



Canadian Natural

Contract No.

Client:

Supplier's Document Review Sheet

Equipment Numbers	Comments
104-E-135, 104-E-136	JPI REV 3A - FINAL <div style="border: 1px solid red; padding: 5px; color: red; text-align: center;">REVIEWED AGAINST VDDR FOR CONTENT ONLY. NOT REVIEWED FOR TECHNICAL CONTENT.</div>

Review Status Codes	Project / Req Title	CNRL – Kirby North phase 1	
<input checked="" type="checkbox"/> 1 - Work May Proceed <input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated <input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture <input type="checkbox"/> 4 - STOP WORK per attached written instructions <input type="checkbox"/> 5 - Review Not Required: Work may proceed <small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small>	Supplier	Exchanger Industries	
	Doc. Description	EXCHANGER - MANUFACTURING RECORD BOOK - 13-3353	
	Vendor Document No.	13-3353 MRB	
	Client Document No.	VP088996-M004-00007	
	Purchase Order No.	Doc Cat.	Issue
CE416040-CC088996-00	M004	1	
BY: <u>Mihnd Kulkarni</u>	Categories		
DATE: <u>8 Dec 2015</u>	Date Received	11/06/2015	



Suite 200, 5811 46th Street SE, Calgary, Alberta T2C 4Y5
Telephone (403) 236-0166 Fax (403) 279-8242 Website: www.exchangerindustries.com

Manufacturer's Record Book

SALES OIL TANK HEATER

CUSTOMER: Jacobs Canada Inc.
FOR: Canadian Natural Resources Limited
LOCATION: Kirby North Phase 1 Project, Conklin, AB
PURCHASE ORDER: CE416040-CC088996
ITEM NO: 104-E-135, 104-E-136
DESCRIPTION: Sales Oil Tank Heater
SOW: Provide Equipment Sales Oil Tank Heater
C.R.N. NO: W3077.2
E.I. JOB NO: 13-3353



VP088996-M004-00007



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Manufacturer's Record Book

Shell & Tube Heat Exchanger

CUSTOMER: Jacobs Canada Inc.
FOR: Canadian Natural Resources Limited
LOCATION: Kirby North Phase 1 Project
PURCHASE ORDER: CE416040-CC088996-00
ITEM NO: 104-E-135, 104-E-136
C.R.N. NO: W3077.2
E.I. JOB NO: 13-3353

CONTENTS (M005)

	Document Code
1. Inspection Release for Shipment	(M008)
2. General Operating Instructions	(E453)
3. U Forms	(M0009 M800)
4. Inspection and Test Plan	(M27)
5. Nameplate Rubbing	(M717)
6. Thermal Data Specification Sheet c/w HTRI Report	(M200 M502)
7. Stress Relief Chart	(M705)
8. Hydrostatic Test Chart, Hydrostatic Report, Pressure Gauge Report; and Water Report	(M712)
9. Hydro Procedure	(M616)
10. Sandblast & Paint Report	(M708)
11. Insulation Report	(M709)
12. N.D.T. Reports	(M802, M805, M806)
13. Mill Test Report	(M017 M725)
14. Production Charpy Reports	(M803)
15. Weld Map	(M028)
16. Weld Procedure	(M600)
17. Welder's Qualification Records	(M010)
18. Weld Repair Procedure	(M601)
19. NDE Operator Certificates	(M011)
20. NDE Procedures	(M606 M609 M610)



Suite 200, 5811 46th Street SE, Calgary, Alberta T2C 4Y5
Telephone (403) 236-0166 Fax (403) 279-8242 Website: www.exchangerindustries.com

21. Tube Rolling Record (M711)
22. Tube Rolling Procedure (M608)
23. Long Term Storage (M615)
24. Mechanical Design Calculations- Supplement al (M500)
25. Mechanical Design Calculations (M500 M514)
26. Boiler's Branch Registered Letter (M703)
27. Complete Set "CERTIFIED AS BUILT" Drawings (B003 B020 S003 S006
S077 E112 M251 M295
M605 M612 M621)

28. Quality Assurance Manual (Cover page, TOC
And U-Stamp Certificate) (M001)
29. Spare Parts List (M901 M902)
30. Non-Conformance Reports (M825)
31. Approved Deviations/Clarifications (A010)
32. EHT Calculations (E201)



Project No.: CE4160

Project: Kirby North Phase 1

SCN-KBN-STR-0507		SHIPPING TERM		FCA	
Supplier: Exchanger Industries		PO No.: CE416040-CC088996			
PO Item No.	Description and Tag No.	Quantity	Estimated Ship Weight	Estimated Ship Dimensions	
25	Sales Oil Tank Heater Tag 104-E-135 For Module PREM-104-02	1	2,500 kgs	23'L x 3'W x 4'H	
26	Sales Oil Tank Heater Tag 104-E-136 For Module PREM-104-02	1	2,500 kgs	23'L x 3'W x 4'H	
25 & 26	Ship Loose Crate of material for Tag 104-E-135 and 104-E-136	1	23 kgs	4'L x 4'W x 10"H	

Issued Date: August 21, 2014		Shipping Date: August 21, 2014	
Issued By: Iain Sewell		Email: iain.sewell@jacobs.com	
Shipping From: Exchanger Industries			
Shipping Address: 5505- 52 Street SE Calgary, Alberta			
Shipping Contact: Tom Baker		Title: Project Manager	Phone No.: 403-203-4591
Estimated Arrival: August 21, 2014		Time: TBD	Carrier: Entrec
Deliver To: Strike Fabrication			
Address: 262, 110 Range Road 281, Kathryn, Alberta T0M 1E0			
Reference #:			
Attention: Shipping / Receiving			
Email: dcoughlin@strikeenergy.com		Phone No.: (403) 946-2234	
Attention: Darrell Coughlin			
Email:		Phone No.:	
Project Name: Kirby North Phase 1 Project		Project Number: CE416041	
Comments and/or Additional Information:			



SHIPPING NOTIFICATION FORM



Canadian Natural

Project No.: CE4160

Project: Kirby North Phase 1

To be emailed to the CNRL Transportation Coordinator or Logistics Manager PRIOR to delivery.
Include with shipment – packing slips and ensure all boxes, crates, etc., are labelled with the project name and number as detailed above.

**Deliveries from Monday to Thursday
8:00am to 4:30pm Only**

THE MATERIAL/EQUIPMENT LISTED BELOW IS RELEASED BY JE INSPECTION. SUPPLIER IS TO CONTACT JE PROJECT EXPEDITING FOR SHIPPING AUTHORIZATION.

JCI PROJECT NO.: CE416040	PROJECT NAME: Kirby North Phase 1	RELEASE NO.: 10
JCI PO/SC No.: CC088996	TYPE OF IRC: <input checked="" type="checkbox"/> INTERIM <input type="checkbox"/> FINAL <input checked="" type="checkbox"/> CONDITIONAL	REF. INSPECTION REPORT No.: 36
JCI INSPECTOR: Ken Bates	DATE: 20 Aug., 2014	JCI OFFICE: Calgary, AB
SUPPLIER & LOCATION: Exchanger Ind. / Calgary	CONTACT: Danette Korchinski	TELEPHONE No.: 403-236-0166
SUB-SUPPLIER & LOCATION: NA	CONTACT:	TELEPHONE No.:

CONDITIONAL RELEASE AUTHORIZATION BY:	CNRL / Soumyabrata Roychowdhury
CLOSE OUT ACCEPT / BACKCHARGE VENDOR BY:	

PURCHASE ORDER DELIVERY DATE:
November 15, 2013 to September 30, 2014

PO/SC ITEM	QTY	EQUIPMENT DESCRIPTION	TAG, MARK OR EQUIPMENT NUMBER
7	1	Emulsion – Trim Cooler	101-E-120
8	1	Emulsion – Trim Cooler	101-E-121
25	1	Sales Oil Tank Heater	104-E-135
26	1	Sales Oil Tank Heater	104-E-136

RELEASED WITH THE FOLLOWING EXCEPTIONS FROM DRAWINGS, PO/SC OR SPECIFICATIONS: (STATE THE EXCEPTION, JE PROJECT ENGINEER WHO AUTHORIZATION THE EXCEPTION AND THE DATE OF SUCH AUTHORIZATION).

LIST OF ALL CONDITIONS OF RELEASE	REF. SPEC.	REC'D INSPECTOR VERIFICATION
101-E-120 & 121 – insufficient bolting in shipping blinds		
101-E-120 & 121 – final verification of flange faces not completed.		
104-E-135 & 136 – insufficient bolting in shipping blinds		
104-E-135 & 136 – EHT and insulation not installed.		

104-E-135 & 136 – final verification of flange faces not completed.		
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INSPECTOR'S SIGNATURE: Ken Bates

(Print Name)



(Signature)

Inspection Release Certificate (IRC)



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments		
101-E-110, 101-E-111, 101-E-112, 101-E-113, 101-E-114, 101-E-115, 101-E-120, 101-E-121, 101-E-210, 101-E-225, 101-E-226, 101-E-240, 101-E-241, 101-E-450, 101-E-451, 102-E-610, 102-E-613, 102-E-655, 103-E-080, 103-E-190, 103-E-290, 103-E-390; 103-E-490; 103-E590; 103-E-705; 103-E-707; 104-E-135; 104-E-136; 107-E305	JPI REV 1 - COORDINATION		
Review Status Codes	Project / Req Title	CNRL – Kirby North phase 1	
<div style="position: absolute; left: -40px; top: 0px; color: blue; font-size: 20px;">me</div> <input checked="" type="checkbox"/> 1 - Work May Proceed <input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated <input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture <input type="checkbox"/> 4 - STOP WORK per attached written instructions <input type="checkbox"/> 5 - Review Not Required: Work may proceed <small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small>	Supplier	Exchanger Industries	
	Doc. Description	EXCHANGER - GENERAL OPERATING INSTRUCTIONS FOR SHELL ADN TUBE HEAT EXCHANGERS	
	Vendor Document No.	SHELL AND TUBE OPERATION INSTRUCTIONS	
	Client Document No.	VP088996-E453-00001	
	Purchase Order No.	Doc Cat.	Issue
CE416040-CC088996-00	E453	0	
BY : _____	Categories		
DATE : _____ <u>12/May/2014</u>	Date Received	04/29/2014	



Revision 0



8805 - 52nd Street S.E.
P.O. Box 1107, Bin. J. Calgary, Alberta T2A 6A2
Telephone (403) 230-0188 Fax (403) 279-8042

General Operating Instructions for SHELL and TUBE HEAT EXCHANGERS

Page 1 of 2

1. DESIGN and OPERATING CONDITIONS

Equipment must not be operated at conditions that exceed those specified on the nameplate(s).

2. OPERATING PROCEDURES

Before placing any exchanger in operation, reference should be made to the exchanger drawings, specification sheet, and nameplate for any special instructions. Improper start-up or shutdown sequences, particularly of fixed tubesheet units, may cause leaking of tube-to-tubesheet and/or bolted flanged joints.

3. START-UP OPERATIONS

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.

4. SHUTDOWN OPERATION

For exchangers with removable bundles, the units may be shutdown 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 shutdown in a manner to minimize differential expansion between shell and tubes.

5. TEMPERATURE SHOCKS

Operation must be started gradually. Hot fluid must not be suddenly introduced when the unit is cold nor cold fluid suddenly introduced when the unit is hot.

6. BOLTED JOINTS

Heat exchangers are hydrostatically tested before leaving Exchanger Industries' shop in accordance with ASME Code requirements. However, normal yielding of gaskets will occur in the interval between hydrostatic testing in the shop and installation at the jobsite. Therefore, all external bolted joints should be properly retightened after installation and, if necessary, after the exchanger has reached operating temperature.



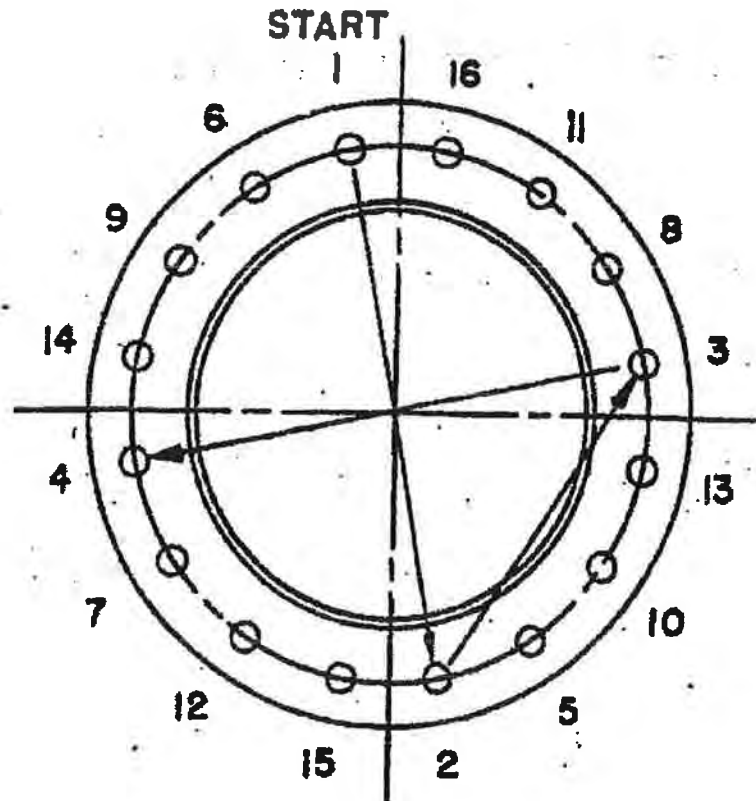
5505 - 52nd Street S.E.
 P.O. Box 1107, Stn. J, Calgary, Alberta T2A 6A8
 Telephone (403) 236-0198 Fax (403) 279-8248

**General Operating Instructions
 for
 SHELL and TUBE HEAT EXCHANGERS**

Page 2 of 2

7. RECOMMENDED BOLT TIGHTENING PROCEDURE

It is important that all bolted joints be tightened uniformly and in a diametrically staggered pattern as illustrated below.



8. DRAINING UNIT

When shutting down the system, all units should be drained completely to minimize the possibility of freezing and corrosion damage. To guard against water hammer, condensate should be drained from steam heaters and similar apparatus when starting up or when shutting down. To reduce water retention after drainage, the tube side of water cooled exchangers should be blown out with air.

①632310

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 EXCHANGER INDUSTRIES LIMITED 5505 - 52 Street S.E., Calgary, AB T2C 2W8
2. Manufactured for Jacobs Canada Inc. 205 Quarry Park Blvd. S.E. Calgary, AB T2C 3E7
3. Location of Installation Canadian Natural Resources Limited, Klrbay North Phase 1 Project, Conklin, AB LSD#21-73-7 W4
4. Type Horizontal Heat Exchanger 13-3353A
5. ASME Code, Section VIII, Div. 1 2010 - 2011a

Items 6-11 incl. to be completed for single wall vessels, jackets of jacketed vessels, shell of heat exchangers, or chamber of multi-chamber vessels.
6. Shell (a) No. of Course(s): 3 (b) Overall length (mm): 6094 mm

Table with columns: Course(s), Material, Thickness (mm), Long. Joint (Cat.A), Circum. Joint (Cat. A,B, & C), Heat Treatment. Rows for courses 1 and 2.

7. Heads: (a) (b) SA516-70N
Table with columns: Location (Top, Bottom, Ends), Thickness (mm), Radius, Elliptical, Conical, Hemispherical, Flat, Side to Pressure, Category A.

8. Type of jacket Jacket closure
If bar, give dimensions
If bolted, describe or sketch.

9. MAWP 3585 103 kpa at max. temp. 150 148 °C Min. design metal temp. -29 °C at 3585 kpa.

10. Impact test No, all shell material exempt per UG-20(f)(1-5).
(Indicate yes or no and the component(s) impact tested)

11. Hydro., pneu., or comb. test press. 6151 kpa Proof test -

Items 12 and 13 to be completed for tube sections.
12. Tubesheet: SA516-70N 381 50 6.4 Bolted
Stationary (Mat'l Spec. No.) Dia., mm. (subject to press.) Nom. thk. mm. Corr. Allow., mm. Attachment (welded or bolted)

13. Tubes: SA 179 19.05 14 BWG MW 51
Floating (Mat'l Spec. No.) Dia., mm. Nom. thk., mm. Corr. Allow., mm. Attachment
Mat'l Spec. No., Grade or Type O.D., mm. Nom. thk., mm. or gauge Number Type (Straight or U)

Items 14-18 Incl. to be completed for inner chambers of jacketed vessels or channels of heat exchangers.
14. Shell (a) No. of course(s) 1 (b) Overall length (mm.): 324 mm

Table with columns: Course(s), Material, Thickness (mm), Long. Joint (Cat.A), Circum. Joint (Cat. A,B, & C), Heat Treatment. Row for course 1.

15. Heads: (a) (b) SA516-70N
Table with columns: Location (Top, Bottom, Ends), Thickness (mm), Radius, Elliptical, Conical, Hemispherical, Flat, Side to Pressure, Category A.

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

FORM U-1 (Back)

16. MAWP 3585 103 kpa at max. temp. 150 148 °C Min. design metal temp. -29 °C at 3585 kpa.
(internal) (external) (internal) (external)

17. Impact test No, all channel material exempt per UG-20(f)(1-5)

(Indicate yes or no and the component(s) impact tested)

18. Hydro., pneu., or comb. test press. 5599 kpa Proof test -

19. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Flange Type	Material		Nozzle Thickness (mm)		Reinforcement Material	How attached		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
Channel Inlet	1	4" CI.300	RFLWN	-	SA105-N	22.2	3.2	None	UW16.1c	-	Top Channel
Channel Outlet	1	4" CI.300	RFLWN	-	SA105-N	22.2	3.2	None	UW16.1c	-	Bottom Channel
Shell Inlet	1	4" CI.300	RFLWN	-	SA105-N	22.2	3.2	None	UW16.1c	-	Bottom Shell
Shell Outlet	1	4" CI.300	RFLWN	-	SA105-N	22.2	3.2	None	UW16.1c	-	Top Shell

20. Supports: Skirt No Lugs N/A Legs N/A Other Saddles Attached Welded to Shell
(Yes/no) (No.) (No.) (Describe) (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)
Complete Heat Exchanger, Patel Airtemp (India) Limited, EXE-1352/1, EXE-1352/2, EXE-1352/3

22. Remarks: * U-Bends and 6" straight length is stress relieved by supplier for 1 Hr.
 SAFETY VALVES: P.S.V. on piping per UG-125 (g) to be installed by owner CUBIC CAPACITY: 0.75 cu.m.
 SURFACE AREA: 36.6 sq.m.
 SERVICE: Sales Oil Tank Heater MK1 / MK2, SA105-N : 524 mm OD x 381 mm ID x 83 mm thk.
MK1 / MK2 Bolting: SA193-B7, 19.05 mm x 203 mm/222 mm lg. (24 /8 pcs.), Nuts: SA194-2H UNC (64 pcs.)
 ITEM #: 104-E-135 Constructed to Drawing #13-3353 A/B Rev.5

CERTIFICATE OF SHOP COMPLIANCE

We certify that the statements made 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 of Authorization Number 5983 Expires March 30, 2017

Date APR 29 2014 Name Exchanger Industries Limited Signed [Signature]
(Manufacturer) (Representative)

CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of ALBERTA and employed by ABSA CALGARY, ALBERTA have inspected the pressure vessel described in this Manufacturer's Data Report on APR 29 2014, 20 , 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/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this Inspection.

Date APR 29 2014 Signed [Signature] Commissions AB 40 NB 9644 A, B
(Authorized Inspector) (Nat'l Board incl. endorsements, State, Prov. and

CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE

We certify that the statements in this report are correct and that the 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 Number _____ Expires _____, 20

Date _____ Name _____ Signed _____
(Assembler) (Representative)

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of _____ 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 subjected to a hydrostatic test of _____. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this Inspection.

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

① 632311.

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 EXCHANGER INDUSTRIES LIMITED 5505 - 52 Street S.E., Calgary, AB T2C 2W8
(Name and address of Manufacturer)

2. Manufactured for Jacobs Canada Inc. 205 Quarry Park Blvd. S.E. Calgary, AB T2C 3E7
(Name and address of Purchaser)

3. Location of Installation Canadian Natural Resources Limited, Kirby North Phase 1 Project, Conklin, AB LSD#21-73-7 W4
(Name and address)

4. Type Horizontal Heat Exchanger 13-3353B
(Horiz., vert., or sphere) (Tank, separator, jkt. vessel, heat exh., etc.) (Mfg's serial No.)

W3077.2 13-3353 A/B Rev.3 - 2014
(CRN) (Drawing No.) (Nat'l. Bd No.) (Year Built)

5. ASME Code, Section VIII, Div. 1 2010 - 2011a
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 multi-chamber vessels.

6. Shell (a) No. of Course(s): 3 (b) Overall length (mm): 6094 mm

Course(s)			Material	Thickness (mm)		Long. Joint (Cat.A)			Circum. Joint (Cat. A,B, & C)			Heat Treatment	
No.	Diameter(mm)	Length (mm.)	Spec./Grade or Type	Nom.	Corr.	Type	Full,Spot,None	Eff.	Type	Full,Spot,None	Eff.	Temp.	Time
2	381	2500	SA516-70N	14	3.2	1	Full	1.0	1	Full	1.0	-	-
1	381	1094	SA516-70N	14	3.2	1	Full	1.0	1	Full	1.0	-	-

7. Heads: (a) _____ (b) SA516-70N
(Mat'l Spec. No., Grade or Type) H.T. - Time & Temp. (Mat'l Spec. No., Grade or Type) H.T. - Time & Temp.

	Location (Top, Bottom, Ends)	Thickness(mm)		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full,Spot,None	Eff.
(a)														
(b)	End	12.4	3.2			2:1					X			

If removable, bolts used (describe other fastening) _____

8. Type of jacket _____ Jacket closure _____
(Mat'l Spec. No., Grade, size, No.) (Describe as ogee & weld, bar, etc)

If bar, give dimensions _____ If bolted, describe or sketch.

9. MAWP 3585 103 kpa at max. temp. 150 148 °C Min. design metal temp. -29 °C at 3585 kpa.
(internal) (external) (Internal) (external)

10. Impact test No, all shell material exempt per UG-20(f)(1-5).

(Indicate yes or no and the component(s) impact tested)

11. Hydro., pneu., or comb. test press. 6151 kpa Proof test -

Items 12 and 13 to be completed for tube sections.

12. Tubesheet: SA516-70N 381 50 6.4 Bolted
Stationary (Mat'l Spec. No.) Dia., mm. (subject to press.) Nom. thk. mm. Corr. Allow., mm. Attachment (welded or bolted)

13. Tubes: SA 179 19.05 14 BWG M/W 51 U*
Floating (Mat'l Spec. No.) Dia., mm. Nom. thk., mm. Corr. Allow., mm. Attachment Mat'l Spec. No., Grade or Type O.D., mm. Nom. thk., mm. or gauge Number Type (Straight or U)

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

14. Shell (a) No. of course(s) 1 (b) Overall length (mm.): 324 mm

Course(s)			Material	Thickness (mm)		Long. Joint (Cat.A)			Circum. Joint (Cat. A,B, & C)			Heat Treatment	
No.	Diameter, mm.	Length (mm)	Spec./Grade or Type	Nom.	Corr.	Type	Full,Spot,None	Eff.	Type	Full,Spot,None	Eff.	Temp.	Time
1	381	324	SA516-70N	14	3.2	1	Full	1.0	1	Full	1.0	-	-

15. Heads: (a) SA516-70N (b) _____
(Mat'l Spec. No., Grade or Type) H.T. - Time & Temp. (Mat'l Spec. No., Grade or Type) H.T. - Time & Temp.

	Location (Top, Bottom, Ends)	Thickness(mm)		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	12.4	3.2			2:1					X			
(b)														

If removable, bolts used (describe other fastening) _____

(Mat'l Spec. No., Grade, size, No.)

