchXH BORE)	SA-105	1	1					*
81	ASME 3" - 150 # FF WN W/ (Sch160 BORE)	SA-105	1	1					*
82	ASME 3" - 150 # FF WN W/ (Sch160 BORE)	SA-105	1	1					*
71A	SMLS.PIPE 14" ODX(0.5000" SchXH)X 5 3/4" LG.	SA-106B	1	1					*
72A	SMLS.PIPE 14" ODX(0.5000" SchXH)X 5 3/4" LG.	SA-106B	1	1					*
81A	SMLS.PIPE 3 1/2" ODX(0.438" Sch160)X 5 1/2" LG.	SA-106B	1	1					*
82A	SMLS.PIPE 3 1/2" ODX(0.438" Sch160)X 5 1/2" LG.	SA-106B	1	1					*
83	ASME 1" - 150 # RF LWN x 9" LG. w/ (1.00" BORE)	SA-105	2	2	1				
83D	ASME 1" - 150 # RF BLIND FLANGE	SA-105	2	2	1				

SEE DWG X-7931-1BM FOR MATERIAL NOTES

* DENOTES PRELIMINARY ORDER

CERTIFIED AS-BUILT

REQ. No: MC206
SERVICE: LP VENT GAS COMPRESSOR PRECOOLER

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

CUST: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES

P.O.: 17497-0001 ITEM: HX0040

NO.	DATE	DESCRIPTION					DWG. NO.	REV
1	8/5/11	ADD P/N 83 & 83D MD/SG	PB/M	DR: DN	CK: MD	DATE: 1/10/11	X-7931-2BM	1
			FB/M	DR: DM	CK: SM	DATE: 3-16-11		

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-7931-D		2	2					
41	7/8" ROUND X 9-THREAD STUDS X 7" LG. 1&2	SA-193B7	28	28					
42	7/8" ROUND X 9-THREAD STUDS X 10 1/8" LG. 3&5	SA-193B7	28	28					
43	7/8" HEAVY HEX NUTS 9-THREAD	SA-194-2H	112	112					
44	1/2" ROUND x 13-THREAD STUDS x 2 1/2" LG. (1"-150# RF)	SA-193-B7	8	8	1				
45	1/2" ROUND x 13-THREAD HEAVY HEX NUTS	SA-194-2H	16	16	1				
	.175" THK 304 STN. STL. SPRL. WND. FLEXIBLE GRAPHITE FILLED GSK'T.								
46	WITH 1/8" THK. C-STL. OUTER RING FOR: (1"-150# RF)		2	2	1				
	MISC. MATERIAL								
60	STD. NAME PLATE	STN.STL.	1	1					
61	STD. NAME PLATE BRK'T.	SA-516-70	1	1					
62	LIFTING LUGS 4 1/4" X 1/2" THK X 6 7/8" LG	SA-516-70	5	5					
23	FT. 1/2" O.D. TIE RODS	C'STL	286	286					
23A	FT. 3/4" O.D. SPACER TUBING	SA-214	286	286					
23B	1/2" TIE ROD HEX NUTS	C'STL	24	24					
22D	3/4" O.D. DUMMY TUBES X 21'-5 3/8" LG.	SA-214	2	2					
24	PULLBOLT PLUGS 3/4" DIA (10 THD)	C'STL	4	4					
34	LONG BAFFLE 27 3/4" X 1/4" THK X 21'-8 1/2" LG	SA-36	1	1					
35	HOLD DOWN BARS 3/4" X 1/4" THK X 21'-8 1/2" LG	SA-36	2	2					
36	SEAL STRIPS 1 3/4" X 0.004" THK X 21'-8 1/2" LG	304 STN STL	12	12					
37	CAP SCREWS 1/4" HEX HEAD BOLTS X 1" LG WITH (1) HEX NUT EACH	STN STL	96	96					
50	PASS PLATES 13 11/16" X 1/2" THK X 17 13/16" LG.	SA-516-70	1	1					
51	PASS PLATES 27 7/8" X 1/2" THK X 17 13/16" LG.	SA-516-70	1	1					
63	DIVIDER PLATE 3 1/4" X 3/8" THK X 49 7/8" LG	SA-516-70	2	2					
70	NOZZLE SHIPPING COVERS PER SKETCH								
	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-60LM)(0-60 PSIG)		2	2	2				
104	1/4" PIPE PLUG	C. STL.	2	2	2				
	SUPPORT MATERIAL								
120	PLATE 10" X 3/8" THK X 38 1/4" LG.	SA-516-70	2	2					
121	PLATE 27" X 1/2" THK X 15 1/4" LG.	SA-516-70	2	2					
122	PLATE 6" X 1/2" THK X 27" LG.	SA-516-70	2	2					
123	PLATE 5 1/2" X 1/2" THK X 15 1/4" LG.	SA-516-70	4	4					
125	5/8" DIA X 11 THD HEX HEAD BOLT X 2" LG	C'STL	1	1					

* DENOTES PRELIMINARY ORDER

CERTIFIED AS-BUILT

REQ. No.: MC206
SERVICE: LP VENT GAS COMPRESSOR PRECOOLER

NO.	DATE	DESCRIPTION
2	10-6-11	ADD NITROGEN PURGE PER CUST. WE/MR
1	8/5/11	ADD HARDWARE FOR 1"-150# MD/SG

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

CUST: MISSISSIPPI POWER CO. c/o SOUTHERN COMPANY SERVICES
P.O.: 17497-0001 ITEM: HX0040

PB/M	DR: ----	CK: ----	DATE: ----	DWG. NO.	REV
FB/M	DR: DM	CK: SM	DATE: 3-16-11	X-7931-3BM	2

X-7931 PACKING LIST

LINE NO	SPARE PARTS LIST	MATERIAL SPEC.	QTY ONE	TOT QTY	REV	NOTE	PO NO	PROMISED	
SP1	SPARE GASKETS PER DWG. X-7931-0		1 SET(S)	1 SET(S)					
SP2									
SP3									
SP4									
SP5									
SP6									
SP7									
SP8									
SP9									
SP10									

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

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

* DENOTES PRELIMINARY ORDER

DO NOT ORDER FROM PACKING LIST

CERTIFIED AS-BUILT

REQ. No.: MC206
SERVICE: LP VENT GAS COMPRESSOR PRECOOLER

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

CUST: MISSISSIPPI POWER / SOUTHERN COMPANY SERVICES
P.O.: 17497-0001 ITEM: HX0040

PB/M	DR: -----	CK: ----	DATE: -----	DWG. NO.	REV
FB/M	DR: DM	CK: [signature]	DATE: 3/16/11	X-7931-PL	0

Energy Exchanger Company

Mike Darnell 10/29/11
CERTIFIED AS-BUILT

DATE: 1/10/2011
PAGE: 1 OF 29 ⚠1

MECHANICAL CALCULATIONS

CUSTOMER:	MISSISSIPPI POWER c/o SOUTHERN COMPANY SERVICES
DESTINATION:	KEMPER COUNTY, MISSISSIPPI
P.O. No.:	17497-0001 ⚠1
ITEM No.:	HX0040
E.E.C. SERIAL No.:	X-7931
SERVICE:	LP VENT GAS COMPRESSOR PRECOOLER
REQ No.:	MC206 ⚠1

DESIGN DATA		
	SHELL SIDE	**TUBE SIDE**
DESIGN PRESSURE	15 PSIG /FV	150 PSIG
DESIGN TEMP.	500°F	145°F
M.D.M.T.	10 °F	10 °F
CORR. ALLOW.	1/8"	1/8"
NO. PASSES	SPLIT	FOUR
M.A.W.P. (H&C)	158 PSIG	185 PSIG
LIMITED BY	GIRTH FLANGE	CHANNEL COVER

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

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

REVISION LOG

DATE	PAGE	REV.	DESCRIPTION
3/9/2011	AS NOTED	1	ADDED PO# & PER CUST. COMMENT
5/10/2011	29	2	ANCHOR BOLT SIZE PER CUST. COMMENT

W.O. No.: X-7931

SHELL SIDE

NOM. SIZE	PRESS.	TEMP.	C.A.	RT	H.T.	TEMA
28.000"	15.0psig	500deg.F	0.1250"	SPOT	0deg.F	R

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

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

SHELL CYL

MATERIAL: SA-516-70 PRESS = 15.0psig TEMP = 500deg.F

I.D.	NOM. THK.	RW=0/PIPE=1	CORR.ALLOW	EFFICIENCY
28.0000"	0.3750"	0	0.1250"	0.85

ATM.STRS	DES.STRS	STRS/STRS	MAWP N-C	MAWP CORR.
20000.0psi	20000.0psi	1.000	448.155psig	297.723psig

P*(R+CA) / S*E-(.6*P) = 0.01247" + CORR. ALLOW. = 0.13747" + MTOL. = 0.13747"

****

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 = 15.0psig TEMP = 500deg.F

I.D.	(min)THK.	CORR.ALLOW	EFFICIENCY
28.0000"	0.3125"	0.1250"	0.85

ATM.STRS	DES.STRS	STRS/STRS	MAWP N-C	MAWP CORR.
20000.0psi	20000.0psi	1.000	378.619psig	225.365psig

P*(R+CA) / S*E-(.1*P) = 0.01246" + CORR. ALLOW. = 0.13746" + MTOL. = 0.13746" + 0.0000

****

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

Ext Press Chart No.=	1
Ext Press Chart....=	CS-2
OD.....=	28.75000
T.....=	0.25000
L.....=	130.00000
Temp.....=	500.00000
Stress from MT.....=	20000.00000
Yield from MT.....=	31000.00000
2 x Stress.....=	40000.00000
B1 from Chart@Right=	0.00000
Yield= 2 x B1 x 0.9=	0.00000
S.....=	0.00000
DO/T.....=	115.00000
L/DO.....=	4.52174
A.....=	0.00022
B.....=	2889.82910
PA1.....=	0.00000
PA2.....=	0.00000
PA.....=	33.50526

Ellip. Head External pressure calculations:

Ext Press Chart No.=	1
Ext Press Chart....=	CS-2
OD.....=	28.75000
RO.....=	25.87500
T.....=	0.18750
Temp.....=	500.00000
Stress from MT.....=	20000.00000
Yield from MT.....=	31000.00000
A.....=	0.00091
B.....=	9670.97754
PA1.....=	70.07954
PA2.....=	158.06487
PA.....=	70.07954

For vapor belt Cyl on following page:

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

Ext Press Chart No.=	1
Ext Press Chart....=	CS-2
OD.....=	35.75000
T.....=	0.37500
L.....=	60.00000
Temp.....=	500.00000
Stress from MT.....=	20000.00000
Yield from MT.....=	31000.00000
2 x Stress.....=	40000.00000
B1 from Chart@Right=	0.00000

---continued--- →

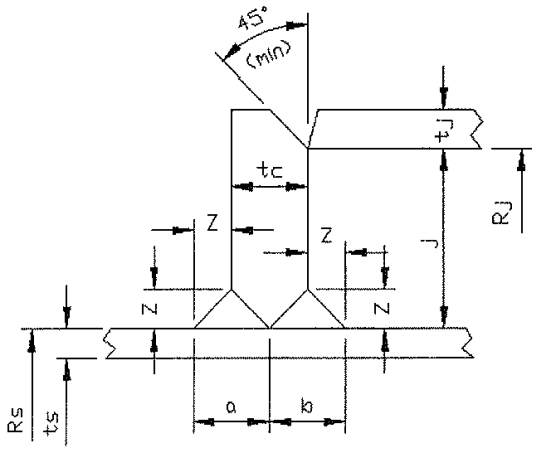
Yield= 2 x B1 x 0.9=	0.00000
S.....=	0.00000
DO/T.....=	95.33334
L/DO.....=	1.67832
A.....=	0.00084
B.....=	9476.95312
PA1.....=	0.00000
PA2.....=	0.00000
PA.....=	132.54480

Energy Exchanger Company

Customer :	Mississippi Power / Southern Company Services	Item No.	HX0040	W.O. :	X-7931
Subject :	Annular Distributor Calculations	Date	3/10/2011	By :	DN/MD

Jacket Cylinder - Per UG-27 of ASME Sect. VIII, Div. 1

Material :	SA-516-70	Jacket I.D. (in.):	34 3/4
Allowable Stress, Sa (psi):	20000	Rj (in.):	17 1/2
Allowable Stress, Sd (psi):	20000	Required Jacket Thickness, trj (in.):	0.0154
Corrosion Allowance (in.):	0.125	Thickness Used, tj (in.):	1/2
Design Pressure (psi):	15		
Joint Efficiency:	0.85		



Closure Ring - Per Appendix 9 of ASME Sect. VIII, Div. 1

Material :	SA-516-70
Allowable Stress,Sa (psi):	20000
Allowable Stress, Sd (psi):	20000
Corrosion Allowance (in.):	0.125
Joint Efficiency:	1
Shell Outside Radius, Rs (in.):	14 3/8
Jacket Space, j (in.):	3 1/4

(CORRODED) ⚠

Required Closure Ring Thickness, trc (in.)

Greater of (in.)	0.1559
or (in.)	0.1879
Thickness Used, tc (in.):	3/4

Welds Attaching Closure Ring to Shell - Per Appendix 9 of ASME Sect. VIII, Div. 1

ts (in.) = 3/8

Y = a + b; but not less than the smaller of

1 1/2 x tc	0.9375 in.
or	
1 1/2 x ts	0.5625 in.

Z = 3/8" (min)

a = b = 5/8 in.

Welds Attaching Closure Ring to Jacket Cylinder - Per Appendix 9 of ASME Sect. VIII, Div. 1

Weld Detail shall be per UW-13.2 (c).

FRONT CHAN.

NOM. SIZE	PRESS.	TEMP.	C.A.	RT	H.T.	TEMA
28.000"	150.0psig	145deg.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-516-70		PRESS = 150.0psig	TEMP = 145deg.F	
I.D.	NOM. THK.	RW=0/PIPE=1	CORR.ALLOW	EFFICIENCY
28.0000"	0.3750"	0	0.1250"	0.85
ATM.STRS	DES.STRS	STRS/STRS	MAWP N-C	MAWP CORR.
20000.0psi	20000.0psi	1.000	448.155psig	297.723psig

$$\frac{P*(R+CA)}{S*E-(.6*P)} = 0.12530" + \text{CORR. ALLOW.} = 0.25030" + \text{MTOL.} = 0.25030"$$

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NOZZLE REINFORCEMENT CALCULATIONS/ ASME SEC.VIII DIV.I UG-37 & UG-16
NOZ NO= S1 & S2     14.00"    150 LB RF  WN
[INLET/OUTLET] SHELL SIDE
PRESSURE =   15.0psig   TEMP =  500.0deg.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.     =  34.75000"            I.D.     =  13.00000"
O.D.     =  35.75000"            O.D.     =  14.00000"
THK.     =   0.50000"            THK.   XH=   0.50000"
T        =   0.37500"            TN       =   0.37500"
TR       =   0.01313"            TRN      =   0.00614"
ET       =   0.36187"            ETN      =   0.36886"

MIN STD. WT. PIPE+C.A.=  0.45312"   TR+C.A.=  0.13813"
LIMITS=  26.50000"
fr1= 0.8550 fr2= 0.8550 fr3= 0.0000 fr4= 0.0000     F=   1.00000
Min weld sizes:NS=  0.3536" NP=  0.0000" PS=  0.0000" IF=  0.0000"

AREA REQD.              A =   0.17541in^2
EXCESS IN CYL.          A1=   4.75541in^2
EXCESS IN NOZ.(OUTSIDE) A2=   0.59133in^2  H =   0.93750"
AREA OF FILLETS           =   0.12023in^2
AREA AVAILABLE            =   5.46698in^2

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

< AREA REQD-AREA AVAILABLE >  =   -5.29157in^2

MAWP N-C=   321.0psig  LIMITED BY AR
MAWP COR=   235.0psig  LIMITED BY AR
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EXTERNAL PRESSURE:

NOZTYP[ 0.0] X-7931        14.00"- 150# RF  WN   PRESS= -15 TEMP= 500
<<<<<< CYLINDER >>>>  <<<<<< NOZZLE >>>>>>
      SA-516-70             SA-106B
OPER STRS=20000.0000  OPER STRS=17100.0000  Area reqd.     A=  0.9151
ATM STRS =20000.0000  ATM STRS =17100.0000  Excess in cyl A1=  3.1276
C.A.     =   0.12500  C.A.     =   0.12500  Excess in noz A2=  0.5362 H= 0.9375
I.D.     =  34.75000  I.D.     =  13.00000  Excess in noz A3=  0.0000 H= 0.0000
O.D.     =  35.75000  O.D.     =  14.00000  Area fillets    =  0.1202
THK.     =   0.50000  THK.   XH=   0.50000  Area avail.    =  3.7841
T        =   0.37500  TN       =   0.37500  Noz neck weld  =  0.3750 A= 0.1202
TR       =   0.13700  TRN      =   0.04050  Pad weld       =  0.0000 A= 0.0000
ET       =   0.23800  ETN      =   0.33450  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.=0.13813   CHORD=  0.0000
LIMITS=  26.50000    fr1= 0.8550 fr2= 0.8550 fr3= 0.0000 fr4= 0.0000
Min weld sizes: NS= 0.3536 NP= 0.0000 PS= 0.0000 IF= 0.0000
Area reqd-Area avail =<< -2.86902>>
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```
NOZZLE REINFORCEMENT CALCULATIONS/ ASME SEC.VIII DIV.I UG-37 & UG-16
NOZ NO= T1 & T2      3.00"    150 LB FF  WN
[INLET/OUTLET] FRONT CHANNEL SIDE
PRESSURE =  150.0psig   TEMP =  145.0deg.F
OFFSET VERTICAL NOZZLE: OFFSET =   2.5000"

-------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.     =  28.00000"            I.D.     =   2.62400"
O.D.     =  28.75000"            O.D.     =   3.50000"
THK.     =   0.37500"            THK.sc160=   0.43800"
T        =   0.25000"            TN       =   0.31300"
TR       =   0.10642"            TRN      =   0.01530"
ET       =   0.14358"            ETN      =   0.29770"

MIN STD. WT. PIPE+C.A.=  0.31400"   TR+C.A.=  0.23142"
LIMITS=   5.74800"
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 =   0.31550in^2
EXCESS IN CYL.          A1=   0.39963in^2
EXCESS IN NOZ.(OUTSIDE) A2=   0.31817in^2  H =   0.62500"
AREA OF FILLETS           =   0.12023in^2
AREA AVAILABLE            =   0.83803in^2

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

< AREA REQD-AREA AVAILABLE >  =   -0.52253in^2

MAWP COR=   273.0psig  LIMITED BY AR
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ASME SEC.VIII DIV.1 APPENDIX 2 — Front Channel to cover flange

DESIGN CONDITIONS		GASKET and BOLTING CALCULATIONS		TABLE	
Design Pres=	150.0 psig	Eff.Gsk OD=	29.8750"	No.Passes=	4
Neg. Pres=	None	Eff.Gsk ID=	28.8750"	N=	0.500"
Design Temp=	145 deg.F	THK= 0.1250"	col.=2	b=	0.250
Flg Matl=	SA-266-2OR4	Gsk Matl=	SIDJNAF	y=	7600psi
Bolt Matl=	SA-193B7	Gsk Face=	FLAT FACE	w= 0.0000" m=	3.750

Corr Allow=	0.1250"	Wm2=	245289 #	Am =	9.8116in^2
Flange Desn Sfo	20000.0 psi	Hp =	36309 #	Ab =	11.7320in^2
Atm. Sfa	20000.0 psi	H =	101656 #	W =	269294 #
Bolting Desn Sb	25000.0 psi	Wm1=	137966 #	Wm1=	137966 #
Atm. Sa	25000.0 psi	Gasket Width Check		Nmin =	0.2091"

CONDITION	LOAD	x	LEVER ARM =	MOMENT	
	HD =	94019 #	hD= 1.43750"	MD=	135152 in#
Operating	HG =	36309 #	hG= 1.06250"	MG=	38578 in#
	HT =	7637 #	hT= 1.34375"	MT=	10262 in#
				Mo=	183994 in#
Gasket Seating	HG =	269294 #	hG= 1.06250"	mo=	286125 in#

Allow.Stress-STRESS CALCULATIONS-Operating		SHAPE CONSTANTS			
1.5 Sfo Long Hub,SH	13999.6 psi	K =	1.1814	h/ho=	0.4704
Sfo Radial Flg,SR	652.0 psi	T =	1.8464	F =	0.8530
Sfo Tang Flg,ST	8278.4 psi	Z =	6.0538	V =	0.3196
Sfo .5(SH+SR)or.5(SH+ST)	11139.0 psi	Y =	11.7316	f =	1.0000
J(APP.2-14)=	0.6446	U =	12.8918	e =	0.3210in^-1

Allow.Stress-STRESS CALCULATIONS-Gsk.Seating		g1/go= 1.5000 d = 6.700In^3	
1.5 Sfa Long Hub,SH	21770.6 psi	ho =	2.6575"
Sfa Radial Flg,SR	1013.9 psi		
Sfa Tang Flg,ST	12873.6 psi	OTHER STRESS FORMULA FACTORS	
Sfa .5(SH+SR)or.5(SH+ST)	17322.1 psi	t	2.5000"
J(APP.2-14)=	0.9905	Alpha	1.8024
		Beta	2.0699
		Gamma	0.9762
		Delta	2.3321
		Lambda	3.3083
		M	6513 #
		m	10128 #

O.D. =	33.3750"	THK. =	2.6875"		
I.D. =	28.0000"	T-Adder =	0.0000"		
GO =	0.3750"	G1 =	0.5000"		
HUB O.D. =	29.0000"	HUB LEN =	1.2500"		
HUB ANG =	5.7106deg	RIB LENGTH =	49.0875"		
G(MEAN) =	29.3750"	G(CALC) =	29.3750"		
G(MIN.) =	28.7500"	G(MAX.) =	29.5000"		
B.C. =	31.5000"	B.S.C.F. =	1.0000		
No. BOLTS =	28	BOLT DIAMETER =	0.8750"		
R =	1.2500"	E =	0.9375"		
BOLT SPAC =	3.5269"	TORQUE =	183ft#		
MIN. SPAC =	2.0625"	TEMA MAX. SPAC=	5.2794"		
FLG TURN =	0.1875"	FACING =	RECESS		
BPRIME =	0.0000"	BG1 =	0.0000"		
FLG RWT =	289Lbs	FLG FWT =	201Lbs		