Handwritten signature/initials

FORM U-1 (Back)

16. MAWP 3585 103 kpa at max. temp. 150 148 °C Min. design metal temp. -29 °C at 3585 kpa.
(Internal) (external) (Internal) (external)

17. Impact test No, all channel material exempt per UG-20(f)(1-5)

(Indicate yes or no and the component(s) impact tested)

18. Hydro., pneu., or comb. test press. 5599 kpa Proof test -

19. Nozzles, Inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Flange Type	Material		Nozzle Thickness (mm)		Reinforcement Material	How attached		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
Channel Inlet	1	4" CI.300	RFLWN	-	SA105-N	22.2	3.2	None	UW16.1c	-	Top Channel
Channel Outlet	1	4" CI.300	RFLWN	-	SA105-N	22.2	3.2	None	UW16.1c	-	Bottom Channel
Shell Inlet	1	4" CI.300	RFLWN	-	SA105-N	22.2	3.2	None	UW16.1c	-	Bottom Shell
Shell Outlet	1	4" CI.300	RFLWN	-	SA105-N	22.2	3.2	None	UW16.1c	-	Top Shell

20. Supports: Skirt No Lugs N/A Legs N/A Other Saddles Attached Welded to Shell
(Yes/no) (No.) (No.) (Describe) (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)
Complete Heat Exchanger, Patel Airtemp (India) Limited, EXE-1353/1, EXE-1353/2, EXE-1353/3

22. Remarks: * U-Bends and 6" straight length is stress relieved by supplier for 1 Hr.
 SAFETY VALVES: P.S.V. on piping per UG-125 (g) to be installed by owner CUBIC CAPACITY: 0.75 cu.m.
 SURFACE AREA: 36.6 sq.m.
 SERVICE: Sales Oil Tank Heater MK1 / MK2, SA105-N : 524 mm OD x 381 mm ID x 83 mm thk.
MK1 / MK2 Bolting: SA193-B7, 19.05 mm x 203 mm/222 mm lg. (24 /8 pcs.), Nuts: SA194-2H UNC (64 pcs.)
 ITEM #: 104-E-136 Constructed to Drawing #13-3353 A/B Rev.5

CERTIFICATE OF SHOP COMPLIANCE

We certify that the statements made 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 of Authorization Number. 5983 Expires March 30, 2017

Date APR 29 2014 Name Exchanger Industries Limited Signed [Signature]
(Manufacturer) (Representative)

CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of ALBERTA and employed by ABSA of CALGARY, ALBERTA have inspected the pressure vessel described in this Manufacturer's Data Report on APR 29 2014, 2014, 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/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date APR 29 2014 Signed [Signature] Commissions AB 40 NB 9644 A, B
(Authorized Inspector) (Nat'l Board incl. endorsements, State, Prov. and

CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE

We certify that the statements in this report are correct and that the 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 Number _____ Expires _____, 20____

Date _____ Name _____ Signed _____
(Assembler) (Representative)

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of _____ 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 subjected to a hydrostatic test of _____. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

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

FORM U-2 MANUFACTURER'S PARTIAL DATA REPORT
A Part of Pressure Vessel Fabricated by One Manufacturer for Another Manufacturer
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by Pateis Airtemp (India) Limited, Plot No. 805, 806, 807, 810, Rakanpur, District Gandhinagar, Taluka Kalot, Gujarat 382721, India
(Name and address of manufacturer)

2. Manufactured for EXCHANGER INDUSTRIES LIMITED, CALGARY, ALBERTA
(Name and address of purchaser)

3. Location of installation UNKNOWN
(Name and address)

4. Type: SHELL ASSEMBLY, CHANNEL ASSEMBLY & TUBE BUNDLE ASSEMBLY
[Description of vessel part (shell, two piece head, tube bundle)] EXE-1352(1 to 3)
AS PER ATTACHED U-4 EI.DRG.NO:13-3353A/B
(National board number) (Drawing No.) (Mfg's serial No.) (CRN)
EXCHANGER INDUSTRIES LIMITED 2014
(Drawing prepared by) (Year built)

5. ASME Code, Section VIII, Div. 1 ED. 2010 - AD. 2011a
(Edition and Addenda (date)) (Code Case No.) (Special Service per UG-120 (d))

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

6. Shell (a) No. of course(s): THREE (b) Overall Length (mm) 6094

No.	Course(s)		Material Spec./Grade or Type	Thickness (mm)		Long. Joint (Cat. A)			Circum. Joint (Cat. A,B & C)			Heat Treatment	
	Diameter (mm)	Length (mm)		Nom	Corr	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp	Time
2	381	2500	SA 516 GR 70N	14	3.2	1	FULL	1.0	1	FULL	1.0	-	-
1	381	1094	SA 516 GR 70N	14	3.2	1	FULL	1.0	1	FULL	1.0	-	-

7. Heads: (a) SA 516 GR 70N (b) SA 516 GR 70N
(Mat'l Spec. Number, Grade or Type) (H.T. - Time & Temp.) (Mat'l Spec. Number, Grade or Type) (H.T. - Time & Temp.)

	Location (top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)	SHELL HEAD	12.4	3.2	-	-	2:1	-	-	-	-	✓	-	-	-
(b)	-	-	-	-	-	-	-	-	-	-	-	-	-	-

If removable, bolts used (describe other fastening)

8. Type of jacket Jacket closure
(Mat'l Spec. No., Grade, size, No.)
 If bolted, describe or sketch (Describe as ogee & weld, bar, etc.)

9. MAWP 3585 kPaG 103 kPaG at max. temp. 150°C 148°C Min. design metal temp (-29°C) at 3585 kPaG
(Internal) (External) (Internal) (External)

10. Impact test Remark-7 at test temperature of Remark-7
(Indicate yes or no and the component(s) impact tested)

11. Hydro, pneu, or comb. Test pressure Remark-2 Proof test Remark-2

Items 12 and 13 to be completed for tube sections.

12. Tubesheet: SA-516 Gr. 70N 381 mm 50 mm 6.4 mm BOLTED
[Stationary (Material Spec. No.)] [Diameter (subject to pressure)] (Nom. Thickness) (Corr. Allow.) [Attachment (welded or bolted)]

SA-179 19.05 mm 2.11 mm 51 U (Remark - 8)
[Floating (Material Spec. No.)] (Diameter) (Nom. Thickness) (Number) [Type (Straight or U)]

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

14. Shell (a) No. of course(s) ONE (b) Over all length 324 mm

No.	Course(s)		Material Spec./Grade or Type	Thickness (mm)		Long. Joint (Cat. A)			Circum. Joint (Cat. A,B & C)			Heat Treatment	
	Diameter (mm)	Length (mm)		Nom	Corr	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp	Time
1	381	324	SA 516 GR 70N	14	3.2	1	FULL	1.0	1	FULL	1.0	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-

15. Heads: (a) SA 516 GR 70N (b) (Mat'l Spec. Number., Grade or Type) (H.T. - Time & Temp.)

	Locallon (Top, Bottom, Ends)	Thickness (mm)		Radius (mm)		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter (mm)	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Ell.
(e)	Channel Head	12.4	3.2	-	-	2:1	-	-	-	-	✓	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

If removable, bolts used (describe other fastening)

(Mat'l Spec. No., Grade, size, No.)

16. MAWP 3585 kPaG (Internal) 103 kPaG (External) at max. temp 150°C (Internal) 148°C (External) Min. design metal temp (-)28°C at 3585 kPaG

17. Impact test Remark-7 at test temperature of (Indicate yes or no and the component(s) impact tested)

18. Hydro, pneu. or comb. Test press. Remark-2 Proof test

19. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Flange Type	Material		Nozzle Thickness (MM)		Reinforcement Material	How Attached		Location
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
SHELL INLET (S1)	1	DN 100	CL 300 LWNRF	-	SA 105N	22.2	3.2	-	UW 16.1 (c) Remark-6	-	SHELL BTM
SHELL OUTLET (S2)	1	DN 100	CL 300 LWNRF	-	SA 105N	22.2	3.2	-	UW 16.1 (c) Remark-6	-	SHELL TOP
CHANNEL INLET (T1)	1	DN 100	CL 300 LWNRF	-	SA 105N	22.2	3.2	-	UW 16.1 (c) Remark-6	-	CHANNEL TOP
CHANNEL OUTLET (T2)	1	DN 100	CL 300 LWNRF	-	SA 105N	22.2	3.2	-	UW 16.1 (c) Remark-6	-	CHANNEL BTM

20 Identification of part(s)

Name of part	Quantity	Line No.	Mfr's Identification No.	Mfr's Drawing No.	CRN	National Board No.	Year Built
SHELL ASSEMBLY	1	6,7,8,9,10,11,19,21	EXE-1352/1	13-3353A/B (3 of 13)	-	-	2013
CHANNEL ASSEMBLY	1	14,15,16,17,18,19	EXE-1352/2	13-3353A/B (3 of 13)	-	-	2013
TUBE BUNDLE ASSEMBLY	1	12,13	EXE-1352/3	13-3353A/B (6 & 7 of 13)	-	-	2013

21 Supports: Skirt NO (Yes or No) Lugs NO (No) Legs NO (No) Others SADDLE (Describe) Attached WELDED TO SHELL SUPPORT PAD (Where and how)

22 Remarks:

- DESIGN & DRAWINGS ARE NOT IN PATELS AIRTEMP(INDIA) LIMITED SCOPE
- ALL PARTS SUPPLIED WITHOUT HYDROTEST.
- N-NORMALIZED
- TUBE TO TUBESHEET JOINT EXPANDED IN TWO GROOVES.
- ALL OTHER PARTS WHICH ARE NOT SHOWN IN PDR ARE SUPPLIED AS PER FORM U-4 SUPPLEMENTRY SHEET.
- CATEGORY-D JOINT, TYPE-7 NO RADIOGRAPHY, JOINT EFFICIENCY-NOT APPLICABLE.
- IMPACT TESTING EXEMPTED ON SHELL SIDE & TUBESIDE AS PER UG-20(f)(1 to 5), TUBES EXEMPT AS PER UCS-68(d).
- U-BENDS & 152 mm OF STRAIGHT LENGTH HEAT TREATED AT 635°C FOR 1 HOUR.

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 pressure vessel part conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1.

U Certificate of Authorization Number. 33711 Expires December, 19 2014
 Date 07-02-2014 Name PATELS AIRTEMP (INDIA) LIMITED Signed D-P-PATEL (Manufacturer) (Representative)

CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State of Province of OHIO and employed by LR INSURANCE INC of DELWARE

have inspected the pressure vessel described in this Manufacturer's Data Report on 07-02-2014 and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel part in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel part described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 07-02-2014 Signed TAPASH K GUHA (Authorized Inspector) Commissions NB 12894A, OHIO 633 (NB1 Board Incl. endorsements, State, Province, and No.)

FORM U-2 MANUFACTURER'S PARTIAL DATA REPORT
A Part of Pressure Vessel Fabricated by One Manufacturer for Another Manufacturer
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by Pateis Airtemp (India) Limited, Plot No. 805, 806, 807, 810, Rakanpur, District Gandhinagar, Taluka Kadi, Gujarat 382721, India
(Name and address of manufacturer)

2. Manufactured for EXCHANGER INDUSTRIES LIMITED, CALGARY, ALBERTA
(Name and address of purchaser)

3. Location of installation UNKNOWN
(Name and address)

4. Type: SHELL ASSEMBLY, CHANNEL ASSEMBLY & TUBE BUNDLE ASSEMBLY
[Description of vessel part (shell, two piece head, tube bundle)]

AS PER ATTACHED U-4
(Drawing No.)

EXCHANGER INDUSTRIES LIMITED 2014
(Drawing prepared by) (Year built)

5. ASME Code, Section VIII, Div. 1 ED. 2010 - AD. 2011a
[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): THREE (b) Overall Length (mm) 6084

No.	Course(s)		Material Spec./Grade or Type	Thickness (mm)		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
	Diameter (mm)	Length (mm)		Nom	Corr	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp	Time
2	381	2500	SA 516 GR 70N	14	3.2	1	FULL	1.0	1	FULL	1.0	-	-
1	381	1084	SA 516 GR 70N	14	3.2	1	FULL	1.0	1	FULL	1.0	-	-

7. Heads: (a) SA 516 GR 70N (b)
(Mat'l Spec. Number, Grade or Type) (H.T. - Time & Temp.) (Mat'l Spec. Number, Grade or Type) (H.T. - Time & Temp.)

	Location (top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)	SHELL HEAD	12.4	3.2	-	-	2:1	-	-	-	-	✓	-	-	-
(b)	-	-	-	-	-	-	-	-	-	-	-	-	-	-

If removable, bolts used (describe other fastening)

8. Type of jacket Jacket closure
(Mat'l Spec. No., Grade, size, No.) (Describe as open & weld, bar, etc.)

If bar, give dimensions If bolted, describe or sketch

9. MAWP 3685 kPaG 103 kPaG at max. temp. 150°C 148°C Min. design metal temp (-)29°C at 3685 kPaG
(Internal) (External) (Internal) (External)

10. Impact test Remark-7 at test temperature of
(Indicate yes or no and the component(s) impact tested)

11. Hydro, pneu. or comb. Test pressure Remark-2 Proof test

Items 12 and 13 to be completed for tube sections.

12. Tubesheet: SA-516 Gr. 70N 381 mm 50 mm 6.4 mm BOLTED
[Stationary (Material Spec. No.)] [Diameter (subject to pressure)] [Nom. Thickness] [Corr. Allow.] [Attachment (welded or bolted)]

[Floating (Material Spec. No.)] [Diameter] [Nom. Thickness] [Corr. Allow.] [Attachment]

13. Tubes: SA-179 19.05 mm 2.11 mm 51 U (Remark - 8)
(Material Spec. No., Grade or Type) (O.D.) (Nom. Thickness) (Number) [Type (Straight or U)]

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

14. Shell (a) No. of course(s) ONE (b) Over all length 324 mm

No.	Course(s)		Material Spec./Grade or Type	Thickness (mm)		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
	Diameter (mm)	Length (mm)		Nom	Corr	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp	Time
1	381	324	SA 516 GR 70N	14	3.2	1	FULL	1.0	1	FULL	1.0	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-

15. Heads: (a) SA 516 GR 70N (b) (Mell Spec. Number, Grade or Type) (H.T. - Time & Temp.) (Mell Spec. Number, Grade or Type) (H.T. - Time & Temp.)

	Location (top, Bottom, Ends)	Thickness (mm)		Radius (mm)		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter (mm)	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)	Channel Head	12.4	3.2	-	-	2:1	-	-	-	-	✓	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

If removable, bolts used (describe other fastening)

(Mell Spec. No., Grade, size, No.)

16. MAWP 3585 kPaG (Internal) 103 kPaG (External) at max. temp 150°C (Internal) 148°C (External) Min. design metal temp. (-)28°C at 3585 kPaG

17. Impact test Remark-7 at test temperature of (Indicate yes or no and the component(s) impact tested)

18. Hydro, pneu, or comb. Test press. Remark-2 Proof test

19. Nozzles, inspection, and safety valve openings:

Purpose (inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Flange Type	Material		Nozzle Thickness (MM)		Reinforcement Material	How Attached		Location
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
SHELL INLET (S1)	1	DN 100	CL 300 LWNRF	-	SA 105N	22.2	3.2	-	UW 16.1 (c) Remark-6	-	SHELL BTM
SHELL OUTLET (S2)	1	DN 100	CL 300 LWNRF	-	SA 105N	22.2	3.2	-	UW 16.1 (c) Remark-6	-	SHELL TOP
CHANNEL INLET (T1)	1	DN 100	CL 300 LWNRF	-	SA 105N	22.2	3.2	-	UW 16.1 (c) Remark-6	-	CHANNEL TOP
CHANNEL OUTLET (T2)	1	DN 100	CL 300 LWNRF	-	SA 105N	22.2	3.2	-	UW 16.1 (c) Remark-6	-	CHANNEL BTM

20 Identification of parts(s)

Name of part	Quantity	Line No.	Mfr's Identification No.	Mfr's Drawing No.	CRN	National Board No.	Year Built
SHELL ASSEMBLY	1	6,7,8,9,10,11,18,21	EXE-1353/1	13-3353A/B (3 of 13)	-	-	2013
CHANNEL ASSEMBLY	1	14,15,16,17,18,19	EXE-1353/2	13-3353A/B (3 of 13)	-	-	2013
TUBE BUNDLE ASSEMBLY	1	12,13	EXE-1353/3	13-3353A/B (6 & 7 of 13)	-	-	2013

21 Supports: Skirt NO (Yes or No) Lugs NO (No) Legs NO (No) Others SADDLE (Describe) Attached WELDED TO SHELL SUPPORT PAD (Where and how)

22 Remarks:

- DESIGN & DRAWINGS ARE NOT IN PATELS AIRTEMP(INDIA) LIMITED SCOPE.
- ALL PARTS SUPPLIED WITHOUT HYDROTEST.
- N-NORMALIZED
- TUBE TO TUBESHEET JOINT EXPANDED IN TWO GROOVES.
- ALL OTHER PARTS WHICH ARE NOT SHOWN IN PDR ARE SUPPLIED AS PER FORM U-4 SUPPLEMENTRY SHEET.
- CATEGORY-D JOINT, TYPE-7 NO RADIOGRAPHY, JOINT EFFICIENCY-NOT APPLICABLE.
- IMPACT TESTING EXEMPTED ON SHELL SIDE & TUBESIDE AS PER UG-20(f)(1 to 5), TUBES EXEMPT AS PER UCS-88(d).
- U-BENDS & 152 mm OF STRAIGHT LENGTH HEAT TREATED AT 635°C FOR 1 HOUR.

CERTIFICATE OF SHDP COMPLIANCE

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

U Certificate of Authorization Number: 33711 Expires December, 19 2014
 Date 07-02-2014 Name PATELS AIRTEMP (INDIA) LIMITED (Manufacturer) Signed SPP Patel D.P. Patel (Representative)

CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State of Province of OHIO and employed by LR INSURANCE INC of DELWARE have inspected the pressure vessel described in this Manufacturer's Data Report on and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel part in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel part described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.
 Date 07-02-2014 Signed TAPASH K GUHA (Authorized Inspector) Commissions NB 12994A, OHIO 633 (Natl Board Incl. endorsements, State, Province, and No.)

FORM U-4 MANUFACTURER'S DATA REPORT SUPPLEMENTARY SHEET
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by	Patels Airtemp (India) Limited, Plot No. 805, 808, 807, 810, Ratanpur, District Gandhinagar, Taluka Katal, Gujarat 382721, India		
Manufactured for	EXCHANGER INDUSTRIES LIMITED, CALGARY, ALBERTA, CANADA		
3. Location of installation	UNKNOWN		
4. Type	HORIZONTAL	HEAT EXCHANGER	EXE-1353(1 to 3) ELDRG.NO:13-3353A/B
	(Horizontal, Vertical, or sphere)	(Tank, separator, heat exch. Etc.)	(Manufacturer's Serial Number)
	--	AS PER BELOW	2014
	(Class)	(Drawing Number)	(Year built)

Data Report Item Number	Remarks
1) 13-3353A/B SHEET 01 of 13 REV-4	Shell & Tube Exchanger Outline Drawing
2) 13-3353A/B SHEET 01A of 13 REV-3	Materials & Design Conditions
3) 13-3353A/B SHEET 01B of 13 REV-1	API 660 Notes & Customer Specification
4) 13-3353A/B SHEET 02 of 13 REV-2	Name Plate Detail
5) 13-3353A/B SHEET 03 of 13 REV-2	Shell & Channel Detail
6) 13-3353A/B SHEET 04 of 13 REV-2	Shell & Channel Sections
7) 13-3353A/B SHEET 05 of 13 REV-1	Flange Detail
8) 13-3353A/B SHEET 06 of 13 REV-1	Tube Hole Layout
9) 13-3353A/B SHEET 07 of 13 REV-2	Bundle Detail
10) 13-3353A/B SHEET 08 of 13 REV-1	U-Bend Schedule
11) 13-3353A/B SHEET 09 of 13 REV-4	Bolt Schedule
12) 13-3353A/B SHEET 10 of 13 REV-1	Gasket Detail
13) 13-3353A/B SHEET 11 of 13 REV-2	Nozzle Detail
14) 13-3353A/B SHEET 12 of 13 REV-2	Lift Lug Detail
15) 13-3353A/B SHEET 13 of 13 REV-2	Support Detail

Certificate of Authorization	Type	U	No	33711	Expires	December 18, 2014
Date	07-02-2014	Name	Patels Airtemp (India) Ltd.		Signed	<i>Sandeep J. Patel</i>
						(Representation)
Date	07-02-2014	Name	TAPASH K GUHA	Commissions	NB 12884A, OHIO 633	
			(Authorized Inspector)		(National Board (incl. endorsements), State, Province, and number)	

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EXCHANGER INDUSTRIES

INSPECTION AND TEST PLAN

This information is proprietary and shall not be used without the express written permission of Exchanger Industries

For Canadian Natural Resources Limited
Kirby North Phase-1 Project / Conklin, Alberta

EI Job Number 13-3353A
Item Number 104-E-135/136
Cust'r Reference CE416040-CC088996

Dsg TJB
Chk'd TJB
Date August 20, 2013
File 3353
V3.03

Location	Activity Number	Description Inspection / Test	Procedure #	Specific Instructions for Inspection / Test	Authorized Inspector		CNRL / Jacobs Representative		E.I. Personnel	
					Date:	Initials	Date:	Initials	Date:	Initials
CGY	1	Customer Specs Reviewed & OK'd		Engineering Check-off Sheets; Note-5,6			R	FEB 25 2014		27/8/13 ca
CGY	2	Pre-Inspection Meeting					H	FEB 25 2014		27/8/13 ca
CGY	3	Drawings and Calculations Approved by Client		Note-6 + API-660(6.1)			R	FEB 25 2014		27/8/13 ca
CGY	4	Drawings and Calculations to Shop		Drafting Check-off Sheets			R	FEB 25 2014		27/8/13 ca
India	5	Materials Ordered		Note-9(Exh-10.1,10.3,10.4,10.5,10.9)/P.O.; Note-6(4.0) 7: API-660(8) CRN # W-30722			R	FEB 25 2014		27/8/13 ca
CGY + India	6	Registered Drawings to Shop		Note-6(4.0) 7: API-660(8)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	7	A.I. Hold Points Established		CRN # W-30722			R	FEB 25 2014		APR 11 2014 DK
CGY + India	8	Customer Hold Points Established		AUG 29 2013			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	9	WPS Approval	6, 7	Customer Rep to verify Client Approval			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	10	PQR Approval	6, 7	Note-5; Customer Rep to verify Client Approval to ASME-VIII UW-28/UCS-67 + ASME-IX			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	11	Welders Qualification Records		Note-5; Customer Rep to verify Client Approval to ASME-VIII UW-28/UCS-67 + ASME-IX			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	12	Welding Inspector Qualifications		Note-5; 8(Exh-14.2,15.1,15.2,15.3,15.4); Client Rep to verify Client Approval to ASME-VIII UW-29			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	13	NDE Qualification Certificates		Note-8(Exh-18)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	14	MTR Review & Heat # Checked		Note-8(Exh-10.8,11.6); ASME-VIII (UG 77, UG-93)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	15	Dimensional Check		Shellside, Note-8(Exh-10.9)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	16	Dimensional Check		Channelside; Note-8(Exh-10.9)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	17	Back gouging and Welding		Note-5, ASME-VIII			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	18	Bundle Assembly		Note-5, ASME-VIII			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	19	Nozzle Flange Finish at Gasket Surface		125 - 150 AARRH (ASME-B16.5)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	20	RT-1 Radiography Shellside	9	Note-4,7(9), ASME-VIII(UW-51), API-660(10.2.1)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	21	RT-1 Radiography Channelside	9	Note-4,7(9), ASME-VIII(UW-51), API-660(10.2.1)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	22	MPI Lift Lug Welds	10, 11	Note-4, 7(9)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	23	MPI or LPI Arc Strikes + Temp Attachments	10, 11	Note-4, 8			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	24	MPI or LPI Attachment Weld	10, 11	Note-4, 8			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	25	Pig shell		Note-8			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	26	Final Internal Tubeshield	5	Note-8			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	27	Final Internal Shellside	5	Note-8			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	28	Tube Expansion		API-660(9.10), Note-7(6)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	29	Air Test Repads		350-kPa, Note-6(6.1.6)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	30	Hardness Test	4	237-BHN Max, Note-10, API-660(10.2.5)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	29	Weld Map + NDE Map		Shellside, Note-8			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	32	Final External	5	Channelside, Note-8			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	33	Final External	5	Channelside, Note-8			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	34	Hydrostatic Test Shellside (Charted)	2	6151-kPa Gage #9223, Note-6(6.1), 8; API-660(10.3)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	35	Hydrostatic Test Tubeshield (Charted)	2	5599-kPa Gage # 3334, Note-6(6.1), 8; API-660(10.3)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	36	Stamping (TEMA Flanges + Tubeshield)		API-660(10.4)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	37	Nameplate Complete		Note 2,4,8(Exh-11.2) / Photocopy			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	38	Data Report Complete		(3) Copies; Note-8, ASME-VIII			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	39	Surface Prep (Blast)		Note 2,11 Paint notes			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	40	Prime		Note 2,11 Paint notes			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	41	Finish		Note 2,11 Paint notes			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	42	Paint Logs		Note-4,11			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	43	EHT Resistance check		Note-7 (11)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	44	EHT Megger Check (Phase to Ground)		Note-7 (11)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	45	Insulation		KBP-SPEC-PL-100			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	46	EHT Resistance check		Note-7 (11)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	47	EHT Megger Check (Phase to Ground)		Note-7 (11)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	48	Stenciling		Note-2,12, API-660(11)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	49	Shipping Covers		Plywood, Note-12, API-660(11)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	50	Spare parts to go with shipment		Gaskets + Bolting, Note-9			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	51	Signature Log		Note-8(Exh-13.1)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	52	Closure of any NCR's		Note-6, API-660(6.3), PO			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	53	Closure of any RFI's		IRC by Jacobs; Note-8(Exh-11.5)			R	FEB 25 2014		AUG 29 2013 DK
CGY + India	54	Turnover Documents					R	FEB 25 2014		AUG 29 2013 DK
CGY + India	55	Final Shipping Release					R	FEB 25 2014		AUG 29 2013 DK
CGY + India	56	Shipping Photo					R	FEB 25 2014		AUG 29 2013 DK
CGY + India		Partial Data Report					R	FEB 25 2014		AUG 29 2013 DK

EXCHANGER INDUSTRIES

INSPECTION AND TEST PLAN

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For Canadian Natural Resources Limited
Kirby North Phase-1 Project / Conklin, Alberta
EI Job Number 13-3353 A
Item Number 104-E-135/136
Cust'r Reference GE416040-CC088996

Dsg TJB
Chk'd TJB
Date August 20, 2013
File 3353
V3.03

Location	Activity Number	Description Inspection / Test	Procedure #	Specific Instructions for Inspection / Test	Authorized Inspector	CNRL / Jacobs Representative	E.I. Personnel	Rev

Notes:

Exchanger Industries Standard Procedures (#)	
1.	(4) Hardness Testing Procedure
	(5) NDE Visual Examination Procedure
	(6) Weld Procedure C17 + C2
	(7) Weld Procedure 210 + SAW-4
	(9) Radiography Procedure
	(10) NDE MPI
	(11) NDE LPI

2. EI Drawing Number 13-3353

3. See NDE notes on Drawing 13-3353
4. Record to be maintained in QC Job file for incorporation into Data Report.
5. KBP-SPEC-WM-100
6. KBP-SPEC-ME-103
7. KNP-DS-M-104-E-135
8. EI QC Manual
9. Per PO MR Section-1 Clause 2.2
10. KBP-SPEC_ME-106(12.16)
11. KBP-SPEC-PL-101
12. Per PO Addendum D1
- 13.