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

```
EXCHANGER TYPE....= A G U              MATERIAL..........= SA-516-70N
PRESSURE..........=       150.0 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................=    11.7320 in^2
d.................=     29.3750"       C.................=      0.3000
W.................=      269294 #      Wm1...............=      137966 #
hG (ASME).........=      1.0625"       hG (TEMA).........=      1.0625"
G (TEMA)..........=     29.3750"       E (MOD.) x (10)-6..=        28.9 psi
COVER THK SET HOLD=     [ NO]
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[PER ASME SECT.VIII UG-34 USING Wm1 (OPERATING)]

$$THK = d \sqrt{\frac{C\,P}{S\,E} + \frac{1.9\,Wm1\,hG}{S\,E\,d^3}} = 1.5542"$$

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

$$THK = d \sqrt{\frac{1.9\,W\,hG}{S\,E\,d^3}} = 0.9619"$$

[PER TEMA RCB-9.2 FLAT CHANNEL COVER]
MAXIMUM DEFLECTION = 28.0000" x 0.00125 = 0.0350"
DEFLECTION at 2.1062" THICK = 0.0350"

$$Y = \frac{G}{E\left(\frac{2.188}{\left|0.0435\,G^3\,P + 0.5\,Sb\,Ab\,hG\right|}\right)^3} = 0.0312"$$

[COV THK Min] TEMA Deflection = 2.1062" + 0.1875" = 2.2937"
[COV THK Min] CODE Operating = 1.5542" + 0.1875" = 1.7417"
[COV THK Min] CODE Gasket Seating = 0.9619" + 0.1875" = 1.1494"
ACTUAL COVER THICKNESS USED (SET HOLD[NO])= 2.3750"

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

/// INDIVIDUAL COMPONENTS ///
MAWP CORR. MAIN FLG = 232.0 Limited by: J-Calc. Operating
MAWP CORR. COVER = 185.0

ASME SEC.VIII DIV.1 APPENDIX 2 — Front chan to tubesheet flange

DESIGN CONDITIONS		GASKET and BOLTING CALCULATIONS		TABLE	
Design Pres=	150.0 psig	Eff.Gsk OD=	29.7500"	No.Passes=	4
Neg. Pres=	None	Eff.Gsk ID=	28.7500"	N=	0.500"
Design Temp=	145 deg.F	THK=	0.1250"	col.= 2	b= 0.250
Flg Matl=	SA-266-2or4	Gsk Matl=	SIDJNAF		y= 7600psi
Bolt Matl=	SA-193B7	Gsk Face=	FLAT FACE	w= 0.0000"	m= 3.750

Corr Allow=	0.1250"	Wm2=	244240 #	Am =	9.7696in^2
Flange Desn Sfo	20000.0 psi	Hp =	36154 #	Ab =	11.7320in^2
Atm. Sfa	20000.0 psi	H =	100793 #	W =	268770 #
Bolting Desn Sb	25000.0 psi	Wm1=	136947 #	Wm1=	136947 #
Atm. Sa	25000.0 psi	Gasket Width Check		Nmin =	0.2100"

CONDITION	LOAD	x	LEVER ARM =	MOMENT	
	HD =	94019 #	hD= 1.43750"	MD=	135152 in#
Operating	HG =	36154 #	hG= 1.12500"	MG=	40673 in#
	HT =	6774 #	hT= 1.37500"	MT=	9314 in#
				Mo=	185140 in#
Gasket Seating	HG =	268770 #	hG= 1.12500"	mo=	302366 in#

Allow.Stress-STRESS CALCULATIONS-Operating		SHAPE CONSTANTS			
1.5 Sfo Long Hub,SH	13321.1 psi	K =	1.1814	h/ho=	0.4704
Sfo Radial Flg,SR	598.1 psi	T =	1.8464	F =	0.8530
Sfo Tang Flg,ST	8087.9 psi	Z =	6.0538	V =	0.3196
Sfo .5(SH+SR)or.5(SH+ST)	10704.5 psi	Y =	11.7316	f =	1.0000
J(APP.2-14)=	0.6134	U =	12.8918	e =	0.3210in^-1

Allow.Stress-STRESS CALCULATIONS-Gsk.Seating		g1/go=	1.5000	d =	6.700In^3
1.5 Sfa Long Hub,SH	21755.6 psi	ho =	2.6575"		
Sfa Radial Flg,SR	976.8 psi				
Sfa Tang Flg,ST	13208.9 psi	OTHER STRESS FORMULA FACTORS			
Sfa .5(SH+SR)or.5(SH+ST)	17482.3 psi	t	2.5625"		
J(APP.2-14)=	0.9898	Alpha	1.8225		
		Beta	2.0966		
		Gamma	0.9870		
		Delta	2.5115		
		Lambda	3.4985		
		M	6553 #		
		m	10703 #		

O.D. =	33.3750"	THK. =	2.7500"		
I.D. =	28.0000"	T-Adder =	0.0000"		
GO =	0.3750"	G1 =	0.5000"		
HUB O.D. =	29.0000"	HUB LEN =	1.2500"		
HUB ANG =	5.7106deg	RIB LENGTH =	48.8750"		
G(MEAN) =	29.2500"	G(CALC) =	29.2500"		
G(MIN.) =	28.7500"	G(MAX.) =	29.5000"		
B.C. =	31.5000"	B.S.C.F. =	1.0000		
No. BOLTS =	28	BOLT DIAMETER =	0.8750"		
R =	1.2500"	E =	0.9375"		
BOLT SPAC =	3.5269"	TORQUE =	183ft#		
MIN. SPAC =	2.0625"	TEMA MAX. SPAC=	5.3676"		
FLG TURN =	0.1875"	FACING =	RECESS		
BPRIME =	0.0000"	BG1 =	0.0000"		
FLG RWT =	293Lbs	FLG FWT =	205Lbs		

ASME SEC.VIII DIV.1 APPENDIX 2 — Shell to tubesheet flange

DESIGN CONDITIONS		GASKET and BOLTING CALCULATIONS		TABLE	
Design Pres=	15.0 psig	Eff.Gsk OD=	29.7500"	No.Passes=	1
Neg. Pres=	15.0 psig	Eff.Gsk ID=	28.7500"	N=	0.500"
Design Temp=	500 deg.F	THK= 0.1250"	col.=2	b=	0.250
Flg Matl=SA-266-2or4	Gsk Matl=SIDJNAF			y=	7600psi
Bolt Matl=SA-193B7	Gsk Face=FLAT FACE	w= 0.0000"		m=	3.750

Corr Allow=	0.1250"	Wm2=	244240 #	Am =	9.7696in^2
Flange Desn Sfo	19600.0 psi	Hp =	2584 #	Ab =	11.7320in^2
Atm. Sfa	20000.0 psi	H =	10079 #	W =	268770 #
Bolting Desn Sb	25000.0 psi	Wm1=	136947 #	Wm1=	136947 #
Atm. Sa	25000.0 psi	Gasket Width Check		Nmin =	0.2100"

CONDITION	LOAD	x	LEVER ARM =	MOMENT	
	HD =	9401 #	hD= 1.43750"	MD=	13515 in#
Operating	HG =	126868 #	hG= 1.12500"	MG=	142726 in#
	HT =	677 #	hT= 1.37500"	MT=	931 in#
				Mo=	157173 in#
Gasket Seating	HG =	268770 #	hG= 1.12500"	mo=	302366 in#

Allow.Stress-STRESS CALCULATIONS-Operating		SHAPE CONSTANTS			
1.5 Sfo Long Hub,SH	11308.8 psi	K = 1.1814	h/ho=	0.4704	
Sfo Radial Flg,SR	507.8 psi	T = 1.8464	F =	0.8530	
Sfo Tang Flg,ST	6866.1 psi	Z = 6.0538	V =	0.3196	
Sfo .5(SH+SR)or.5(SH+ST)	9087.5 psi	Y = 11.7316	f =	1.0000	
J(APP.2-14)=	0.5544	U = 12.8918	e =	0.3210in^-1	

Allow.Stress-STRESS CALCULATIONS-Gsk.Seating		g1/go= 1.5000	d =	6.700In^3
1.5 Sfa Long Hub,SH	21755.6 psi	ho = 2.6575"		
Sfa Radial Flg,SR	976.8 psi			
Sfa Tang Flg,ST	13208.9 psi	OTHER STRESS FORMULA FACTORS		
Sfa .5(SH+SR)or.5(SH+ST)	17482.3 psi	t	2.5625"	
J(APP.2-14)=	0.9898	Alpha	1.8225	
		Beta	2.0966	
		Gamma	0.9870	
		Delta	2.5115	
		Lambda	3.4985	
		M	5563 #	
		m	10703 #	

O.D. =	33.3750"	THK. =	2.7500"		
I.D. =	28.0000"	T-Adder =	0.0000"		
GO =	0.3750"	G1 =	0.5000"		
HUB O.D. =	29.0000"	HUB LEN =	1.2500"		
HUB ANG =	5.7106deg	RIB LENGTH =	0.0000"		
G(MEAN) =	29.2500"	G(CALC) =	29.2500"		
G(MIN.) =	28.7500"	G(MAX.) =	29.5000"		
B.C. =	31.5000"	B.S.C.F. =	1.0000		
No. BOLTS =	28	BOLT DIAMETER =	0.8750"		
R =	1.2500"	E =	0.9375"		
BOLT SPAC =	3.5269"	TORQUE =	183ft#		
MIN. SPAC =	2.0625"	TEMA MAX. SPAC=	5.3676"		
FLG TURN =	0.1875"	FACING =	RECESS		
BPRIME =	0.0000"	BG1 =	0.0000"		
FLG RWT =	293Lbs	FLG FWT =	205Lbs		

```
          MAIN FLG IS FLANGE MARK # 3
          COMP FLG IS FLANGE MARK # 5


           /// INDIVIDUAL COMPONENTS ///
MAWP CORR. MAIN FLG     =   244.0 Limited by: J-Calc. Operating
MAWP CORR. COMP FLG     =   245.0 Limited by: J-Calc. Operating


    /// AS MATING FLANGES (NO VACCUUM INCLUDED) ///
MAWP CORR. MAIN FLG     =   244.0 Limited by: J-Calc. Operating
MAWP CORR. COMP FLG     =   158.0 Limited by: J-Calc. Operating
```

(U-Tube) Configuration d

No or EPC=Elastic-Plastic Calcs	SSC=Simply Supported Calcs		=NO
MT Tubes	=SA-214	MT Tubesheets	=SA-516-70N
MT Channel	=SA-516-70	MT Shell	=SA-516-70
Diameter (Do)	= 27.4254"	Pass Lane Area (AL)	= 96.778in^2
Perimeter of layout (CP)	= 0.0000"	Area enclosed by CP (AP)	= 0.000in^2
Tubesheet thickness (h)	= 3.0000"	Tubesheet thickness HOLD	= NO
Tube Pitch (p)	= 1.1250"	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)	= 0.1875"	Groove shell side	= 0.0000"
Channel I.D. (Dc)	= 28.0000"	Channel thickness (Tc)	= 0.3750"
Shell I.D. (Ds)	= 28.0000"	Shell thickness (Ts)	= 0.3750"
TS outside diameter (A)	= 29.7500"	Bolt circle (C)	= 31.5000"
G Channel side (Gc or G1)	= 29.2500"	G Shell side (Gs or G1)	= 29.2500"
Bolt load Chan side (Wc)	=268770.38#	Bolt load Sh side (Ws)	=268770.38#
1.8*Sqrt(Dc*Tc)	= 0.0000"	1.8*Sqrt(Ds*(Ts or Ts1))	= 0.0000"
Thickness at Top TS (tr)	= 2.6250"	Outer Tube Circle	= 27.5508"
hr Ch Op= 0.0000" Ch Atm=	0.0000"	Sh Op= 0.0000" Sh Atm	= 0.0000"
Tubes welded Backside TS	=NO	Hole Size in Tubesheet	= 0.0000"

Design Press Chan (Pt)	= 150.0psig	Design Press Shell (Ps)	= 15.0psig
Design Temp Chan	= 145.0deg.	Design Temp Shell	= 500.0deg.
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 UHX-12 Case 1

(U-Tube) Configuration d

Tubesheet Thickness (h)	= 2.7500"		
Exp length of tube (ltx)	= 2.6125"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 28.2500"	Channel thickness (Tc)	= 0.2500"
Shell I.D. (Ds)	= 28.2500"	Shell thickness (Ts)	= 0.2500"
Press Chan (Pt)	= 150.0psi	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 = 500deg.F	S = 20000psi	Sy = 0psi	E =27.1000		V =.000	Sps = 0psi
Temp TBS	Tt= 500deg.F	St = 13411psi	Syt= 0psi	Et =27.1000		Vt=.000	
Temp CH	Tc= 145deg.F	Sc = 20000psi	Syc= 35930psi	Ec =28.8538		Vc=.300	Spsc= 71860psi
Temp SH	Ts= 500deg.F	Ss = 20000psi	Sys= 31000psi	Es =27.1000		Vs=.300	Spss= 62000psi

Mu= 0.3333 d*= 0.6442" P*= 1.2336" Mu*= 0.4778 hg'= 0.0625" hgs'= 0.0000"

Wmax	= 268770.3750#	Rho s	= 1.066529155		
Rho c	= 1.066529155	Mts	=-1002.749573In-Lb/In	h/p	= 2.444444418
E*	= 13959893.00psi	v*	= 0.301038027	Beta s	= 0.0in^-1
Kappa s	= 0.0#	Lambda s	= 0.0psi	Delta s	= 0.0In^3/Lb
Delta c	= 0.0In^3/Lb	Beta c	= 0.0in^-1	Kappa c	= 0.0#
Lambda c	= 0.0psi	Omega s	= 0.0in^2	Omega c	= 0.0in^2
K	= 1.084760427	F	= 0.110394433	M*	=-1002.749573In-Lb/In
Mp	=-552.5333862In-Lb/In	Mo	=-6371.797363In-Lb/In	M	= 6371.797363In-Lb/In
Sigma s,m=	0.0psi	Sigma s,b=	0.0psi	Sigma s =	0.0psi
Sigma c,m=	0.0psi	Sigma c,b=	0.0psi	Sigma c =	0.0psi

Sigma	11078 psi	<= 2S	40000 psi	[OK	]
Tau	1121 psi	<= .8S	16000 psi	[OK	]

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

(U-Tube) Configuration d

Tubesheet Thickness (h)	= 2.7500"		
Exp length of tube (ltx)	= 2.6125"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 28.2500"	Channel thickness (Tc)	= 0.2500"
Shell I.D. (Ds)	= 28.2500"	Shell thickness (Ts)	= 0.2500"
Press Chan (Pt)	= 0.0psi	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 = 500deg.F	S = 20000psi	Sy = 0psi	E =27.1000		V =.000	Sps = 0psi
Temp TBS	Tt= 500deg.F	St = 13411psi	Syt= 0psi	Et =27.1000		Vt=.000	
Temp CH	Tc= 145deg.F	Sc = 20000psi	Syc= 35930psi	Ec =28.8538		Vc=.300	Spsc= 71860psi
Temp SH	Ts= 500deg.F	Ss = 20000psi	Sys= 31000psi	Es =27.1000		Vs=.300	Spss= 62000psi

Mu= 0.3333 d*= 0.6442" P*= 1.2336" Mu*= 0.4778 hg'= 0.0625" hgs'= 0.0000"

Wmax	= 268770.3750#	Rho s	= 1.066529155		
Rho c	= 1.066529155	Mts	= 100.2749557In-Lb/In	h/p	= 2.444444418
E*	= 13959893.00psi	v*	= 0.301038027	Beta s	= 0.0in^-1
Kappa s	= 0.0#	Lambda s	= 0.0psi	Delta s	= 0.0In^3/Lb
Delta c	= 0.0In^3/Lb	Beta c	= 0.0in^-1	Kappa c	= 0.0#
Lambda c	= 0.0psi	Omega s	= 0.0in^2	Omega c	= 0.0in^2
K	= 1.084760427	F	= 0.110394433	M*	= 100.2749557In-Lb/In
Mp	= 55.25333786In-Lb/In	Mo	= 637.1797485In-Lb/In	M	= 637.1797485In-Lb/In
Sigma s,m=	0.0psi	Sigma s,b=	0.0psi	Sigma s =	0.0psi
Sigma c,m=	0.0psi	Sigma c,b=	0.0psi	Sigma c =	0.0psi

Sigma	1107 psi	<= 2S	40000 psi	[OK	]
Tau	112 psi	<= .8S	16000 psi	[OK	]

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

(U-Tube) Configuration d

Tubesheet Thickness (h)	= 2.7500"		
Exp length of tube (ltx)	= 2.6125"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 28.2500"	Channel thickness (Tc)	= 0.2500"
Shell I.D. (Ds)	= 28.2500"	Shell thickness (Ts)	= 0.2500"
Press Chan (Pt)	= 150.0psi	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 = 500deg.F	S = 20000psi	Sy = 0psi	E =27.1000	V =.000	Sps =	0psi
Temp TBS	Tt= 500deg.F	St = 13411psi	Syt= 0psi	Et =27.1000	Vt=.000		
Temp CH	Tc= 145deg.F	Sc = 20000psi	Syc= 35930psi	Ec =28.8538	Vc=.300	Spsc=	71860psi
Temp SH	Ts= 500deg.F	Ss = 20000psi	Sys= 31000psi	Es =27.1000	Vs=.300	Spss=	62000psi

Mu= 0.3333 d*= 0.6442" P*= 1.2336" Mu*= 0.4778 hg'= 0.0625" hgs'= 0.0000"

Wmax	= 268770.3750#	Rho s	= 1.066529155		
Rho c	= 1.066529155	Mts	=-902.4746094In-Lb/In	h/p	= 2.444444418
E*	= 13959893.00psi	v*	= 0.301038027	Beta s	= 0.0in^-1
Kappa s	= 0.0#	Lambda s	= 0.0psi	Delta s	= 0.0In^3/Lb
Delta c	= 0.0In^3/Lb	Beta c	= 0.0in^-1	Kappa c	= 0.0#
Lambda c	= 0.0psi	Omega s	= 0.0in^2	Omega c	= 0.0in^2
K	= 1.084760427	F	= 0.110394433	M*	=-902.4746094In-Lb/In
Mp	=-497.2800293In-Lb/In	Mo	=-5734.617676In-Lb/In	M	= 5734.617676In-Lb/In
Sigma s,m=	0.0psi	Sigma s,b=	0.0psi	Sigma s	= 0.0psi
Sigma c,m=	0.0psi	Sigma c,b=	0.0psi	Sigma c	= 0.0psi

Sigma	9971 psi	<= 2S	40000 psi	[OK	]
Tau	1009 psi	<= .8S	16000 psi	[OK	]

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

(U-Tube) Configuration d

Tubesheet Thickness (h)	= 2.7500"		
Exp length of tube (ltx)	= 2.6125"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 28.2500"	Channel thickness (Tc)	= 0.2500"
Shell I.D. (Ds)	= 28.2500"	Shell thickness (Ts)	= 0.2500"
Press Chan (Pt)	= 150.0psi	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 = 500deg.F	S = 20000psi	Sy = 0psi	E =27.1000		V =.000	Sps = 0psi
Temp TBS	Tt= 500deg.F	St = 13411psi	Syt= 0psi	Et =27.1000		Vt=.000	
Temp CH	Tc= 145deg.F	Sc = 20000psi	Syc= 35930psi	Ec =28.8538		Vc=.300	Spsc= 71860psi
Temp SH	Ts= 500deg.F	Ss = 20000psi	Sys= 31000psi	Es =27.1000		Vs=.300	Spss= 62000psi

Mu= 0.3333 d*= 0.6442" P*= 1.2336" Mu*= 0.4778 hg'= 0.0625" hgs'= 0.0000"

Wmax	= 268770.3750#	Rho s	= 1.066529155		
Rho c	= 1.066529155	Mts	=-1103.024536In-Lb/In	h/p	= 2.444444418
E*	= 13959893.00psi	v*	= 0.301038027	Beta s	= 0.0in^-1
Kappa s	= 0.0#	Lambda s	= 0.0psi	Delta s	= 0.0In^3/Lb
Delta c	= 0.0In^3/Lb	Beta c	= 0.0in^-1	Kappa c	= 0.0#
Lambda c	= 0.0psi	Omega s	= 0.0in^2	Omega c	= 0.0in^2
K	= 1.084760427	F	= 0.110394433	M*	=-1103.024536In-Lb/In
Mp	=-607.7867432In-Lb/In	Mo	=-7008.977051In-Lb/In	M	= 7008.977051In-Lb/In
Sigma s,m=	0.0psi	Sigma s,b=	0.0psi	Sigma s	= 0.0psi
Sigma c,m=	0.0psi	Sigma c,b=	0.0psi	Sigma c	= 0.0psi

Sigma	12186 psi	<= 2S	40000 psi	[OK	]
Tau	1234 psi	<= .8S	16000 psi	[OK	]

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

(U-Tube) Configuration d

Tubesheet Thickness (h)	= 2.7500"		
Exp length of tube (ltx)	= 2.6125"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 28.2500"	Channel thickness (Tc)	= 0.2500"
Shell I.D. (Ds)	= 28.2500"	Shell thickness (Ts)	= 0.2500"
Press Chan (Pt)	= 185.0psi	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 = 500deg.F	S = 20000psi	Sy = 0psi	E =27.1000		V =.000	Sps = 0psi
Temp TBS	Tt= 500deg.F	St = 13411psi	Syt= 0psi	Et =27.1000		Vt=.000	
Temp CH	Tc= 145deg.F	Sc = 20000psi	Syc= 35930psi	Ec =28.8538		Vc=.300	Spsc= 71860psi
Temp SH	Ts= 500deg.F	Ss = 20000psi	Sys= 31000psi	Es =27.1000		Vs=.300	Spss= 62000psi

Mu= 0.3333 d*= 0.6442" P*= 1.2336" Mu*= 0.4778 hg'= 0.0625" hgs'= 0.0000"

Wmax	= 268770.3750#	Rho s	= 1.066529155		
Rho c	= 1.066529155	Mts	=-1236.724487In-Lb/In	h/p	= 2.444444418
E*	= 13959893.00psi	v*	= 0.301038027	Beta s	= 0.0in^-1
Kappa s	= 0.0#	Lambda s	= 0.0psi	Delta s	= 0.0In^3/Lb
Delta c	= 0.0In^3/Lb	Beta c	= 0.0in^-1	Kappa c	= 0.0#
Lambda c	= 0.0psi	Omega s	= 0.0in^2	Omega c	= 0.0in^2
K	= 1.084760427	F	= 0.110394433	M*	=-1236.724487In-Lb/In
Mp	=-681.4578247In-Lb/In	Mo	=-7858.549805In-Lb/In	M	= 7858.549805In-Lb/In
Sigma s,m=	0.0psi	Sigma s,b=	0.0psi	Sigma s	= 0.0psi
Sigma c,m=	0.0psi	Sigma c,b=	0.0psi	Sigma c	= 0.0psi

Sigma	13664 psi	<= 2S	40000 psi	[OK	]
Tau	1383 psi	<= .8S	16000 psi	[OK	]

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

(U-Tube) Configuration d

Tubesheet Thickness (h)	= 2.7500"		
Exp length of tube (ltx)	= 2.6125"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 28.2500"	Channel thickness (Tc)	= 0.2500"
Shell I.D. (Ds)	= 28.2500"	Shell thickness (Ts)	= 0.2500"
Press Chan (Pt)	= 0.0psi	Press Shell (Ps)	= 158.0psi
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 = 500deg.F	S = 20000psi	Sy = 0psi	E =27.1000		V =.000	Sps = 0psi
Temp TBS	Tt= 500deg.F	St = 13411psi	Syt= 0psi	Et =27.1000		Vt=.000	
Temp CH	Tc= 145deg.F	Sc = 20000psi	Syc= 35930psi	Ec =28.8538		Vc=.300	Spsc= 71860psi
Temp SH	Ts= 500deg.F	Ss = 20000psi	Sys= 31000psi	Es =27.1000		Vs=.300	Spss= 62000psi

Mu= 0.3333 d*= 0.6442" P*= 1.2336" Mu*= 0.4778 hg'= 0.0625" hgs'= 0.0000"

Wmax	= 268770.3750#	Rho s	= 1.066529155		
Rho c	= 1.066529155	Mts	= 1056.229492In-Lb/In	h/p	= 2.444444418
E*	= 13959893.00psi	v*	= 0.301038027	Beta s	= 0.0in^-1
Kappa s	= 0.0#	Lambda s	= 0.0psi	Delta s	= 0.0In^3/Lb
Delta c	= 0.0In^3/Lb	Beta c	= 0.0in^-1	Kappa c	= 0.0#
Lambda c	= 0.0psi	Omega s	= 0.0in^2	Omega c	= 0.0in^2
K	= 1.084760427	F	= 0.110394433	M*	= 1056.229492In-Lb/In
Mp	= 582.0017700In-Lb/In	Mo	= 6711.626465In-Lb/In	M	= 6711.626465In-Lb/In
Sigma s,m=	0.0psi	Sigma s,b=	0.0psi	Sigma s	= 0.0psi
Sigma c,m=	0.0psi	Sigma c,b=	0.0psi	Sigma c	= 0.0psi

Sigma	11669 psi	<= 2S	40000 psi	[OK	]
Tau	1181 psi	<= .8S	16000 psi	[OK	]

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

Tube size.....=	0.75000"	Straight or U-Tube.=	U-Tube
Internal Press...=	165.00000psig	External press.....=	15.00000psig
Temperature used.=	500.00000deg.	Tube Matl MT# 61...=	SA-214
Stress Oper.....=	11400.00000psi	Stress Atm.....=	11400.00000psi
Yield.....=	21200.00000psi	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 =	0.00426"	(tr*TF)+MT+CA.....=	0.00497"
MAWP Internal H/C=	2423.25439psig	MAWP Internal N/C..=	2423.25439psig
MAWP External H/C=	1518.30225psig	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 = 15.00000

FRONT PASS PLATE THK..... = 0.50000
MATERIAL..... = SA-516-70
STRESS OPER..... = 20000.00
FRONT Chan ID..... = 28.00000
FRONT Chan OAL..... = 19.37500
a..... = 17.31250
b..... = 14.00000
TABLE RCB-9.132..... = Long sides fixed
a/b..... = 1.23661
B..... = 0.46688
t..... = 0.21390
Min fillet leg [both sides] = 3/4t = .75 x 0.21390 = 0.16043

Energy Exchanger Company

Page :

Customer :	SOUTHERN / MISS. POWER CO.	Item No.	HX 0040	W.O. :	X-7931
Subject :	Seismic and Wind Loading Factors	Date	3/10/2011	By :	DN/MD

Wind Loading

Given Data: From Customer Spec

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

Seismic Loading

Given Data: From Customer Spec

Occupancy Cat:	III	
Design Cat:	B	
Reliability	1	
Importance Factor	1.25	
Site Class	C	
Ss	0.204	g
S1	0.087	g
R (Table 15.4.2)	3	
Fa	1.2	
Fv	1.7	
Sms	0.2448	g
Sm1	0.1479	g
Sds	0.1632	g
Sd1	0.0986	g
Cs = Sds/(R/I)	0.0680	
Min Cs =	0.0100	

SNOW LOADS

Pg	5	psf
CAT	C	
Ct	1.2	
I	1.1	
Pf = 0.7*Ct*I	6.6	psf
SNOW LOAD AREA	89	sf
ADDITIONAL WEIGHT	587.4	lbs

Results for Horizontal Vessel Number 1, Description: X-7931 SPTS

Vessel Stress Summary

Shell Allowable Stress used in Calculation	20000.00	psi
Shell Compressive Yield used in Calculation	31000.00	psi
Head Allowable Stress used in Calculation	20000.00	psi
Volume of Vessel	108.51	ft.**3
Weight of Vessel, Empty	12587.40	lb.
Weight of Vessel, Full	19337.76	lb.
Shell Thk. + CA, Reqd. vs. Actual	0.188 / 0.375	in.
Head Thk. + CA, Reqd. vs. Actual	0.188 / 0.312	in.
Shell M.A.W.P. , Reqd. vs. Actual	15.00 / 297.72	psig
Head M.A.W.P. , Reqd. vs. Actual	15.00 / 225.36	psig

	Actual	Allowable	
Long. Stress at Top of Saddles	7951.39	17000.00	psi
Long. Stress at Bottom of Saddles	-7109.89	-11641.08	psi
Long. Stress at Top of Midspan	-1047.81	-11641.08	psi
Long. Stress at Bottom of Midspan	1889.31	17000.00	psi
Tangential Shear in Shell	2452.52	16000.00	psi
Circ. Stress at Horn of Saddle	-16932.95	-27900.00	psi
Circ. Stress at Tip of Wear Plate	-13174.32	-27900.00	psi
Circ. Compressive Stress in Shell	-1488.29	-15500.00	psi

Wind(ASCE #7) and Seismic Results :

Transverse Wind Load Component, Ftw:

```
Ftw = ( AFT * Cf * QZ * Cnv_Fac) * 0.5
Ftw = ( 17620.781 * 1.000 * 16.1440 * 0.00694 )* 0.5
Ftw = 987.743 lb.
```

Longitudinal Wind Load Component, Flw:

```
Flw = ( AFL * QZ * Cnv_fac)
Flw = ( 1460.657 * 16.1440 * 0.00694 )
Flw = 163.756 lb.
```

Transverse Earthquake Load Component, Fte:

```
Fte = ( Cs * Wo ) * 0.5
Fte = ( 0.0680 * 19337.76 ) * 0.5
Fte = 657.484 lb.
```

Longitudinal Earthquake Load Component, Fle:

```
Fle = Cs * Wo
Fle = 0.0680 * 19337.76
Fle = 1314.968 lb.
```

Longitudinal force due to Friction, Flf:

```
Flf = mu * W0/2
Flf = 0.300 * 9668.88
Flf = 2900.664 lb.
```

Saddle Reaction Force due to Transverse Forces, Qr:

```
Qr = ftr * Max( Ftw, Fte ) * B / E
Qr = 3.0 * Max( 987.74 , 657.48 ) * 21.7500 / 25.1147
Qr = 2566.231 lb.
```

Saddle Reaction Force due to Longitudinal forces, Ql:

```
Ql = Max( Flw, Fle, Flf, Flu ) * B / Ls
Ql = Max( 163.76 , 1314.97 , 2900.66 , 9000.00 ) * 21.7500 / 186.6250
Ql = 1048.895 lb.
```

Input Echo, Horizontal Vessel Item 1, Description: X-7931 SPTS

Design Internal Pressure		15.00	psig
Design Temperature		500.00	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		62.2100	lb./ft³
Liquid Height in Vessel		28.2500	in.

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

Extra Weight		9675.420	lb. ← INCLUDES SNOW LOAD
Saddle Reaction Force Factor	ftr	3.00	
Distance from Center of Vessel to Support	B	21.75	in.
Baseplate Length		27.0000	in.
Baseplate Thickness		0.5000	in.
Baseplate Width		6.0000	in.
Number of Ribs (inc. outside ribs)		2	
Rib Thickness		0.5000	in.
Web Thickness		0.5000	in.
Web Location		Side	
Height of Center Web		6.5000	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		4500.0000	in²
User defined Wind Pressure on Vessel	Wpre	16.14	psf
Friction Coefficient	mu	0.30	
User defined Longitudinal Force	Flu	9000.00	lb.
Seismic Zone Idenifier, Zone		0 Zone 0	
User Entered Seismic Zone Coefficient		0.0680	⚠1
Diameter Basis for Vessel		ID	
Shell Diameter		28.000	in.
Shell Length Tangent to Tangent		24.156	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		51.625	in.
Saddle Width		6.000	in.
Saddle Bearing Angle		120.0000	degrees
Wear Pad Thickness		0.3750	in.
Wear Pad Extension above Horn of Saddle		2.0000	in.
Wear Pad Width		10.000	in.
Stiffening Ring Present		N	

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

```
Q = Wo/2 + Max( Qr, Ql )
Q = 9668.88 + Max( 2566.23 , 1048.89 )
Q = 12235.111 lb.
```

Summary of Loads on this Saddle Support:

Vertical Load on this Saddle	12235.11	lb.
Transverse Shear Load on this Saddle	987.74	lb.
Longitudinal Shear Load on this Saddle	9000.00	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)
= (16.02*(28.0000/2+0.1250))/(20000.00*0.85-0.6*16.02)
= 0.0133 + 0.1250 = 0.1383 in.
= 0.0625 in. ( Per Ug 16b )
```

Max. All. Working Pressure at Given Thickness (MAWP):
Less Operating Hydrostatic Head Pressure of 1.02 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))/((28.0000/2+0.1250)+0.6*0.2500)
= 297.72 - 1.02 = 296.71 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)/(28.0000/2+0.6*0.3750)
= 448.15 psig
```

Actual stress at given pressure and thickness (Sact):

```
= (P*((D/2+CA)+0.6*(T-CA-CAE))) / (E*(T-CA-CAE))
= (16.02*((28.0000/2+0.1250)+0.6*(0.2500)))/(0.85*(0.2500))
= 1075.97 psi
```

Elliptical Head:

Thickness Due to Internal Pressure:

```
= (P*(D+2*CA)*K) / (2*S*E-0.2*P) Appendix 1-4(c)
= (16.02*(28.0000+2*0.1250)*1.00)/(2*20000.00*0.85-0.2*16.02)
= 0.0133 + 0.1250 = 0.1383 in.
= 0.0625 in. ( Per Ug 16b )
```

Max. All. Working Pressure at Given Thickness (MAWP):
Less Operating Hydrostatic Head Pressure of 1.02 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*(28.0000+2*0.1250)+0.2*(0.1875))
= 225.36 - 1.02 = 224.35 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*28.0000+0.2*0.3125)
= 378.62 psig
```

Actual stress at given pressure and thickness (Sact):

```
= (P*(K*(D+2*CA)+0.2*(T-CA-CAE))) / (2*E*(T-CA-CAE))
= (16.02*(1.00*(28.0000+2*0.1250)+0.2*(0.1875)))/(2*0.85*(0.1875))
= 1421.43 psi
```

Longitudinal Bending (+-) at Midspan
```
= ( 3 * Q * L * K.2 / ( PI * R^2 * ( T - CA )))
= ( 3 * 12235 * 24.16 * 0.2595 ) /
  ( PI * 14.1250 * 14.1250 * ( 0.3750 - 0.1250 )))
= 1468.56 psi
```

Compute the area ratio [K]:
```
= Pi * (Sin(Delta)/Delta - Cos(Delta) ) / (Delta + Sin(Delta) * Cos(Delta) -
  (Delta + Sin(Delta) * Cos(Delta) - 2 * Sin(Delta) * Sin(Delta)/Delta)
= Pi * (Sin(1.396 ) / 1.396 - Cos(1.396 )) / ( 1.396 + Sin(1.396 ) *
  Cos(1.396 ) - 2 * Sin(1.396 ) * Sin(1.396 )/ 1.396 )
= 9.3799
```

Compute the moment fraction [X]:
```
= (1 - (1 - A/L + ( R² - H² )/(2 * A*L ) )/(1 + (4*H )/( 3 * L ) ) )
= (1 - (1 - 4.302 /24.156 + (1.177² - 0.590²)/( 2 * 4.302 * 24.156 ) ) /
  (1 + (4 * 0.590 )/(3 * 24.156 ) ) )
= 0.1992
```

Intermediate Product [K.1]:
```
= K * X  * 4 * A / L
= 9.380 * 0.199 * 4 * 4.302 / 24.156 = 1.3309
```

Longitudinal Bending (+-) at Saddle
```
= ( 3 * Q * L * K.1 / ( PI * R^2 * ( T - CA )))
= ( 3 * 12235 * 24.16 * 1.3309 ) /
  ( PI * 14.1250 * 14.1250 * ( 0.3750 - 0.1250 )))
= 7530.64 psi
```

Longitudinal Pressure Stress
```
= DP*((SID/2+CA)-0.4*(T-CA))/(2.0*(T-CA))
= 15.0 * (( 28.00 / 2 + 0.1250 - 0.4 * ( 0.375 - 0.1250 )) /
  ( 2.0 * ( 0.375 - 0.1250 ))
= 420.75 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))
= 12235 * 1.1707 * (( 24.16 - 0.59 - 2 * 4.30 )/
  ( 24.16 + 0.59 ))/( 14.1250 * ( 0.3750 - 0.1250 ))
= 2452.52 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)
= -12235 /( 4 * 0.2500 * (6.00 + 1.56*SQRT(14.1250 *0.2500 )))
  -3 * 12235 * 0.0402 / ( 2 * 0.2500 ^2 )
= -13174.32 psi
```