* Indicate Hold / Witness / Review / Inspect points on bar: (H), (W), (R), (I), etc. Approved: DK Date: 20.8.13 Rev: 1

EXCHANGER INDUSTRIES

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INSPECTION AND TEST PLAN

For Canadian Natural Resources Limited
 Kirby North Phase-1 Project / Conklin, Alberta
 EI Job Number 13-3353 B
 Item Number 104-E-135/136
 Cust'r Reference CE416040-CC088996

Dsg TJB
 Chik'd TJB
 Date August 20, 2013
 File 3353
 V3.03

Location	Activity Number	Description Inspection / Test	Procedure #	Specific Instructions for Inspection / Test	Authorized Inspector		CNRL / Jacobs Representative		E.I. Personnel	
					Date	Initials	Date	Initials	Date	Initials
CGY	1	Customer Specs Reviewed & OK'd		Engineering Check-off Sheets; Note-5,6			R	FEB 25 2014		
CGY	2	Pre-Inspection Meeting					H	FEB 25 2014	27/8/13	AK
CGY	3	Drawings and Calculations Approved by Client		Note-6 + API-660(6.1)					27/8/13	AK
CGY	4	Drawings and Calculations to Shop		Drafting Check-off Sheets					27/8/13	AK
India	5	Materials Ordered		Note-8(Exh-10.1,10.3,10.4,10.5,10.9) / P.O.			R	FEB 25 2014		DK
CGY	6	Registered Drawings to Shop		Note-6(4.0,7, API-660(8)					AUG 29 2013	DK
CGY + India	7	A.I. Hold Points Established		CRN #V-3072					29.8.14	DK
CGY + India	8	Customer Hold Points Established		Customer Rep to verify Client Approval					AUG 29 2013	DK
CGY + India	9	WPS Approval	6,7	Note-5; Customer Rep to verify Client Approval to ASME-VIII UW-28/UCS-67 + ASME-IX			R	FEB 25 2014		DK
CGY + India	10	PQR Approval	6,7	Note-5; Customer Rep to verify Client Approval to ASME-VIII UW-28/UCS-67 + ASME-IX			R	FEB 25 2014		DK
CGY + India	11	Welders Qualification Records		Note-5; 8(Exh-14.2,15.1,15.2,15.3,15.4); Client Rep to verify Client Approval to ASME-VIII UW-29			R		AUG 29 2013	DK
CGY + India	12	Welding Inspector Qualifications		Note-8(Exh-18)						PAT
CGY + India	13	NDE Qualification Certificates		Note-8(Exh-18)						PAT
CGY + India	14	MTR Review & Heat # Checked		Note-8(Exh-10.8,11.6); ASME-VIII (UG 77, UG-93)						PAT
CGY + India	15	Dimensional Check		Shellside, Note-8(Exh-10.9)						PAT
CGY + India	16	Dimensional Check		Channelside; Note-8(Exh-10.9)						PAT
India	17	Back gouging and Welding		Note-5, ASME-VIII						PAT
India	18	Bundle Assembly								PAT
CGY + India	19	Nozzle Flange Finish at Gasket Surface		125 - 150 AARH (ASME-B16.5)						PAT
India	20	RT-1 Radiography Shellside	9	Note-4,7(9), ASME-VIII(UW-51), API-660(10.2.1)						PAT
India	21	RT-1 Radiography Channelside	9	Note-4,7(9), ASME-VIII(UW-51), API-660(10.2.1)						PAT
India	22	MPI Lift Lug Welds	10	Note-4, 7(9)						PAT
CGY + India	23	MPI or LPI Arc Strikes + Temp Attachments	10, 11	Note-4, 8						PAT
CGY + India	24	MPI or LPI Attachment Weld	10, 11	Note-4, 8						PAT
India	25	Pig shell		Note-8						PAT
India	26	Final Internal Tubeside	5	Note-8			H	APR 10 2014		PAT
India	27	Final Internal Shellside	5	Note-8			H	APR 10 2014		PAT
India	28	Tube Expansion		API-660(9.10), Note-7(5)						PAT
India	29	Air Test Repads		350-kPa, Note-6(1.6)						PAT
India	30	Hardness Test		237-BHN Max, Note-10, API-660(10.2.5)						PAT
CGY	29	Weid Map + NDE Map								PAT
CGY	32	Final External		Shellside, Note-8			R	APR 10 2014		PAT
CGY	33	Final External		Channelside, Note-8			R	APR 10 2014		PAT
CGY	34	Hydrostatic Test Shellside (Charted)	2	6151-kPag Gage #77,259; Note-6(6.1), 8; API-660(10.3)			H	APR 10 2014		PAT
CGY	35	Hydrostatic Test Tubeside (Charted)	2	5599-kPag Gage #23,265, Note-6(6.1), 8; API-660(10.3)			H	APR 10 2014		PAT
CGY + India	36	Stamping (TEMA Flanges + Tubesheet)		API-660(10.4)						PAT
CGY	37	Nameplate Complete		Note 2,4,8(Exh-11.2) / Photocopy						PAT
CGY	38	Data Report Complete		(3) Copies; Note-8, ASME-VIII						PAT
CGY	39	Surface Prep (Blast)		Note 2,11 Paint notes						PAT
CGY	40	Prime		Note 2,11 Paint notes						PAT
CGY	41	Finish		Note 2,11 Paint notes						PAT
CGY	42	Paint Logs		Note-4,11						PAT
CGY	43	EHT Resistance check		Note-7 (11)						PAT
CGY	44	EHT Megger Check (Phase to Ground)		Note-7 (11)						PAT
CGY	45	Insulation		KBP-SPEC-PL-100						PAT
CGY	46	EHT Resistance check		Note-7 (11)						PAT
CGY	47	EHT Megger Check (Phase to Ground)		Note-7 (11)						PAT
CGY	48	Stenciling		Note-2,12, API-660(11)						PAT
CGY	49	Shipping Covers		Plywood, Note-12, API-660(11)						PAT
CGY	50	Spare parts to go with shipment		Gaskets + Bolting, Note-9						PAT
CGY	51	Signature Log		Note-8(Exh-13.1)						PAT
CGY	52	Closure of any NCR's		Note-6, API-660(6.3), PO						PAT
CGY	53	Closure of any RFI's		IRC by Jacobs, Note-8(Exh-11.5)						PAT
CGY	54	Turnover Documents								PAT
CGY	55	Final Shipping Release								PAT
CGY	56	Shipping Photo								PAT
		Partial Data Report								PAT

Rev #

EXCHANGER INDUSTRIES

INSPECTION AND TEST PLAN

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For Canadian Natural Resources Limited
 Kirby North Phase-1 Project / Conklin, Alberta
 Dsg TJB
 Chkd TJB
 Date August 20, 2013
 File 3353
 V3.03

EI Job Number 13-3353
 Item Number 104-E-135/136
 Cust'r Reference CE416040-CC088996

Location	Activity Number	Description Inspection / Test	Procedure #	Specific Instructions for Inspection / Test	Authorized Inspector	CINRL / Jacobs Representative	E.I. Personnel	Rev

Notes:

1

1. Exchanger Industries Standard Procedures (#)
- | |
|--------------------------------------|
| (4) Hardness Testing Procedure |
| (5) NDE Visual Examination Procedure |
| (9) Radiography Procedure |
| (2) Hydrostatic Test Procedure |
| (6) Weld Procedure C17 + C2 |
| (10) NDE MPI |
| (7) Weld Procedure 210 + SAW-4 |
| (11) NDE LPI |

- 2. EI Drawing Number 13-3353
- 3. See NDE notes on Drawing 13-3353
- 4. Record to be maintained in QC Job file for incorporation into Data Report.
- 5. KBP-SPEC-WM-100
- 6. KBP-SPEC-ME-103
- 7. KNP-DS-M-104-E-135
- 8. EI QC Manual
- 9. Per PO MR Section-1 Clause 2.2
- 10. KBP-SPEC_ME-106(12.16)
- 11. KBP-SPEC-PL-101
- 12. Per PO Addendum D1
- 13.

* Indicate Hold / Witness / Review / Inspect points on bar: (H), (W), (R), (I), etc. Approved: DK Date: 29.8.13 Rev: 1

CERTIFIED BY
EXCHANGER INDUSTRIES LIMITED
CALGARY, ALBERTA, CANADA



U	MAWP: SHELL	3585 KPAG	AT	150 C
W	MAWP: SHELL	103 KPAG	AT	148 C
RT1	MAWP: TUBE	3585 KPAG	AT	150 C
PHT-T	MAWP: TUBE	103 KPAG	AT	148 C
	MDMT: SHELL	-29 C	AT	3585 KPAG
	MDMT: TUBE	-29 C	AT	3585 KPAG

SERIAL NO. **13-3353A** YEAR MFD. **2014**

SALES OIL TANK HEATER

PO NO.: CE416040-CC088996-00 ITEM#: 104-F-135 CNRI KNP-1

SIZE: 381-6096 TYPE: BEU TEMA CLASS: R

TEST PRESS: SHELL: 4661 KPAG TUBE SIDE: 4661 KPAG

SHELL MATL SA516-70N THK. 14 MIN. C.A. 3.2

CHAN. MATL SA516-70N THK. 14 MIN. C.A. 3.2

TUBE MATL: SA 179 ANNEALED 14 BWG M/W

PROV. REG. **(A 632310)**

CRN **W30772**

SH-1001

Handwritten signature or initials.

CERTIFIED BY
EXCHANGER INDUSTRIES LIMITED
CALGARY, ALBERTA, CANADA



U	MAWP: SHELL	3585 KPAG	AT	150 C
W	MAWP: SHELL	103 KPAG	AT	148 C
RT1	MAWF: TUBE	3585 KPAG	AT	150 C
PHT-T	MAWF: TUBE	103 KPAG	AT	148 C
	MDMT: SHELL	-29 C	AT	3585 KPAG
	MDMT: TUBE	-29 C	AT	3585 KPAG

SERIAL NO. **13-3353B** YEAR MFD. **2014**

SALES OIL TANK HEATER

PO NO.: CE416040-CC088996-00 ITEM#: 104-E-136 CNRL KNP-1

SIZE: 381-6096 TYPE: BEU TEMA CLASS: R

TEST PRESS: SHELL: 4661 KPAG TUBE SIDE: 4661 KPAG

SHELL MATL SA516-70N THK. 14 MIN. C.A. 3.2

CHAN. MATL SA516-70N THK. 14 MIN. C.A. 3.2

TUBE MATL: SA 179 ANNEALED 14 BWG M/W

PROV. REG. **(A)632311** CRN **W30772**

SH-1001

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135

CERTIFIED BY

PATELS AIRTEMP INDIA SUMITRA

U MFR SRINOLEXEN 627/1

PAFT YE/REBUNN 210712

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REGISTERED BY

PATELS AIRTEL INDIA LIMITED

U M.F.R. SR. NO. EXE 0352/2

PART YEAR BUILT 201

REGISTERED BY

134

U. S. DEPARTMENT OF ATELS AIRTEL INQUIRY LIMITED
PATRICK R. FR. SER. NO. EXE 135213 YEAR BUHNT 2011

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IA LIMITED

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CERTIFIED BY

PATELS AIRTEMP INDIA LIMITED

U M F R S P NO F X F 1353371

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PATEL S ALI TEM P INDIA LIMITED

U MFR SR NO EXS 1353/4018

FAPPT YEAP BUILT 2007

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CERTIFIED BY PATILS / PRITEMP INDIA LIMITED
PARI MFRS R NO EXE 1353/3 YEAR BUILT 2014



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments		
104-E-135	JPI REV 2 - VERIFICATION		
Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1	
<i>CN</i> <input checked="" type="checkbox"/> 1 - Work May Proceed <input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated <input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture <input type="checkbox"/> 4 - STOP WORK per attached written instructions <input type="checkbox"/> 5 - Review Not Required: Work may proceed <small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small>	Supplier	Exchanger Industries	
	Doc. Description	EXCHANGER - THERMAL SPECIFICATION SHEETS 13-3353	
	Vendor Document No.	13-3353 TDS	
	Client Document No.	VP088996-M200-00009	
	Purchase Order No.	Doc Cat.	Issue
CE416040-CC088996-00	M200	1	
BY : <u>SYED SHAH</u>	Categories		
DATE : <u>JUNE 13, 2013</u>	Date Received	06/04/2013	



SHELL & TUBE HEAT EXCHANGER SPECIFICATION SHEET
(S.I Units)

Sheet No.	1	of	2
Job No.	#13-3353		
Reference No.	CE416040-CC088996-00		
Proposal No.	P12S-13230		
Date	May 30 2013 1:56 PM		
Item No.	104-E-135		

No	Date	By
0	17-Apr-13	ML
1	30-May-13	ML

V3.00x

Customer	Canadian Natural Resources Limited c/o JACOBS		
Address			
Plant Location	Kirby North Phase 1, Conklin, AB		
Service of Unit	SALES OIL TANK HEATER		
Size	381 - 6096	Type	BEU
Shells per Unit	1	Connected	1
In Parallel	1	In Series	
Surface / Unit (gross)	36.9	m ²	Surface / Shell (eff)
			36.6 m ²

PERFORMANCE OF ONE UNIT

Fluid Allocation			(In) SHELL SIDE (out)		(In) TUBE SIDE (out)	
	Fluid Name		Sales Oil		Glycol	
Fluid Quantity, Total	kg / hr	56,485			10,527	
Vapour	kg / hr					
Liquid	kg / hr	56,485	56,485		10,527	10,527
Steam / Water	kg / hr					
Noncondensable	kg / hr					
Temperature - In / Out	°C	30.0	40.0		90.0	60.0
Density - Liq / Vap	kg / m ³	920.001	915.000		1038.600	1062.000
Viscosity - Liq / Vap	cP	230.000	119.000		1.411	2.743
Molecular Weight - Liq / Vap						
Specific Heat - Liq / Vap	kJ / kg·°C	1.823	1.864		3.408	3.274
Thermal Conductivity - Liq / Vap	W / m·°C	0.143	0.140		0.337	0.345
Latent Heat	kJ / kg					
Inlet Pressure	kPa a	313.0	243.1		1,264.0	1,245.4
Velocity	m / s	0.59 / 0.59 Cross / Window			0.618 Maximum	
Pressure Drop (Allow / Calc.)	kPa	70.000	69.946		70.000	18.558
Fouling Resistance	m ² ·°C / KW		0.528			0.176

Heat Exchanged	291.21	kW	MTD (Corrected)	37.92	°C
Heat Transfer Rate	Service (U)	210.94	Clean	348.87	W / m ² ·°C

	Shell	DESIGN	Tube
Design / Test Pressure	kPa g	3,500.0	3,500.0
Design Temperature / MDMT	°C	150.0	-29.0
Passes Per Shell / Vacuum		1	FV @ 148.0°C
Corrosion Allowance	mm	3.20	3.20
CONNECTIONS	Inlet	1 - 101.6 mm C300 RFLWN	1 - 101.6 mm C300 RFLWN
Size & Rating	Intermediate	1 - 101.6 mm C300 RFLWN	1 - 101.6 mm C300 RFLWN

AS PROVED ... *M* ...
MAY 30 2013
FOR CONSTRUCTION

MATERIALS OF CONSTRUCTION

(102) U-Tube Legs	19.05 mm OD	2.11 mm Min Thickness	(14 BWG)	6.10 m Long	Pattern 45 ° Pitch 25.40 mm
Tube Material	SA-179	Seamless	Tube Type	PLAIN	
Shell	381.0 mm ID	SA-516-70 N	Shell Cover	SA-516-70 N	
Channel	SA-516-70 N		Channel Cover	SA-516-70 N	
Tubesheet - Stationary	SA-516-70 N		Tubesheet - Floating		
Tube - Tubesheet Joint	Rolled 2 RG		Floating Head Cover		
Baffles - Cross	(26) SA-36	Type SEGMENTAL	Spacing	212.7 mm	Cut (%dia) 36.1% Horizontal
Baffles - Long		Seal Type			
Supports - Tube		U-Bend	1 Full Support	Type	
Bypass Seal Arrangement	Seal Rods	Impingement Protection	round plate		
Expansion Joint		Type			
pV ² kg / s ² ·m	Inlet Nozzle 4,073	Bundle Entrance 247	Bundle Exit 204	API	Yes
Gaskets: Shell Side	316SS Kammprofile	Code Requirements	Shell ASME Sec VIII Div 1	Channel ASME Sec VIII Div 1	
Tube Side	316SS Kammprofile	Inspection	Shell RT1	Channel RT1	
Floating Head		Heat Treatment	U-Bends	TEMA Class	R
Weight kg	Shell 2,500	Filled with water 3,250	Bundle 820	Customer Spec	Yes

Notes:
1. 104-E-135 and 104-E-136 are identical

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JUN 04 2013
JACOBS CANADA INC.
DOCUMENT CONTROL

VPO88996-M200-00009



SHELL & TUBE HEAT EXCHANGER SPECIFICATION SHEET (Imperial Units)

V3.00x

Sheet No. 2 of 2

Job No. #13-3353

Reference No. CE416040-CC088996-00

Proposal No. P12S-13230

Date May 30 2013 1:58 PM

Item No. 104-E-135

Revision table with columns: No, Date, By. Row 0: 17-Apr-13, ML. Row 1: 30-May-13, ML.

Customer Canadian Natural Resources Limited c/o JACOBS

Address

Plant Location Kirby North Phase 1, Conklin, AB

Service of Unit SALES OIL TANK HEATER

Summary table with columns: Size, Type, Shells per Unit, Connected, in Parallel, In Series, Surface / Unit (gross), Surface / Shell (eff).

PERFORMANCE OF ONE UNIT

Main performance table with columns: Fluid Allocation, Fluid Name, Fluid Quantity, Temperature, Density, Viscosity, Molecular Weight, Specific Heat, Thermal Conductivity, Latent Heat, Inlet Pressure, Velocity, Pressure Drop, Fouling Resistance.

Heat Exchanged 993,865 BTU / hr MTD (Corrected) 68.25 °F

Heat Transfer Rate Service (U) 37.15 Clean 61.44 BTU / hr-ft²-°F

Shell DESIGN Tube

Design table with columns: Design / Test Pressure, Design Temperature / MDMT, Passes Per Shell / Vacuum, Corrosion Allowance, CONNECTIONS (Inlet, Intermediate, Outlet), Rating.

APPROVED ... MAY 30 2013 FOR CONSTRUCTION

MATERIALS OF CONSTRUCTION

Materials of construction table with columns: U-Tube Legs, Tube Material, Shell, Channel, Tubesheet, Tube - Tubesheet Joint, Baffles, Supports, Bypass Seal Arrangement, Expansion Joint, pV², Gaskets, Floating Head, Weight, Filled with water, Bundle, Customer Spec.

Notes: 1. 104-E-135 and 104-E-136 are identical

Empty table with rows 66-76.

pls let the customer know
that 26 is bagle No. and
27 in HTR Han is ~~bagle~~
crosspasses.

M. May 30.



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments		
104-E-135, 104-E-136	JPI REV 2 - VERIFICATION		
Review Status Codes <input checked="" type="checkbox"/> 1 - Work May Proceed <input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated <input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture <input type="checkbox"/> 4 - STOP WORK per attached written instructions <input type="checkbox"/> 5 - Review Not Required: Work may proceed <small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small>	Project / Req Title	CNRL Kirby North Phase 1	
	Supplier	Exchanger Industries	
	Doc. Description	EXCHANGER - HTRI OUPUT SUMMARY - 13-3353	
	Vendor Document No.	13-3353 HTRI RUN	
	Client Document No.	VP088996-M502-00001	
	Purchase Order No.	Doc Cat.	Issue
	CE416040-CC088996-00	M502	1
	Categories	M200	
Date Received	02/18/2014		
BY : <u>SYED SHAH</u>			
DATE : <u>Mar 04, 2014</u>			



Output Summary

Released to the following HTRI Member Company:
Exchanger Industries
Exchanger Industries

Xist Ver. 6.00 SP3 18/04/2013 8:58 SN: 1500213483

Simo Units

#13-3353 104-E-135 + 136

Rating - Horizontal Multipass Flow TEMA BEU Shell With Single-Segmental Baffles

See Data Check Messages Report for Warning Messages.

See Runtime Message Report for Warning Messages.