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

Saddle-Tangent Distance A (51.6) is > R/2 (7.1 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)
= -12235 /( 4 * 0.2500 * (6.00 + 1.56*SQRT(14.1250 *0.2500 )))
  -3 * 12235 * 0.0530 / ( 2 * 0.0625 )
= -16932.95 psi
```

Circumferential Compression at Bottom of Shell
```
= (Q*( K.9/( TEM9 * WPDWTH ) ) )
= ( 12235 *( 0.7603 /( 0.6250 * 10.000 ) ) )
= -1488.29 psi
```

RESULTS for VESSEL RIBS, WEB and BASE

Moment of Inertia of Saddle - Lateral Direction

	Y	A	AY	Ay^2	Io
Shell	0.1250	3.2329	0.4041	0.0505	0.0168
Wearplate	0.4375	3.7500	1.6406	0.7178	0.0439
Web	3.3125	2.6875	8.9023	29.4890	6.4703
BasePlate	6.2500	3.0000	18.7500	117.1875	0.0625
Totals	10.1250	12.6704	29.6971	147.4448	6.5936

Value C1 = Sumof(Ay)/Sumof(A) = 2.3438 in.
Value I = Sumof(Ay²) + Sumof(Io) - C1*Sumof(Ay) = 84.4338 in**4
Value As = Sumof(A) - Ashell = 9.4375 in²

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

Fh = K1 * Q = 0.2035 * 12235.111 = 2490.111 lb.

Tension Str., St = (Fh/As) = 263.8528 psi
Allowed Str., Sa = .6 * Yield Stress = 22800.0000 psi

d = B - R*Sin(theta) / theta = 8.9437 in.
Bending Moment, M = Fh * d = 1855.9043 ft.lb.

Bending Stress, Sbnd = (M * C1 / I) = 618.2228 psi
Allowed Str., Sa = .66 * Yield Str. = 25080.0020 psi

Minimum Thickness of Baseplate

= (3 * Q * BasePlateWidth / (2 * BasePlateLength * AllStress))½
= (3 * 12235 * 6.00 / (2 * 27.000 * 25080.002))½
= 0.403 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 * 6.0000 / 2 = 78.0000 in²

Axial Load (P)
= Ap * Bp
= 78.00 * 75.53 = 5890.98 lb.

Area of the Rib and Web (Ar)
= (Bpwid - Clearance - Webtk) * Ribtk + e/2 * Webtk
= (6.000 - 1.0 - 0.500) * 0.500 + 26.0000 /2 * 0.500
= 8.750 in²

Compressive Stress (Sc)
= P/Ar
= 5890.98 / 8.7500 = 673.2548 psi

Check of Outside Ribs

Inertia of Saddle, Outer Ribs - Axial Direction

	Y	A	AY	Ay^2	Io
Rib	2.7500	2.5000	6.8750	8.1501	6.9323
Web	0.2500	6.5000	1.6250	3.1346	0.2708
Values	0.9444	9.0000	8.5000	11.2847	7.2031

KL/R < Cc (9.2444 < 123.2882) per AISC E2-1 9th Edition

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

$Sca = (1-(9.24)^2/(2 * 123.29^2)) * 38000 /$

$(5/3+3*(9.24)/(8* 123.29)-(9.24^3)/(8*123.29^3)$

Sca = 22359.39 psi

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

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

Check = 673.25 / 22359.39 + (29114.58 /4.559) / 25080.00

Check = 0.28

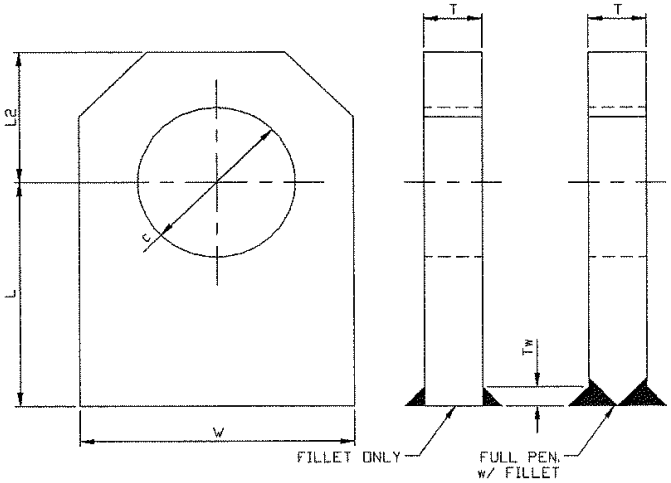
Energy Exchanger Company

Page :

Customer :	MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES	Item No	HX0040	W.O. :	X-7931
Subject :	LIFTING LUG CALCULATION	Date	3/10/2011	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=	4 1/4	in
L =	4 3/4	in
L2=	2 1/8	in
OAL =	6 7/8	in
C=	2	in
Analysis Type	Full Pen w/ Fillet (1)	
Impact Factor	1.500	
Occasional Load Factor	1.125	
Heaviest Lug Load	1250	#
	(CHANNEL)	
Weld Group Area (Aw)	3.182	in^2
Weld Group Inertia (Iw)	5.321	in^4
Shear Area (As)	0.563	in^2
Lug Inertia (I)	3.199	in^4



Allowable Loading

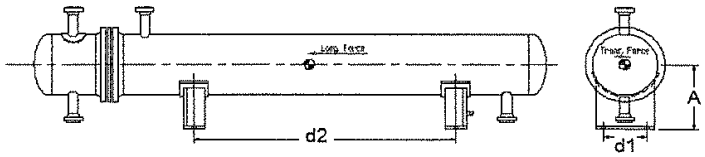
Shear Stress	17100	psi
0.4 * Yield * Occ Factor		
Bearing Stress	32062.5	psi
MIN(0.75*Yield*Occ Factor, 0.9*Yield)		
Combined	28215	psi
MIN(.66*Yield*Occ Factor, 0.75*Yield)		

Calculated Loads

Primary Shear in Welds	589.34 psi
Load*Impact/(Aw)	
Bending Shear Stress in Welds	836.91 psi
Load*Impact*(W+2*Tw)/2/(Iw)	
Total Combined Shear	1426.25 psi
Shear in Lug Above Hole	2222.22 psi
Load*Impact/(As)	
Pin Hole Bearing Stress	1875.00 psi
Load*Impact/(T*C)	
Bending Stress @ Lug Base	5916.96 psi
Load*Impact*L/(W^2*T/6)	
Tensile @ Lug Base	882.35 psi
Load*Impact/(W*T)	
Total Combined Stress @ lug Base	6799.31 psi

Energy Exchanger Company

Customer :	MISSISSIPPI POWER c/o SOUTHERN COMPANY SERVICES	Item Nc	HX0040	W.O. :	X-7931
Subject :	ANCHOR BOLTING CALC	Date	5/10/2011	By :	DN/MD



Static Balance

Near Saddle Ref Dimension:	49 in	Number of Bolts (Fixed only)*	2
Far Saddle Ref Dimension:	241 in	Bolt Diam.	1 in (2)
COG Ref Dimension:	121 in	Bolt Area (Ab)	0.6057 in^2
Weight	18750 lb	Bolting Material	F1554(Gr. 36)
Dim A	21.75 in	Allowable Stress Shear	11880 psi
Dim d1	20.5 in	Allowable Stress Tension	11880 psi
Dim d2	192 in		
		Greatest Transverse Load (Ft)	988 lb
Reaction Forces		Greatest Longitudinal Load (Fl)	9000 lb
Near Saddle (Rfn)	11719 lb		
Far Saddle (Rff)	7031 lb		
Rf = 0 or Rff if COG outside saddles	0 lb		
Transverse Shear Calculation:		* Longitudinal shear foces countered by bolting	
Ss = Ft/(total bolts*bolt area) =	408 psi	in stationary support only.	
		transverse forces counter by full bolting	
Longitudinal Shear Calculation:		(fixed support bolts * 2)	
Sl = Fl/(fixed bolts*bolt area) =	7429 psi		
		All calcualted stresses are less than allowable	
Transverse Overturning Moment Calc		Anchor bolting design is accebtale.	
Stm = (48*(Ft*A/12)/(d1*total bolts)-(Weight/total bolts))/Ab			
Stm =	-6008 psi		
		CALCULATION IS FOR SIZING OF SUPPORT	
Longitudinal Overturning Moment Calc		**HOLES & SLOTS. THIS CALCULATION DOES**	
Slm = (48*(Fl*A/12)/(d2*total bolts)-(Weight/total bolts))/Ab		**NOT REPLACE OR RELIEVE THE**	
Slm =	-6055 psi	**CIVIL/STRUCTURAL ENGINEERING DESIGN**	
		FOR THE PARTY SUPPLYING ANCHOR BOLTS	

SECTION 3

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

1. Manufactured and certified by ENERGY EXCHANGER COMPANY, 1844 NORTH GARNETT ROAD, TULSA, OK 74116 (Name and address of Manufacturer)
2. Manufactured for SOUTHERN COMPANY SERVICES, INC. 42 INVERNESS CENTER PARKWAY BIRMINGHAM, AL 35242 (Name and address of Purchaser)
3. Location of installation MISSISSIPPI POWER CO., DEKALB, MS. (Name and address)
4. Type: HORIZ. (Horiz., vert., or sphere) | HEAT EXCHANGER (Tank, separator, jkt. vessel, heat exh., etc.) | X-7931 (Mfg's serial No.)
   (CRN) | X-7931-A REV. 5 (Drawing No.) | 5966 (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 / 1 (b) Overall length (ft & in.): 23'-10 5/8" / 4'-2" *(1)*

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	28" I.D.	8'-0"	SA-516-70	3/8"	1/8"	1	SPOT	0.85	1	SPOT	0.85	---	---
1	28" I.D.	7'-10 5/8"	SA-516-70	3/8"	1/8"	1	SPOT	0.85	1	SPOT	0.85	---	---
1	34 3/4" I.D.	4'-2"	SA-516-70	1/2"	1/8"	1	SPOT	0.85	1	NONE	1.0	---	---

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	1.00
(b)														

If removable, bolts used (describe other fastening) SHELL TO CHANNEL; SA-193-B7,7/8" DIA, 28 (Mat'l Spec. No., Grade, size, No.)

8. Type of jacket Jacket closure (Describe as ogee & weld, bar, etc.)
   If bar, give dimensions If bolted, describe or sketch.
9. MAWP 158 (internal) 15 (external) psi at max. temp. 500 (internal) 500 (external) °F Min. design metal temp. 10 °F at 158 psi.
10. Impact test NO, EXEMPT PER UG-20(f) [Indicate *yes* or *no* and the component(s) impact tested] at test temperature of --- °F.
11. Hydro., ~~pneu., or comb.~~ Test press. 210 P.S.I.G. Proof test

Items 12 and 13 to be completed for tube sections.

12. Tubesheet: SA-516-70N [Stationary (Mat'l Spec. No.)] | 29 1/4" [Dia., In. (subject to press.)] | 3" (Nom. thk., in.) | 5/16" (Corr. Allow., in.) | Bolted [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.) | 0.083" THK (MIN) (Nom. thk., in. or gauge) | 125 (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.): 0'-9 5/8"

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B, & C)			Heat Treatment	
No.	Diameter, in.	Length (ft & in.)	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time
1	28" I.D.	0'-9 5/8"	SA-516-70	3/8"	1/8"	1	SPOT	0.85	1	SPOT	0.85	1150° F.	1-Hr.

15. Heads: (a) SA-516-70N (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	2 3/8"	3/16"						29 3/8"					
(b)														

If removable, bolts used (describe other fastening) a) SA-193B7, 7/8" DIA, 28 (Mat'l Spec. No., Grade, size, No.)

FORM U-1 (Back)

16. MAWP 185 (internal) --- (external) psi at max. temp. 145 (internal) --- (external) °F Min. design metal temp. 10 °F at 185 psi.

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

18. Hydro., ~~pneu., or comb.~~ Test press. 245 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/OUTLET	1/1	14"-150#	RF-WN	SA-106B	SA-105	.500"	1/8"	WELD	WELDED	WELDED	SHELL
INLET	1	3"-150#	FF-WN	SA-106B	SA-105	.438"	1/8"	WELD	WELDED	WELDED	CHANNEL
OUTLET	1	3"-150#	FF-WN	SA-106B	SA-105	.438"	1/8"	WELD	WELDED	WELDED	CHANNEL
VENT/DRAIN	1/1	1"-150#	RF WN	SA-105	---	.500"	1/8"	WELD	WELDED	---	CHANNEL COVER

20. Supports: Skirt NO (Yes or no) Lugs ___ (No.) Legs ___ (No.) Others (2)Saddles (Describe) Attached WELDED TO SHELL (Where and how)

21. Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report: (List the name of part, item number, mfg's. name and identifying number)

22. Remarks: SERVICE: LP VENT GAS COMPRESSOR PRE COOLER; P.O. NO: 17497-0001; ITEM NO.: HX0040; SIZE: 28-288: TYPE: AGU TUBES DESIGNED W/ 0" C.A., SAFETY RELIEF DEVICES BY OTHERS; LINES 6-11 INCLUDES (1) 33 3/8"OD x 28" ID x 4" THK. SA-266-4N RING LINES 14-18 INCLUDES (1) 33 3/8" O.D. X 28" I.D. X 3 15/16" THK. RING & (1) 33 3/8" OD x 28" ID x 4" THK. RING, BOTH SA-266-4N

(1) Annular distributor contains (2) 35 3/4"OD x 28 7/8"ID x 3/4" thk. SA-516-70 Closure Rings & (2) 3 1/4" x 3/8" thk. x 49 7/8" SA-516-70 Divider Plates

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 10-6-11 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 10.6.2011, 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 10.6.11 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 ___

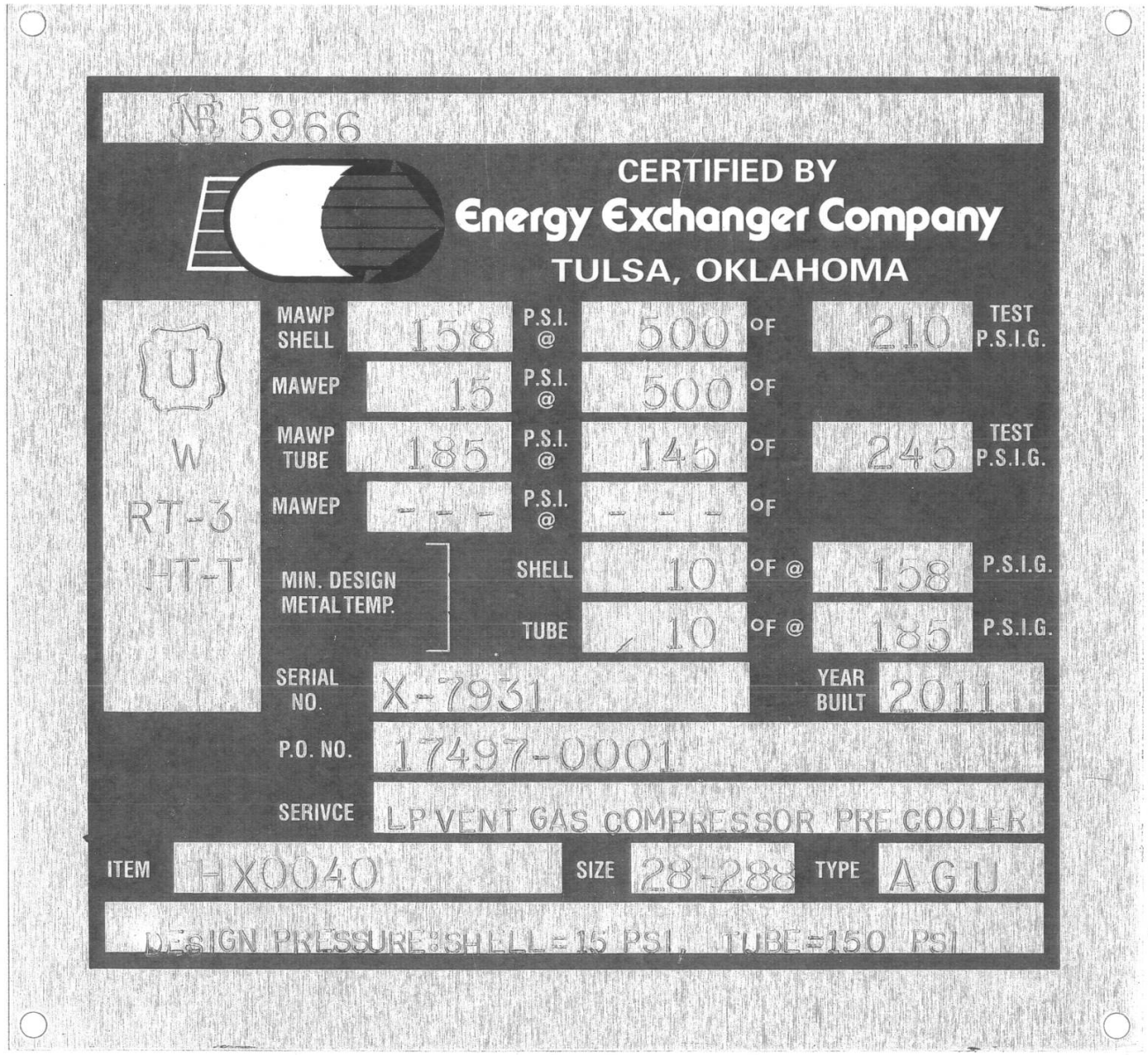
Date ___ Name ___ (Assembler) Signed (Representative)

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

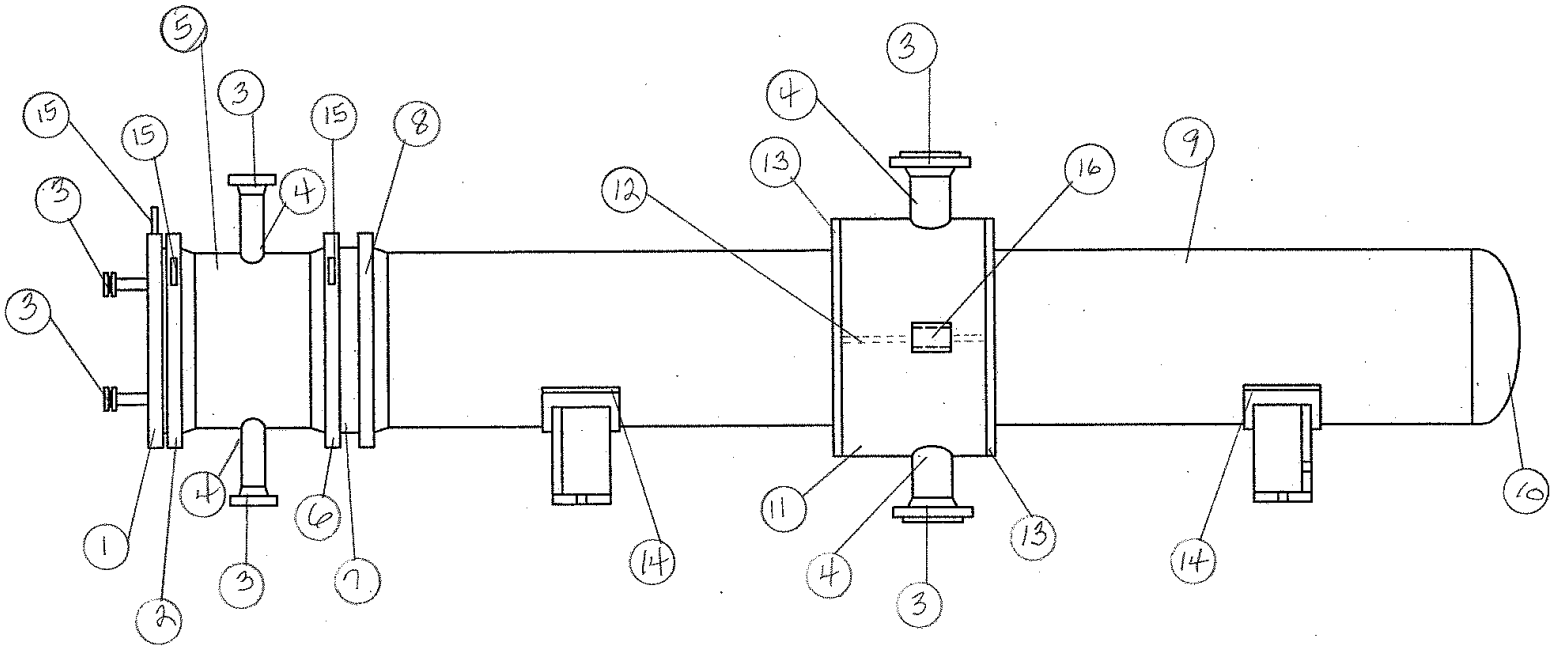
I, the undersigned, holding a valid commision issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of ___ and employed by ___ of ___, have compared the statements in this Manufacturer's Data Report with the described pressure vessel and state that parts referred 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 5966
CERTIFIED BY
Energy Exchanger Company
TULSA, OKLAHOMA
U
W
RT-3
HT-T
MAWP SHELL 158 P.S.I. @ 500 °F 210 TEST P.S.I.G.
MAWEP 15 P.S.I. @ 500 °F
MAWP TUBE 185 P.S.I. @ 140 °F 245 TEST P.S.I.G.
MAWEP - - - P.S.I. @ - - - °F
MIN. DESIGN METAL TEMP.
SHELL 10 °F @ 158 P.S.I.G.
TUBE 10 °F @ 185 P.S.I.G.
SERIAL NO. X-7931
YEAR BUILT 2011
P.O. NO. 17497-0001
SERIVCE LP VENT GAS COMPRESSOR PRE COOLER
ITEM HX0040
SIZE 28-288
TYPE AGU
DESIGN PRESSURE: SHELL=15 PSI, TUBE=150 PSI

SECTION 4



HEAT NUMBER LOCATION MAP

17 TUBES
18 STUDS
19 NUTS
20 PASS PLATES

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

X-7931

ENERGY EXCHANGER COMPANY

MATERIAL HEAT NUMBER INDEX

Project: Kemper County 1 - IGCC

CUSTOMER:	**Southern Company Services (for) Mississippi Power**	**ITEM NO:**	**HX0040**	**PAGE:**	**1 of 3**
DESTINATION:	**DeKalb, Mississippi**	**SERVICE:**	**LP Vent Gas Compressor Precooler**	**DATE:**	**October 5, 2011**
P.O. No:	**17497-0001**	**DESCRIPTION:**	**1-28" x 288" AGU Exchanger**	**JOB NO:**	**X-7931**
REQ No:	**MC206**				

PART NO.	HEAT NO.	SLAB NO.	STEEL PRODUCER	GRADE	DESCRIPTION	PCS.	SIZE
1	NW1353		Evraz Oregon	SA-516-70N	**(#1 Channel Cover)**	1	33 3/8" OD x 2 3/8" thk.
2	110785		Nucor	SA-266-4N	**(#2 Channel Flange)**	1	33 3/8" OD x 28" ID x 3 15/16" thk.
3	GLZ		Coffer	SA-105	**(Nozzle Flange T-1 & 2)**	2	3" 150# FF WN Sch 160 Bore
3	C830AF		FVC	SA-105	**(Nozzle Flange V & D)**	2	1" 150# RF LWN x 9" lg.
3	72229		Galperti	SA-105	**(Nozzle Flange V & D)**	2	1" 150# RF Blind
3	091447N/02		Galperti	SA-105-N	**(Nozzle Flange S-1 & 2)**	2	14" 150# RF WN Sch X-Hvy. Bore
4	472004		TMK Ipsco	SA-106-B	**(Nozzle Pipe T-1 & 2)**	2	3" Sch 160 x 5 1/2" lg.
4	S20385		U.S.S.	SA-106-B	**(Nozzle Pipe S-1 & 2)**	2	14" Sch X-Hvy. X 5 3/4" lg.
5	1502825	09	Nucor	SA-516-70	**(Channel Cylinder)**	1	28" ID x 3/8" thk. x 9 5/8" lg.
6	110785		Nucor	SA-266-4N	**(#3 Channel Flange)**	1	33 3/8" OD x 28" ID x 4" thk.
7	R8207	2	ArcelorMittal	SA-516-70N	**(#4 Tubesheet)**	1	29 3/4" OD x 3" thk.
8	110785		Nucor	SA-266-4N	**(#5 Shell Flange)**	1	33 3/8" OD x 28" ID x 4" thk.

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

ENERGY EXCHANGER COMPANY

By: Lynda Patterson

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

ENERGY EXCHANGER COMPANY
MATERIAL HEAT NUMBER INDEX

Project: Kemper County 1 - IGCC

CUSTOMER:	**Southern Company Services (for) Mississippi Power**	**ITEM NO:**	**HX0040**	**PAGE:**	**2 of 3**
DESTINATION:	**DeKalb, Mississippi**	**SERVICE:**	**LP Vent Gas Compressor Precooler**	**DATE:**	**October 5, 2011**
P.O. No:	**17497-0001**	**DESCRIPTION:**	**1-28" x 288" AGU Exchanger**	**JOB NO:**	**X-7931**
REQ No:	**MC206**				

PART NO.	HEAT NO.	SLAB NO.	STEEL PRODUCER	GRADE	DESCRIPTION	PCS.	SIZE
9	1502825	09	Nucor	SA-516-70	**(Shell Cylinder) "Courses 1 & 2"**	2	28" ID x 3/8" thk.
9	1502456	03	Nucor	SA-516-70	**(Shell Cylinder) "Course 3"**	1	28" ID x 3/8" thk.
10	AWIZ 812T34100	J063899	ArcelorMittal	SA-516-70	**(Shell Head)**	1	28" ID x 5/16" (min) thk. 2:1 Ellip. w/2" S.F.
11	1501468	08	Nucor	SA-516-70	**(Distributor Cylinder)**	1	34 3/4" ID x 1/2" thk. x 4'-2" lg.
12	E0J010	0063	SSAB	SA-516-70	**Distributor Divider Plates)**	2	3 1/4" x 3/8" thk. x 49 7/8" lg.
13	B1M5109	01	Nucor	SA-516-70	**(Closure Rings)**	2	35 3/4" OD x 287/8" ID x 3/4" thk.
14	0508228	04	Nucor	SA-516-70	**(Support Pads)**	2	10" x 3/8" thk. x 38 1/4" lg.
15	1500860	09	Nucor	SA-516-70	**(Lifting Lugs)**	5	4 1/4" x 1/2" thk. x 6 7/8" lg.
16	W0H543	0024	SSAB	SA-516-70	**(Name Plate Bracket)**	1	7 1/2" x 3/16" thk. x 22" lg.
17	GC51644		Webco	SA-214	**(Tubes)**	7	3/4" OD x .083" (min) x V/L
17	WA101431		Webco	SA-214		118	3/4" OD x .083" (min) x V/L
18	783584		Vulcan Thrd. Prod.	SA-193-B7	**(Studs)**	28	7/8" (9 Thd) x 7" lg.
18	783584		Vulcan Thrd. Prod.	SA-193-B7	**(Studs)**	28	7/8" (9 Thd) x 10 1/8" lg.

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

ENERGY EXCHANGER COMPANY

By: Lynda Patterson

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

ENERGY EXCHANGER COMPANY
MATERIAL HEAT NUMBER INDEX

Project: Kemper County 1 - IGCC

CUSTOMER:	**Southern Company Services (for) Mississippi Power**	**ITEM NO:**	**HX0040**	**PAGE:**	**3 of 3**
DESTINATION:	**DeKalb, Mississippi**	**SERVICE:**	**LP Vent Gas Compressor Precooler**	**DATE:**	**October 5, 2011**
P.O. No:	**17497-0001**	**DESCRIPTION:**	**1-28" x 288" AGU Exchanger**	**JOB NO:**	**X-7931**
REQ No:	**MC206**				

PART NO.	HEAT NO.	SLAB NO.	STEEL PRODUCER	GRADE	DESCRIPTION	PCS.	SIZE
19	BD291		Unytite	SA-194-2H	**(Nuts)**	112	7/8" (9 Thd)
20	1500860	09	Nucor	SA-516-70	**(Pass Plate)**	1	13 11/16" x 1/2" thk. x 17 13/16" lg.
20	1500860	09	Nucor	SA-516-70	**(Pass Plate)**	1	27 7/8" x 1/2" thk. x 17 13/16" lg.

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

ENERGY EXCHANGER COMPANY

By: Lynda Patterson

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

20220

EVRAZ EVRAZ INC. NA
Evraz Oregon Steel 14400 N. Rivergate Blvd., Portland, Oregon 97203

REPORT OF CHEMICAL/PHYSICAL TESTS

CERTIFICATE NO.	DATE	PAGE
1162024	Jun 08, 2011	1

ISO 9001 REGISTERED U.S. PLATE PRODUCER

SOLD TO

C G MARTIN COMPANY INC
PO BOX 9345
TULSA, OK 74157
USA

X-7931-1

C G MARTIN COMPANY INC
PO BOX 9345
TULSA, OK 74157
USA

MILL ORDER NO.	DATE
243927	
CUSTOMER ORDER NO.	
6286	
JOB/REQ. NO.	
SHIPPING NO.	DATE
1162024	06/08/2011
CARRIER	
BURLINGTON NORTHERN	
CAR/TRUCK NO.	
CW6053	

THIS MATERIAL HAS BEEN MANUFACTURED, TESTED AND FOUND TO MEET THE SPECIFICATIONS AND PURCHASE ORDER REQUIREMENTS
EOS CARBON PRESSURE VESSEL QUALITY ASTM A516-06 GRADE 70 ASME SA516 GRADE 70 2010 EDITION NORMALIZED NO WELD REPAIR. PRESSURE VESSEL QUALITY. KILLED FINE GRAIN PRACTICE. REPORT B. "WE CERTIFY THIS MATERIAL WAS FREE OF (continued)

PHYSICAL PROPERTIES

ITEM NO	DESCRIPTION	HEAT NO.	SLAB	YIELD PSI X 100	TENSILE PSI X 100	% ELONG 8"	% ELONG 2"	% RA	HARDNESS BHN	BEND TEST	IMPACTS
	MERCURY CONTAMINATION DURING MANUFACTURING, TESTING AND INSPECTION." NO DELIBERATE ADDITIONS OF B AND TI. ITEMS WITH(**)ALSO MEET ASTM/ASME A516 GR60. ITEMS WITH (**) ALSO MEET ASTM/ASME A516 GR65.										
0220----> 1	2.7500 X 96.000ME X 260.000										
	^	NW1353	A26	466	745		36				
	THE FOLLOWING PLATES WERE NORMALIZED AT 1660 DEGS F FOR 218 MINUTES AND AIR COOLED										
	1 PC 19466 LBS 11F1096 ^	NW1353	A26								
	1 PC 19466 LBS TOTALS										

VERIFIED BY
JUN 21 2011
EOS QA DEPT

DUPLICATE ORIGINAL TEST REPORT FROM C.G. MARTIN CO., INC.

CUST ID	22	WO#	79851
CUST	ENERGY EXCHANGER COMPANY		
P.O. #	1273		
ITEM #	4 & 6		
DESC	(1) 32-5/8" OD(F) X 2-3/8" THK(F)		
	(1) 33-7/8" OD(F) X 2-3/8" THK(F)		
DATE	06/30/11	BY:	

CHEMICAL ANALYSIS

HEAT NO.	C	Mn	P	S	Si	Cu	Ni	V	Cb	Al	Cr	Mo	Ti	B	N	Ca			CE	McQuaid Ehn Grain Size
NW1353	.20	1.32	.012	.007	.30	.01	.05	.026	.005	.038	.02	.00	.004	.0000						

HEATS INDICATED WITH (+) WERE MELTED & MANUFACTURED IN THE USA. HEATS INDICATED WITH (^) WERE ROLLED IN THE USA.

..... END OF REPORT .....

Part #1