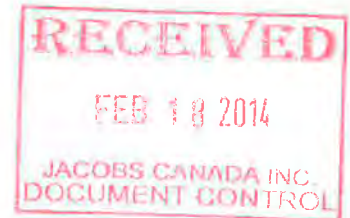
Process Conditions	Cold Shellside		Hot Tubeside	
Fluid name		Sales Oil		Glycol
Flow rate (kg/hr)		56495.1		10527.0
Inlet/Outlet Y (Wt. frac vap.)	0.000	0.000	0.000	0.000
Inlet/Outlet T (Deg C)	30.00	40.00	90.00	60.00
Inlet P/Avg (kPa)	313.000	278.027	1264.00	1254.72
dP/Allow. (kPa)	69.946	70.000	18.558	70.000
Fouling (m2-K/W)		0.000528		0.000176

Exchanger Performance				
Shell h (W/m2-K)	598.95	Actual U (W/m2-K)		275.99
Tube h (W/m2-K)	1109.28	Required U (W/m2-K)		210.80
Hot regime (-)	Sens. Liquid	Duty (MegaWatts)		0.2910
Cold regime (-)	Sens. Liquid	Area (m2)		36.592
EMTD (Deg C)	37.9	Overdesign (%)		30.92

Shell Geometry			Baffle Geometry		
TEMA type (-)		BEU	Baffle type (-)		Single-Seg.
Shell ID (mm)		381.001	Baffle cut (Pct Dia.)		36.10
Series (-)		1	Baffle orientation (-)		Perpend.
Parallel (-)		1	Central spacing (mm)		212.725
Orientation (deg)		0.00	Crosspasses (-)		27

Tube Geometry			Nozzles		
Tube type (-)		Plain	Shell inlet (mm)		101.600
Tube OD (mm)		19.050	Shell outlet (mm)		101.600
Length (m)		6.096	Inlet height (mm)		61.211
Pitch ratio (-)		1.3333	Outlet height (mm)		54.553
Layout (deg)		45	Tube inlet (mm)		101.600
Tubecount (-)		102	Tube outlet (mm)		101.600
Tube Pass (-)		4			

Thermal Resistance, %		Velocities, m/s		Flow Fractions	
Shell	46.08	Shellside	0.55	A	0.003
Tube	31.95	Tubeside	0.62	B	0.707
Fouling	20.84	Crossflow	0.59	C	0.048
Metal	1.13	Window	0.59	E	0.054
				F	0.188





HEAT EXCHANGER RATING DATA SHEET

Simo Units

Service of Unit	SALES OIL TANK HEATER	Item No.	104-E-135 + 136 A
Type	BEU	Orientation	Horizontal
Surf/Unit (Gross/Eff)	36.90 / 36.59 m ²	Shell/Unit	1
		Surf/Shell (Gross/Eff)	36.90 / 36.59 m ²

PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		Sales Oil		Glycol	
Fluid Quantity, Total	kg/hr	56495.1		10527.0	
Vapor (In/Out)	wt%	0.0	0.0	0.0	0.0
Liquid	wt%	100.0	100.0	100.0	100.0
Temperature (In/Out)	C	30.00	40.00	90.00	60.00
Density	kg/m ³	920.00	915.00	1038.6	1062.0
Viscosity	mN-s/m ²	230.00	119.00	1.4113	2.7430
Specific Heat	kJ/kg-C	1.8220	1.8630	3.4057	3.2720
Thermal Conductivity	W/m-C	0.1425	0.1402	0.3364	0.3450
Critical Pressure	kPa				
Inlet Pressure	kPa	313.000		1264.00	
Velocity	m/s		0.55		0.62
Pressure Drop, Allow/Calc	kPa	70.000	69.946	70.000	18.558
Average Film Coefficient	W/m ² -K	598.95		1109.28	
Fouling Resistance (min)	m ² -K/W	0.000528		0.000176	
Heat Exchanged	0.2910 MegaWatts	MTD (Corrected)	37.9 C	Overdesign	30.92 %
Transfer Rate, Service	210.80 W/m ² -K	Calculated	275.99 W/m ² -K	Clean	348.64 W/m ² -K

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)

		Shell Side	Tube Side
Design Pressure	kPaG	3500.00	3500.00
Design Temperature	C	150.00	150.00
No Passes per Shell		1	4
Flow Direction		Upward	Downward
Connections	In mm	1 @ 101.600	1 @ 101.600
Size & Rating	Out mm	1 @ 101.600	1 @ 101.600
	Liq. Out mm	@	@



Tube No.	102	OD	19.050 mm	Thk(Avg)	2.108 mm	Length	6.096 m	Pitch	25.400 mm	Layout	45
Tube Type	Plain		Material	CARBON STEEL		Pairs seal strips	0				
Shell ID	381.001 mm		Kettle ID	mm		Passlane Seal Rod No	2				
Cross Baffle Type	PERPEND. SINGLE-SEG.		%Cut (Diam)	36.10		Impingement Plate	Circular plate				
Spacing(c/c)	212.725 mm		Inlet	330.201 mm		No of Crosspasses	27				
Rho-V2-Inlet Nozzle	4072.51 kg/m-s ²		Shell Entrance	788.30		Shell Exit	732.39		kg/m-s ²		
			Bundle Entrance	246.91		Bundle Exit	203.66		kg/m-s ²		
Weight/Shell	1676.24		Filled with Water	2396.95		Bundle	675.39 kg				

Notes:	Thermal Resistance, %	Velocities, m/s	Flow Fractions			
	Shell	46.08	Shellside	0.55	A	0.003
	Tube	31.95	Tubeside	0.62	B	0.707
	Fouling	20.84	Crossflow	0.59	C	0.048
	Metal	1.13	Window	0.59	E	0.054
					F	0.188



Final Results

Released to the following HTRI Member Company:
 Exchanger Industries
 Exchanger Industries

Xist Ver. 6.00 SP3 18/04/2013 8:58 SN: 1500213483

Simo Units

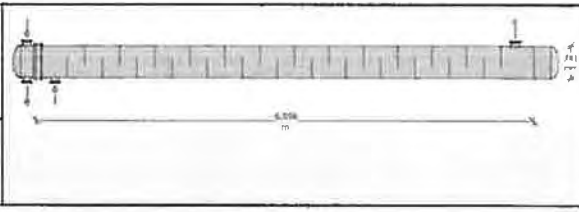
#13-3353 104-E-135

Rating - Horizontal Multipass Flow TEMA BEU Shell With Single-Segmental Baffles

Process Data		Cold Shellside		Hot Tubeside	
Fluid name	Sales Oil			Glycol	
Fluid condition		Sens Liquid		Sens Liquid	
Total flow rate	(kg/hr)	56495.1		10527.0	
Weight fraction vapor, In/Out	(--)	0.000	0.000	0.000	0.000
Temperature, In/Out	(Deg C)	30.00	40.00	90.00	60.00
Temperature, Average/Skin	(Deg C)	35.00	52.79	75.00	61.09
Wall temperature, Min/Max	(Deg C)	46.47	70.97	46.78	71.68
Pressure, In/Average	(kPa)	313.000	278.027	1264.00	1254.72
Pressure drop, Total/Allowed	(kPa)	69.946	70.000	18.558	70.000
Velocity, Mid/Max allow	(m/s)	0.55		0.62	
Mole fraction inert	(--)				
Average film coef	(W/m2-K)		598.95		1109.28
Heat transfer safety factor	(-)		1.000		1.000
Fouling resistance	(m2-KW)		0.000528		0.000176

Overall Performance Data						
Overall coef., Req'd/Clean/Actual	(W/m2-K)	210.80	/	348.64	/	275.99
Heat duty, Calculated/Specified	(MegaWatts)	0.2910	/	0.2925		
Effective overall temperature difference	(Deg C)	37.9				
EMTD = (MTD) * (DELTA) * (F/G/H)	(Deg C)	37.97	*	0.9985	*	1.0000

See Runtime Messages Report for warnings.



Exchanger Fluid Volumes	
Approximate shellside (L)	503.7
Approximate tubeside (L)	217.5

Shell Construction Information					
TEMA shell type	BEU	Shell ID	(mm)	381.001	
Shells Series	1 Parallel 1	Total area	(m2)	36.902	
Passes Shell	1 Tube 4	Eff. area	(m2/shell)	36.592	
Shell orientation angle (deg)	0.00				
Impingement present	Circular plate	Impingement diameter/nozzle		1.1	
Pairs seal strips	0	Passlane seal rods (mm)	19.050	No. 2	
Shell expansion joint	No	Full support at U-Bend		Yes	
Weight estimation Wet/Dry/Bundle	2396.9	/	1676.2	/	675.39 (kg/shell)

Baffle Information					
Type	Perpend. Single-Seg.	Baffle cut (% dia)	36.10		
Crosspasses/shellpass	27	No. (Pct Area)	(mm) to C L		
Central spacing	(mm) 212.725	1	34.36	52.959	
Inlet spacing	(mm) 330.201	2	0.00	0.000	
Outlet spacing	(mm) 346.076				
Baffle thickness	(mm) 4.763				

Tube Information					
Tube type	Plain	Tube count per shell		102	
Length to tangent	(m) 6.096	Pct tubes removed (both)		18.63	
Effective length	(m) 5.994	Outside diameter	(mm)	19.050	
Total tubesheet	(mm) 50.800	Wall thickness	(mm)	2.108	
Area ratio	(out/in) 1.2842	Pitch (mm)	25.4001	Ratio	1.3333
Tube metal	Carbon steel	Tube pattern (deg)		45	

**Final Results**

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 Exchanger Industries

Xist Ver. 6.00 SP3 18/04/2013 8:58 SN: 1500213483

Simo Units

#13-3353 104-E-135 ↑ 136 ▲

Rating - Horizontal Multipass Flow TEMA BEU Shell With Single-Segmental Baffles

Shellside Performance

Nom vel, X-flow/window 0.59 / 0.59

Flow fractions for heat transfer 0.775

A=0.0034 B=0.7089 C=0.0481 E=0.0536 F=0.1881

Shellside Heat Transfer Corrections

Total	Beta	Gamma	End	Fin
0.920	0.920	1.000	0.990	1.000

Pressure Drops (Percent of Total)

Cross	Window	Ends	Nozzle	Shell	Tube
58.28	26.08	6.83	Inlet	4.66	0.37
MOMENTUM		0.00	Outlet	4.16	0.23

Two-Phase Parameters

Method	Inlet	Center	Outlet	Mix F
--------	-------	--------	--------	-------

H. T. Parameters

	Shell	Tube
Overall wall correction	1.177	0.954
Midpoint Prandtl no.	2214.08	20.36
Midpoint Reynolds no.	57	4615
Bundle inlet Reynolds no.	29	6791
Bundle outlet Reynolds no.	54	3671
Fouling layer (mm)		

Thermal Resistance

Shell	Tube	Fouling	Metal	Over Des
46.08	31.95	20.84	1.13	30.92
Total fouling resistance				7.545e-4
Differential resistance				0.00112

Shell Nozzles

	Inlet	Outlet	Liquid Outlet
Inlet at channel end-Yes			
Number at each position	1	1	0
Diameter (mm)	101.600	101.600	
Velocity (m/s)	2.10	2.12	
Pressure drop (kPa)	3.259	2.907	
Height under nozzle (mm)	61.211	54.553	
Nozzle R-V-SQ (kg/m-s2)	4072.51	4094.77	
Shell ent. (kg/m-s2)	788.30	732.39	

Tube Nozzle


	Inlet	Outlet	Liquid Outlet
Diameter (mm)	RADIAL 101.600	RADIAL 101.600	
Velocity (m/s)	0.35	0.34	
Pressure drop (kPa)	0.069	0.043	
Nozzle R-V-SQ (kg/m-s2)	125.25	122.49	

Annular Distributor

	Inlet	Outlet
Length (mm)		
Height (mm)		
Slot area (mm2)		

Diametral Clearances (mm)

Baffle-to-shell	Bundle-to-shell	Tube-to-baffle
3.1750	22.3293	0.7938

HTRI		Vibration Analysis		Page 6	
		Released to the following HTRI Member Company: <i>Exchanger Industries</i> <i>Exchanger Industries</i>			
Xist Ver. 6 00 SP3 18/04/2013 8:58 SN 1500213483				Simo Units	
#13-3353 104-E-135 +136 					
Rating - Horizontal Multipass Flow TEMA BEU Shell With Single-Segmental Baffles					
Shellside condition		Sens Liquid		(Level 2 3)	
Axial stress loading (MPa)		0.000		Added mass factor 1.394	
Beta		4.217			
Position In The Bundle		Inlet		Center	
Outlet					
Length for natural frequency (m)		0.543		0.425	
Length/TEMA maximum span (-)		0.356		0.279	
Number of spans (-)		14		14	
Tube natural frequency (Hz)		211.3		211.4	
Shell acoustic frequency (Hz)				208.5 +	
Flow Velocities		Inlet		Center	
Outlet					
Window parallel velocity (m/s)		0.58		0.58	
Bundle crossflow velocity (m/s)		0.26		0.41	
Bundle/shell velocity (m/s)		0.11		0.18	
Fluidelastic Instability Check		Inlet		Center	
Outlet					
Log decrement HTRI		0.100		0.100	
Critical velocity (m/s)		11.59		18.90	
Baffle tip cross velocity ratio (-)		0.0290		0.0284	
Average crossflow velocity ratio (-)		0.0299		0.0292	
Acoustic Vibration Check		Inlet		Center	
Outlet					
Vortex shedding ratio (-)					
Chen number (-)					
Turbulent buffeting ratio (-)					
Tube Vibration Check		Inlet		Center	
Outlet					
Vortex shedding ratio (-)		0.039		0.062	
Parallel flow amplitude (mm)		0.000		0.000	
Crossflow amplitude (mm)		0.001		0.001	
Tube gap (mm)		6.350		6.350	
Crossflow RHO-V-SQ (kg/m-s2)		110.16		278.55	
Bundle Entrance/Exit (analysis at first tube row)				Entrance	
				Exit	
Fluidelastic instability ratio (-)				0.017	
Vortex shedding ratio (-)				0.078	
Crossflow amplitude (mm)				0.00045	
Crossflow velocity (m/s)				0.52	
Tubesheet to inlet/outlet support (mm)				None	
Shell Entrance/Exit Parameters				Entrance	
				Exit	
Impingement plate				Yes	
Flow area (m2)				0.018	
Velocity (m/s)				0.93	
RHO-V-SQ (kg/m-s2)				788.30	
Shell type BEU		Baffle type		Single-Seg	
Tube type Plain		Baffle layout		Perpend	
Pitch ratio 1.3333		Tube diameter, (mm)		19.050	
Layout angle 45		Tube material		Carbon steel	
Number U-Bend supports		Supports/baffle space			
Program Messages					
+ Frequency ratios are based upon lowest natural or acoustic frequency					
* Items with asterisk exceed a conservative lower limit for vibration-free design. Review your case using the procedure described in Online Help; You may find that a vibration problem is unlikely					



Input Reprint

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Exchanger Industries

Xist Ver 6.00 SP3 18/04/2013 8:58 SN: 1500213483

Simo Units

#13-3353 104-E-135 + 136

Rating - Horizontal Multipass Flow TEMA BEU Shell With Single-Segmental Baffles

Shell Data

Service type	Generic Shell and Tube
TEMA type	BEU
Run mode	Rating
Hot fluid location	Tubeside
Number of shells in series	1
Number of shells in parallel	1
Shell inside diameter	381.001 mm
Flow in 1st tubepass	Cocurrent
Train flow direction	Countercurrent

Reboiler Data

Reboiler type	No piping specified
Inlet pressure location	Inlet nozzle

Tube Data

Tube type	Plain
Tube outside diameter	19.050 mm
Tube wall thickness	2.108 mm
Tube pitch	25.400 mm
Tube pitch ratio	1.333
Tube passes per shell	4
Tube pattern	45 degrees
Number of tubes per shell	102
Tube count method	Rigorous
Tube length	6.096 m
Tube material	Carbon steel

Tubepass Arrangement Data

Parallel/vertical passlane width	16.871 mm
Perpendicular/horizontal passlane width	16.871 mm
Force symmetric layout	No
Force cleaning lanes	Yes
Tubepass layout	Quadrant
First tubepass location	Top left
Tubes to remove for tie rods	None
	Yes
	No

Baffle Data

Baffle type	Single segmental
Baffle orientation	Perpendicular
Baffle cut percent	36.1 % shell ID
Number of crosspasses	27
Central baffle spacing	212.725 mm
Inlet baffle spacing	330.201 mm
Variable baffle spacing	No
Distance from tangent to last baffle	50.800 mm
Window cut from baffles	No



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Simo Units

#13-3353 104-E-135 + 136

Rating - Horizontal Multipass Flow TEMA BEU Shell With Single-Segmental Baffles

Clearance Data

Number of seal strip pairs	None
Baffle clearance type	TEMA
Block A stream	No
Block E stream	No
Block F stream	No
Number of passlane seal rods	Calculated
Bundle to shell clearance	22 329 mm
Height under nozzle	61 211 mm
Height under nozzle	54 553 mm

Nozzle Data

Shellside inlet ID	101.600 mm
Number of shellside inlet nozzles	1
Shellside outlet ID	101.600 mm
Number of shellside outlet nozzles	1
Tubeside inlet ID	101.600 mm
Number of tubeside inlet nozzles	1
Tubeside outlet ID	101.600 mm
Number of tubeside outlet nozzles	1
Radial position on shell inlet nozzle	Bottom
Longitudinal position on shell of inlet nozzle	At front head
Radial position on shell outlet nozzle	Opposite side
Location of nozzle at U-bend	Before U-bend
Tubeside entry type	Radial
Tubeside inlet position	Front head
Tubeside exit type	Same as inlet
Front head location	Left

Impingement Data

Impingement device present	Yes
Impingement type	Circular plate

Optional Geometry Data

Small exchanger	No
Total tubesheet thickness	50 800 mm
Tubesheet type	Single
Shell expansion joint	No
Floating head support type	None
Full support at U-Bend	Full support
Insulated longitudinal baffle	No
Tubeside design temperature	150.00 C
Tubeside design pressure	3500.00 kPaG
Shellside design temperature	150.00 C
Shellside design pressure	3500.00 kPaG



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Simo Units

#13-3353 104-E-135 + 136

Rating - Horizontal Multipass Flow TEMA BEU Shell With Single-Segmental Baffles

Process Conditions Data

	Hot Fluid	Cold Fluid
Phase condition	Sensible liquid	Sensible liquid
Flow rate	10527.0	56495.0 kg/hr
Inlet vapor fraction	0	0
Outlet vapor fraction	0	0
Inlet temperature	90.00	30.00 C
Outlet temperature	60.00	40.00 C
Inlet pressure	1264.00	313.000 kPa
Allowable pressure drop	70.000	70.000 kPa
Exchanger duty		0.2925 MegaWatts
Duty multiplier		1

Process Fouling Data

	Hot Fluid	Cold Fluid
Fouling resistance	1.761e-4	5.283e-4 m2-K/W

Hot Fluid Property Data

Fluid name	Glycol
Physical property method	Component by component properties
Heat release method	Program calculated
Flash type	Integral
Quantity units	Moles
Temperature interpolation option	Program
Number of components	1
Property package	HTRI

Hot Fluid Component Data

Component number	1
Component name	[New User-Defined]
Comp bank name	<User-Defined>
Component bank	HTRI
Component code	-1
Component phase	Liquid
Component quantity	1
Liquid Properties	
Reference temperature, C	90.00 60.00
Density, kg/m3	1038.60 1062.00
Viscosity, mN-s/m2	1.4113 2.7430
Thermal conductivity, W/m-C	0.3364 0.3450
Heat capacity, kJ/kg-C	3.4057 3.2720

Cold Fluid Property Data

Fluid name	Sales Oil
Physical property method	Bulk properties via grid
Heat release method	User specified via TP grid
Flash type	Integral
Quantity units	Moles
Temperature interpolation option	Program
Heat release type	Specific enthalpy



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Simo Units

#13-3353 104-E-135 + 134

Rating - Horizontal Multipass Flow TEMA BEU Shell With Single-Segmental Baffles

Cold Fluid Physical Property Data

Pressure Set, 313 000 kPa						
Temp C	Enthalpy kJ/kg	Vapor Mass Fraction	Liquid Density kg/m3	Liquid Dynamic Viscosity mN-s/m2	Liquid Thermal Cond W/m-C	Liquid Heat Capacity kJ/kg-C
30.00	--	--	920.000	230.000	0.1425	1.8220
35.00	--	--	--	--	--	--
40.00	--	--	915.000	119.000	0.1402	1.8630

Control Name Data

Case name #13-3353 104-E-135
 Item Number 104-E-135
 Reference Number CE416040-CC088996-00
 Proposal Number P12S-13230
 Service SALES OIL TANK HEATER
 Customer Canadian Natural Resources Limited c/o JACOBS
 Plant Kirby North Phase 1, Conklin, AB

Control Methods Data

Shellside friction factor method Commercial
 Tubeside friction factor method Commercial
 Pure longitudinal flow No
 Pure component condensation No
 Condensing correlation HTRI Proration
 Mole fraction inerts 0
 Momentum exclusion 0 %
 Pure component boiling No
 Check film boiling Yes
 Nucleate boiling method Physical property/theoretical boiling range
 Component boiling method Nucleate and convective

Control Safety Data

Cold fluid/shellside film coefficient multiplier 1
 Hot fluid/tubeside film coefficient multiplier 1

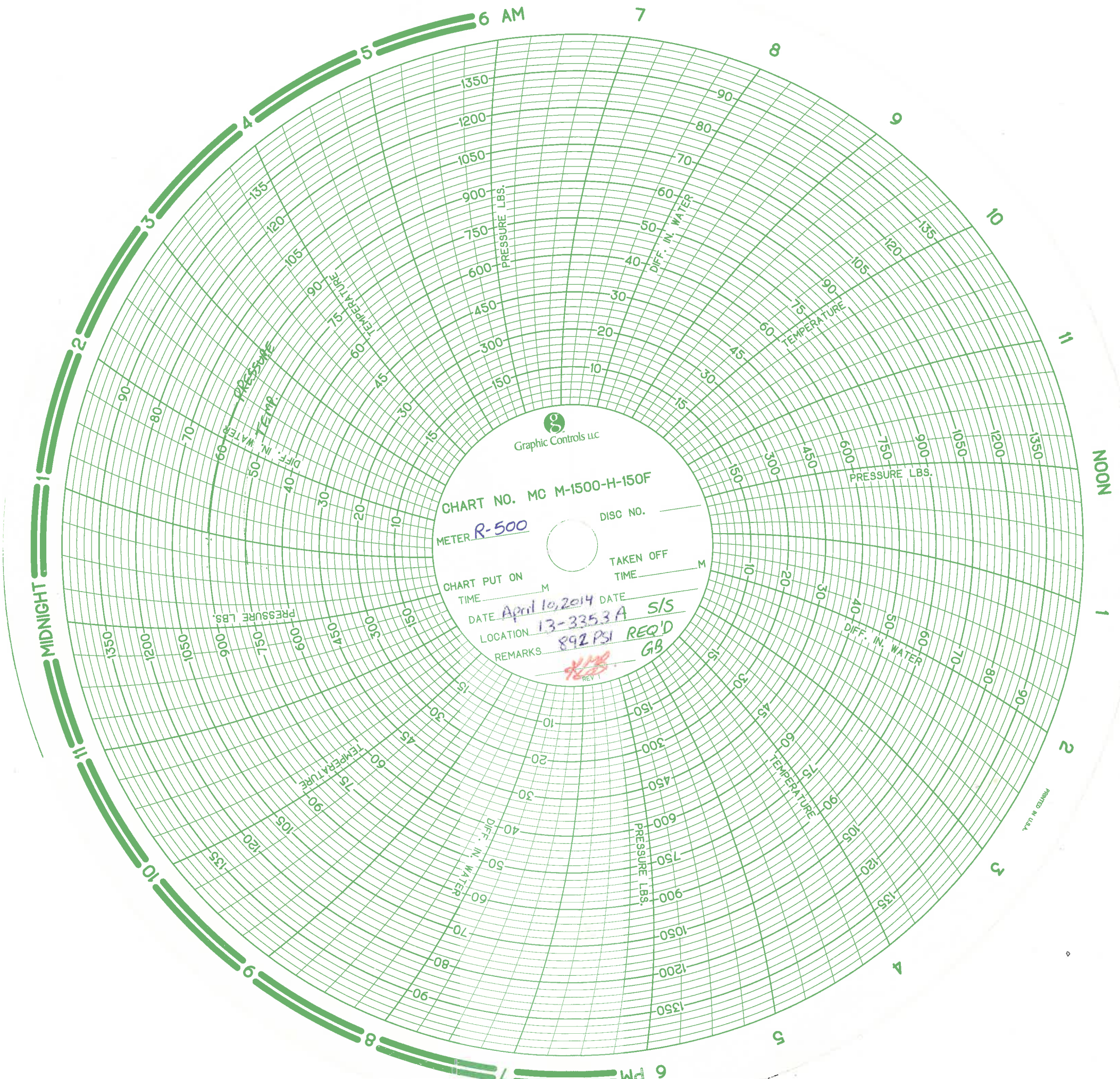
Control User-Defined Methods Data

Add non-nucleate boiling Yes

Control Vibration Data

Damping factor method HTRI Method
 Include inlet vibration support No
 Include outlet vibration support No

This Section is Not Applicable to this ITEM number.



Graphic Controls LLC

CHART NO. MC M-1500-H-150F
METER R-500 DISC NO. _____

CHART PUT ON TIME _____ M
TAKEN OFF TIME _____ M

DATE April 10, 2014
LOCATION 13-3353A SIS

REMARKS 892 PSI REQ'D GB
REV 1

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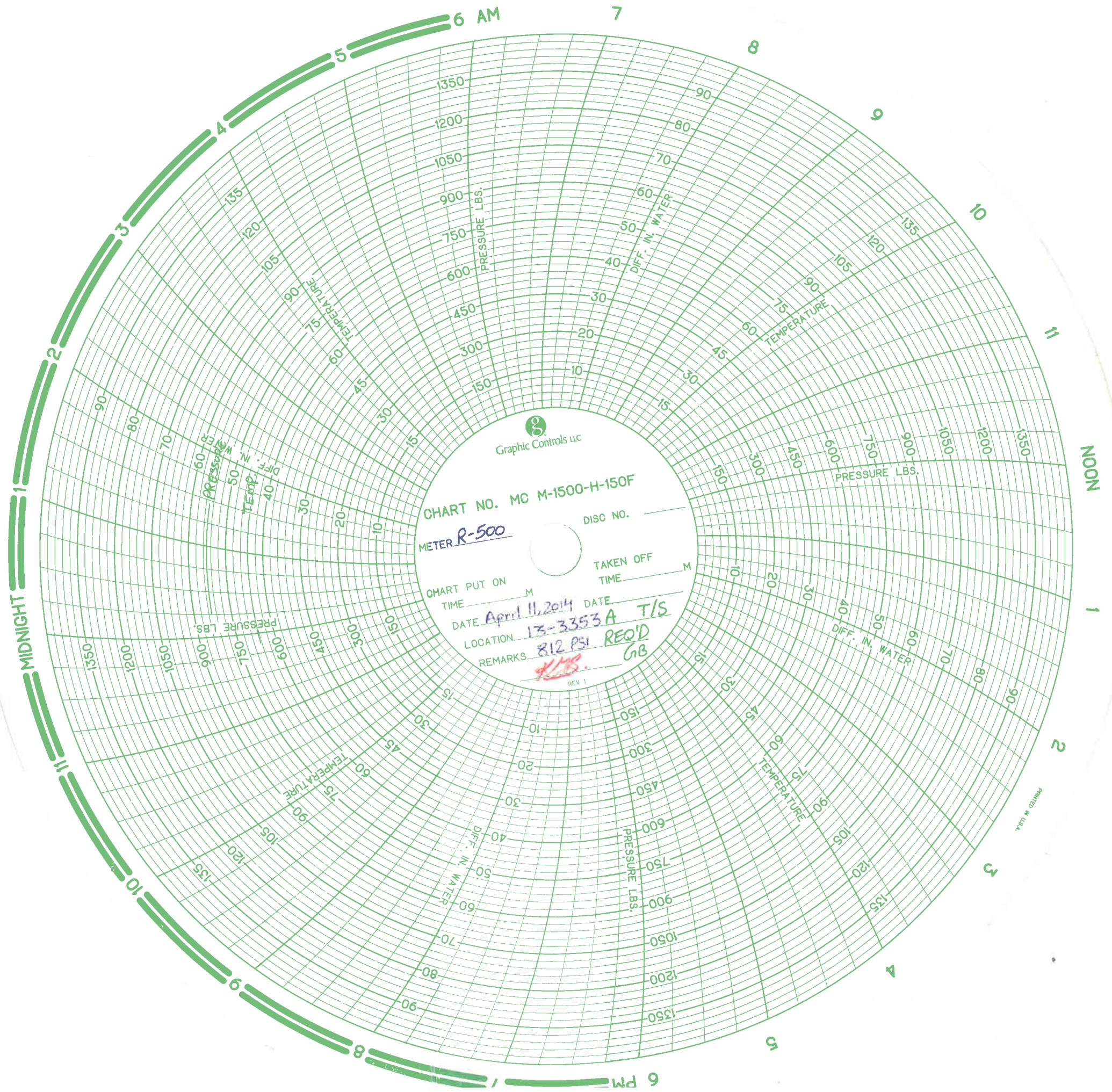
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TYPE IN GREEN



Graphic Controls LLC

CHART NO. MC M-1500-H-150F

METER R-500

DISC NO. _____

CHART PUT ON TIME _____ M

TAKEN OFF TIME _____ M

DATE April 11, 2014

LOCATION 13-3353 A T/S

REMARKS 812 PSI REQ'D
KLB. GB

REV 1

PRINTED IN U.S.A.



EXCHANGER INDUSTRIES
A Division of Premetalco Inc.

HYDROSTATIC TEST REPORT

CUSTOMER: CANADIAN NATURAL RESOURCES LTD.

OWNER: CANADIAN NATURAL RESOURCES LTD.

ITEM NO.: 104-E-135

JOB NO.: 13-3353 A

SHELL SIDE DESIGN PRESSURE: 3585 KPAG (520 PSIG)

SHELL SIDE HYDROSTATIC TEST PRESSURE: 6151 KPAG (892 PSIG)

HYDRO WITNESSED BY: Gauge # 50, 223

EXCHANGER INDUSTRIES: [Signature] DATE: April 10, 2014

CUSTOMER: [Signature] DATE: 10-04-2014

TUBE SIDE DESIGN PRESSURE: 3585 KPAG (520 PSIG)

TUBE SIDE HYDROSTATIC TEST PRESSURE: 5599 KPAG (812 PSIG)

HYDRO WITNESSED BY: Gauge # 33, 34

EXCHANGER INDUSTRIES: [Signature] DATE: April 11, 2014

CUSTOMER: [Signature] DATE: 11-04-2014

Pressure Gauge Calibration Report



Customer Exchanger Ind
Calibration
Date 11-Oct-13

Device Type Pressure Gauge Instrument Range 0-2000
Make WIKA Units PSI
Serial Number 50

Input		Output	As Found	As Left
0%	0	0%	0	0
25%	500	25%	500	500
50%	1000	50%	1000	1000
75%	1500	75%	1500	1500
100%	2000	100%	2000	2000

Remarks:

Calibrated Using NIST Traceable Test Equipment

Test Gauge Asset Number K3172
Test Gauge Serial Number 545712
Test Medium Hydraulic Fluid
Calibrated by Brett Trockstad Date 11-Oct-13

Signature 

Pressure Gauge Calibration Report



Customer Exchanger Ind
 Calibration
 Date 10-Oct-13

Device Type Pressure Gauge Instrument Range 0-2000
 Make WIKA Units PSI
 Serial Number 223

Input		Output	As Found	As Left
0%	0	0%	-5	0
25%	500	25%	500	500
50%	1000	50%	1000	1000
75%	1500	75%	1500	1500
100%	2000	100%	2000	2000

Remarks:

Calibrated Using NIST Traceable Test Equipment

Test Gauge Asset Number K3172
 Test Gauge Serial Number 545712
 Test Medium Hydraulic Fluid

Calibrated by Brett Trockstad Date 10-Oct-13

Signature

Pressure Gauge Calibration Report



Customer Exchanger Ind
 Calibration
 Date 4-Dec-13

Device Type Pressure Gauge Instrument Range 0-1500
 Make Nuova Fima Units PSI
 Serial Number 33

Input		Output	As Found	As Left
0%	0	0%	40	0
25%	375	25%	375	375
50%	750	50%	750	750
75%	1125	75%	1125	1125
100%	1500	100%	1500	1500

Remarks: Calibrated to within 1% of span

Calibrated Using NIST Traceable Test Equipment

Test Gauge Asset Number K3172
 Test Gauge Serial Number 545712
 Test Medium Hydraulic Fluid

Calibrated by Brett Trockstad Date 4-Dec-13

Signature 

Pressure Gauge Calibration Report



Customer Exchanger Ind
Calibration
Date 4-Dec-13

Device Type Pressure Gauge Instrument Range 0-1500
Make Nuova Fima Units PSI
Serial Number 34

Input		Output	As Found	As Left
0%	0	0%	0	0
25%	375	25%	375	375
50%	750	50%	750	750
75%	1125	75%	1125	1125
100%	1500	100%	1500	1500

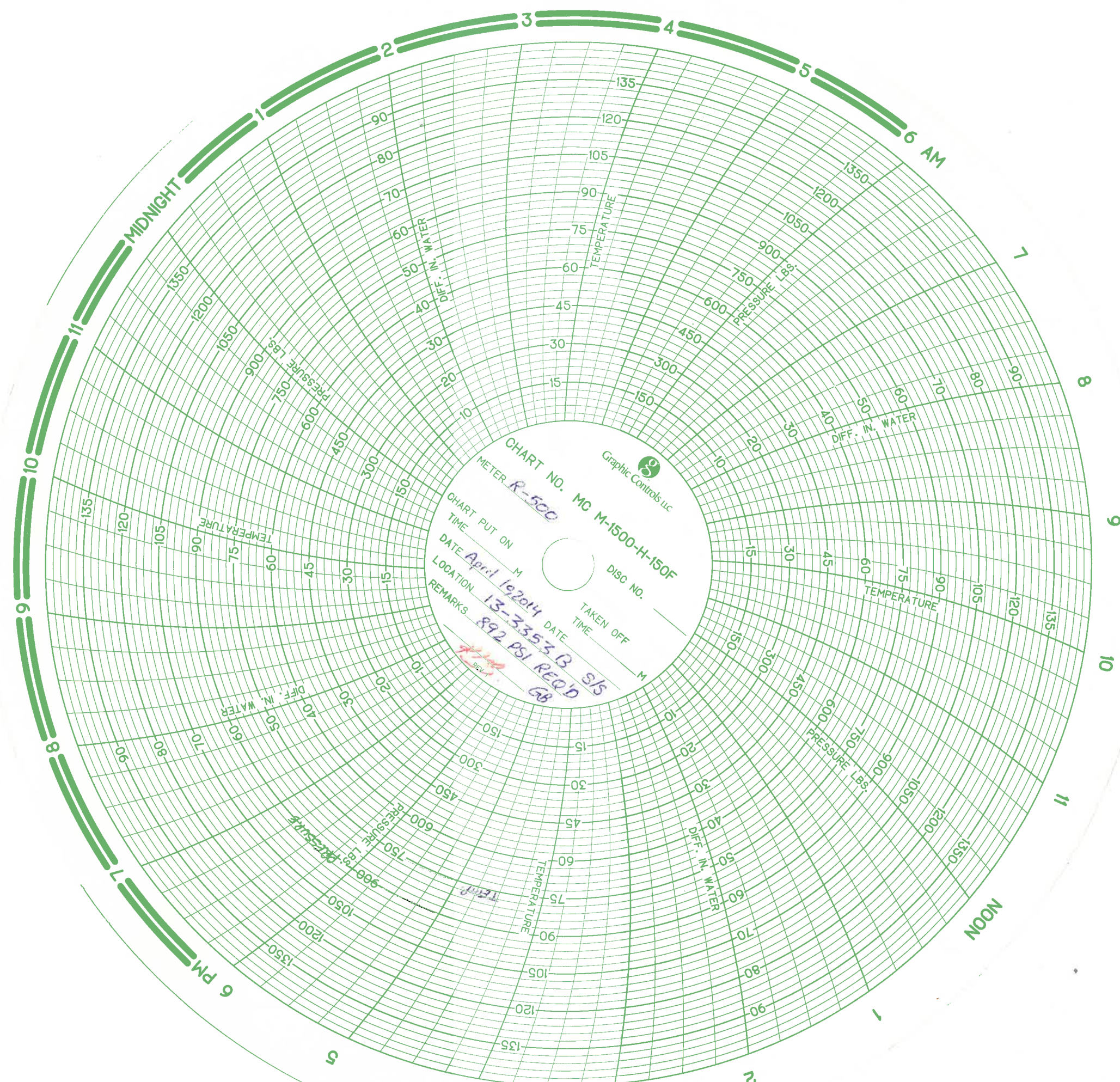
Remarks: Calibrated to within 1% of span

Calibrated Using NIST Traceable Test Equipment

Test Gauge Asset Number K3172
Test Gauge Serial Number 545712
Test Medium Hydraulic Fluid

Calibrated by Brett Trockstad Date 4-Dec-13

Signature 



Graphic Controls, LLC

CHART NO. MC M-1500-H-150F

METER R-500

CHART PUT ON TIME _____

DATE April 19 2014

LOCATION 13-33553 B S/S

REMARKS 892 PSI READ GB

TAKEN OFF TIME _____



DISC NO. _____

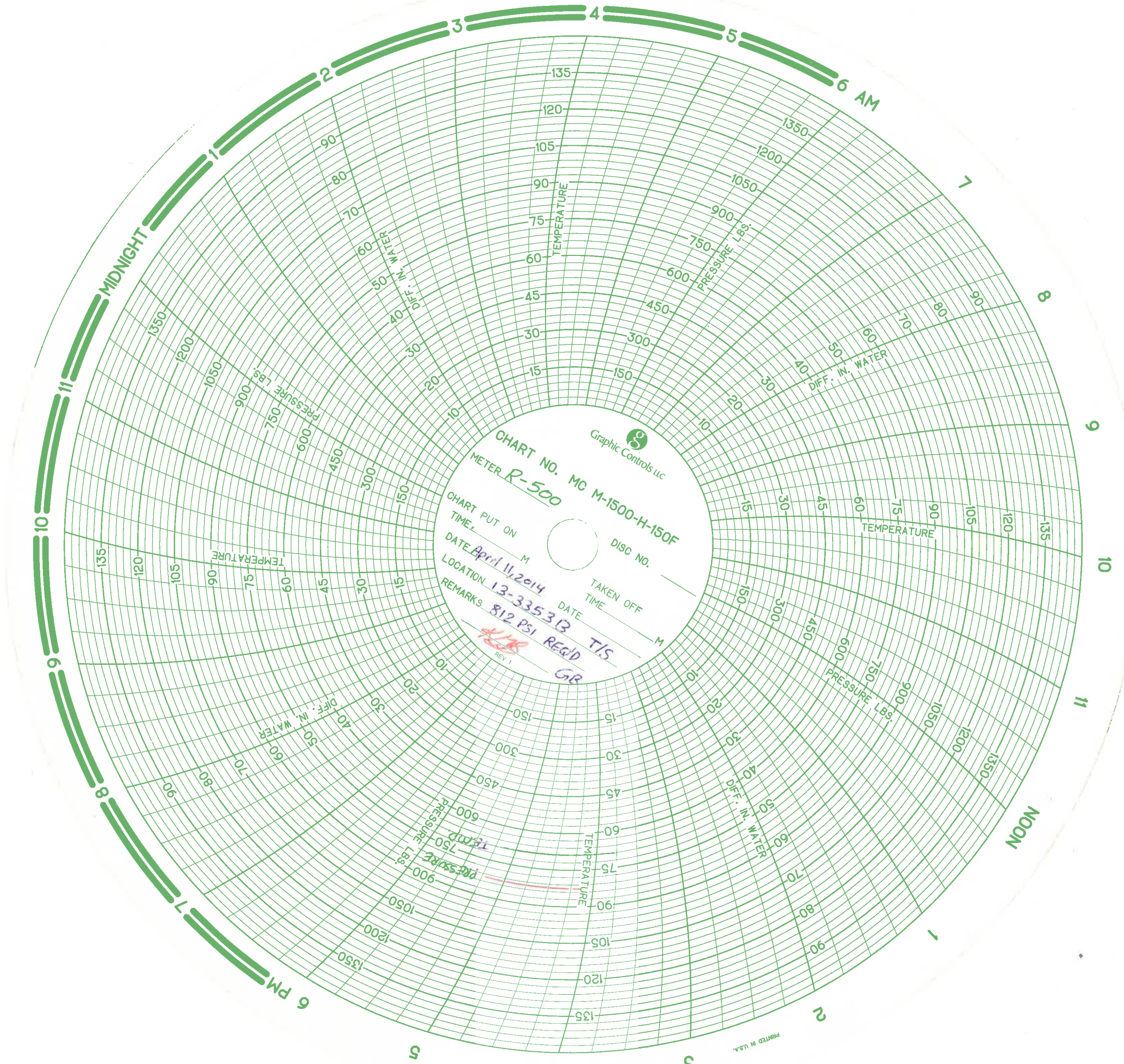


CHART NO. MC M-1500-H-150F
 METER R-500
 CHART PUT ON _____ DISC NO. _____
 DATE April 11, 2014
 LOCATION 13-335-313
 REMARKS 812 PSI REQ'D T/S
 TAKEN OFF _____
 DATE _____
 GR



**EXCHANGER
INDUSTRIES**
A Division of Premetalco Inc.

HYDROSTATIC TEST REPORT

CUSTOMER: CANADIAN NATURAL RESOURCES LTD.

OWNER: CANADIAN NATURAL RESOURCES LTD.

ITEM NO.: 104-E-136

JOB NO.: 13-3353 B

SHELL SIDE DESIGN PRESSURE: 3585 KPAG (520 PSIG)

SHELL SIDE HYDROSTATIC TEST PRESSURE: 6151 KPAG (892 PSIG)

HYDRO WITNESSED BY:

EXCHANGER INDUSTRIES: *[Signature]* DATE: April 10, 2014

CUSTOMER: *[Signature]* DATE: 10-04-2014

TUBE SIDE DESIGN PRESSURE: 3585 KPAG (520 PSIG)

TUBE SIDE HYDROSTATIC TEST PRESSURE: 5599 KPAG (812 PSIG)

HYDRO WITNESSED BY:

EXCHANGER INDUSTRIES: *[Signature]* DATE: April 11, 2014

CUSTOMER: *[Signature]* DATE: 10-01-2014

Pressure Gauge Calibration Report



Customer Exchanger Ind
Calibration
Date 11-Oct-13

Device Type Pressure Gauge Instrument Range 0-2000
Make WIKA Units PSI
Serial Number 47

Input		Output	As Found	As Left
0%	0	0%	10	0
25%	500	25%	500	500
50%	1000	50%	1000	1000
75%	1500	75%	1500	1500
100%	2000	100%	2000	2000

Remarks:

Calibrated Using NIST Traceable Test Equipment

Test Gauge Asset Number K3172
Test Gauge Serial Number 545712
Test Medium Hydraulic Fluid

Calibrated by Brett Trockstad Date 11-Oct-13

Signature 

Pressure Gauge Calibration Report



Customer Exchanger Ind

Calibration

Date 23-Oct-13

Device Type Pressure Gauge

Make WIKA

Serial Number 265

Instrument Range 0-2000

Units PSI

Input		Output	As Found	As Left
0%	0	0%	20	0
25%	500	25%	510	500
50%	1000	50%	1010	1000
75%	1500	75%	1510	1500
100%	2000	100%	2010	2000

Remarks:

Calibrated Using NIST Traceable Test Equipment

Test Gauge Asset Number K3172

Test Gauge Serial Number 545712

Test Medium Hydraulic Fluid

Calibrated by Brett Trockstad

Date 23-Oct-13

Signature 

Pressure Gauge Calibration Report



Customer Exchanger Ind
Calibration
Date 9-Dec-13

Device Type Pressure Gauge Instrument Range 0-1500
Make Nuova Fima Units PSI
Serial Number 28

Input		Output	As Found	As Left
0%	0	0%	5	0
25%	375	25%	375	375
50%	750	50%	750	750
75%	1125	75%	1125	1125
100%	1500	100%	1500	1500

Remarks: Calibrated to within 1% of span

Calibrated Using NIST Traceable Test Equipment

Test Gauge Asset Number K3172
Test Gauge Serial Number 545712
Test Medium Hydraulic Fluid

Calibrated by Brett Trockstad Date 9-Dec-13

Signature 

Drinking Water Quality Summary

Glenmore Water Treatment Plant
January 01 - December 31, 2012

PARAMETER	UNITS	MAXIMUM ACCEPTABLE CONCENTRATIONS‡	CITY OF CALGARY WATER CONCENTRATION RANGE	
			Untreated Water (Raw)	Treated Water (Finished) *
Aldicarb	mg/L	0.009	Not Tested	Not Tested
Aldrin & Dieldrin	mg/L	0.0007	<0.00007	<0.00007
Alkalinity	mg/L as CaCO ₃	No Guidelines	133 - 180	109 - 176
Aluminum	mg/L	≤0.1 (O)	0.005 - 1.829	0.013 - 0.177
Ammonium	mg/L as N	No Guidelines	<0.10	<0.10
Antimony	mg/L	0.006	<0.0005	<0.0005
Arsenic	mg/L	0.010	<0.0005 - 0.0010	<0.0005
Atrazine + metabolites	mg/L	0.005	<0.0017	<0.0017
Azinphos - methyl	mg/L	0.02	<0.001	<0.001
Barium	mg/L	1	0.0630 - 0.1089	0.0565 - 0.0778
Bendiocarb	mg/L	0.04	Not Tested	Not Tested
Benzene	mg/L	0.005	<0.0005	<0.0005
Benzo(a)pyrene	mg/L	0.00001	<0.00001	<0.00001
Beryllium	mg/L	No Guidelines	<0.0005	<0.0005
Bicarbonate	mg/L as CaCO ₃	No Guidelines	133 - 180	109 - 176
Boron	mg/L	5.0	0.005 - 0.010	0.006 - 0.010
Bromate	mg/L	0.01	Not Tested	<0.01 - 0.01
Bromoxynil	mg/L	0.005 (I)	<0.0002	<0.0002
Cadmium	mg/L	0.005	<0.0001 - <0.0005	<0.0001 - <0.0005
Calcium	mg/L	No Guidelines	46 - 71	48 - 71
Carbaryl	mg/L	0.09	<0.002	<0.002
Carbofuran	mg/L	0.09	Not Tested	Not Tested
Carbonate	mg/L as CaCO ₃	No Guidelines	<20	<20
Carbon Tetrachloride	mg/L	0.005	<0.002	<0.002
Cesium - 137	Bq/L	10	<0.2	<0.3
γ-Chlordane	mg/L	No Guidelines	<0.00005	<0.00005
Chloramine	mg/L	3	Not Tested	<0.15
Chloride	mg/L	≤250 (A)	2.7 - 15	7.1 - 16
Chlorine, free	mg/L	No Guidelines	Not Tested	0.85 - 1.42
Chlorpyrifos	mg/L	0.09	<0.001	<0.001
Chromium	mg/L	0.05	<0.0005 - 0.0034	<0.0005 - 0.0018
Cobalt	mg/L	No Guidelines	<0.0005 - 0.0006	<0.0005

- * At plant effluent
- † Monitored Monthly
- ‡ Health Canada, August 2012. Guidelines for Canadian Drinking Water Quality (Summary Table)
- I Interim health-based guideline
- A Aesthetic Objective
- O Operational Guidance Value
- P Proposed Guideline
- UR/SR Under Review or Scheduled for Review

Drinking Water Quality Summary

Glenmore Water Treatment Plant
January 01 - December 31, 2012

PARAMETER	UNITS	MAXIMUM ACCEPTABLE CONCENTRATIONS‡	CITY OF CALGARY WATER CONCENTRATION RANGE	
			Untreated Water (Raw)	Treated Water (Finished)*
Coliforms, <i>E. coli</i>	MPN/100mL	0	<1 - 579.4	<1
Coliforms, Total	MPN/100mL	0	<1 - >24196	<1
Color	TCU	≤15 (A)	<2 - 22	<2
Conductivity at 25°C	uS/cm	No Guidelines	324 - 505	336 - 514
Copper	mg/L	≤1.0 (A)	0.0013 - 0.0055	<0.0005-0.0028
Cryptosporidium	oocysts/100L	No Guidelines	<1 - 39.4	Not Tested
Cyanazine	mg/L	0.01 (I)	<0.001	<0.001
Cyanide	mg/L	0.2	<0.002	<0.002
Cyanobacterial toxins – microcystin - LR	mg/L	0.0015	<0.00022 - 0.00029	0.00038 - 0.00048
Diazinon	mg/L	0.02	<0.001	<0.001
Dicamba	mg/L	0.12	<0.0002	<0.0002
1,2-Dichlorobenzene	mg/L	0.2	<0.0005	<0.0005
1,4-Dichlorobenzene	mg/L	0.005	<0.0005	<0.0005
2,4-DDT	mg/L	No Guidelines	<0.00005	<0.00005
4,4'-DDT	mg/L	No Guidelines	<0.00005	<0.00005
1,1-Dichloroethylene	mg/L	0.014	<0.001	<0.001
1,2-Dichloroethane	mg/L	0.005 (I)	<0.001	<0.001
Dichloromethane	mg/L	0.05	<0.005	<0.005
2,4-Dichlorophenol	mg/L	0.9	<0.001	<0.001
2,4-D	mg/L	0.1 (I)	<0.0002	<0.0002
Diclofop-methyl	mg/L	0.009	<0.00005	<0.00005
Dimethoate	mg/L	0.02 (I)	<0.001	<0.001
Dinoseb	mg/L	0.01	<0.0002	<0.0002
Diquat	mg/L	0.07	Not Tested	Not Tested
Diuron	mg/L	0.15	<0.001	<0.001
Endrin	mg/L	No Guidelines	<0.00005	<0.00005
Ethylbenzene	mg/L	≤0.0024 (A)	<0.0005	<0.0005
Extractable Hydrocarbons	mg/L	No Guidelines	<0.01	<0.01
Fluoride	mg/L	1.5	0.21 - 0.34	0.16 - 0.30
Giardia	cysts/100L	No Guidelines	1.6 - 63.8	Not Tested
Glyphosate	mg/L	0.28 (I)	<0.005	<0.005
Hardness	mg/L as CaCO ₃	No Guidelines	170 - 257	176 - 260