Reviewed / Accepted
EOS #5

QUALITY COORDINATOR

I certify the above to be correct as contained in the records of EVRAZ INC. NA By _____

Part #2.6.8

OKLAHOMA FORGE, INC.

Certification of Analysis and Tests

INVOICE NUMBER 111-67291

Date: 7/12/11

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

Sold To	Your Purchase Order	Sales Order
ENERGY EXCHANGER COMPANY 1844 N. GARNETT ROAD TULSA, OK 74116 USA	Number 1275 By JIM ELDER Dated 6/09/2011	Number 111-52240 Shipped Via DELIVERY Ship Date 7/12/2011

1 | X-7934-2/2A | 111-52240-01 | RING | 28.125"OD x 23.250"ID x 3.188"TH | Qty 2

NUCOR | 110785 | SA266-10 GR4 NORMALIZED

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.18	1.16	.010	.004	.16	.09	.10	.19	.03	.014	.003	.023		.42	SN-.008;TI-.001

Yield Lb/Sqin	Tensile Strength Lb/Sqin	Elong%in 2in	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
47,700	73,000	35	73	144			FINE	CVN	-50F	85	90	80	85

2 | X-7938-2 | 111-52240-02 | RING | 33.000"OD x 26.000"ID x 4.750"TH | Qty 2

NUCOR | 111398 | SA266-10 GR4 NORMALIZED

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.17	1.18	.008	.005	.18	.07	.06	.17	.03	.019	.001	.023		.40	SN-.010;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
49,200	73,000	36	73	149			FINE	CVN	-50F	87	88	92	83

3 | X-7935-2 | 111-52240-03 | RING | 32.625"OD x 27.250"ID x 3.813"TH | Qty 1

NUCOR | 100652 | SA266-10 GR4 NORMALIZED

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.18	1.18	.010	.0016	.22	.06	.06	.20	.02	.018	.002	.028		.41	SN-.008;TI-.001

Yield Lb/Sqin	Tensile Strength Lb/Sqin	Elong%in 2in	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
49,400	74,000	36	73	149			FINE	CVN	-50F	138	106	112	198

4 | X-7931-2/3/5 | 111-52240-04 | RING | 33.375"OD x 28.000"ID x 4.000"TH | Qty 3

NUCOR | 110785 | SA266-10 GR4 NORMALIZED

Part #2.6.8

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.18	1.16	.010	.004	.16	.09	.10	.19	.03	.014	.003	.023		.42	SN-.008;TI-.001

Yield Lb/Sqin	Tensile Strength Lb/Sqin	Elong%in 2in	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
47,700	73,000	35	73	144			FINE	CVN	-50F	85	90	80	85

5 | X-7933-2 | 111-52240-05 | RING | 37.750"OD x 32.000"ID x 3.625"TH | Qty 1

NUCOR | 110785 | SA266-10 GR4 NORMALIZED

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.18	1.16	.010	.004	.16	.09	.10	.19	.03	.014	.003	.023		.42	SN-.008;TI-.001

Yield Lb/Sqin	Tensile Strength Lb/Sqin	Elong%in 2in	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
47,700	73,000	35	73	144			FINE	CVN	-50F	85	90	80	85

6 | X-7932-2/2A | 111-52240-06 | RING | 39.750"OD x 34.375"ID x 3.750"TH | Qty 2

NUCOR | 110785 | SA266-10 GR4 NORMALIZED

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.18	1.16	.010	.004	.16	.09	.10	.19	.03	.014	.003	.023		.42	SN-.008;TI-.001

Yield Lb/Sqin	Tensile Strength Lb/Sqin	Elong%in 2in	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
47,700	73,000	35	73	144			FINE	CVN	-50F	85	90	80	85

Notes:

VERIFIED BY

JUL 18 2011

EEC QC DEPT

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.

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

R Patterson

Noz. T-1,2

This MTR applies to your PO# 13360 Part #3

Material Test Report

Heat Code: GLZ

ISO 9001:2008 Certified

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

Progressive Supply Inc.	PO: 109361	Sales Order: 89296	Line: 3
PO Box 470748	Item Code: 0151300196-0020F	Qty Shipped: 8	
Tulsa, OK 74147-0748	Item Desc: FLG 03.00 0150 WN RF 160		
	Supplier: CMC	Supplier Heat: 3006390	

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

Element	(%wt)	Ladle	Product	EPCRA	CAS#
C	Carbon	0.19 ✓			
Mn	Manganese	0.90 ✓			7439-96-5
P	Phosphorous	0.005 ✓			
S	Sulphur	0.019 ✓			
Si	Silicon	0.19 ✓			
Cu	Copper	0.20 ✓			7440-50-8
Ni	Nickel	0.07 ✓			7440-02-0

Element	(%wt)	Ladle	Product	EPCRA	CAS#
Cr	Chromium	0.06 ✓			7440-47-3
Mo	Molybdenum	0.03 ✓			
V	Vanadium	0.003 ✓			
Cb	Columbium	0.003 ✓			
C.E.		0.376			
CuNiCrMo		0.357			
CrMo		0.087			

X-7931-81+82

Mechanical Testing	
Test Lab	AFG
Test Bar Size	SACRIFICIAL PIECE
HBW	156 - 156 ✓
Elg (%)	32.0 ✓
RA (%)	53.0 ✓
Tensile Specimen Size (in)	.245
Tensile (ksi)	76.6 ✓
Yield (ksi)	43.5 ✓
Gauge Length	1

Other	
MILL	CMC
MHC	3006390
Country of Origin	USA (US) ✓
EF	Y

No Weld repair performed. Chemical Analysis results shown are actual. Forgings are capable of passing hydrostatic test compatible with the appropriate rating. Elongation taken from a round specimen. All material supplied under this order is certified to be free of mercury contamination and no mercury bearing equipment was used in manufacturing, fabrication or testing. Yield strength was determined using the 0.2% offset method.
No weld repair performed on this product.
Product compliant with and meets all requirements of ASTM A105/

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.

RECEIVED
JUL 19 2011
EEC QC DEPT

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

Certification No.: 193329
Certification Date: 10/29/2010

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

Nicholas Tepovich - Metallurgic Lab Manager

GLZ3P30S160.max

Part #3

MATERIAL TEST REPORT

MTR # A203620

Forged Vessel Connections
2525 De Soto St. (77091)
P.O. Box 38421 (77238-8421)
Houston, Texas
FVC an Ameriforge Group company

This MTR applies to your PO# 1419

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

TEL: (713) 688-9705 FAX: (713) 688-7954 ISO 9001:2008 certified

S.O. No: 0-01968 Date: 08/18/2010 REV #
Purchaser: Progressive Supply Distributor:
P.O. No.: 10-9262 Distributor's Order No: Page 1

ITEM NO	QTY	DESCRIPTION	SPEC	HEAT #	HEAT TREAT
5	15	LWN,SA105, 150#, 1 x 9",RF&D .43 Max CE - Long Formula U.S. Melt & Manufacture .02 Max V, .02 Max Nb/Cb,	SA105 2007 Edition, 2008a Adden	C830AF	As-Forged

(C + (Mn / 6)) + ((Cr + Mo + V) / 5) + ((Ni + Cu) / 15) = .402

X-7931-83 Noz. V&D

CHEMICAL ANALYSIS AND MECHANICAL PROPERTIES

Heat #: C830AF A100469 United States

Chemical values below represent percentage of weight

C (Carbon)	Mn (Manganese)	P (Phosphorus)	S (Sulphur)	Si (Silicon)	Cr (Chromium)	Ni (Nickel)	Mo (Molybdenum)
.18	1.11 *CAS # 7349-96-5	.004 *CAS # 7723-14-0	.003	.23	.06 *CAS # 7440-47-3	.07 *CAS # 7440-02-0	.02 *CAS # 1313-27-5

Cu (Copper)	Al (Aluminum)	V (Vanadium)	As (Arsenic)	Sb (Antimony)	Sn (Tin)	Co (Cobalt)	N (Nitrogen)
.17 *CAS # 7440-50-8		.027 *CAS # 7440-62-2	.005 *CAS # 7440-38-2	.0060 *CAS # 7440-36-0	.009	.005 *CAS # 7440-48-4	.00700

Ti (Titanium)	Ta (Tantalum)	Cb (Columbium)	O (Oxygen)	H (Hydrogen)
.001		.000		

TENSILE (PSI)	YIELD (PSI)	ELONG (IN 2")	R.A. (%)	CHARPYS (FT - LBS)	TEMP ° F
79976	53885	30.0	69.0		

SHEAR %	LATERAL EXPANSION (MILS)	BHN
		< 187

COMMENTS

Test bar: 163-163 BHN

VERIFIED BY
AUG 12 2011
EEC QC DEPT
L Patterson

FVC STANDARD MANUFACTURING PRACTICES:

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

EPRCA Supplier Notification

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

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

Estela Cuellar

C830AF1X9P170.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. V4D

TEST/CERTIFICATE: EN 10204 — 3.1B

INTERNAL JOB: 104400

PROGRESSIVE SUPPLY
P. O. BOX 470748
TULSA OK 74145

This MTR applies to your PO# 1419

M.T.CERTIFICATE N.	DATE	YOUR P.O.	DATE
012992/B	12/15/2010	109389 X-7931-83D	11/29/2010

ITEM	DESCRIPTION	QUANTITY	B/P	MATERIAL	HEAT N°		#
013/013	1" 150 BL RF A105 B1 F	25	B	ASTM A/SA105 03c	72229		A
014/014	2" 150 WN RF STD A105 B1 F	11	A	ASTM A/SA105 03c	.3364-08		B
014/014	2" 150 WN RF STD A105 B1 F	19	B	ASTM A/SA105 03c	6297-09		C
016/016	2" 600 WN RF XS A105 B1 F	25	B	ASTM A/SA105 03c	5954/02		D

CHEMICAL ANALYSIS

#		C %	MN %	SI %	P %	S %	CR %	NI %	MO %	CU %	V %	SN %	AL %	NB %	TI %	N %	CB%	B %	FL%
A		0.175	1.200	0.250	0.017	0.010	0.140	0.110	0.020	0.200	0.011	0.010	0.025	0.001	0.005		0.001		0.42
A	C	0.165	1.220	0.220	0.012	0.005	0.160	0.140	0.030	0.230	0.006	0.010	0.030	0.001	0.005		0.001		0.43
B		0.164	1.180	0.274	0.005	0.008	0.080	0.140	0.040	0.140	0.001	0.006	0.020	0.0001		0.010	0.0001	0.0002	0.40
B	C	0.154	1.200	0.254	0.002	0.005	0.090	0.150	0.050	0.150	0.001	0.006	0.030	0.0001		0.010	0.0001		0.40
C		0.154	1.160	0.180	0.006	0.010	0.090	0.190	0.066	0.190	0.012		0.022	0.0010	0.001	0.012	0.0010	0.0004	0.40
C	C	0.144	1.180	0.200	0.003	0.013	0.080	0.200	0.056	0.200	0.007		0.038	0.0010	0.001	0.012	0.0010	0.0004	0.39
D		0.162	1.210	0.200	0.004	0.008	0.130	0.140	0.078	0.130	0.013	0.008	0.024	0.0010	0.001	0.009	0.0010	0.0005	0.42
D	C	0.152	1.230	0.180	0.007	0.011	0.140	0.130	0.088	0.140	0.008	0.008	0.034	0.0010	0.001	0.009	0.0010	0.0005	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	77,945	47,218	28.8	69.8				163
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	77,570	46,373	26.9	66.0				152
C	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
C	O		12.50	122.70	50.00	68	78,976	48,333	28.5	66.0				161
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	78,840	47,985	30.6	68.5				164

NOTES

O = OBTAINED
S = STANDARD

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

GENERAL NOTES

ROUGHNESS
F =STOCK FINISH 125-250 microinch

VERIFIED BY
AUG 12 2011
EEC QC DEPT

STANDARD
B1 = ASME B16.5

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

L. Patterson

TRADE MARK / LOGO	INT. INSPECT DATE	INT. INSPECTOR
Stamped on product	12/15/2010	D.RUZICKA

INSPECTION AUTHORITY
Don Ruzicka

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

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

722291P70.max

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

Noz. S1 + 2

TEST/CERTIFICATE EN 10204 — 3.1B
INTERNAL JOB — 111505

PROGRESSIVE SUPPLY
P. O. BOX 470748
TULSA OK 74145

Part # 3

This MTR applies to your PO# 13336

M.T.CERTIFICATE N. 004087/B — DATE 05/06/2011
YOUR P.O. 119545 X-7931-71+72 — DATE 05/03/2011

ITEM	DESCRIPTION	QUANTITY	B/P	MATERIAL	HEAT N°		#
006/006	14" 150 WN RF XS A105 B1 F	5	B	ASTM A/SA105 03c	091447N/02	←	A
008/008	20" 150 WN RF XS A105 B1 F	2	B	ASTM A/SA105 03c	10357W/02		B
009/009	24" 150 WN RF XS A105 B1 F	2	B	ASTM A/SA105 03c	100928N/02		C
011/011	3" 150 WN RF XXS A105 B1 F	10	B	ASTM A/SA105 03c	74845		D

CHEMICAL ANALYSIS

#		C %	MN %	SI %	P %	S %	CR %	NI %	MO %	CU %	V %	SN %	AL %	NB %	TI %	N %	CO%	FC%	FL%
* A		0.160	1.180	0.230	0.010	0.002	0.130	0.070	0.020	0.170	0.020	0.009	0.032	0.002	0.001	0.009	0.007		0.40
A	C	0.150	1.200	0.250	0.007	0.002	0.120	0.080	0.030	0.180	0.015	0.009	0.037	0.002	0.001	0.009	0.007		0.40
B		0.160	1.180	0.170	0.010	0.004	0.090	0.100	0.020	0.190	0.014		0.020	0.0002					0.40
B	C	0.150	1.200	0.190	0.013	0.001	0.100	0.110	0.010	0.200	0.009		0.030	0.0002					0.39
C		0.160	1.160	0.210	0.008	0.003	0.180	0.080	0.020	0.170	0.016		0.030	0.0020	0.001				0.41
C	C	0.150	1.180	0.190	0.005	0.006	0.190	0.070	0.010	0.160	0.011		0.040	0.0020	0.001				0.40
D		0.190	1.090	0.170	0.016	0.015	0.080	0.060	0.010	0.170	0.024							0.371	0.40
D	C	0.180	1.110	0.140	0.021	0.020	0.100	0.030	0.020	0.200	0.019							0.365	0.40

NOTES
FC=Carbon Equivalent Short Formula
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	76,643	49,514	28.0	66.0				151
B	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
B	O		12.50	122.70	50.00	68	78,911	50,132	28.2	66.6				157
C	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
C	O		12.50	122.70	50.00	68	76,952	49,421	27.2	67.2				154
D	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
D	O		12.50	122.70	50.00	68	76,377	49,373	30.0	66.0				153

NOTES

O = OBTAINED
S = STANDARD

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

GENERAL NOTES

ROUGHNESS
F =STOCK FINISH 125-250 microinch

STANDARD
B1 = ASME B16.5

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

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

TRADE MARK / LOGO
Stamped on product

INT. INSPECT DATE
05/06/20

INT. INSPECTOR
VERIFIED BY D.RUZICKA

INSPECTION AUTHORITY
JUL 19 2011
EEC QC DEPT

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

091447N14P30BX.max

Part #4 1500

TUBE TEST REPORT

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

IPSCO

X-7931. 81A & 82A Noz. 1-1, 2

ORDER: T14619 001	HEAT: 47200	P.O.: 6192	PART NO.

SOLD TO:	SHIP TO: STOCK

SPECIFICATION(S): ASME ASTM SA53/A53-10 GR B/SA106/A106-10 GR B
API5L PSL1 GR B/X42 FORTY FOURTH EDITION
CERTIFIED NACE MR0175 DATED 10/15/2009

GRADE: 1023M	SIZE: 3.500 X 0.438 DRL	WPF: 14.34	QUALITY: SEAMLESS HOT FINISH

CONDITION (SPECIAL): QUENCH & TEMPER
FINE GRAIN MELT PRACTICE
TEST METHODS USED: ASTM E415

TEST RESULTS CONFORM TO THE STANDARDS AND SPECIFICATION LISTED ABOVE.

	C	Mn	S	P	Si	Cr	Ni	Mo	Cu	Al	V	Cb	Ti	B
L	.21	.57	.008	.008	.21	.12	.11	.04	.23	.012	.003	.001	.0010	.0002
P	.20	.55	.003	.007	.20	.12	.10	.03	.21	.011	.001	.001	.0020	.0001
P	.20	.55	.003	.007	.20	.12	.10	.03	.21	.010	.001	.001	.0010	.0001

MATERIAL 100% MELTED AND MANUFACTURED IN THE USA.

Specimen ASTM E8	Yield KSI	Tensile KSI	ELNG 2"	R/A	C.E.	Rockwell ASTM E18 Avg	Hydrotest
.750 " STR	50.2 46.6	70.3 71.4	44.0 42.0		.36	70.4 73.1 73.8 72.4 RB	3000 PSI 5 Sec Hold

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

VERIFIED BY
JUL 19 2011
EEC QC DEPT

L. Patterson

Melinda Amoriale

4/1/11

DATE QUALITY ASSURANCE/KOPPEL

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

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

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

IPSCO BAYTOWN WORKS
2600 SPUR 55
BAYTOWN, TX 77523

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

4720043438.max

UNITED STATES STEEL

DATE: 03/10/06
TIME: 07:09:57
SERIAL NO:

TUBULAR PRODUCTS
CERTIFIED TEST REPORT

(TYPE B - IN ACCORDANCE WITH ISO 10474/EN10204/DIN50049 3.1.b)

MILL ORDER/ITEM NO.	SHIPPERS NO.	P.O. NUMBER	VEHICLE I.D.
DR34852 02		68005-00	

SOLD TO ADDRESS

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

MAIL TO ADDRESS

This MTR applies to your
PO# 1760

VENDOR

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

#70
STOCK 14" XH

SPECIFICATION AND GRADE

PIPE CARBON SMLS STD PIPE API 5L-*43RD EDITION DATED 3/04 PSL-2 GRADE B AND GRADE X42 ASTM A53-*04A ASTM A106-*04B GRADE B QUAD STENCIL ASME SA53-*2004 EDITION ASME SA106-*2004 EDITION GRADE B BLK REG MILL COAT PE BEV 30 DEG MEETING ALL THE APPLICABLE REQUIREMENTS OF NACE STANDARD MR-01-75 *2002

Noz. 2 1+2

MTR Verified
L. Patterson 6-13-06
ENERGY EXCHANGER COMPANY

X. 7931-71A+72A

MATERIAL COND: AS ROLLED | O.D.: 14.000(355.600) 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: 42000 MAX: 65000		MIN: 70000 MAX: 110000	MAX:	MIN: 30.0	MIN: MAX: 99.0	2550	5
S20385 G703AA	STRIP/L/B	AR	1.500	44300	.50	74000	0.60	43.0	B 79.3	2550	5
S20386 G701AA	STRIP/L/B	AR	1.500	51000	.50	75000	0.68	46.0	B 78.0	2550	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 .43
* S20385	HEAT		.20	1.06	.010	.005	.21	.05	.06	.10	.02	.031		.003	.0001	.002	.003					.41
S20385 G703AA	PROD		.19	1.05	.009	.006	.19	.05	.06	.11	.02	.030		.004	.0002	.002	.001					.40
S20385 G703AA	PROD		.18	1.05	.009	.006	.19	.05	.06	.10	.02	.033		.004	.0002	.002	.001					.39
S20386	HEAT		.19	1.06	.009	.004	.21	.05	.10	.09	.03	.035		.003	.0001	.002	.001					.40
S20386 G701AA	PROD		.18	1.07	.008	.005	.20	.06	.10	.09	.03	.037		.005	.0002	.002	.002					.40
S20386 G701AA	PROD		.19	1.06	.008	.005	.20	.05	.10	.09	.03	.036		.004	.0001	.002	.002					.40
			** END OF DATA THIS SHEET **																			

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

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

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

UNITED STATES STEEL

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

DATE: 03/10/06
TIME: 07:09:57
SERIAL NO:

MILL ORDER/ITEM NO.	SHIPPERS NO.	PO NUMBER
DR34852 02		68005-00

MATERIAL COND: AS ROLLED

O.D.: 14.000(355.600) 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 DEG F	SIZE	TEST COND.	FT-LBS 1	FT-LBS 2	FT-LBS 3	FT-LBS AVG	% SHEAR 1	% SHEAR 2	% SHEAR 3	% SHEAR AVG
S20385 G703AA	OK				T	B	+ 32	FULL	AR	96	109	94	99	20	50	40	36
S20386 G701AA	OK				T	B	+ 32	FULL	AR	146	153	154	151	100	100	100	100
			** END OF DATA THIS SHEET **														

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

TESTING / INSPECTION INFORMATION

TEST / INSPECTION	YES	RESULTS / COMMENTS
FULL LENGTH VISUAL	X	
FULL LENGTH EMI	X	OD X OD/ID ____ L ____ L/T X 10.0% NOTCH
FULL LENGTH MPI		
FULL LENGTH UT	X	OD ____ OD/ID X L X L/T ____ 10.0/10.0% NOTCH
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 HOT FINISHED.
PIPE ALSO MEET THE REQUIREMENTS OF ASTM A106 GRADE C & ASME SA106 GRADE C

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

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

DATE 03/10/06

Part #4

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-7931-12 + 15

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												

Part #9, 2 pcs Part #9

VERIFIED BY
JUN 20 2011
EEC QC DEPT

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

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. A. Depretis, Metallurgist