- * At plant effluent
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Drinking Water Quality Summary

Glenmore Water Treatment Plant
January 01 - December 31, 2012

PARAMETER	UNITS	MAXIMUM ACCEPTABLE CONCENTRATIONS‡	CITY OF CALGARY WATER CONCENTRATION RANGE	
			Untreated Water (Raw)	Treated Water (Finished) *
Heptachlor + heptachlorepoxide	mg/L	No Guidelines	<0.00007	<0.00007
Heterotrophic Plate Count	CFU/mL	No Guidelines	<1 - 5200	<1 - 26
Iodine - 131	Bq/L	6	<0.1	<0.2
Iron	mg/L	≤0.3 (A)	<0.050 - 1.083	<0.030 - <0.060
Lead	mg/L	0.01	<0.0005 - 0.0017	<0.0005
Lindane	mg/L	No Guidelines	<0.00005	<0.00005
Lithium	mg/L	No Guidelines	0.0031 - 0.0057	0.0026 - 0.0055
Magnesium	mg/L	No Guidelines	12 - 19	12 - 20
Malathion	mg/L	0.19	<0.001	<0.001
Manganese	mg/L	≤0.05 (A)	0.0014 - 0.0554	<0.0005 - 0.0027
Mercury	mg/L	0.001	<0.00005	<0.00005
Methoxychlor	mg/L	0.9	<0.00005	<0.00005
Methyl parathion	mg/L	No Guidelines	<0.001	<0.001
Metolachlor	mg/L	0.05 (I)	<0.001	<0.001
Metribuzin	mg/L	0.08	<0.001	<0.001
Mirex	mg/L	No Guidelines	<0.00005	<0.00005
Molybdenum	mg/L	No Guidelines	0.0005 - 0.0009	0.0005 - 0.0010
Monochlorobenzene	mg/L	0.08	<0.0005	<0.0005
Nickel	mg/L	UR/SR	0.0007 - 0.0024	<0.0005 - 0.0014
Nitrate	mg/L as N	10.0	0.004 - 0.19	0.008 - 0.19
Nitrite	mg/L as N	1.0	<0.0044	<0.0044
NTA	mg/L	0.4	<0.20	<0.20
Odour	Scale = 0-12	Inoffensive	<1 - 7	7 - 10
Paraquat	mg/L	0.01 (I)	Not Tested	Not Tested
Parathion	mg/L	0.05	<0.001	<0.001
Pentachlorophenol	mg/L	0.06	<0.001	<0.001
Pesticides, total	mg/L	No Guidelines	<0.005	<0.005
pH	pH units	6.5 - 8.5 (A)	8.0 - 8.5	7.2 - 8.0
Phorate	mg/L	0.002	<0.001	<0.001
Phosphorus, Total	mg/L	No Guidelines	0.004 - 0.012	<0.001 - 0.034
Phthalate Esters	mg/L	No Guidelines	<0.01	<0.01
Picloram	mg/L	0.19 (I)	<0.0002	<0.0002

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Drinking Water Quality Summary

Glenmore Water Treatment Plant

January 01 - December 31, 2012

PARAMETER	UNITS	MAXIMUM ACCEPTABLE CONCENTRATIONS†	CITY OF CALGARY WATER CONCENTRATION RANGE	
			Untreated Water (Raw)	Treated Water (Finished) *
Potassium	mg/L	No Guidelines	0.84 - 1.4	0.81 - 1.4
Polycyclic Aromatic Hydrocarbons (PAH)	mg/L	No Guidelines	<0.01	<0.01
Radium - 226	Bq/L	0.5	0.008 - 0.009	<0.005 - 0.009
Radium - 228	Bq/L	No Guidelines	<0.7	<0.9
Radon - 222	Bq/L	No Guidelines	<2	<2
Saturation Index	Saturation Index Units	No Guidelines	Not Tested	Not Tested
Selenium	mg/L	0.01	<0.0005 - 0.0009	<0.0005 - 0.0012
Silica	mg/L	No Guidelines	3.4 - 5.0	3.2 - 4.8
Silver	mg/L	No Guidelines	<0.001	<0.001
Simazine	mg/L	0.01 (I)	<0.001	<0.001
Sodium	mg/L	≤200 (A)	3.2 - 12	6.6 - 12
Strontium	mg/L	No Guidelines	0.2608 - 0.4971	0.2542 - 0.4817
Strontium 90	Bq/L	5	Not Tested	Not Tested
Sulphate	mg/L	≤500 (A)	27 - 72	40 - 81
Sulphide	mg/L as H ₂ S	≤0.05 (A)	<0.04	<0.04
Taste	mg/L	Inoffensive (A)	N/A	Not Tested
Temperature	°C	≤15 (A)	1.9 - 21	1.5 - 20
Terbufos	mg/L	0.001 (I)	<0.0006	<0.0006
Tetrachloroethylene	mg/L	0.03	<0.001	<0.001
2,3,4,6-Tetrachlorophenol	mg/L	0.1	<0.001	<0.001
Thallium	mg/L	No Guidelines	<0.0005	<0.0005
Tin	mg/L	No Guidelines	<0.0005	<0.0005
Titanium	mg/L	No Guidelines	<0.0005 - 0.0432	<0.0005 - 0.0008
TKN	mg/L	No Guidelines	<0.07 - 0.38	<0.07 - 0.24
Toluene	mg/L	≤0.024 (A)	<0.0005	<0.0005
Total Dissolved Solids	mg/L	≤500 (A)	202 - 298	215 - 299
Total Haloacetic Acids	mg/L	0.08	<0.0023	0.008 - 0.036
Total Organic Carbon	mg/L	No Guidelines	0.7 - 5.8	0.6 - 2.3
Triallate	mg/L	No Guidelines	<0.001	<0.001

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Drinking Water Quality Summary

Glenmore Water Treatment Plant

January 01 - December 31, 2012

PARAMETER	UNITS	MAXIMUM ACCEPTABLE CONCENTRATIONS‡	CITY OF CALGARY WATER CONCENTRATION RANGE	
			Untreated Water (Raw)	Treated Water (Finished) *
Trichloroethylene	mg/L	0.005	<0.001	<0.001
2,4,6-Trichlorophenol	mg/L	0.005	<0.001	<0.001
2,4,5-T	mg/L	No Guidelines	<0.0002	<0.0002
Trichlorophenoxypropionic Acid (2,4,5-TP)	mg/L	No Guidelines	<0.0002	<0.0002
Trifluralin	mg/L	0.045 (I)	<0.001	<0.001
Total Trihalomethanes (TTHMs)	mg/L	0.100	<0.0013	0.0072 - 0.0408
Tritium	Bq/L	7000	Not Tested	Not Tested
Turbidity	NTU	1	0.35 - 182	<0.05 - 0.09
Uranium	mg/L	0.02	<0.0005 - 0.0007	<0.0005 - 0.0006
Vanadium	mg/L	No Guidelines	<0.0005 - 0.0050	<0.0005 - 0.0006
Vinyl Chloride	mg/L	0.002	<0.001	<0.001
Viruses	mg/L	UR/SR	Not Tested	Not Tested
Xylenes, total	mg/L	≤0.3 (A)	<0.0007	<0.0007
Zinc	mg/L	≤5.0 (A)	<0.002 - 0.012	<0.002 - 0.010

- * At plant effluent
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PATELS AIRTEMP (INDIA) LTD.

PRESSURE TEST REPORT

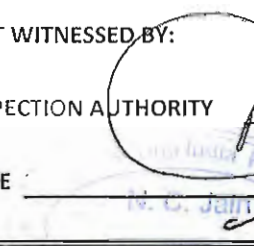
S.O. NO. : PEX-71213	DATE : 12/10/2013
CLIENT : M/s, EXCHANGER INDUSTRIES LTD.	INSP. AUTH : EI/JACOBS
P.O. NO. : 98999 DTD:- 15/07/2013	EI JOB Ref. : 13-3354
EQUIPMENT : FUEL GAS PRE-HEATER	DRG. NO. : 13-3354 SH. 1A TO 14 R-03
ASME SEC-VIII, DIV-1 ED-2010, ADD-2011a, TEMA	MFR.SR. NO. : EXE-1349
CODE : CLASS "R" 9TH EDITION, API 660	PROCEDURE NO. : PAT - QC/001 R 02
TYPE OF TEST & POSITION : HYDRO TEST & HORIZONTAL	METAL TEMP. AMBIENT
TEST MEDIUM : WATER	

Particulars	Design Pressure	Test Pressure	Pressure Guage Detail	Holding Time	Date	Test Result
SHELL SIDE HYDRO TEST (ITEM No- 107-E-305)	71.38 KG/CM ² G (1015.3 PSI)	109.60 KG/CM ² G (1559 PSI) (ACTUAL PRESSURE - 112 KG/CM ² G)	Range: 0-210 KG/CM ² G No. MPC-210-04 Calibration Due Date 6/3/2014 Range: 0-210 KG/CM ² G No. MPC-210-05 Calibration Due Date 6/3/2014	01 HOUR	12/10/2013	NEITHER LEAKAGE NOR PRESSURE DROP FOUND DURING THE HOLDING TIME. HYDRO TEST FOUND SATISFACTORY.
			Range : No. : Date of : Calibration : Range : No. : Date of : Calibration :			<input checked="" type="checkbox"/> Witnessed <input type="checkbox"/> Reviewed JOE AFONSO <i>[Signature]</i> Exchanger Industries. OCT 12 2013

TESTS WITNESSED BY: *[Signature]*
 QCE _____
 DATE Oct-19-2013



TEST WITNESSED BY: _____
 INSPECTION AUTHORITY *[Signature]*
 DATE _____



[Handwritten] A-Jacobs 16/10/2013



PATELS AIRTEMP (INDIA) LTD.

PRESSURE TEST REPORT

S.O. NO. : PEX-71213
 CLIENT : M/s, EXCHANGER INDUSTRIES LTD.
 P.O. NO. : 98999 DTD:- 15/07/2013
 EQUIPMENT : FUEL GAS PRE-HEATER
 ASME SEC-VIII, DIV-1 ED-2010, ADD-2011a, TEMA
 CODE : CLASS "R" 9TH EDITION, API 660
 TYPE OF TEST & POSITION : HYDRO TEST & HORIZONTAL
 TEST MEDIUM : WATER

DATE : 17/10/2013
 INSP. AUTH : EI/CENOVUS
 EI JOB Ref. : 13-3354
 DRG. NO. : 13-3354 SH. 1A TO 14 R-03
 MFR.SR. NO. : EXE-1349
 PROCEDURE NO. : PAT - QC/001 R 02
 METAL TEMP. AMBIENT

Particulars	Design Pressure	Test Pressure	Pressure Guage Detail	Holding Time	Date	Test Result
FINAL TUBE SIDE HYDRO TEST (ITEM No- 107-E-305)	92.58 KG/CM ² G (1316.9 PSI)	124.23 KG/CM ² G (1767 PSI) (ACTUAL PRESSURE - 127 KG/CM ² G)	Range: 0 TO 200 KG/CM ² G No. MPC/210/04 Calibration Due Date 6/3/2014	01 HOUR	17/10/2013	NEITHER LEAKAGE NOR PRESSURE DROP FOUND DURING THE HOLDING TIME. HYDRO TEST FOUND SATISFACTORY.
			Range: 0 TO 200 KG/CM ² G No. MPC/210/05 Calibration Due Date 6/3/2014			
			Range : No. : Date of : Calibration			
			Range : No. : Date of : Calibration			

Witnessed
 Reviewed
JOE AFONSO
 Exchange Industries.
 OCT 17 2013
witnessed

TEST WITNESSED BY :
 H.B.B.

 DATE

TEST WITNESSED BY:

 INSPECTION AUTHORITY
 DATE

 17/10/13



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments		
101-E-110;101-E-111;101-E-112;101-E-113;101-E-114;101-E-115;101-E-120;101-E-121;101-E-210;101-E-225;101-E-226;101-E-240;101-E-241;101-E-450;101-E-451;102-E-610;102-E-613;102-E-655;103-E-080;103-E-190;103-E-290;103-E-390;103-E-490;103-E-590;103-E-705;103-E-707;104-E-135;104-E-136;107-E-305	JPI REV 1 - COORDINATION		
Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1	
<input checked="" type="checkbox"/> 1 - Work May Proceed <input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated <input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture <input type="checkbox"/> 4 - STOP WORK per attached written instructions <input type="checkbox"/> 5 - Review Not Required: Work may proceed <small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small>	Supplier	Exchanger Industries	
	Doc. Description	EXCHANGER - HYDROSTATIC TESTING PROCEDURE	
	Vendor Document No.	QC-PR-014-HYDROTESTING	
	Client Document No.	VP088996-M616-00001	
	Purchase Order No.	Doc Cat.	Issue
CE416040-CC088996-00	M616	2	
BY: <u>SYED SHAH</u>	Categories		
DATE: <u>JULY 17, 2013</u>	Date Received	07/08/2013	



**EXCHANGER
INDUSTRIES
LIMITED**

Suite 200, 5811 48th Street SE, Calgary, Alberta T2C 4Y5
Telephone (403) 236-0166 Fax (403) 279-8242 Website: www.exchangerindustries.com



Hydrostatic Testing Procedure

SCOPE

This procedure outlines the necessary actions to be taken in order to perform hydrostatic tests.

PURPOSE

This procedure is intended to ensure that Hydrostatic Tests are performed safely and meet the requirements of the Code and the Drawings.

RESPONSIBILITY

Drafting Department

- Ensure that the test pressure(s) and any special requirements are specified on the drawing and that the unit can be properly vented and drained

Quality Control Department

- Notify the Authorized Inspection Agency and the Customer's Inspector (if required) of the scheduled testing time
- escort the Authorized Inspector and the Customer's Inspector (if required) to the unit to witness the Hydro Test

Lead Hand

- Prepare the unit and the area for testing at the specified time and supervise the performance of the test and notify the Quality Control Department when the test is ready

PROCEDURE

- For shell and tube units, the shell side and the tube side are tested separately
 - Unless specifically stated otherwise, the shell side will be tested separately from the tube side order to examine the tube to tubesheet joints
 - For removable bundles, the shell side gasket load must be maintained by collar bolts, tapped bolt holes in an extended tubesheet, a type A channel or some other method for maintaining a minimum load on the gasket
 - The channel side will then be tested in a separate Hydro Test
- Exchangers designed for stacking will be tested in the stacked position unless specifically stated otherwise on the drawing
- Prior to bundle insertion, the shell inside will be cleaned by brushing or blowing compressed air
- Before filling the unit,
 - Properly block the unit to permit examination of all parts during the test, to insure proper venting and drainage and to guard against undue strains caused by the water load.
 - All nozzles and flanges must be secured with gaskets in place
 - All vents must be open – no air locks should be permitted

Revision Number	Revision Date (mmddyy)	Author	Reason for Revision	Approved by	Date Approved	Approval Initial
1	11/14/11		Update Document			
2	10/19/12	K. Hawley	Update Format			



4. All low pressure lines, fittings and appurtenances that should not be subject to pressure must be disconnected
5. Water used for hydrostatic testing
 1. Potable with less than 100 mg/liter of chloride ions (30 mg/liter for austenitic stainless steel)
 2. At a temperature above 70°F (20°C) for Section I units
 3. 30°F (17°C) above the MDMT but no more than 120°F (48°C) or no less than 35°F (2°C) for other units
6. Two Pressure gages will be used for the test,
 1. The gages will be connected directly to the vessel (no intermediate valves)
 2. The gages must have been calibrated in the last 12 months
 3. If there is any reason to question a gage it will be rejected
 4. The range of the gages will be not less than 1½ nor more than 4 times the test pressure
 5. If specified on the drawing, attach a pressure/temperature recorder to the unit. Ensure that the pressure is accurate according to the drawing and record the gauge serial numbers on the ITP. Check hydro charts for the correct time intervals, pressure and temperature.
7. Fill the unit with water and check each nozzle and flange for leakage and forgotten appurtenances
8. Clean the area around the unit and post the test pressure notice (QC-FM-14) on the outside of the unit in a conspicuous location
9. Using compressed air, blow the unit clean and dry
10. Apply 1/3 of the test pressure and check for leaks
11. If no leaks are found, apply the test pressure and hold it for a minimum of one half an hour and notify the Quality Control Department that the unit is to be Hydro Tested.
12. A Quality Control Inspector will accompany the Authorized Inspector and the Customer's Inspector to inspect the unit
13. After the inspection is complete,
 1. The Authorized Inspector, the Quality Control Inspector and the Customer's inspector (if required) shall sign off the Inspection and Test Plan
 2. The Authorized Inspector and the Quality Control Inspector will sign off the Manufacturer's Data Report
 3. The unit shall be drained of water, raising one or both ends to assure that the maximum amount of water is removed
 4. If special drying and / or sealing requirements are on the drawing, these shall be attended to

REFERENCE

CP-ST-001-Acronyms-R0
QC-FM-14-Test Press

Acronyms List
Test Pressure Notice Form



DATE: April 15, 2014

13-3353 A/B

INSPECTION

SANDBLASTER JIMMYE SAGUN

SURFACE PREP: SSPC-SP6 - 13-3353 A/B VESSEL

PROFILE THICKNESS: 2.5-3.0

ABRASIVE USED: COOPER SLAG

EQUIPMENT: 375 CFM Compressor NOZZLE: 10

COMMENTS: Surface preparation met SPEC requirement and the project was released for coating.

SURFACE PREP CONDITIONS

AIR TEMP: 3°C

SUBSTRATE TEMP: 3°C

RELATIVE HUMIDITY: 46%

DEW POINT: -3°C

Checked as per dry Sp

Supervisor P. Goyal

ALB



8305 42nd Street SE, Calgary, Alberta T2C 1W0
Tel: (403) 233-3137 Fax: (403) 273-3242 Website: www.exchangerindustries.com

CHECKLIST FOR PAINT LOGS

Date: APR 15 2014 Employee Name: VIMMIE SAGUN Employee #: 791

Job Number	<u>13-3353 A/B</u>		
Component(s) Painted	<u>VESSEL</u>	Coat #	<u>1</u> of <u>2</u>

Paint Brand, Type & #	<u>INTERTHERM 228</u>		
Batch & Lot Number(s)	<u>PART-A PK51364H PART-B-PP90414H</u>		
Paint Expiry Date	<u>2016</u>	Colour	<u>GREY</u>

Ambient Temperature	<u>75°F</u>
Surface Temperature	<u>72°F</u>
Dew Point	<u>45°F</u>
Relative Humidity (%)	<u>31.9%</u>

Induction Time	<u>15-MINS</u>	Kit Size	<u>4-GAL</u>
Time Mixed	<u>7:00 PM</u>	Pot Life	<u>2-HRS</u>
Time Painting Started	<u>7:15 PM</u>		
Time Painting Finished	<u>8:00 PM</u>		
Amount Discarded	<u>NONE</u>		

Required DFT - This Coat	<u>4-5 MILS DFT</u>
Required DFT - Total	<u>4-5 MILS DFT</u>
Actual DFT - Total	<u>4-5 MILS DFT</u>

DFT= Dry Film Thickness (mils)

COMMENTS:

Checked by Paul DM SS

V.S.



2505 Ford Street SE, Calgary, Alberta T2C 2W8
Telephone (403) 278-2185 Fax (403) 278-2042 Website: www.exchangerindustries.com

CHECKLIST FOR PAINT LOGS

Date: APRIL 16, 2014 Employee Name: DAMIAN RIVAMONTE Employee #: 720

Job Number	<u>13-3353 A/B</u>		
Component(s) Painted	<u>VESSEL (PROTRUSION ONLY)</u>	Coat #	<u>2</u> of <u>2</u>

Paint Brand, Type & #	<u>INTERFINE 629 HS</u> ✓		
Batch & Lot Number(s)	<u>PART A NM5124UH PART B PE4455UH</u>		
Paint Expiry Date	<u>2016</u>	Colour	<u>GREY</u>

Ambient Temperature	<u>78°F</u>
Surface Temperature	<u>69°F</u>
Dew Point	<u>48°F</u>
Relative Humidity (%)	<u>36%</u>

Induction Time	<u>15 MIN</u>	Kit Size	<u>3 GAL</u>
Time Mixed	<u>5:00 AM</u>	Pot Life	<u>2 hours</u>
Time Painting Started	<u>5:15 AM</u>		
Time Painting Finished	<u>7:00 AM</u>		
Amount Discarded	<u>NONE</u>		

Required DFT - This Coat	<u>2-3 MILS dft</u> ✓
Required DFT - Total	<u>4-6 MILS dft</u> ✓
Actual DFT - Total	<u>6-9 MILS dft</u> ✓

DFT= Dry Film Thickness (mils)

COMMENTS:

Checked on / per dry - SS
RMB

This Section is Not Applicable to this ITEM number.



PATELS AIRTEMP (INDIA) LTD.

PLOT NO. 805,806,807,810, RAKAMPUR - 382 721,
TALUKA : KALOL, DIST.: GANDHINAGAR, GUJARAT, INDIA.

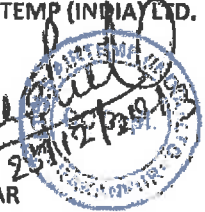
RADIO GRAPHY SUMMARY

CLIENT : M/s. EXCHANGER INDUSTRIES LTD. S.O. No. : PEX-71413
 P.O. NO. : 98998 DTD:- 08/07/2013 DRG. NO. : 13-3353A/B SH. 1A OF 13 R-03
 INSP. AUTH. : AI/EI/JACOBS EQUIPMENT : SALES OIL TANK HEATER
 EI JOB NO. : 13-3353A/B RT : SHELL SIDE - RT1
 TUBE SIDE - RT1

EXE-1352 (104-E-135)					
SR NO	IDENTIFICATION	POSITION	REPORT NO	DATE	REMARK
1	EXE-1352 A1 - W46/W105/OP1	0-1 TO 8-9	720/2013	2/12/2013	ACCEPTABLE
2	EXE-1352 A2 - W46/W105/OP1	0-1 TO 3-4	760/2013	14/12/2013	ACCEPTABLE
3	EXE-1352 A3 - W46/W105/OP1	0-1 TO 8-9	720/2013	2/12/2013	ACCEPTABLE
4	EXE-1352 A4 - W105/OP1	A-B	700/2013	27/11/2013	ACCEPTABLE
5	EXE-1352 B1 - W46/W105/OP1	0-1 TO 4-0	799/2013	24/12/2013	ACCEPTABLE
6	EXE-1352 B2 - W46/W105/OP1	0-1 TO 3-0	788/2013	21/12/2013	ACCEPTABLE
7	EXE-1352 B3 - W46/W105/OP1	0-1 TO 3-0	788/2013	21/12/2013	ACCEPTABLE
8	EXE-1352 B4 - W105/OP1	0-1 TO 4-0	700/2013	27/11/2013	ACCEPTABLE
9	EXE-1352 C1 - W46/W105/OP1	0-1 TO 3-0	788/2013	21/12/2013	ACCEPTABLE
10	EXE-1352 C2 - W105/OP1	0-1 TO 4-0	700/2013	27/11/2013	ACCEPTABLE

For, PATELS AIRTEMP (INDIA) LTD.

KAUSHIK THAKAR
ENGINEER - QC



P
AK
28/12/13
AI

Witnessed
 Reviewed
A FONSO

Exchanger Industries Limited

DEC 28 2013

[Handwritten signature]
[Handwritten signature]
[Handwritten signature]
Circular stamp: PATEL'S AIRTEMP (INDIA) LTD. (104-E-135)



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

ES-13-3353A

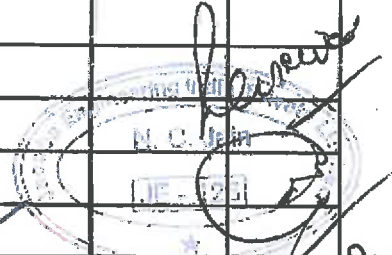
Radiograph Review Form / RT Report (RT-13/2)

Ref. Technique Sheet No. & Date

988/2013 dtd 24/12/13


Report No. : 999/2013. Date : 24/12/13
 RT Procedure No. : PATIART101. Date : 19/12/11 Acceptance Standard : UWS2
 Mr. Sr. No. : ERE 1352 SO No. : PEN71413 Extent of RT : RT1

Sr. No.	Weld Joint No.	Segment	Film Size	Density Obtained			IQI Sensitivity Achieved	Observation	Result/Remark
				IQI	Min.	Max.			
1	ERE1352BIW41W105	0-1	3+15"	2.50	2.53	2.55	7 Wire	NRE	All
2	1)	2-2	"	2.35	2.35	2.41	"	NRE	All
3	"	2-3	"	2.23	2.27	2.34	"	NRE	All
4	"	3-4	"	2.17	2.21	2.25	"	NRE	All
5	"	4-0	"	2.15	2.19	2.25	"	NRE	All




Interpretation & Evaluation carried out by :

Inspection Authority :

SIGN. : 
 NAME : Tejas
 QUALIFICATION : RT LEVEL II
 DATE : 24/12/13

Witnessed
 Reviewed
 A. FONSAR
 Exchanger Industries Limited

SIGN. : 
 NAME : A. FONSAR
 DATE : DEC 24 2013
 24/12/13
 AS



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

Radiography Technique Sheet

RT Technique Sheet No. : 799/2013
RT Procedure No. : PATIAT101
Drawing No. : PE-71413
Code of Construction : ASME SECTION VIII

Date : 28/12/13
Date : 19/12/11
Extent of RT : RTI
Date of RT : -

Identification

Manufacturer's Sr. No.	Weld Joint No.	Welder No.
EXE 1352.	B1	W46 W1050P1

Base Material Type : SA516 Gr 70 N Thickness : T = 14 mm

Reinforcement Thickness : R = 4.0 mm Weld Thickness : t = T + R = 18.0 mm

Type of Joint : category B SOD (D) : 400 mm OFD (d) : 18.0 mm

Welding Process : GTAW/SMA/SMAW

Radiation Source Type : Isotope - Ir 192 X-ray -
Voltage _____ Kvp ci = 23ci

Source / Focal Sport Size : 2.7 @ + 1.9 mm

Film Make & Designation (Brand) : Agfa 104 D3 Lead Screen : 0.1 mm

IQI Hole Type : ASTM _____ Required Hole : -

IQI Wire Type : ASTM 10-22 Required Wire : 8th wire identifier

Exposure Technique : Single Wall / Double Wall : Viewing :
Single Wall / Double Wall

Film Viewing : Single Film / Composite Film
No. of Film/s in Each Cassette 01

No. of Exposures

Location Markers : As per Sketch on Page 2

Letter 'B' : Kept on back side of each film cassette 1.5 mm T + 13 mm

Weld Joint No.	Segment No.	Film Size
B1.	0-1 to 4-0	3' x 15"



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

FI-13-3353A

Radiograph Review Form / RT Report (RT-13/2)

Ref. Technique Sheet No. & Date

788/2013 dtd 22/12/13

Report No. : 788/2013

Date : 22/12/13

RT Procedure No. : P011A1101

Date : 19/12/11 Acceptance Standard : UWSJ

Mfr. Sr. No. : FNE 1352

SO No. : PE 71413

Extent of RT : RT1

Sr. No.	Weld Joint No.	Segment	Film Size	Density Obtained			IQI Sensitivity Achieved	Observation	Result/Remark
				IQI	Min.	Max.			
1	FNE1352 CW46W1050P1	0-1	4x15"	3.00	3.10	3.13	7 Wire	Porous	Fail
2	"	1-2	"	2.99	2.94	3.00	"	Porous	Fail
3	"	2-3	"	2.80	2.88	2.91	"	NRI	Pass
4	"	RB 3-0	"	2.60	2.64	2.74	"	NRI	Pass
5	B2	RB 0-1	"	2.71	2.73	2.84	"	NRI	Pass
6	"	1-2	"	2.61	2.64	2.72	"	NRI	Pass
7	"	2-3	"	2.85	2.87	2.92	"	NRI	Pass
8	"	RB 3-0	"	2.90	2.94	3.05	"	NRI	Pass
9	B3 W46W1050P1	0-1	"	2.64	2.68	2.76	"	Porous	Fail
10	"	1-2	"	2.61	2.50	2.59	"	Porous	Fail
11	"	2-3	"	2.60	2.58	2.67	"	Porous	Fail
12	"	3-0	"	2.57	2.55	2.58	"	NRI	Pass

Witnessed

Reviewed

A. FONSO

Exchanger Industries Limited

DEC 21 2013

Interpretation & Evaluation carried out by :

SIGN. :

NAME :

QUALIFICATION :

DATE :

T. V. Patil
ASNT RT LEVEL-II

RT LEVEL II

22/12/13

Inspection Authority :

SIGN. :

NAME :

DATE :

22/12/13
AT



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

Radiography Technique Sheet
 RT Technique Sheet No. : 788/2013 Date: 23/12/13
 RT Procedure No. : PATASTRTO-1 Date: 19/12/11
 Drawing No. : PE-21413 Extent of RT: full RTI
 Code of Construction : ASME SEC III DIV 1 Date of RT: -

Identification

Manufacturer's Sr. No.	Weld Joint No.	Welder Number
EXE 1352	C1, B2, B3	WUB W105 OPI

Base Material Type : SA516 Gr 70 N Thickness : T = 14.0mm
 Reinforcement Thickness : R = 4.0mm Weld Thickness : t = T + R = 18.0mm
 Type of Joint : category B & C SOD (D) : 400mm
 OFD (d) : 18.0mm
 Welding Process : GTAW / SMAW / SAW
 Radiation Source Type : Isotope - Ir 192 X-ray -
 Voltage _____ Kvp C = 34kV
 Source / Focal Sport Size : 2.75 x 1.2mm H
 Film Make & Designation (Brand) : Agfa Hd D7 Lead Screen : 0.1mm H.
 IQI Hole Type : ASTM _____ Required Hole : -
 IQI Wire Type : ASTM 1B-1 Required Wire : 7th wire Jdental
 Exposure Technique : Single Wall / Double Wall : Viewing :
 Single Wall / Double Wall
 Film Viewing : Single Film / Composite Film
 No. of Film/s in Each Cassette : 01
 Location Markers : As per Sketch on Page 2
 Letter 'B' : Kept on back side of each film cassette (5mm x 13mm)

Weld Joint No.	Segment No.	Film Size
C1	0-1 to 3-0	4" x 15"
B2	1)	1)
B3	1)	1)

FIGAG/12 00 16-05-2013



PATELS AIRTEMP (INDIA) LTD.

FS: **NDE - RT**
13-3353. A

Radiograph Review Form / RT Report (RT-13/2)

Ref. Technique Sheet No. & Date
76012013 dtd 14/12/13

Report No. : 760/2013 Date : 14/12/13
RT Procedure No. : PAMAT12102 Date : 15/12/11 Acceptance Standard : UW51
Mfr. Sr. No. : EXE1352 SO No. : PER71413 Extent of RT : full

Sr. No.	Weld Joint No.	Segment	Film Size	Density Obtained			IQI Sensitivity Achieved	Observation	Result/Remark
				IQI	Min.	Max.			
1	EXE1352 A2 W46W102	0-1	3" x 5"	3.23	3.30	3.45	5 th WIM	NRF	ALL
2	"	1-2	"	3.34	3.38	3.44	"	NRF	ALL
3	"	2-3	"	2.84	2.90	2.94	"	NRF	ALL
4	"	3-4	"	2.64	2.70	2.73	"	NRF	ALL

Interpretation & Evaluation carried out by :

SIGN.

NAME

QUALIFICATION

DATE



RT LEVEL II

14/12/13

Witnessed DEC 16 2013
Reviewed
A FONSO
Exchanger Industries Limited

Inspection Authority :

SIGN.

NAME

DATE

Handwritten signature and date: 24/12/13
AI
30/12/13



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

Radiography Technique Sheet

RT Technique Sheet No.

RT Procedure No.

Drawing No.

Code of Construction

: 760/2013
: PATAIR101
: PER 71413
: HOME SERVICE DIV 2

Date: 14/12/13
Date: 19/12/11
Extent of RT: full
Date of RT: -

Identification

Manufacturer's Sr. No.

Weld Joint No.

EXE 1352

A 2

Base Material Type

: SA 516 GR 70 N Thickness : T = 14 mm

Reinforcement Thickness

: R = 2.4 mm Weld Thickness : t = T + R = 16.4 mm

Type of Joint

: category A SOD (D) : 350 mm
OFD (d) : 16.4 mm

Welding Process

: GMAW / SMAW / MMAW

Radiation Source Type

: Isotope - Ir 192 X-ray -
Voltage _____ Kvp c = 150

Source / Focal Spot Size

: 2-3 d + 1-2 mm H

Film Make & Designation (Brand)

: Fuji HD 7 Lead Screen : 0.1 mm H

IQI Hole Type

: ASTM _____ Required Hole : -

IQI Wire Type

: ASTM 10-11 Required Wire : 6th wire.

Exposure Technique

: Single Wall / Double Wall : Viewing:
Single Wall / Double Wall

Film Viewing

: Single Film / Composite Film
No. of Film/s in Each Cassette 02

No. of Exposures

Location Markers

: As per Sketch on Page 2 -

Letter 'B'

: Kept on back side of each film cassette 1.5 mm x 1.3 mm

Weld Joint No.

Segment No.

Film Size

A 2

0-1 + 3-4

3' x 15"



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

13-3353.A

Radiograph Review Form / RT Report (RT-13/2)

Ref. Technique Sheet No. & Date

700/2013 dtd 29/11/13

Report No. : 700/2013

Date : 29/11/13

RT Procedure No. : PAT1313102

Date : 19/12/13

Acceptance Standard: UWSI
AIM F SECTORS DIV 1

Mfr. Sr. No. : EXE 1352

SO No. : PER 21413

Extent of RT : RT1

Sr. No.	Weld Joint No.	Segment	Film Size	Density Obtained			IQI Sensitivity Achieved	Observation	Result/Remark
				IQI	Min.	Max.			
1	EXE 1352 A4W105DPI	A-B	2x15"	2.44	2.45	2.52	5mm WIRE	NRS	ALL
2	B4	0-1	4x15"	2.50	2.60	2.65	"	NRS	ALL
3	"	1-2	"	2.54	2.50	2.57	"	NRS	ALL
4	"	2-3	"	2.81	2.84	2.89	"	NRS	ALL
5	"	3-4	"	2.71	2.74	2.78	"	NRS	ALL
6	"	4-0	"	2.81	2.86	2.90	"	NRS	ALL
7	C2W105DPI	0-1	"	2.61	2.64	2.63	"	CIP	ALL
8	"	1-2	"	2.71	2.74	2.78	"	PODDH	ALL
9	"	2-3	"	2.79	2.71	2.80	"	NRS	ALL
10	"	3-4	"	2.81	2.84	2.81	"	CIP	ALL
11	"	4-0	"	2.71	2.76	2.80	"	NRS	ALL

Interpretation & Evaluation carried out by :

Inspection Authority:

SIGN. :



NAME :

QUALIFICATION : RT LEVEL II

DATE :

29/11/13

Witnessed
 Reviewed
NAME
JOE ALFONSO

Signature of Joe Alfonso
03/12/13
RTI

Exchanger Industries Limited
OCT 29 2013



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

Radlography Technique Sheet

RT Technique Sheet No. : 800/2013 Date: 29/11/13
 RT Procedure No. : PAT/RT/ST/02 Date: 29/11/13
 Drawing No. : PEN 21413 Extent of RT: full RT
 Code of Construction : PD 05/E/C/01/01/1 Date of RT: -

Identification

Manufacturer's Sr. No.	Weld Joint No.	
EX E 1852	A4, B4, C2	

Base Material Type : SA516 Gr 70 N Thickness : T = 12 mm
 Reinforcement Thickness : R = 2.4 mm Weld Thickness : t = T + R = 14.4 mm
 Type of Joint : category A, B, C SOD (D) : 800 mm
 Welding Process : SMAW / SAW OFD (d) : 164 mm
 Radiation Source Type : Isotope - Ir 192 X-ray -
 Voltage _____ Kvp - CI = 37 Ci
 Source / Focal Spot Size : 2.7 ϕ x 1.2 mm H
 Film Make & Designation : Agfa 12 D7 Lead Screen : 0.1 mm H
 (Brand)
 IQI Hole Type : ASTM _____ Required Hole : -
 IQI Wire Type : ASTM 1A-11 Required Wire : 8th wire identify
 Exposure Technique : Single Wall / Double Wall : Viewing :
 Single Wall / Double Wall
 Film Viewing : Single Film / Composite Film
 No. of Film/s in Each Cassette : 01
 No. of Exposures :
 Location Markers : As per Sketch on Page 2 -
 Letter 'B' : Kept on back side of each film cassette 1.5 mm x 13 mm H

Weld Joint No.	Segment No.	Film Size
A4	AB	3" x 15"
B4	0-1 to 4 D	"
C2	0-1 to 4 U	"



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

Radiograph Review Form / RT Report (RT-13/2)

Ref. Technique Sheet No. & Date

7-2012013 dtd 02/12/13

Report No. : 720/2013 Date : 02/12/13 *CS 106-20-23-33503 A*

RT Procedure No. : PATIART101 Date : 19/12/11 Acceptance Standard : UWS1 *FORMEJPLVDI DIV 2*

Mfr. Sr. No. : EXE1352. SO No. : PE731413 Extent of RT : RTI

Sr. No.	Weld Joint No.	Segment	Film Size	Density Obtained			IQI Sensitivity Achieved	Observation	Result/Remark
				IQI	Min.	Max.			
1	EXE1352A1W16W10500	0-1	9" x 15"	1.50	2.56	2.62	8 TH WINE	NRI	ALL
2	"	RB 1-2	"	2.91	3.00	3.12	"	NRI	ALL
3	"	2-3	"	2.68	2.79	2.85	"	NRI	ALL
4	"	3-4	"	2.79	2.81	2.89	"	NRI	ALL
5	"	4-5	"	2.40	2.57	2.63	"	NRI	ALL
6	"	RB 5-6	"	3.18	3.21	3.27	"	NRI	ALL
7	"	RB 6-7	"	2.89	2.97	3.15	"	NRI	ALL
8	"	7-8	"	3.09	3.00	3.18	"	NRI	ALL
9	"	8-9	"	3.24	3.30	3.40	"	NRI	ALL
10	A-3W14W10501	0-1	"	2.70	2.80	2.90	"	NRI	ALL
11	"	1-2	"	2.48	2.52	2.56	"	NRI	ALL
12	"	2-3	"	2.77	2.81	2.87	"	NRI	ALL
13	"	3-4	"	2.71	2.83	2.90	"	NRI	ALL
14	"	4-5	"	2.88	2.82	2.89	"	NRI	ALL
15	"	5-6	"	2.40	2.57	2.68	"	NRI	ALL
16	"	RB 6-7	"	2.70	2.80	2.97	"	NRI	ALL
17	"	7-8	"	2.74	2.80	2.84	"	NRI	ALL
18	"	8-9	"	2.73	2.86	2.89	"	NRI	ALL

Interpretation & Evaluation carried out by :

Inspection Authority :

SIGN. : *[Signature]*

NAME : *G. V. Patil*

QUALIFICATION : RT LEVEL I

DATE : 02/12/13



[Signature]

[Signature]

SIGN. : *[Signature]*

DATE : 03/12/13

[Signature]

Witnessed

Reviewed

DATE : *[Signature]*

JOE ALFONSO



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

Radiography Technique Sheet

RT Technique Sheet No.

: 420/2013

Date: 02/12/13

RT Procedure No.

: PAT/RT/01/RT

Date: 18/12/11

Drawing No.

: PEN 71413

Extent of RT: RT1

Code of Construction

: ASME SECTION VIII

Date of RT: -

Identification

Manufacturer's Sr. No.

Weld Joint No.

FAE 1352

A1, A3

Base Material Type

: SA516 GR 70 N Thickness : T = 14 mm

Reinforcement Thickness

: R = 2.4 mm Weld Thickness : t = T + R = 16.4 mm

Type of Joint

: category A SOD (D) : 400 mm

OFD (d) : 16.4 mm

Welding Process

: SMAW / SAW

Radiation Source Type

: Isotope - Ir 192 X-ray -
Voltage _____ Kvp C = 13 Ci

Source / Focal Spot Size

: 2.5 x 1.2 mm H

Film Make & Designation (Brand)

: Agfa 114 D7 Lead Screen : 0.1 mm

IQI Hole Type

: ASTM _____ Required Hole : -

IQI Wire Type

: ASTM B-71 Required Wire : 8th wire

Exposure Technique

: Single Wall / Double Wall : Viewing:
Single Wall / Double Wall

Film Viewing

: Single Film / Composite Film
No. of Film/s in Each Cassette 01

No. of Exposures

Location Markers

: As per Sketch on Page 2 -

Letter 'B'

: Kept on back side of each film cassette 1.5 mm / 18 mm H

Weld Joint No.

Segment No.

Film Size

A1

0-1 to 8-y

3" x 15"

A3

0-1 to 8-y

11



PATELS AIRTEMP (INDIA) LTD.

PLOT NO. 805,806,807,810, RAKANPUR - 382 721,
TALUKA : KALOL, DIST.: GANDHINAGAR, GUJARAT, INDIA.

RADIO GRAPHY SUMMARY

CLIENT : M/s. EXCHANGER INDUSTRIES LTD. S.O. No. : PEX-71413
P.O. NO. : 98998 DTD:- 08/07/2013 DRG. NO. : 13-3353A/B SH. 1A OF 13 R-03
INSP. AUTH. : AI/EI/JACOBS EQUIPMENT : SALES OIL TANK HEATER
EI JOB NO. : 13-3353A/B RT : SHELL SIDE - RT1
TUBE SIDE - RT1

EXE-1353 (104-E-136)					
SR NO	IDENTIFICATION	POSITION	REPORT NO	DATE	REMARK
1	EXE-1353 A1 - W46/W105/OP1	0-1 TO 8-9	721/2013	2/12/2013	ACCEPTABLE
2	EXE-1353 A2 - W46/W105/OP1	0-1 TO 3-4	759/2013	14/12/2013	ACCEPTABLE
3	EXE-1353 A3 - W46/W105/OP1	0-1 TO 8-9	721/2013	2/12/2013	ACCEPTABLE
4	EXE-1353 A4 - W105/OP1	A-B	700/2013	27/11/2013	ACCEPTABLE
5	EXE-1353 B1 - W46/W105/OP1	0-1 TO 4-0	800/2013	24/12/2013	ACCEPTABLE
6	EXE-1353 B2 - W46/W105/OP1	0-1 TO 3-0	787/2013	21/12/2013	ACCEPTABLE
7	EXE-1353 B3 - W46/W105/OP1	0-1 TO 3-0	787/2013	21/12/2013	ACCEPTABLE
8	EXE-1353 B4 - W105/OP1	0-1 TO 4-0	700/2013	27/11/2013	ACCEPTABLE
9	EXE-1353 C1 - W46/W105/OP1	0-1 TO 3-0	787/2013	21/12/2013	ACCEPTABLE
10	EXE-1353 C2 - W105/OP1	0-1 TO 4-0	700/2013	27/11/2013	ACCEPTABLE

For, PATELS AIRTEMP (INDIA) LTD.

KAUSHIK THAKAR
ENGINEER - QC

Handwritten signature
28/12/2013

Handwritten signature

Witnessed
 Reviewed
A FONSO

Handwritten signature
Exchanger Industries Limited

DEC 28 2013

Handwritten signature
N. G. Jain
JJE - 123

(R)

Handwritten signature
28/12/2013



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

13 - 3353.B

Radiograph Review Form / RT Report (RT-13/2)

Ref. Technique Sheet No. & Date

700/2013 dtd 27/11/13

Report No. : 700/2013 Date : 27/11/13
 RT Procedure No. : PATIART101 Date : 13/12/11 ASME SEC III DIV 2
 Mfr. Sr. No. : EXE 1353 SO No. : REF 71413 Acceptance Standard : UWS 1
 Extent of RT : RT 1.

Sr. No.	Weld Joint No.	Segment	Film Size	Density Obtained			IQI Sensitivity Achieved	Observation	Result/Remark
				IQI	Min.	Max.			
1	EXE1353 AW1050P1	A-B	3"x15"	2.78	2.71	2.80	8 th wire	Potential	ALL
2	B4 W1050P1	0-1	"	2.91	2.80	2.90	"	NRE	ALL
3	"	1-2	"	2.74	2.78	2.81	"	NRE	ALL
4	"	2-3	"	2.81	2.84	2.87	"	NRE	ALL
5	"	3-4	"	2.89	2.90	2.93	"	NRE	ALL
6	"	4-0	"	2.81	2.74	2.78	"	NRE	ALL
7	C2 W1050P1	0-1	"	2.55	2.46	2.60	"	Potential	ALL
8	"	1-2	"	2.50	2.60	2.61	"	Potential	ALL
9	"	2-3	"	2.44	2.42	2.46	"	NRE	ALL
10	"	3-4	"	2.43	2.43	2.50	"	NRE	ALL
11	"	4-0	"	2.61	2.63	2.68	"	NRE	ALL

Interpretation & Evaluation carried out by :

Inspection Authority :

SIGN. : *[Signature]*
 NAME : Tejus
 QUALIFICATION : RT LEVEL II
 DATE : 27/11/13



Signed
 Reviewed
 NAME : JOE ALFONSO
 DATE : 27/11/13

Exchanger Industries Limited
 OCT 29 2013

[Handwritten signatures and dates]
 03/12/13
 RT



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

Radiography Technique Sheet

RT Technique Sheet No. : 900/2013

Date : 27/11/13

RT Procedure No. : PAT/RT/15102

Date : 10/12/11

Drawing No. : PEN/1413

Extent of RT : RTI

Code of Construction : ASME SEC VIII DIV 1

Date of RT : -

Identification

Manufacturer's Sr. No.

Weld Joint No.

EXE 1353

A4, B4, C2

Base Material Type : SA516 R 70N

Thickness : T = 2.2 mm

Reinforcement Thickness : R = 2.4 mm

Weld Thickness : 1 = T + R = 4.4 mm

Type of Joint : Category A, B, L

SOD (D) : 300 mm

Welding Process : SMAW / SAW

OFD (d) : 14.4 mm

Radiation Source Type : Isotope - Ir 192

X-ray -

Voltage : _____ Kvp

CF = 17.2

Source / Focal Spot Size : 2.7 x 1.8 mm

Film Make & Designation : Agfa 102 D7

Lead Screen : 0.1 mm

(Brand)

IQI Hole Type : ASTM _____ Required Hole : -

IQI Wire Type : ASTM 19-11 Required Wire : 8th wire identify

Exposure Technique : Single Wall / Double Wall

Viewing :

Single Wall / Double Wall

Film Viewing : Single Film / Composite Film

No. of Film/s in Each Cassette : 01

No. of Exposures

Location Markers : As per Sketch on Page 2

Letter 'B' : Kept on back side of each film cassette

5 mm x 13 mm

Weld Joint No.

Segment No.

Film Size

A4

A-B

3" x 15"

B4

0-1 to 40

"

C2

0-1 to 40

"



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

Radiograph Review Form / RT Report (RT-13/2)

Ref. Technique Sheet No. & Date

721/2013 dtd 02/12/13

Report No. : 721/2013 Date : 02/12/13. GENO: 13-3353 B.