05/12/2011 12:52:48 PM

Part #7

TEST CERTIFICATE

ARCELORMITTAL PLATE LLC

PAGE NO: 01 OF 02
FILE NO: 5064-01-02
MILL ORDER NO: 54135-002
MELT NO: R8207
SLAB NO: 2
DATE: 02/26/11

SHIP TO:
C.G. MARTIN, INC.
C/O OAKHURST STATION
OAKHURST OK 74050

X-7931-4

SOLD TO:
C. G. MARTIN, INC.
P.O. BOX 9345
TULSA OK 74157

SEND TO:

01-C

PLATE DIMENSIONS / DESCRIPTION

TOTAL QTY	GAUGE	WIDTH	LENGTH	DESCRIPTION	PIECE WEIGHT
1	3-1/4"	120"	360"	RECTANGLE	39817#

CUSTOMER INFORMATION

CUSTOMER PO: 6211

SPECIFICATION(S)

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

ASME SA516 REV ED YR 07 GR 70
ASTM A516 YR 06 GR 70
THE MANAGEMENT SYSTEMS FOR MANUFACTURE OF THIS PRODUCT ARE CERTIFIED TO ISO 9001:2000 (CERTIFICATE NO. 30130) AND ISO 14001 (CERTIFICATE NO. 006928).

CHEMICAL COMPOSITION

	C	MN	P	S	CU	SI	NI	CR	MO
MELT:R8207	.24	.97	.008	.002	.11	.21	.09	.09	.02

	V	TI	B	AL	CB	CEF
MELT:R8207	.001	.003	.0005	.025	.001	.44

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

MANUFACTURE

MCQUAID-EHN GRAIN SIZE PER E112 - 7-8

HEAT TREAT CONDITION

MATL OR TEST	HEAT TREAT DESCRIPTION	NOM TEMP	HOLD MINS	COOL MTHD
PL/TEST	NORMALIZE	1650F	98	AIR COOL

VERIFIED BY
JUL 06 2011
EEC QC DEPT

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

WE HEREBY CERTIFY THE ABOVE INFORMATION IS CORRECT:

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

L. Patterson
Elinore Zaplitny

SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

 Part #7

TEST CERTIFICATE

PAGE NO: 02 OF 02
FILE NO: 5064-01-02
MILL ORDER NO: 54135-002
MELT NO: R8207
SLAB NO: 2
DATE: 02/26/11

TENSILE PROPERTIES

SLAB NO.	LOC	DIR	YIELD STRENGTH PSI X 100	TENSILE STRENGTH PSI X 100	ELONGATION GAGE LGTH	%
2	BOT.	TRANS.	449	816	2.00"	21.0

GENERAL INFORMATION

ALL STEEL HAS BEEN MELTED AND MANUFACTURED IN THE U.S.A.
TEST CERTS. ARE PREPARED IN ACCORD. WITH PROCEDURES
OUTLINED IN EN 10204:2004 TYPE 3.1.
MERCURY OR MERCURY COMPOUNDS ARE NOT USED IN THE
MANUFACTURE OF ARCELORMITTAL PLATE LLC PRODUCTS.
FOR MORE INFORMATION AND PROCESSING GUIDELINES, REFER TO
WWW.ARCELORMITTAL.COM/PLATEINFORMATION

B/L #33076 TTPX 804076

DUPLICATE ORIGINAL TEST REPORT FROM C.G. MARTIN CO., INC.

CUST ID	22	WO#	79851
CUST	ENERGY EXCHANGER COMPANY		
P.O. #	1273		
ITEM #	5		
DESC	(1) 29-3/4" OD(F) X 3" THK(F)		
DATE	06/30/11	BY:	

WE HEREBY CERTIFY THE ABOVE INFORMATION IS CORRECT:

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

Elinore Zaplitny
SUPERVISOR – TEST REPORTING
ELINORE ZAPLITNY

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-7931-15

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
L. Patterson

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

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. ;

1 pc. Part #4

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.
Yield by 0.5EUL method unless otherwise specified. Ceq = C+(Mn/6)+((Cr+Mo+V)/5)+((Cu+Ni)/15)
Pcm = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/60)+(Cr/20)+(Mo/15)+(V/10)+5B
Melted and manufactured in the USA. ISO 9001:2008 certified (#008083) by SRI Quality System Registrar (#0985-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant. DIN 50049 3.1.B/EN 10204 3.1B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only, Quality Assurance certificate 09-MMPQA-546

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

T. A. Depretis

T. A. Depretis, Metallurgist

04/26/2011 10:32:37 AM

PRESCOR, INC.

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

MILL TEST REPORT

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

CUSTOMER	CUSTOMER ORDER NO.	OUR JOB NO.	DATE
ENERGY EXCHANGER COMPANY	1304	171248	8-16-2011

CODE	QTY.	SIZE O.D. & THK.	PLATE MFG'R.	HEAT NO.	SLAB NO.	ASTM NO.	YIELD PSI	TENSILE PSI	% ELONG.	BEND TEST	C	MN	P	S	SI
AWGS	2	(1/2")NOM 26"ID X 5/16"MIN	NUCOR	0508877	01	SA 516 70	SEE ATTACHED								
AWJX	2	(1/2")NOM 26"ID X 5/16"MIN	SSAB	B1F546	A30	SA 516 70	SEE ATTACHED								
AWIZ	1	(1/2")NOM 28"ID X 5/16"MIN	MITTAL	812T34100	J063899	SA 516 70	SEE ATTACHED			X	7931		-18		
AWJX	1	(1/2")NOM 32"ID X 7/16"MIN	SSAB	B1F546	A30	SA 516 70	SEE ATTACHED								
AWDS	1	(1/2")NOM 31"ID X 7/16"MIN	MITTAL	812P40380	H073694	SA 516 70	SEE ATTACHED								
AWDW	1	(1/2")NOM 31"ID X 7/16"MIN	MITTAL	812P40380	H073696	SA 516 70	SEE ATTACHED								

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

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

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

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

By Sherry Tockey

PRESCOR, INC.

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

Part # 10

Part # 10

ArcelorMittal Burns Harbor Plate

QUALITY ASSURANCE
REPORT OF TEST AND ANAYLSES

SHIPMENT NO.	DATE SHIPPED	CAR OR VEHICLE NO.	
803-07423	05-07-11	IHB-MCCOO-BNSF-TULSBNSF 545489	PAGE 6

SOLD TO:
PRESCOR INC
PO BOX 9856
TULSA OK 74157-0856

SHIP TO:
PRESCOR INC
8901 NEW SAPULPA RD
SAPULPA OK 74131

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

QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A.
PLATES - ASME SA516 GR 70 PVQ 2010 EDITION
--- MILL TEST PCS NORM 1650F FOR
1HR/IN AIRCL --- TEST CERTS ARE
PREPARED IN ACCORD WITH PROCEDURES
OUTLINED IN EN 10204:2004 TYPE 3.1
NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)
MFST - MFST MM11066 MFST MILL SERIAL# MFST TEST CERTS
ARE PREPARED IN ACCORD WITH PROCEDURES OUTLINED
IN EN MFST 10204:2004 TYPE 3.1
- LIFT MAX 10
TON UNLDG MOBILE CRANE-PLATE CLAMP
CO# MM11066 GH 820-4547B
TEST SPECIMENS LABORATORY HEAT TREATED AND YIELD STRENGTH @ .5% E.U.L.
MERCURY IN ANY FORM HAS NOT BEEN USED
IN THE PRODUCTION OF THIS ORDER

J063899	812T34100	3	1/2	96	240	AWIZ	9801	53700	76600	8	24
J062375	821T01340	3	1/2	96	240	AWIU	9801	53800	76600	8	22

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

X-7931-18

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

HEAT NUMBER	CHEMICAL ANALYSIS C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti	Al	B	Cb	N	Sn	MQUAID GRAIN SIZE
* 812T34100	.17	1.09	.014	.004	.346	.226	.17	.03	.006	.002	.002	.035	.0002		.002	.004	.005
821T01340	.17	1.04	.011	.003	.390	.243	.18	.03	.005	.001	.002	.061	.0002		.002	.004	.007

VERIFIED BY

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

D. W. ELWOOD PER WNK
SUPV. QUALITY ASSURANCE

BHPLTRPT.TIF

EEC QC DEPT
K Patterson

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

303

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 : 03/02/2011 B/L No. : 287140 Load No. : 288873 Our Order No. : 88447/4 Cust. Order No. : MUS-232901

Vehicle No: NOKL 725191

Specification : 0.5000" x 120.000" x 480.000"
ASTM A516 70-10/ASME SA516 70 PVQ 2009 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-7931-16

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
1501468	0.20	1.06	0.014	0.002	0.20	0.26	0.09	0.09	0.02	0.024	0.005	0.002	0.002		0.0040	0.0003	0.012	0.42	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.
1501468-07	5	20.41	T	49,900	78,500		23.3												
* 1501468-08	4	16.33	T	48,800	78,700		23.2												
1501468-07	5	20.41	T	48,600	73,900		23.1	N											
1501468-08	4	16.33	T	47,500	71,500		21.9	N											

VERIFIED BY
APR 27 2011
EEC QC DEPT

Reviewed / Accepted
I.Q.S. #
William B

Part # 11

NACE MR0175 ANNEX 2.1.2 COMPLIANT

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

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.
Yield by 0.5EUL method unless otherwise specified. Ceq = C+(Mn/6)+((Cr+Mo+V)/5)+((Cu+Ni)/15)
Pcm = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/60)+(Cr/20)+(Mo/15)+(V/10)+5B
Melted and manufactured in the USA. ISO 9001:2008 certified (#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

03/07/2011 9:09:47 AM

SSAB

Test Certificate

318

13609 Industrial Road, Houston, TX 77015

Form TC1: Revision 1: Date 31 Oct 2000

Customer: METALS USA PLATES & SHAPES SOU P.O. BOX 3528 101 EAST ILLINOIS ENID OK 73702	**Customer P.O. No.:** MUS-232724	**Mill Order No.:** 41-289050-03	**Shipping Manifest :** HT067336
	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-7921-63	

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

Reviewed / Accepted
I.Q.S. # 9

(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 # 12

NUCOR STEEL TUSCALOOSA, INC.

MILL TEST CERTIFICATE

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

NU319

Load Number	Tally	Mill Order Number	P.O. Number	Part Number	Certificate Number	Date
380953	00000000397845	N-104142-011	MUS-232791		L313214-1	01/20/2011 09:28

Grade

Order Description:
A516 70, 0.7500 IN x 96.000 IN x 480.000 IN

Quality Plan Description:
A51670 NORM: ASTM A516-70-06/ASME SA516-70-06 09 add NORMTEST

Customer:

Sold TO:
METALS USA MUSKOGEE OK

Ship TO:
METALS USA Muskogee OK

X-7931-17

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
1A0894B	A1M0119-02 ***	A1M0119	0.24	1.08	0.010	0.004	0.21	0.20	0.08	0.07	0.016	0.000	0.001	0.036	0.001	0.007	0.0002	0.0037	0.007	0.45
1A0894C	A1M0119-02 ***	A1M0119	0.24	1.08	0.010	0.004	0.21	0.20	0.08	0.07	0.016	0.000	0.001	0.036	0.001	0.007	0.0002	0.0037	0.007	0.45
* 1A0896B	B1M5109-01 ***	B1M5109	0.23	1.09	0.011	0.006	0.21	0.18	0.06	0.07	0.015	0.000	0.001	0.043	0.001	0.010	0.0001	0.0028	0.007	0.45
1A0896C	B1M5109-01 ***	B1M5109	0.23	1.09	0.011	0.006	0.21	0.18	0.06	0.07	0.015	0.000	0.001	0.043	0.001	0.010	0.0001	0.0028	0.007	0.45
1A0896D	B1M5109-01 ***	B1M5109	0.23	1.09	0.011	0.006	0.21	0.18	0.06	0.07	0.015	0.000	0.001	0.043	0.001	0.010	0.0001	0.0028	0.007	0.45
1A0897B	B1M5109-03 ***	B1M5109	0.23	1.09	0.011	0.006	0.21	0.18	0.06	0.07	0.015	0.000	0.001	0.043	0.001	0.010	0.0001	0.0028	0.007	0.45
1A0897C	B1M5109-03 ***	B1M5109	0.23	1.09	0.011	0.006	0.21	0.18	0.06	0.07	0.015	0.000	0.001	0.043	0.001	0.010	0.0001	0.0028	0.007	0.45

Shipped Item	Certified By	Heat Number	Yield ksi	Tensile ksi	Y/T %	ELONGATION % 2"	ELONGATION % 8"	Bend OK?	Hard HB	Charpy Impacts (ft-lbf) Size mm	1	2	3	Avg	Shear % 1	2	3	Avg	Test Temp
1A0894B	S1A0894BTT	A1M0119 ***	51.7	73.7	70.1	35.8													
1A0894B	S1A0894FTT	A1M0119 ***	50.1	79.0	63.4	37.5													
1A0894B	S1A0894MTT	A1M0119 ***	52.5	73.8	71.1	36.1													
1A0894B	S1A0894NBT	A1M0119 ***	52.3	76.5	68.4	39.2													
1A0894B	S1A0894NFT	A1M0119 ***	53.5	77.3	69.2	37.8													
1A0894B	S1A0894NMT	A1M0119 ***	51.6	77.2	66.8	38.2													
1A0894C	S1A0894BTT	A1M0119 ***	51.7	73.7	70.1	35.8													
1A0894C	S1A0894FTT	A1M0119 ***	50.1	79.0	63.4	37.5													
1A0894C	S1A0894MTT	A1M0119 ***	52.5	73.8	71.1	36.1													
1A0894C	S1A0894NBT	A1M0119 ***	52.3	76.5	68.4	39.2													
1A0894C	S1A0894NFT	A1M0119 ***	53.5	77.3	69.2	37.8													

Items: 7 PCS: 18 Weight: 176422 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. 1650 F FOR 60 MIN PER INCH OF THICKNESS Manufactured to a fully killed fine grain practice. ** Produced from Coil ** ISO 9001:2008 Registered, PED Certified

"***" indicates Heats melted and Manufactured in the U.S.A. ✓

VERIFIED BY
JUN 16 2011
EEC QC DEPT

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

April Pitts - QA Engineer
Reviewed / Accepted
I.Q.S. # 3
William Bronaugh

Part #13

NUCOR
NUCOR STEEL TUSCALOOSA, INC.

MILL TEST CERTIFICATE

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

Load Number	Tally	Mill Order Number	P.O. Number	Part Number	Certificate Number	Date
380953	00000000397845	N-104142-011	MUS-232791		L313214-1	01/20/2011 09:28

Grade

Order Description:
A516 70, 0.7500 IN x 96.000 IN x 480.000 IN
Quality Plan Description:
A51670 NORM: ASTM A516-70-06/ASME SA516-70-06 09 add NORMTEST

Customer:

Sold TO:
METALS USA MUSKOGEE OK
Ship TO:
METALS USA Muskogee OK

Shipped Item	Certified By	Heat Number	Yield ksi	Tensile ksi	Y/T %	ELONGATION % 2"	ELONGATION % 8"	Bend OK?	Hard HB	Charpy Impacts (ft-lbf) Size mm	1	2	3	Avg	Shear % 1	2	3	Avg	Test Temp
1A0894C	S1A0894NMT	A1M0119 ***	51.6	77.2	66.8	38.2													
* 1A0896B	S1A0896BTT	B1M5109 ***	54.5	74.8	72.9	36.1													
1A0896B	S1A0896FTT	B1M5109 ***	52.9	77.7	68.1	35.9													
1A0896B	S1A0896MTT	B1M5109 ***	52.3	73.6	71.1	37.0													
1A0896B	S1A0896NBT	B1M5109 ***	54.7	76.0	72.0	40.2													
1A0896B	S1A0896NFT	B1M5109 ***	51.1	75.7	67.5	40.1													
1A0896B	S1A0896NMT	B1M5109 ***	53.1	76.3	69.6	40.4													
1A0896C	S1A0896BTT	B1M5109 ***	54.5	74.8	72.9	36.1													
1A0896C	S1A0896FTT	B1M5109 ***	52.9	77.7	68.1	35.9													
1A0896C	S1A0896MTT	B1M5109 ***	52.3	73.6	71.1	37.0													
1A0896C	S1A0896NBT	B1M5109 ***	54.7	76.0	72.0	40.2													
1A0896C	S1A0896NFT	B1M5109 ***	51.1	75.7	67.5	40.1													
1A0896C	S1A0896NMT	B1M5109 ***	53.1	76.3	69.6	40.4													
1A0896D	S1A0896BTT	B1M5109 ***	54.5	74.8	72.9	36.1													
1A0896D	S1A0896FTT	B1M5109 ***	52.9	77.7	68.1	35.9													
1A0896D	S1A0896MTT	B1M5109 ***	52.3	73.6	71.1	37.0													
1A0896D	S1A0896NBT	B1M5109 ***	54.7	76.0	72.0	40.2													
1A0896D	S1A0896NFT	B1M5109 ***	51.1	75.7	67.5	40.1													
1A0896D	S1A0896NMT	B1M5109 ***	53.1	76.3	69.6	40.4													
1A0897B	S1A0897BTT	B1M5109 ***	54.9	74.6	73.6	36.0													

Items: 7 PCS: 18 Weight: 176422 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. 1650 F FOR 60 MIN PER INCH OF THICKNESS 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.

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

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

April Pitts - QA Engineer

Part # 13

12/28/2010 From: AMERICAN ALLOY STEEL
P.O.# :0808 S.O.# :380743
Item :6 (2 PC) 3/8" X 120" X 240"
:TAG: STOCK
To: ENERGY EXCHANGERS AA PL#:5105552

293

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

Mill Test Report

Page 2

AMERICAN ALLOY PLATE# 5105552 NUCOR It's our Nature.

Issuing Date : 11/26/2010 B/L No. : 278611 Load No. : 280664 Our Order No. : 88990/5 Cust. Order No. : 83852-OK

Vehicle No: ALY 91733

Specification : 0.3750" x 120.000" x 480.000"
ASTM A516 70-08/ASME SA516 70 PVQ 2009 Addenda Normalized
Test Coupons at 1650F Hold 30 Min per inch of thickness Air Cooled

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

Ship To : AMERICAN ALLOY STEEL C/O
REYNOLDS TRUCKING
BNSF SPUR 280
TULSA,OK 74116

Marking : 6126 83852-OK X-7931-120

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
0508228	0.20	1.05	0.010	0.000	0.22	0.30	0.13	0.06	0.03	0.026	0.004	0.001	0.002		0.0011	0.0001	0.011	0.42	0.28

Tensile Test

Plate Serial No	Pieces	Tons	Dir.	(psi) Yield	(psi) Tensile	Elongation % in 2"	Elongation % in 8"	
0508228-03	5	15.31	T	52,400	77,900		21.6	
→0508228-04	2	6.12	T	54,800	81,300		23.4	
0508228-03	5	15.31	T	50,800	75,400		23.5	N
0508228-04	2	6.12	T	50,500	75,800		24.3	N

Charpy Impacts

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

CHECKED JAN - 3 2011
L. Patterson

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

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

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

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.
Yield by 0.5EUL method unless otherwise specified. Ceq = C+(Mn/6)+((Cr+Mo+V)/5)+((Cu+Ni)/15)
Pcm = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/60)+(Cr/20)+(Mo/15)+(V/10)+5B
Melted and manufactured in the USA. ISO 9001:2008 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, Metallurgist

11/29/2010 10:51:46 AM

Part #14

301

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 : 03/11/2011 B/L No. : 287729 Load No. : 289632 Our Order No. : 88447/3 Cust. Order No. : MUS-232901

Vehicle No: NOKL 725159

Specification : 0.5000" x 72.000" x 480.000"
ASTM A516 70-10/ASME SA516 70 PVQ 2009 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-7931-50,51 + 62

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
1500860	0.19	1.13	0.010	0.000	0.20	0.32	0.09	0.10	0.02	0.031	0.006	0.003	0.002		0.0011	0.0003	0.012	0.43	0.28

Tensile Test

Plate Serial No	Pieces	Tons	Dir.	(psi) Yield	(psi) Tensile	Elongation % in 2"	Elongation % in 8"	
1500860-09	4	9.80	T	54,700	84,500		21.8	
			T	52,500	77,900		25.1	N

Charpy Impacts

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

VERIFIED BY
APR 27 2011
EEC QC DEPT
L Patterson

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

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. ;

Part # 15 & 20

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, Metallurgist

03/28/2011 4:56:58 PM

SSAB

Test Certificate

Form TC1: Revision 1: Date 31 Oct 2000

13609 Industrial Road, Houston, TX 77015

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

Customer P.O. No.: MUS-231893 | Mill Order No.: 41-277716-01 | Shipping Manifest : HT964418

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

STOCK NB BRACKETS

X-7931.61

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

Cert No: 031110772
(Page 1 of 1)

Size: 0.188 X 96.00 X 480.0 (IN)

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
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							

Chemical Analysis

Heat Id	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

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

Part #16

Part #17

MATERIAL TEST REPORT

Sold To: 3010000	Ship To: 3010000
ENERGY EXCHANGER	ENERGY EXCHANGER
1844 N. GARNETT	1844 N. GARNETT
TULSA OK 74116	TULSA OK 74116
	X-7931

Purchase Order:	1070 / X-7931 X-7935 X-7936
Sales Order:	132889
Material:	BA13007500830M A/SA214/178-A ERW 0750 OD 083M
Delivery:	80216992

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:		GC51644 % (7 pcs)	WA101431 % (118 pcs)
CARBON	LDL	0.070	0.061
MANGANESE	LDL	0.460	0.370
PHOSPHORUS	LDL	0.013	0.014
SULFUR	LDL	0.005	0.003
SILICON	LDL	0.030	0.020
NICKEL	LDL	0.030	0.050
CHROMIUM	LDL	0.050	0.060
MOLYBDENUM	LDL	0.010	0.010
COPPER	LDL	0.090	0.130
ALUMINUM	LDL	0.030	0.030
R-EACH	LDL	0.000	0.000
R-TOTAL	LDL	0.000	0.000
BORON	LDL	0.000	0.0001
CALCIUM	LDL	0.000	0.002
NITROGEN	LDL	0.000	0.008
TIN	LDL	0.000	0.006
TITANIUM	LDL	0.000	0.001
VANADIUM	LDL	0.000	0.003
Ultimate (PSI)			
Yield (PSI)			
Elongation (%)			
Hardness (RB)		57 / 59	51 / 57
Origin of Melt		USA	USA
Manufactured in		USA	USA

VERIFIED BY
SEP 15 2011
EEC QC DEPT

L. Patterson

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: 09/15/2011

Tim Benear
Quality Manager

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

DATE: 07/15/11

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

Part #18

CERTIFIED MATERIAL TEST REPORT

ENERGY EXCHANGERS
1844 N. GARNETT RD.
TULSA OK 74116

LOT # 783584
HEAT # 775787
STOCK # B7S087C700
7/8-9 X 7 ASTM A-193 B-7 STUD
CUS PO# 1339
ORDER # 277425
TAG # 7931 LINE 41

SPECIFICATIONS:

ASTM A-193 B-7 ALL THREAD ROD
REV 2007

VENDOR: VULCAN THREADED PRODUCTS, INC. QTY SOLD 28

- CHEMICAL COMPOSITION -

C %	MN %	P %	S %	SI %	NI %	CR %
00.4100	00.8200	00.0100	00.0200	00.2500	00.0800	00.9500

MO %	CU %	CO %	V %	AL %	FE %	TA %
00.1700	00.2300		00.0050			

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

- CHARPY IMPACT -

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

- MECHANCIAL PROPERTIES -

TENSILE STRENGTH: 145,800 Psi
YIELD : 131,300
ELON : 20.00
RA : 58.00

HARDNESS : 29 HRC
PROOF STRESS: 0 Psi

COMMENTS:

NB= .02
COUNTRY OF ORIGIN USA
TEMPERING TEMP 1410 F'
META S1,R1,C1

VERIFIED BY
JUL 19 2011
EEC QC DEPT

W.M. HEITGRAS COMPANY

QUALITY CONTROL MANAGER

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

DATE: 07/15/11

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

Part #18

CERTIFIED MATERIAL TEST REPORT

ENERGY EXCHANGERS
1844 N. GARNETT RD.
TULSA OK 74116

LOT # 783584
HEAT # 783584
STOCK # B7S087C1012
7/8-9 X 10-1/8 ASTM A-193 B-7
CUS PO# 1339
ORDER # 277425
TAG # 7931 LINE 42

SPECIFICATIONS:

ASTM A-193 B-7 ALL THREAD ROD

VENDOR: VULCAN THREADED PRODUCTS, INC. QTY SOLD 28

- CHEMICAL COMPOSITION -

C %	MN %	P %	S %	SI %	NI %	CR %
00.3900	00.8700	00.0100	00.0200	00.2200	00.0800	00.8900

MO %	CU %	CO %	V %	AL %	FE %	TA %
00.2000	00.2500		00.0140			

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

- CHARPY IMPACT -

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

- MECHANCIAL PROPERTIES -

TENSILE STRENGTH: 132,700 Psi
YIELD : 120,000
ELON : 21.00
RA : 61.00

HARDNESS : HRC 26
PROOF STRESS: 0 Psi

COMMENTS:

MELTED AND MFG IN THE USA
TEMPERING TEMP 1405 F
MACRO S2/R2/C2

VERIFIED BY
JUL 19 2011
EEC QC DEPT

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

W.M. HEITGRAS COMPANY

QUALITY CONTROL MANAGER

DATE: 05/26/11

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

Part # 19

CERTIFIED MATERIAL TEST REPORT

ENERGY EXCHANGERS
1844 N. GARNETT RD.
TULSA OK 74116

LOT # BD291
HEAT # S77125
STOCK # H2HHN087C
7/8-9 ASTM A-194 2-H HEAVY
CUS PO# 1242
ORDER # 276291

STOCK

SPECIFICATIONS:

ASTM A-194 2-H HEAVY HEX NUTS

VENDOR: UNYTITE, INC.

QTY SOLD 1,950

- CHEMICAL COMPOSITION -

C %	MN %	P %	S %	SI %	NI %	CR %
00.4500	00.6800	00.0070	00.0230	00.2200	00.1000	00.1000

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 : 24-38
PROOF STRESS: 80,850 Psi

COMMENTS:

MELTED AND MFG IN THE USA

W.M. HEITGRAS COMPANY

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

VERIFIED BY
MAY 3 1 2011
EEC QC DEPT

QUALITY CONTROL MANAGER

IRIS NDT

MATERIAL VERIFICATION REPORT

IRIS No. 131936

Pg No 1 of

Customer:	Energy Exchanger Co.	Job/P.O.#:	X-7931	Location:	Tulsa, OK
Procedure:	8.0 XRF	Code/Specification:	ASME Sec. II		Date: 9/19/2011
X-ray Fluorescence	X	Optical Emission		EQUIPMENT: Niton	IRIS #: 63041
Calibration Standard:	self cal.				

Item	Location	Heat #	Mat. ID	C %	Mo %	Ni %	Cr %	W %	Ti %	Nb%	Cu %	Co %	Fe %	Mn %	V %	Si	S	P	Accept	Reject
1	7/8" X 7" lg studs		B7		0.21		1.05												X	
2	7/8" X 7" lg studs		B7		0.19														X	
3	7/8" X 7" lg studs		B7		0.17														X	
4	7/8" X 7" lg studs		B7		0.19														X	
1	7/8" X 10 1/8"" lg studs		B7		0.17															
2	7/8" X 10 1/8"" lg studs		B7		0.23															
3	7/8" X 10 1/8"" lg studs		B7		0.22															
4	7/8" X 10 1/8"" lg studs		B7		0.22															
1	1/2" X 2 1/2" lg studs		B7		0.21															
2	1/2" X 2 1/2" lg studs		B7		0.19															
3	1/2" X 2 1/2" lg studs		B7		0.20															
4	1/2" X 2 1/2" lg studs		B7		0.19															

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

REMARKS:

NOTE Values derived by X-Ray Fluorescence are subject to the limitations of this analysis method and are to be used only as a guide to the elemental content of a material. These values should not be considered equivalent to those expected from wet analysis, optical emission spectroscopy, or as stated in a Material Test Report.

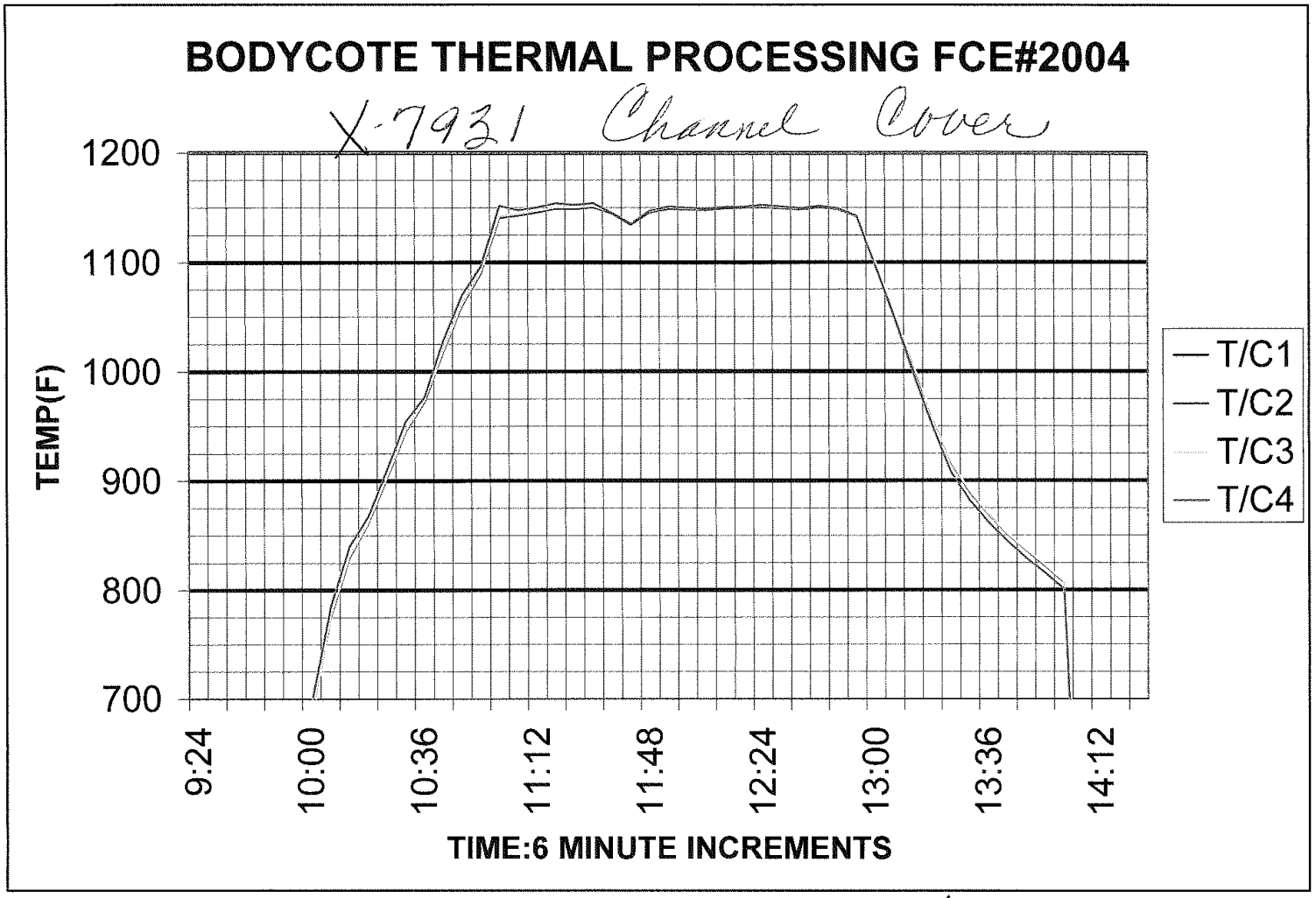
Personnel:		Unit #: 244	Miles:	Hrs:	Consumables: Minimum
Technician Print:	Brent Wilson			I am in full agreement with report contents:	
Signature:				Client Representative:	

SECTION 5

ENERGY EXCHANGER
JOB#49365
P/O#PX 9099

Oil Ex Over 9-6-11

9/2/11



CALIBRATION DATE 8/11/11
CALIBRATION DUE DATE 11/11/11

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

SIGNED BY JOSH SEYMOUR

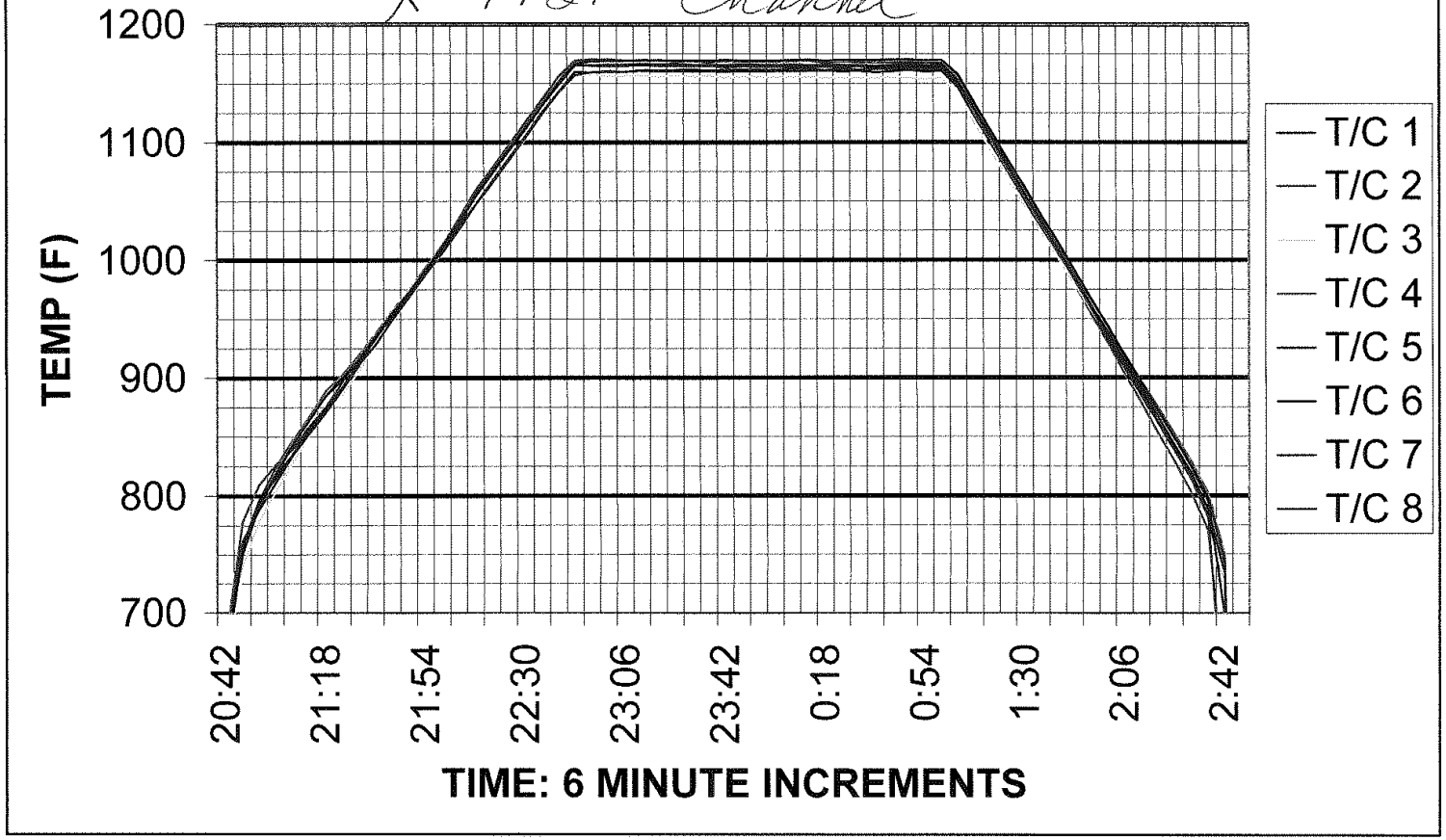
ENERGY EXCHANGER
JOB# 49346
P.O.# PX 9089

ow Power 9-3-11

9-2-11

BODYCOTE THERMAL PROCESSING FCE# 2001

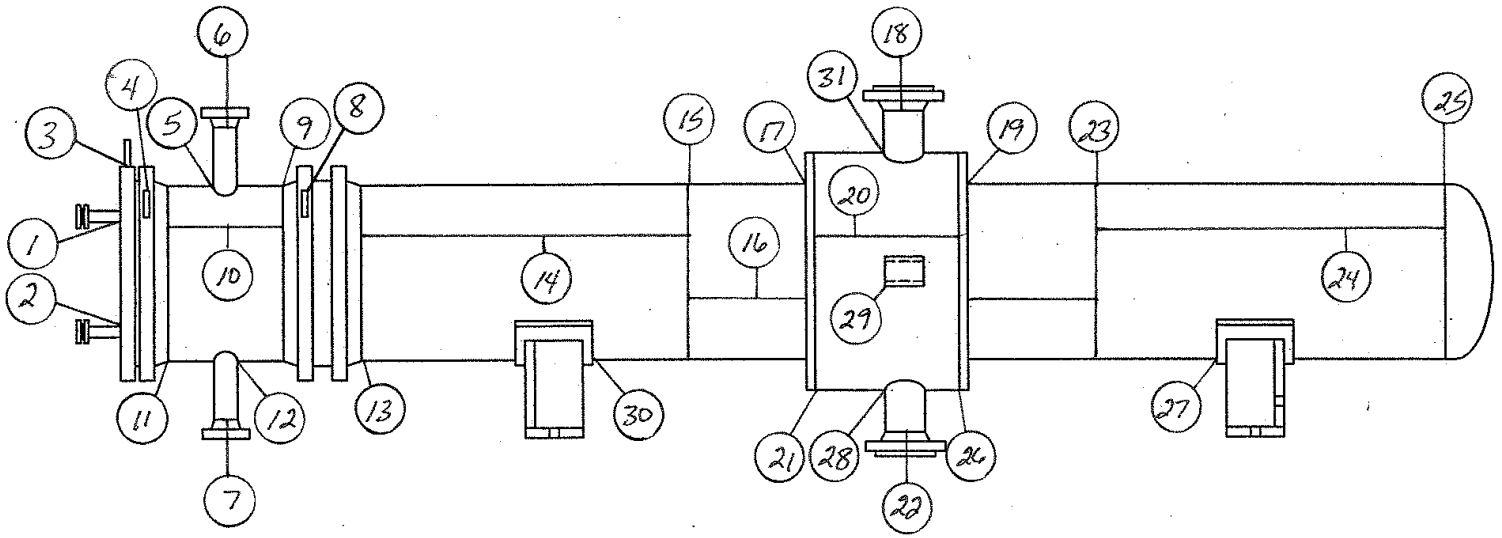
X-7931. Channel



CALIBRATION DATE 8-11-11
CALIBRATIOON DUE DATE 11-11-11

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

SIGNED BY JOHN WINKLE
John Winkle



NDE/WELD MAP

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

X-7931

ENERGY EXCHANGER COMPANY

CUSTOMER: MISSISSIPPI POWER P.O.#: 17497-0001

TAG: HX0040 ENERGY JOB # X-7931

NDE/WELD INDEX

Part #	Consumable	WPS	Weld Stamp	NDE Procedure	NDE Technician
1	E-7018-1	M-S-H	G	MT	M. WEBB / G. CARTER
2	〃	〃	G	〃	〃
3	〃	M-1	G	〃	〃
4	〃	M-1-H	A	〃	〃
5	〃	〃	G	〃	〃
6	〃	M-S-H	A	〃	〃
7	〃	M-S-H	A	〃	〃
8	〃	M-1-H	A	〃	〃
9	L-61	A-1-H	Y	RT	〃
10	〃	〃	F	〃	〃
11	〃	〃	Y	〃	〃
12	E-7018-1	M-1-H	G	〃	〃
13	L-61	A-1	K	RT	〃
14	〃	〃	J	〃	〃
15	〃	〃	K	〃	〃
16	〃	〃	J	〃	〃
17	〃	M-1	S	〃	〃
18	〃	A-1	Y	RT	〃
19	〃	M-1	G	〃	〃
20	〃	A-1	J	〃	〃
21	〃	〃	VQ	〃	〃
22	〃	〃	Y	RT	〃
23	〃	〃	K	〃	〃
24	〃	〃	J	〃	〃
25	〃	〃	U	〃	〃
26	〃	〃	VQ	〃	〃
27	E-7018-1	M-1	L	〃	〃
28	〃	〃	S	MT	〃
29	〃	〃	L	〃	〃
30	〃	〃	L	〃	〃
31	〃	〃	S	MT	〃

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

ENERGY EXCHANGER COMPANY

JOB # X-7931

P.O.# 17497-0001

PART IDENTIFICATION CHANNEL Spot UW 51 (APWHT)

TYPE OF MATERIAL SA-516-70 MATERIAL THICKNESS 28 3/4" OD x 3/8"

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

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

RADIOGRAPHIC DATA

1. RT DATE 9-9-11

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 0.18
   - 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 X1
   - CURIES 82 E.T. _____
   - S.O.D. 18 S.S.O.F. 3/8

RADIOGRAPHER S. Howard

INTERPRETER Edwin SNT TC-1A II DATE REVIEWED 9-10-11

CUSTOMER INSPECTOR Reviewed / Accepted I.Q.S. # 3 DATE REVIEWED 9/23/11

William Bronaugh

readersheet(A99).doc

ENERGY EXCHANGER COMPANY

JOB # X-7931

P.O.# 17497-0001

PART IDENTIFICATION CHANNEL SPOT UW51

TYPE OF MATERIAL SA-516-70 MATERIAL THICKNESS 28 3/4" X 3/8"

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

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

RADIOGRAPHIC DATA

1. RT DATE 8-25-11

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 D7
   - FILM DENSITY MAX. 3.5
   - FILM DENSITY MIN. 2.0

6. SOURCE DATA:
   - ISOTOPE Ir192 SIZE 1x 1
   - CURIES 68 E.T. 48
   - S.O.D. 14 3/8 S.S.O.F. 3/8

RADIOGRAPHER R. Stahl R. T3

INTERPRETER Mark Wells II DATE REVIEWED 8-26-11

CUSTOMER INSPECTOR Reviewed / Accepted I.Q.S. # 3 William Bronaugh DATE REVIEWED 9/23/11

readersheet(A99).doc

ENERGY EXCHANGER COMPANY

JOB # X-7931

P.O.# 17497-0001

PART IDENTIFICATION SHELL Spot UW51

TYPE OF MATERIAL SA-516-70 MATERIAL THICKNESS 28 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												
R1												
1-2	X											
L1												
1-2	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 9-1-11

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 1x1
   - CURIES 88 E.T. 15-6
   - S.O.D. 18 S.S.O.F. 1/2

RADIOGRAPHER R. Stahl RT II

INTERPRETER Elmer SNT-TC-1A II DATE REVIEWED 9-6-11

CUSTOMER INSPECTOR Reviewed / Accepted WB DATE REVIEWED 9/23/11

I.Q.S. # 3

William Branaugh

readersheet(A99).doc

ENERGY EXCHANGER COMPANY

JOB # X-7931

P.O.# 17497-0001

PART IDENTIFICATION SHELL Spot UW51

TYPE OF MATERIAL SA-516-70 MATERIAL THICKNESS 28 3/4" 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 9-27-11

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 1018
   - 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 1X1
   - CURIES 95 E.T. 1'10
   - S.O.D. 18 S.S.O.F. 1/2

RADIOGRAPHER S. Howard

INTERPRETER E. Duran SNT-TC-1A II DATE REVIEWED 9-28-11

Reviewed / Accepted
I.Q.S. #3

CUSTOMER INSPECTOR William Bronaugh DATE REVIEWED 9/29/11

readersheet(A99).doc

ENERGY EXCHANGER COMPANY

JOB # X-7931

P.O.# 17497-0001

PART IDENTIFICATION ANNULAR DIST Spot UWSI

TYPE OF MATERIAL SA-516-70 MATERIAL THICKNESS 35 3/4" OD x 1/2"

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

FILM IDENTIFICATION	ACCEPTABLE	REJECTED	FILM ARTIFACTS	SURFACE INDICATIONS	POROSITY	SLAG INCLUSIONS	CRACKS	INCOMPLETE FUSION	INADEQUATE PENETRATION	UNDERCUT	BURN THROUGH	REMARKS
A. D.												
11												
1-2	X											

RADIOGRAPHIC DATA

1. RT DATE 9-1-11

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 0/6
   - 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 88 E.T. 1105
   - S.O.D. 18 S.S.O.F. 1/2

RADIOGRAPHER [signature]

INTERPRETER Edward SMITH-IA II DATE REVIEWED 9-2-11

CUSTOMER INSPECTOR ~~Reviewed / Accepted~~ I.Q.S. # 3 William Branaugh DATE REVIEWED 9/23/11

readersheet(A99).doc

Energy Exchanger Company

DATE: 8-27-11

CERTIFICATION OF EXAMINATION
BY
MAGNETIC PARTICLE (DRY POWDER METHOD)

P.O. # 17497-0001

TAG # HX0040

ENERGY JOB # X-7931

CHANNEL
NOZZLE T1 & T2
BACK-CUTS

ACCEPTABLE

This certification is made to document that all Magnetic Particle Examinations have been performed on X-7931 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: 17173

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

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

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

Energy Exchanger Company

DATE: 8-30-11

CERTIFICATION OF EXAMINATION
BY
MAGNETIC PARTICLE (DRY POWDER METHOD)

P.O. # 17497-0001 CHANNEL

TAG # HX0040 Lifting Lug Weld

ENERGY JOB # X-7931 ACCEPTABLE

This certification is made to document that all Magnetic Particle Examinations have been performed on X-7931 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: 17173

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

LIGHTING: 100 FT CANDLES MIN. @ SURFACE

ENERGY EXCHANGER COMPANY

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

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

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

Energy Exchanger Company

DATE: 9-2-11

CERTIFICATION OF EXAMINATION
BY
MAGNETIC PARTICLE (DRY POWDER METHOD)

P.O. # 17497-0001

TAG # HX0040

ENERGY JOB # X-7931

CHANNEL (APWHT)
ALL WELDS
INTERNAL + EXTERNAL
ALL TEMP ATTACHMENTS
ALL ARC-STRIKES

ACCEPTABLE

This certification is made to document that all Magnetic Particle Examinations have been performed on X-7931 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: 17173

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

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

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

Energy Exchanger Company

DATE: 9-7-11

CERTIFICATION OF EXAMINATION
BY
MAGNETIC PARTICLE (DRY POWDER METHOD)

P.O. # 17497-0001

TAG # HX0040

ENERGY JOB # X-7931

SHELL
NOZZLE S1 & S2
BACK-CUTS

ACCEPTABLE

This certification is made to document that all Magnetic Particle Examinations have been performed on X-7931 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: 17173

MATERIAL AND THICKNESS: _____

LIGHTING: 100 FT CANDLES MIN. @ SURFACE

ENERGY EXCHANGER COMPANY

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

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

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

Energy Exchanger Company

DATE: 9-26-11

CERTIFICATION OF EXAMINATION
BY
MAGNETIC PARTICLE (DRY POWDER METHOD)

P.O. # 17497-0001

TAG # HX0040

ENERGY JOB # X-7931

SHELL
NOZZLE S1 +S2
INSERTION WELDS

ACCEPTABLE

This certification is made to document that all Magnetic Particle Examinations have been performed on X-7931 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: 17173

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

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

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

Energy Exchanger Company

BRINELL HARDNESS REPORT

JOB NO: X-7931

COMPONENT	LOCATION	WELD METAL	BHN HEAT AFFECTED ZONE	BHN PLATE	WELD PROCEDURE NUMBER
CHANNEL	R1	179	175		A-1-H
	L1	168	173		〃
	R2	176	172		〃
	T1	172	167		M-1-H
	T2	170	164		〃
SHELL	R1	178	182		A-1
	L1	187	191		〃
	R2	182	184		〃
	L2	180	181		〃
	R3	182	184		〃
	L3	186	179		〃
	R4	188	183		〃
	S1	182	182		M-1
	S2	179	184		〃
A.D.	R1	192	188		A-1
	L1	195	191		〃
	R2	186	180		〃
					E. Duran
					9-27-11

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

SECTION 6

Energy Exchanger Company

DATE: 9-26-11

CERTIFICATE OF WELD/SUPPORT PAD AIR TEST

P.O.# 17497-0001

TAG# HX0040

ENERGY JOB # X-7931

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

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

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

Energy Exchanger Company

DATE: 9-29-11

CERTIFICATION OF EXAMINATION
BY
LIQUID PENETRANT - WATER WASHABLE

P.O. # 17497-0001

TAG # HX0040

ENERGY JOB # X-7931

TUBE TO TUBESHEET WELDS (AFTER ROLL)

ACCEPTABLE

This certification is made to document that all Liquid Penetrant Examinations have been performed on X-7931 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: 3/4" X .083" SA-214

LIGHTING: 100 FT CANDLES MIN. @ SURFACE

ENERGY EXCHANGER COMPANY

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

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

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

Energy Exchanger Company

DATE: 9-29-11

CERTIFICATE OF TUBE TO TUBESHEET AIR TEST

P.O.# 17497-0001

TAG# HX 0040

ENERGY JOB # X-7931

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.

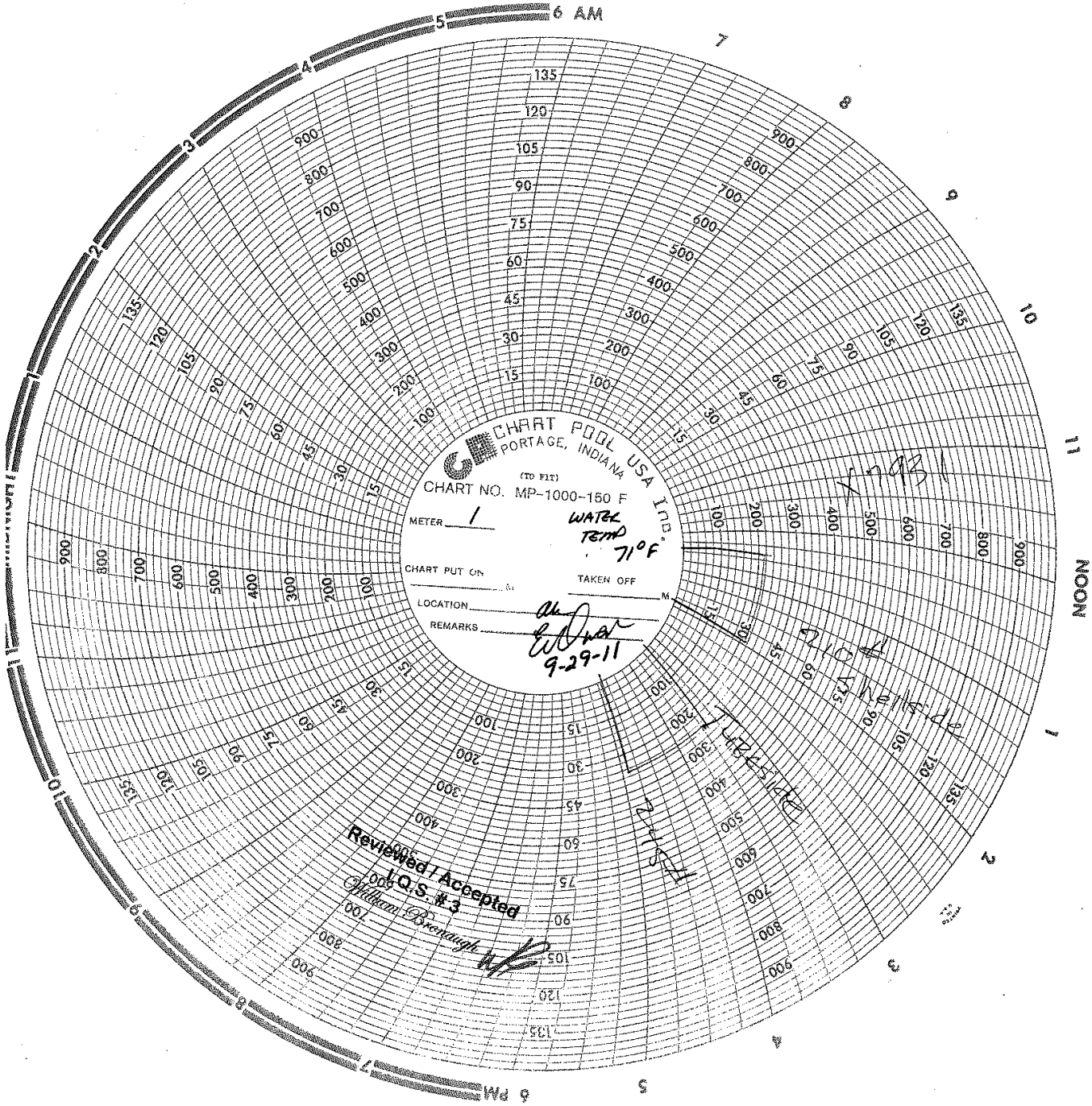
ENERGY EXCHANGER COMPANY

Edgar O. Owen

Edgar O. Owen
Quality Control Manager

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

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


6 AM
NOON
6 PM
CHART POOL USA Inc.
PORTAGE, INDIANA
(TO FIT)
CHART NO. MP-1000-150 F
METER 1
WATER TEMP 71°F
CHART PUT ON
TAKEN OFF
LOCATION
REMARKS
9-29-11
Reviewed / Accepted
I.Q.S. #3
William Brenaugh

Energy Exchanger Company

DATE: 9-29-11

CERTIFICATE OF HYDROSTATIC TEST

P.O.# 17497-0001

TAG# HX0040

ENERGY JOB # X-7931

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

210 PSI SHELL SIDE

245 PSI TUBE SIDE

BUBBLE TEST ON END

ENERGY EXCHANGER COMPANY

Edgar O Owen

Edgar O. Owen
Quality Control Manager

/lt

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

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

CITY OF Tulsa
A New Kind of Energy.

AB Jewell Treatment Plant: Oolagah Finished Water
Lab Analysis - Monthly Summary
(ppm/mg/L)

	Oct-08	Jan-09	Apr-09	Jul-09	Oct-09	Jan-10	Apr-10	Jul-10	Oct-10	Jan-11	Apr-11	MCL/SMCL*	Max	Min	Avg
Inorganics															
Chloride (Cl)	11.00	15.00	20.00	14.00	11.00	14.00	21.00	12.40	14.00	13.00	15.00	250*	21.00	11.00	14.58
MBAS	0.038	0.040	0.049	0.023	0.038	0.032	0.031	0.029	n/a	n/a	n/a	0.5*	0.049	0.023	0.035
Nitrate (N)	0.000	0.000	0.000	0.260	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.0	0.260	0.000	0.024
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 (PO4-Ortho)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.120	0.000	0.000	NR	0.120	0.000	0.011
Solids, T. Dis	180	190	250	190	140	51	190	320	170	180	190	500*	320	51	186
Sulfate	42.0	28.0	42.0	26.0	16.0	30.0	43.0	5.9	19.0	19.0	27.0	250*	43.0	5.9	27.1
Metals															
Aluminum (Al)	0.082	0.000	0.040	0.052	0.110	0.049	0.140	0.000	0.042	0.000	0.000	0.05-0.2*	0.140	0.000	0.047
Antimony (Sb)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	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	0.05	0.000	0.000	0.000
Barium (Ba)	0.046	0.052	0.063	0.052	0.042	0.046	0.061	0.059	0.053	0.048	0.056	2.0	0.063	0.042	0.053
Beryllium (Be)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000
Cadmium (Cd)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.005	0.0000	0.0000	0.0000
Calcium (Ca)	30.8	42.1	51.6	38.8	29.2	42.9	56.4	47.5	37.2	40.0	44.2	NR	56.4	29.2	41.9
Chromium (Cr)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.1	0.000	0.000	0.000
Copper (Cu)	0.0000	0.0000	0.0000	0.0620	0.0000	0.0000	0.0310	0.0000	0.0092	0.0000	0.0170	1.3/1.0*	0.0620	0.0000	0.0108
Cyanide	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	0.000	0.017	0.000	0.013	0.015	0.000	0.000	0.028	0.000	0.016	0.3*	0.028	0.000	0.008
Lead (Pb)	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	0.008
Magnesium (Mg)	5.45	6.91	8.80	7.42	5.45	7.26	9.14	9.64	6.32	7.40	7.74	NR	9.64	5.45	7.41
Manganese (Mn)	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.05*	0.002	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	0.002	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	NR	0.000	0.000	0.000
Potassium (K)	2.75	3.25	3.16	2.44	2.75	3.14	2.81	3.09	2.86	4.20	2.86	NR	4.20	2.44	3.03
Selenium (Se)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.05	0.000	0.000	0.000
Silicon (Si)	1.30	2.16	0.22	2.72	1.30	1.50	1.60	1.25	1.75	0.79	0.19	NR	2.72	0.19	1.34
Silver (Ag)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.1*	0.000	0.000	0.000
Sodium (Na)	16.3	10.0	13.6	12.1	9.2	10.2	16.4	19.7	11.5	12.0	13.3	NR	19.70	9.24	13.12
Thallium (Tl)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000
Zinc (Zn)	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	5.0*	0.02	0.00	0.00

	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	MCL/SMCL*	Max	Min	Avg
General															
Alkalinity (Avg)	138	123	110	109	113	116	119	121	121	122	125	NR	138	109	120
Total Hardness	169	143	121	118	121	125	128	132	133	132	140	NR	169	118	133
Fluoride (F)	0.88	1.05	0.97	0.96	0.93	0.90	0.87	0.76	0.70	0.47	0.55	2.0*	1.05	0.47	0.82
Spec. Conductance	356	326	288	253	252	258	258	261	264	275	292	NR	356	252	280
Chlorine Residual	2.21	2.26	2.3	2.2	2.2	2.22	2.24	2.26	2.37	2.29	2.34	4.0	2.37	2.20	2.26
Avg Water Temp. (F)	80	84	86	80	71	60	47	42	42	53	61	NR	86	42	64
Turbidity (NTU)	0.11	0.09	0.1	0.05	0.03	0.03	0.03	0.02	0.02	0.04	0.08	0.5	0.110	0.020	0.055
pH	7.7	7.8	7.8	7.9	7.8	7.9	8.0	8.1	8.0	8.1	8.1	6.5-8.5*	8	8	8

MCL - Maxmium Contaminant Level (40 CFR 141) - Primary levels are enforced by the state and the federal government.
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SMCL is indicated by an (*) next to the level.
NR - Not Regulated
TT - Treatment Technique
(#) - Indicates Below Detectable Level (less than zero)

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

CITY OF Tulsa
A New Kind of Energy.

Mohawk Treatment Plant: Spavinaw/Eucha Finished Water
Lab Analysis - Monthly Summary

(ppm \ mg/L)

	Oct-08	Jan-09	Apr-09	Jul-09	Oct-09	Jan-10	Apr-10	Jul-10	Oct-10	Jan-11	Apr-11	MCL/SMCL*	Max	Min	Avg
Inorganics															
Chloride (Cl)	9.40	9.40	11.00	12.00	9.40	9.20	9.90	12.00	12.00	12.00	11.00	250*	12.00	9.20	10.66
MBAS	0.019	0.027	0.021	0.000	0.019	0.026	0.020	0.023	n/a	n/a		0.5*	0.027	0.000	0.019
Nitrate (N)	0.000	0.000	0.290	0.000	0.000	0.830	1.300	0.000	0.220	0.000	0.000	10.0	1.300	0.000	0.240
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 (PO4-Ortho)	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.	120	89	150	120	120	41	130	120	120	180	140	500*	180	41	121
Sulfate	3.9	5.4	6.2	6.2	3.9	5.7	6.3	6.1	5.5	5.5		250*	6.3	3.9	5.5
Metals															
Aluminum (Al)	0.000	0.000	0.000	0.000	0.000	0.025	0.150	0.000	0.000	0.000	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	0.006	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	0.05	0.000	0.000	0.000
Barium (Ba)	0.036	0.042	0.045	0.034	0.036	0.029	0.045	0.034	0.031	0.052	0.051	2.0	0.052	0.029	0.040
Beryllium (Be)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000
Cadmium (Cd)	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.001	0.000	0.000
Calcium (Ca)	27.4	33.4	38.6	28.3	27.4	37.8	42.5	31.8	29.8	34.0	43.1	NR	43.1	27.4	34.0
Chromium (Cr)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.400	0.000	0.1	6.400	0.000	0.582
Copper (Cu)	0.0000	0.0000	0.0000	0.0240	0.0000	0.0000	0.0200	0.0000	0.0069	0.0000	0.0000	1.3/1.0*	0.0240	0.0000	0.0046
Cyanide	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	0.000	0.005	0.000	0.000	0.010	0.000	0.000	0.024	0.000	0.015	0.3*	0.024	0.00	0.005
Lead (Pb)	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)	1.55	1.80	1.81	1.97	1.55	1.92	1.63	1.96	1.82	2.10	2.07	NR	2.10	1.55	1.83
Manganese (Mn)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.05*	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	0.002	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	NR	0.000	0.000	0.0000
Potassium (K)	2.22	2.30	2.17	2.02	2.22	2.30	2.00	2.29	2.29	2.90	2.24	NR	2.90	2.00	2.27
Selenium (Se)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.05	0.000	0.000	0.000
Silicon (Si)	3.63	0.76	0.22	1.88	3.63	0.32	0.64	2.22	2.50	0.53	0.43	NR	3.63	0.22	1.52
Silver (Ag)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.1*	0.000	0.000	0.000
Sodium (Na)	7.77	7.30	6.29	8.06	7.77	5.69	7.72	8.87	9.78	8.20	7.24	NR	9.78	5.69	7.70
Thallium (Tl)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	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	5.0*	0.000	0.000	0.000

	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	MCL/SMCL*	Max	Min	Avg
General																	
Alkalinity (Avg)	99	97	86	81	76	80	86	90	89	97	102	103	101		103	76	91
Total Hardness	106	103	87	82	74	76	80	87	88	96	102	106	112	NR	112	74	92
Fluoride (F)	0.95	0.90	0.90	0.90	0.90	1.00	1.00	1.00	0.95	0.80	0.70	0.65	0.61	2.0*	1.00	0.61	0.87
Spec. Conductance	246	240	240	208										NR	246	208	234
Chlorine Residual	2.23	2.22	2.22	2.22		2.27	2.25	2.2	2.19	2.18	2.11	2.23	2.2	4.0	2.27	2.11	2.21
Avg Water Temp.(F)	65	73.6	82.4	86	89.9	85.1	76	52.2	51.9	46.9	47			NR	89.9	46.9	68.7
Turbidity (NTU)	0.05	0.06	0.05	0.04	0.05	0.04	0.05	0.02	0.02	0.02	0.02	0.02	0.04	0.5	0.06	0.02	0.037
pH	7.5	7.7	7.6	7.6	7.6	7.6	7.6	7.8	8.1	8.0	8.0	7.9	7.8	6.5-8.5*	8.1	7.50	7.76

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SMCL is indicated by an (*) next to the level.

NR - Not Regulated
TT - Treatment Technique
(#) - Indicates Below Detectable Level (less than zero)

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

Energy Exchanger Company

DATE: 10-17-11

CERTIFICATE OF NITROGEN PURGE

P.O.# 17497-0001

TAG# HX0040

ENERGY JOB # X-7931

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

ENERGY EXCHANGER COMPANY

PAINT CHECK LIST

Contractor: EATON INDUSTRIAL COATINGS

Unit Serial No: X-7931 Customer Specification No: _____

Paint Required: 2-3 mils C2-11 Primer; _____ mils _____ Intermediate;

1-2 mils 4700 Finish

Testex PRESS-O-FILM™ HT
www.testextape.com
Coarse
0.8 to 2.5 mil
20 to 64 µm
Made in USA
1.9
(C+XC) / 2

Satisfactory Date

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

2. Notify Energy Exchanger Company

3. Weather Conditions:
   81 temperature; 54% humidity; 75 substate, 63 dew point,
   EEC verify EW

4. Surface Prep:
   (Req'd) SSPC-SP- 10 1-2 mils; (Actual) SSPC-SP- 10 1.9 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

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

12. Dry Film Thickness:
    (Req'd) 3-5 (Actual) 4-6

13. Tie Down/Shipping Preparation

2nd COAT
TEMP 74
S. TEMP 70
HUMIDITY 52%
DEWPOINT 54

SECTION 7

SPL-7931

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-7931		11/1/2011
		SPARE GASKETS					
TAG NO.	EEC JOB NUMBER	QTY. SETS	NO. GASKETS PER SET	EEC DWG. NUMBER	UNIT $ PRICE *	SHIPMENT	
HX0040	X-7931	**	3	X-7931-O	$ 345.00	2-3 Weeks	

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

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

Energy Exchanger Company

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

A Member of the
Tubular Exchanger
Manufacturers Association

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

FOREWORD

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

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

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

TABLE OF CONTENTS

GENERAL INSTRUCTIONS FOR INSTALLATION, OPERATION AND MAINTENANCE OF SHELL AND TUBE HEAT EXCHANGERS

SAFETY CONSIDERATIONS

LIFTING DEVICES

When eyebolts, lugs, clips or other devices are installed by the manufacturer, it is intended that these lifting devices are to lift only the empty components to which they are attached and not the assembled heat exchanger, unless explicitly specified otherwise.

Proper rigging must be used in lifting assembled heat exchangers. Exchangers are usually much heavier than pressure vessels of comparable dimensions; therefore, weights should be carefully evaluated. Where available, determinations should include reference to manufacturers drawings, added components, bill of lading, etc. Special care must be exercised in handling exchangers with expansion joints.

ROUTINE PRECAUTIONARY PROCEDURES

A heat exchanger is a multi-chamber pressure vessel designed at specific limits of pressure, temperature and fluid flow conditions as shown on the exchanger specification sheet and heat exchanger nameplate(s). The process system, which includes the heat exchanger, must be safeguarded so that the heat exchanger design conditions and operating limits are not exceeded. All operating and maintenance personnel should be made aware of specific limitations including pressures and temperatures, flow rates, start-up/shut-down procedures and cleaning procedures.

Do not remove channel covers, shell covers, floating head covers, bonnets or connecting piping until all pressure has been relieved and both shell and tube sides are completely drained. Exceptions are permissible when design permits independent pressure testing of shell or tube sides.

Plugged tubes and double tubesheets, unless vented, may remain pressurized after shell and tube sides are depressurized. Caution may be exercised in loosening of tube plugs or opening of vents to avoid sudden release of pressure or harmful fluids.

Many heat exchangers circulate fluids which are toxic, lethal or flammable and dangerous to the human system. These fluids could cause problems if bolted or threaded joints are not maintained in leak-tight condition under operating or no-flow ambient conditions. Proper precautions, such as effective draining and purging, must be taken in handling and decontamination when exchangers are opened for any reason. It is essential that the user advise maintenance or repair personnel, including outside contractors, when toxic, lethal, or flammable conditions exist.

When heat exchangers are cleaned, it is important that full characteristics of the circulating fluids, fouling material, and the cleaning agent be known and care exercised in handling them. Use eye protection, a respirator, or other appropriate protective devices.

Do not blow out heat exchangers with air when the process fluids or the cleaning fluids being handled are flammable or reactive.

SECTION 1
HEAT EXCHANGER NOMENCLATURE

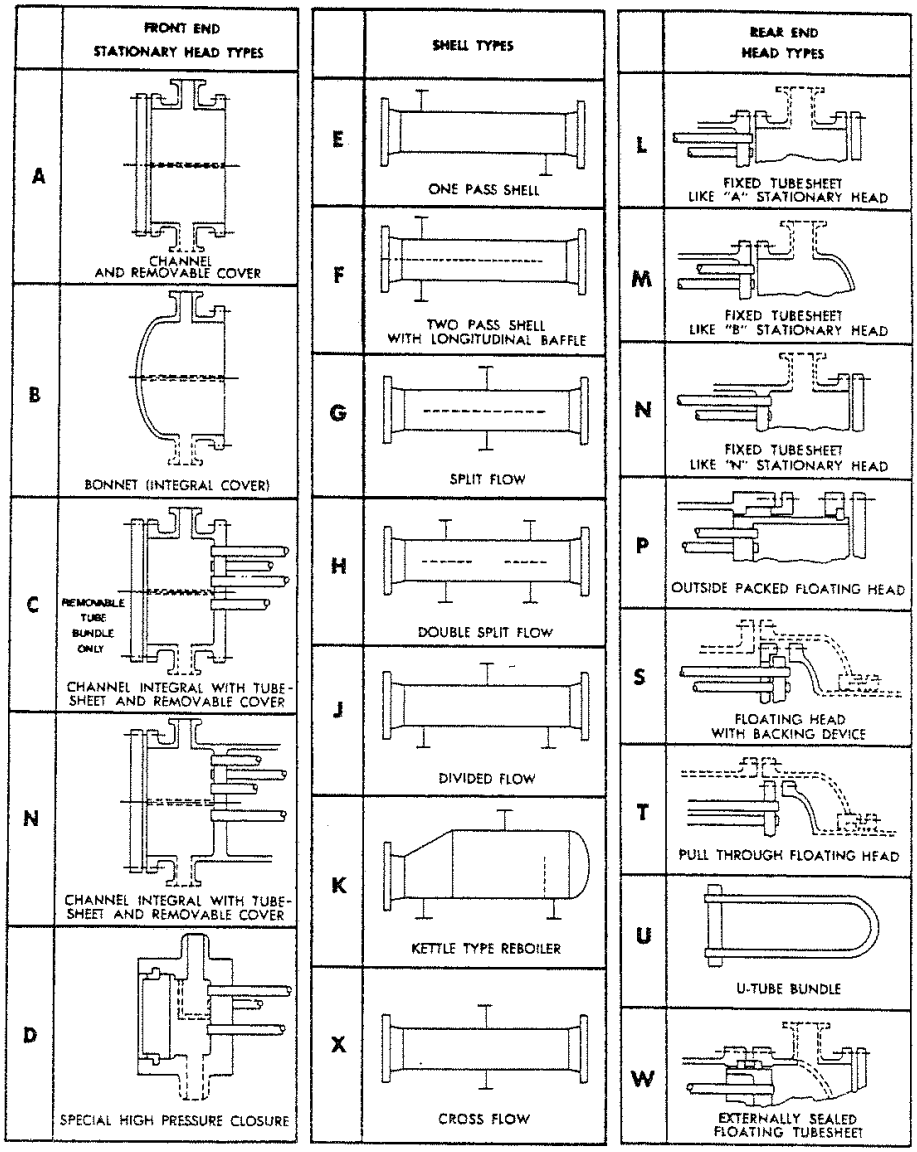
N-1 TYPE DESIGNATION-RECOMMENDED PRACTICE

It is recommended that heat exchanger type be designated by letters as described below.

N-1.1 TYPE

Type designation shall be by letters describing stationary head, shell (omitted for bundles only), and rear head, in that order, as indicated in Figure N-1.1.

Figure N-1.1



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

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

Table N-2

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

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

Figure N-2

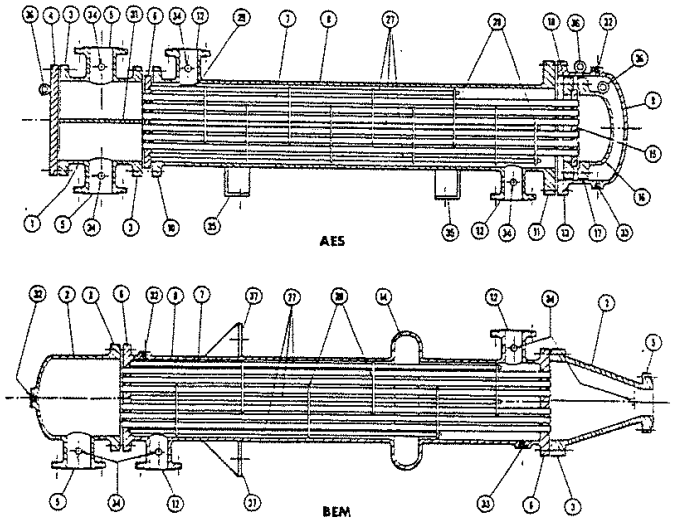
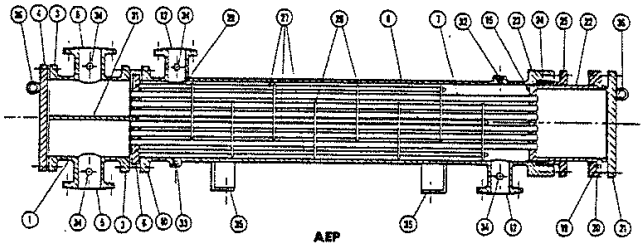
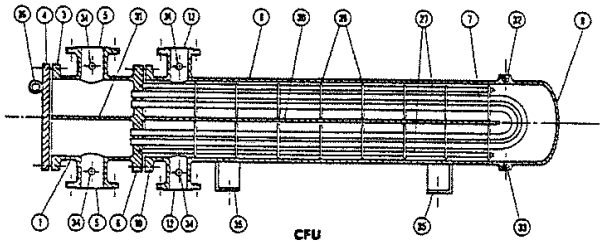


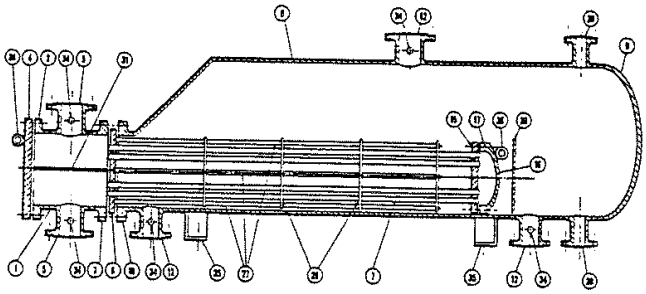
Figure N-2 (Continued)



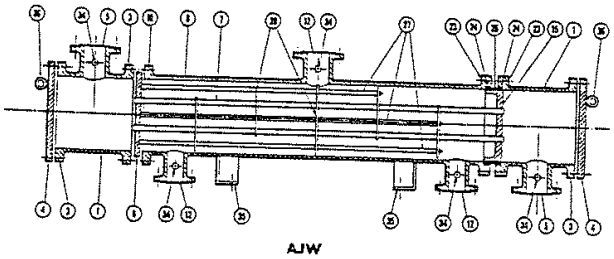
AEP



CFU



AKT



AJW

SECTION 2
HEAT EXCHANGER IDENTIFICATION AND DEFINITIONS

D-2.1 EXCHANGER IDENTIFICATION

D-2.11 COMPLETE EXCHANGER

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

D-2.12 EXCHANGER PARTS

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

D-2.2 DEFINITIONS

D-2.21 EXCHANGER UNIT

One or more exchangers designed for a specific service.

D-2.22 ITEM NUMBER

The purchaser's identification number for an exchanger unit.

D-2.23 NORMAL OPERATING CONDITIONS

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

D-2.24 UPSET CONDITIONS

A departure from specified operating conditions.

D-2.25 PULSATING FLUID CONDITIONS

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

D-2.26 START-UP CONDITIONS

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

D-2.27 SHUT-DOWN CONDITIONS

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

D-2.28 CODE

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

SECTION 3
INSTALLATION OF HEAT EXCHANGERS

E-3 INSTALLATION

E-3.1 INSTALLATION PLANNING

E-3.11 CLEARANCE FOR DISMANTLING

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

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

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

E-3.12 FOUNDATIONS

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

E-3.13 PIPING

E-3.131 THERMAL EXPANSION

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

E-3.132 PULSATION AND VIBRATION

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

E-3.14 CLEANING

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

E-3.15 LEVELING

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

E-3.16 STACKED HEAT EXCHANGERS

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

E-3.17 CONNECTION PROTECTORS

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

E-3.18 PIPE CONNECTIONS

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

E-3.19 FOUNDATION BOLTS

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

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

E-3.3 HEAT EXCHANGER STORAGE

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

SECTION 4
OPERATION OF HEAT EXCHANGERS

E-4. OPERATION

E-4.1 PERFORMANCE OF HEAT EXCHANGERS

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

E-4.11 PERFORMANCE FAILURES

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

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

E-4.2 OPERATION OF HEAT EXCHANGERS

E-4.21 OPERATING PROCEDURES — NORMAL

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

E-4.22 START-UP OPERATION

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

E-4.23 SHUT-DOWN OPERATION

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

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

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

E-4.3 OPERATING LIMITATIONS

E-4.31 NORMAL OPERATING CONDITIONS

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

E-4.32 SUPPLEMENTAL NAME PLATE DATA

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

E-4.33 FLOW RATE

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

E-4.34 HYDRAULIC HAMMER

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

E-4.35 TEMPERATURE SHOCKS

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

E-4.36 FLUID TEMPERATURE LIMITS

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

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

E-4.4 BOLTED JOINTS

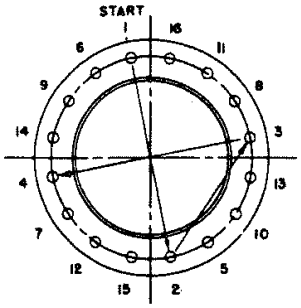
E-4.41 RECOMMENDATIONS FOR RETIGHTENING

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

E-4.42 RECOMMENDED BOLT TIGHTENING PROCEDURE

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

Figure E-4.42



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

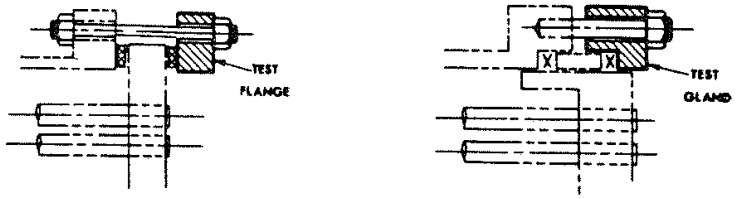
The following procedures may be used to locate perforated or split tubes and leaking joints between tubes and tubesheets. In most cases, the entire front face of each tubesheet will be accessible for inspection. The point where water escapes indicates a defective tube or tube-to-tubesheet joint.

(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

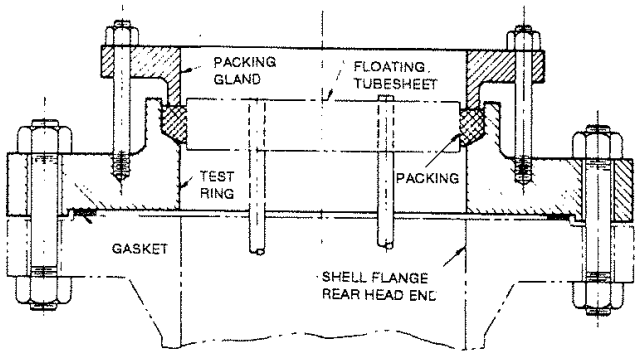


(3) Units with type S or T floating head:
Remove channel cover or bonnet, shell cover and floating head cover. Install test ring and bolt in place with gasket and packing. Apply hydraulic pressure in the shell. A typical test ring is shown in Figure E-5.14-2. When a test ring is not available it is possible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