RT Procedure No. : PATAIRT101. Date : 19/12/11 Acceptance Standard : UWS1

Mfr. Sr. No. : EXE1853. SO No. : PEX71413 Extent of RT : RT3

Sr. No.	Weld Joint No.	Segment	Film Size	Density Obtained			IQI Sensitivity Achieved	Observation	Result/Remark
				IQI	Min.	Max.			
1	EXE1853 A3 W46 W1050 P1	0-1	8" x 15"	2.71	2.77	2.80	7 ^m wire	Porosity	Fail
2	"	1-2	"	2.87	2.75	2.90	"	NRI	Pass
3	"	2-3	"	2.80	2.84	2.90	"	NRI	Pass
4	"	3-4	"	2.83	2.91	2.94	"	NRI	Pass
5	"	4-5	"	2.80	2.83	2.87	"	NRI	Pass
6	"	5-6	"	2.70	2.75	2.81	"	NRI	Pass
7	"	6-7	"	2.78	2.80	2.85	"	NRI	Pass
8	"	7-8	"	2.90	2.75	2.83	"	NRI	Pass
9	"	8-9	"	2.90	2.85	2.95	"	NRI	Pass
10	A3 W105 W460 P1	0-1	"	2.84	2.90	2.94	"	Porosity	Fail
11	"	1-2	"	2.91	2.94	3.00	"	NRI	Pass
12	"	2-3	"	2.90	2.99	3.10	"	NRI	Pass
13	"	3-4	"	2.71	2.74	2.83	"	NRI	Pass
14	"	4-5	"	2.85	2.79	2.74	"	NRI	Pass
15	"	5-6	"	2.90	2.85	2.81	"	NRI	Pass
16	"	6-7	"	2.71	2.78	2.80	"	NRI	Pass
17	"	7-8	"	2.81	2.84	2.90	"	NRI	Pass
18	"	8-9	"	2.71	2.86	2.79	"	NRI	Pass

Interpretation & Evaluation carried out by :

Inspection Authority :

SIGN. : *[Signature]*
 NAME : T. V. Patil
 QUALIFICATION : RT LEVEL II
 DATE : 02/12/13

SIGN. : *[Signature]*
 NAME : J. D. FONSRO
 DATE : 03/12/13
 PI



Witnessed
 Reviewed
 J. D. FONSRO



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

Radiography Technique Sheet

RT Technique Sheet No. : 721/2013. Date: 02/12/13.
 RT Procedure No. : PATEL RT 01. Date: 19/12/11
 Drawing No. : PEA 71413. Extent of RT : RT1
 Code of Construction : ASME SEC VIII DIV 2. Date of RT : -

Identification

Manufacturer's Sr. No.	Weld Joint No.	
67E1853	A1, A3	

Base Material Type : SA516 R 90 Thickness : T = 14 mm
 Reinforcement Thickness : R = 2.4 mm Weld Thickness : t = T + R = 16.4 mm
 Type of Joint : category A SOD (D) : 400 mm
 OFD (d) : 16.4 mm
 Welding Process : SMAW
 Radiation Source Type : Isotope - Ir 192 X-ray -
 Voltage _____ KVP $\phi = 17 \text{ ci}$
 Source / Focal Sport Size : 2.2 - 2.4 mm
 Film Make & Designation (Brand) : Agfa D7 Lead Screen : 0.1 mm Al.
 IQI Hole Type : ASTM _____ Required Hole : -
 IQI Wire Type : ASTM 18-11 Required Wire : 8 wire 5 density
 Exposure Technique : Single Wall / Double Wall : Viewing :
 Single Wall / Double Wall
 Film Viewing : Single Film / Composite Film
 No. of Film/s in Each Cassette 01
 No. of Exposures :
 Location Markers : As per Sketch on Page 2 -
 Letter 'B' : Kept on back side of each film cassette 1.5 mm x 1.9 mm

Weld Joint No.	Segment No.	Film Size
A1	0-1 to 8-9	3" x 5"
A3	0-1 to 8-9	11



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

ES-13-2353 B

Radiograph Review Form / RT Report (RT-13/2)

Ref. Technique Sheet No. & Date

800/2013 Jtd 24/12/13

Report No. : 800/2013 Date : 24/12/13
 RT Procedure No. : PAT/RT/101 Date : 24/12/11 Acceptance Standard : UWS1
 Mfr. Sr. No. : EXE 1353 PER 71413 SO No.: Extent of RT : RT1

Sr. No.	Weld Joint No.	Segment	Film Size	Density Obtained			IQI Sensitivity Achieved	Observation	Result/Remark
				IQI	Min.	Max.			
1	EXE1353 BLW460105	0-1	3'x5"	2.50	2.54	2.63	7 th Fine.	NRI	All
2	" O.P3	1-2	"	2.25	2.30	2.31	"	NRI	All
3	"	2-3	"	2.25	2.23	2.31	"	NRI	All
4	"	3-4	"	2.58	2.59	2.60	"	NRI	All
5	"	4-0	"	2.05	2.10	2.14	"	NRI	All

Interpretation & Evaluation carried out by :

Inspection Authority :

SIGN. : *Teju*
 NAME : *Teju*
 QUALIFICATION : RT LEVEL II
 DATE : 24/12/13.

Witnessed SIGN. :
 Reviewed NAME : A FONDU
 DATE : DEC 24 2013

Exchanger Industries Limited



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

ES-18-3353B

Radiography Technique Sheet

RT Technique Sheet No. : 800/2013.
 RT Procedure No. : PATART12101
 Drawing No. : PEN 314 13
 Code of Construction : ASME SEC VIII DIV 1

Date: 24/12/13
 Date: 25/12/13
 Extent of RT: full
 Date of RT: -

Identification

Manufacturer's Sr. No.	Weld Joint No.	Welder No.
EX F 1853	B1	W46 W1050P1

Base Material Type : SA516 GR 70 N - Thickness : T = 14 mm
 Reinforcement Thickness : R = 4.0 mm Weld Thickness : t = T + R = 18.0 mm
 Type of Joint : category B SOD (D) : 400 mm
 OFD (d) : 18.0 mm
 Welding Process : GTAW / SMAW / SAW
 Radiation Source Type : Isotope - Ir 192 X-ray -
 Voltage _____ Kvp CI = 13 Ci
 Source / Focal Spot Size : 2.7 x 1.2 mm H.
 Film Make & Designation : Agfa 100 D7 Lead Screen : 0.1 mm H.
 IQI Hole Type : ASTM - Required Hole : -
 IQI Wire Type : ASTM 18-11 Required Wire : -
 Exposure Technique : Single Wall / Double Wall : Viewing :
 Single Wall / Double Wall
 Film Viewing : Single Film / Composite Film
 No. of Film/s in Each Cassette 01
 No. of Exposures :
 Location Markers : As per Sketch on Page 2
 Letter 'B' : Kept on back side of each film cassette 1.5 mm T + 13 mm H

Weld Joint No.	Segment No.	Film Size
B1	0-1 to 4-0	3' x 15"



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

FE-13-3353B

Radiograph Review Form/ RT Report (RT-13/2)

Ref. Technique Sheet No. & Date

787/2013 dtd 21/12/13

Report No. : 787/2013 Date : 21/12/13.
 RT Procedure No. : PAT/RT/101 Date : 29/12/11 Acceptance Standard : AWSI
 Mfr. Sr. No. : FE-1353 PE-77413 SO No. : Extent of RT : full

Sr. No.	Weld Joint No.	Segment	Film Size	Density Obtained			IQI Sensitivity Achieved	Observation	Result/Remark
				IQI	Min.	Max.			
1	FE-1353 C-2646W105 R/S	0-1	4"x15"	2.33	2.38	2.40	7 th Wire	NRI	Pass
2	"	1-2	"	3.14	3.10	3.13	7 th Wire	NRI	Pass
3	"	2-3	"	3.08	2.92	2.93	"	NRI	Pass
4	"	R/S	3-0	3.13	3.03	3.15	"	Slugg	Pass
5	B-2646W1050P1	0-1	"	2.85	2.80	2.90	"	NRI	Pass
6	"	1-2	"	2.89	2.97	2.94	"	NRI	Pass
7	"	2-3	"	2.65	2.60	2.68	"	Porousity	Pass
8	"	3-0	"	2.68	2.61	2.71	"	NRI	Pass
9	B-2646W1050P1R/S	0-1	"	2.91	2.94	2.98	"	NRI	Pass
10	"	1-2	"	3.27	3.08	3.30	"	NRI	Pass
11	"	2-3	"	3.02	3.14	3.18	"	NRI	Pass
12	"	R/S	3-0	2.61	2.60	2.64	"	NRI	Pass

Witnessed
 Reviewed
 A. FONSU
 Exchanger Industries Limited
 DEC 21 2013

Inspection Authority:
 SIGN. :
 NAME :
 DATE : 24/12/13
 PI 108

Interpretation & Evaluation carried out by :

SIGN. :
 NAME : S.V.
 QUALIFICATION : RT LEVEL II
 DATE : 21/12/13





PATELS AIRTEMP (INDIA) LTD.

NDE - RT

Radiography Technique Sheet

RT Technique Sheet No. : 787/2013 Date: 22/12/13
 RT Procedure No. : PAT/RT/RS/01 Date: 29/12/13
 Drawing No. : PE 21413 Extent of RT: full
 Code of Construction : ASME SEC VIII DIV 1 Date of RT: -

Identification

Manufacturer's Sr. No.	Weld Joint No.	Welder No.
EXE 1353	C1, B2, B3	W46W1050P1

Base Material Type : SA516 G R 70 N Thickness : T = 14 mm
 Reinforcement Thickness : R = 4.0 mm Weld Thickness : t = T + R = 18.0 mm
 Type of Joint : category B & C SOD (D) : 400 mm
 OFD (d) : 18.0 mm
 Welding Process : GTAW / SMAW / SAW
 Radiation Source Type : Isotope - Ir 192 X-ray -
 Voltage _____ Kvp ci = 34ci
 Source / Focal Sport Size : 2.7 x 1.2 mm
 Film Make & Designation : Agfa Ltd D7 Lead Screen : 0.1 mm
 (Brand)
 IQI Hole Type : ASTM _____ Required Hole : -
 IQI Wire Type : ASTM 181 Required Wire : 7 mm wire - identify
 Exposure Technique : Single Wall / Double Wall : Viewing :
 Single Wall / Double Wall
 Film Viewing : Single Film / Composite Film
 No. of Film/s in Each Cassette 01
 No. of Exposures :
 Location Markers : As per Sketch on Page 2 -
 Letter 'B' : Kept on back side of each film cassette 5 mm x 13 mm

Weld Joint No.	Segment No.	Film Size
C1	0-1 to 3-0	4" x 15"
B2	"	"
B3	"	"



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

13-3353 B

Radiograph Review Form / RT Report (RT-13/2)

Ref. Technique Sheet No. & Date

759/2013 dtd 14/12/13

Report No. : 759/2013 Date : 14/12/13
 RT Procedure No. : PAT/RT/101 Date : 14/12/11 Acceptance Standard : UW51
 Mfr. Sr. No. : EXE 1353 SO No. : PEX 71413 Extent of RT : full

Sr. No.	Weld Joint No.	Segment	Film Size	Density Obtained			IQI Sensitivity Achieved	Observation	Result/Remark
				IQI	Min.	Max.			
1	EXE 1353 A2 W6 LWS 09	0-1	3" x 15"	3.18	3.20	3.24	8 Wire	NRI	Full
2	11	1-2	11	3.21	3.29	3.37	11	NRI	Full
3	11	2-3	11	3.34	3.01	3.05	11	NRI	Full
4	11	3-4	11	3.30	3.35	3.43	11	NRI	Full

Reviewed

 B. C. Jhal
 30/12/13

Interpretation & Evaluation carried out by : *Parvinder*
 SIGN. : *Parvinder*
 NAME : *Parvinder*
 QUALIFICATION : RT LEVEL II
 DATE : 14/12/13

Witnessed & Reviewed by : *A. FONSO*
 A FONSO
 Exchange Industries Limited
 DEC 16 2013

Inspection Authority :
 SIGN. : *[Signature]*
 NAME : *[Signature]*
 DATE : 24/12/13
 AJ



PATELS AIRTEMP (INDIA) LTD.

NDE - RT

Radiography Technique Sheet	: 759/2013	Date: 14/12/13
RT Technique Sheet No.	: PATIAT/AT101	Date: 19/12/13
RT Procedure No.	: PER 11413	Extent of RT: full
Drawing No.	: ASME SECTION VIII	Date of RT: -
Code of Construction		

Identification

Manufacturer's Sr. No.	Weld Joint No.	Welder No.
EXE 1353	A-2	W46 W105 OP1

Base Material Type : SA516 G R70N Thickness : T = 14 mm

Reinforcement Thickness : R = 2.4 mm Weld Thickness : t = T + R = 16.4 mm

Type of Joint : category A SOD (D) : 350 mm
OFD (d) : 16.4 mm

Welding Process : GTAW / SMAW / SAW

Radiation Source Type : Isotope - Ir 192 X-ray -
Voltage _____ Kvp cI = 15ci

Source / Focal Sport Size : 2.7 x 1.2 mm

Film Make & Designation : Agfa Hrd Lead Screen : 0.1 mm H

(Brand)

IQI Hole Type : ASTM _____ Required Hole : -

IQI Wire Type : ASTM A-11 Required Wire : 8th wire Identical

Exposure Technique : Single Wall / Double Wall : Viewing :
Single Wall / Double Wall


Film Viewing : Single Film / Composite Film
No. of Film/s in Each Cassette 01

No. of Exposures

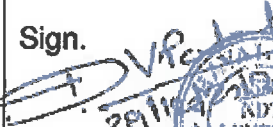
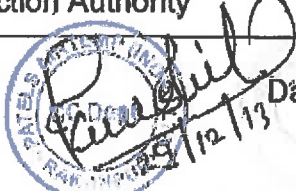
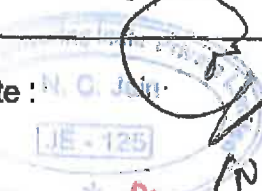
Location Markers : As per Sketch on Page 2 -

Letter 'B' : Kept on back side of each film cassette 1.5 mm T x 13 mm H

Weld Joint No.	Segment No.	Film Size
A-2	0-1 to 3-4	3' x 15'

	MT Report
	Procedure No.: PAT/AT/MT/03 (Rev.0)
	Dated: 05/08/2012
Page : 1 of 1	

MAGNETIC PARTICLE EXAMINATION REPORT


Procedure No.	: PAT/AT/MT/03 (Rev.0)	Date : 05/08/2012
Report No.	: EXE-1353/MT/01,	Date : 29.12.2013
S.O. No.	: PEX-71413	
Job No.	: EXE-1353,	Item No. 104-E-136
EI Job No.	: 13-3353 B,	EI Client P.O. No.: CE416040-CC088996-00
EI Drg. No.	: 13-3353 A/B	
Reference / Identification:	MT of all Lifting Lug welds on Channel Cylinder assembly.	
Test Date	: 29.12.2013	
Test Material	: SA-516 GR.70N	
Surface Condition	: As Welded	
Object	: To check surface and sub-surface discontinuities.	
Test Equipment	: Electromagnetic Yoke : Make : SIMS Model : Y AC/DC	
Test Technique	: Wet Visible Continuous Technique	
Magnetizing Current	: AC & HWDC	
Inspection Medium	: Wet Visible Black Magnetic Particles, Make:Magnaflux-7C Black	
Lighting Equipment	: 60 W Bulb Hand Lamp (Incandescent lamp) with 230 V power supply enclosed in a pan held at a distance of 200 mm from the examination surface.	
Reference	: ASME Sec. V, Article 7	
Acceptance Standard	: ASME Sec. VIII, Div. 1, Appendix – 6	
Result of calibration	: For AC : 4.5 Kgs (10 Lbs.) at 4" and 6" pole spacing For DC:18.1 Kgs. (40 Lbs.) at 4" and 6" pole spacing.	
Maximum pole spacing during examination : 4"		
Observations: No Relevant indication was observed.		
Result : MT Satisfactory Result was found.....Acceptable		
Name of Operator : Dhaval Patel	Inspection Authority	
Qualification : MT Level II		
Sign.  Date : 29.12.2013	Sign.  Date : 29/12/13	

Witnessed

Reviewed

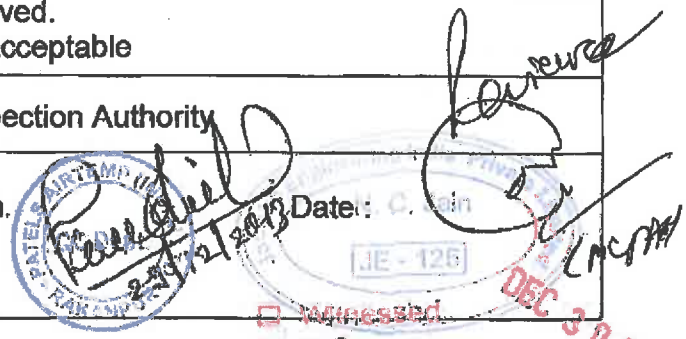
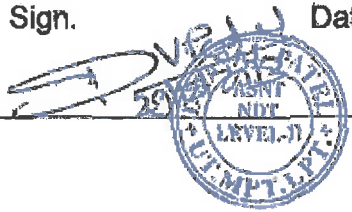
A FONSO

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	MT Report
	Procedure No.: PAT/AT/MT/03 (Rev.0)
	Dated: 05/08/2012
Page : 1 of 1	

MAGNETIC PARTICLE EXAMINATION REPORT


Procedure No.	: PAT/AT/MT/03 (Rev.0)	Date : 05/08/2012
Report No.	: EXE-1352/MT/01,	Date : 29.12.2013
S.O. No.	: PEX-71413	
Job No.	: EXE-1352,	Item No. 104-E-135
EI Job No.	: 13-3353 A,	EI Client P.O. No.: CE416040-CC088996-00
EI Drg. No.	: 13-3353 A/B	
Reference / Identification:	MT of all Lifting Lug welds on Channel Cylinder assembly.	
Test Date	: 29.12.2013	
Test Material	: SA-516 GR.70N	
Surface Condition	: As Welded	
Object	: To check surface and sub-surface discontinuities.	
Test Equipment	: Electromagnetic Yoke : Make : SIMS Model : Y AC/DC	
Test Technique	: Wet Visible Continuos Technique	
Magnetizing Current	: AC & HWDC	
Inspection Medium	: Wet Visible Black Magnetic Particles, Make:Magnaflux-7C Black	
Lighting Equipment	: 60 W Bulb Hand Lamp (Incandescent lamp) with 230 V power supply enclosed in a pan held at a distance of 200 mm from the examination surface.	
Reference	: ASME Sec. V, Article 7	
Acceptance Standard	: ASME Sec. VIII, Div. 1, Appendix – 6	
Result of calibration	: For AC : 4.5 Kgs (10 Lbs.) at 4" and 6" pole spacing For DC:18.1 Kgs. (40 Lbs.) at 4" and 6" pole spacing.	
Maximum pole spacing during examination : 4"		
Observations: No Relevant indication was observed.		
Result : MT Satisfactory Result was found.....Acceptable		
Name of Operator : Dhaval Patel	Inspection Authority	
Qualification : MT Level II		
Sign.	Date : 29.12.2013	Sign. Date: C. in



Witnessed
 Reviewed

A FONSO




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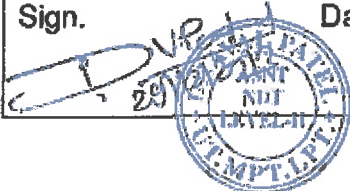
	MT Report
	Procedure No.: PAT/AT/MT/03 (Rev.0)
	Dated: 05/08/2012
Page : 1 of 1	

MAGNETIC PARTICLE EXAMINATION REPORT

Procedure No.	: PAT/AT/MT/03 (Rev.0)	Date : 05/08/2012
Report No.	: EXE-1352/MT/02,	Date : 29.12.2013
S.O. No.	: PEX-71413	
Job No.	: EXE-1352,	Item No. 104-E-135
EI Job No.	: 13-3353 A,	EI Client P.O. No.: CE416040-CC088996-00
EI Drg. No.	: 13-3353 A/B	
Reference / Identification:	MT of temporary attachment removed area by grinding on Channel Cylinder assembly.	
Test Date	: 29.12.2013	
Test Material	: SA-516 GR.70N	
Surface Condition	: As Grind	
Object	To check surface and sub-surface discontinuities.	
Test Equipment	Electromagnetic Yoke : Make : SIMS Model : Y AC/DC	
Test Technique	Wet Visible Continuos Technique	
Magnetizing Current	AC & HWDC	
Inspection Medium	Wet Visible Black Magnetic Particles, Make:Magnaflux-7C Black	
Lighting Equipment	60 W Bulb Hand Lamp (Incandescent lamp) with 230-V power supply enclosed in a pan held at a distance of 200 mm from the examination surface.	
Reference	ASME Sec. V, Article 7	
Acceptance Standard	ASME Sec. VIII, Div. 1, Appendix – 6	
Result of calibration	For AC : 4.5 Kgs (10 Lbs.) at 4" and 6" pole spacing For DC:18.1 Kgs. (40 Lbs.) at 4" and 6" pole spacing.	
Maximum pole spacing during examination	: 4"	


Observations: No Relevant indication was observed.
Result : MT Satisfactory Result was found.....Acceptable

Name of Operator : Dhaval Patel	Inspection Authority
Qualification : MT Level II	
Sign.  Date : 29.12.2013	Sign.  Date : 



Witnessed
 Reviewed
DEC 30 2013

A FONSO 115
Exchanger Industries Limited

	MT Report
	Procedure No.: PAT/AT/MT/03 (Rev.0)
	Dated: 05/08/2012
Page : 1 of 1	

MAGNETIC PARTICLE EXAMINATION REPORT

Procedure No.	: PAT/AT/MT/03 (Rev.0)	Date : 05/08/2012
Report No.	: EXE-1353/MT/02,	Date : 29.12.2013
S.O. No.	: PEX-71413	
Job No.	: EXE-1353,	Item No. 104-E-136
EI Job No.	: 13-3353 B,	EI Client P.O. No.: CE416040-CC088996-00.
EI Drg. No.	: 13-3353 A/B	
Reference / Identification:	MT of temporary attachment removed area by grinding on Channel Cylinder assembly.	
Test Date	: 29.12.2013	
Test Material	: SA-516 GR.70N	
Surface Condition	: As Grind	
Object	: To check surface and sub-surface discontinuities.	
Test Equipment	: Electromagnetic Yoke : Make : SIMS Model : Y AC/DC	
Test Technique	: Wet Visible Continuous Technique	
Magnetizing Current	: AC & HWDC	
Inspection Medium	: Wet Visible Black Magnetic Particles, Make:Magnaflux-7C Black	
Lighting Equipment	: 60 W Bulb Hand Lamp (Incandescent lamp) with 230 V power supply enclosed in a pan held at a distance of 200 mm from the examination surface.	
Reference	: ASME Sec. V, Article 7	
Acceptance Standard	: ASME Sec. VIII, Div. 1, Appendix – 6	
Result of calibration	: For AC : 4.5 Kgs (10 Lbs.) at 4" and 6" pole spacing For DC:18.1 Kgs. (40 Lbs.) at 4" and 6" pole spacing.	
Maximum pole spacing during examination : 4"		

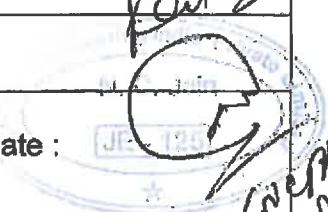
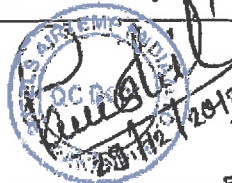
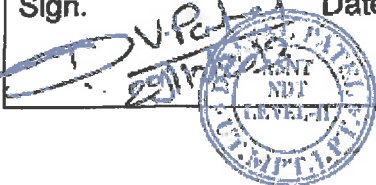
Observations: No Relevant indication was observed.
Result : MT Satisfactory Result was found.....Acceptable

Name of Operator : Dhaval Patel
Qualification : MT Level II

Inspection Authority

Sign.  Date : 29.12.2013

Sign.  Date : 



Witnessed
 Reviewed
A FONSO
DEC 30 2013
116



PATELS AIRTEMP (INDIA) LTD.

FINAL DIMENSION REPORT FOR MAIN SHELL ASSEMBLY

S.O. NO. : PEX-71413	DATE : 27/12/2013
P.O. NO. : 98998	DATE : 8/7/2013
CLIENT : M/s. EXCHANGER INDUSTRIES LTD.	INSP. AUTH. : AI/EI
JOB DETAILS : SALES OIL TANK HEATER	EI JOB NO : 13-3353A
MFG. SRL No : EXE-1352	ITEM NO. : 104-E-135
CODE : ASME SEC-VIII, DIV-1 ED-2010, ADD-2011a & TEMA CLASS -"R" 9TH EDITION & API 660	DRG. NO. : 13-3353A/B SH. 1 OF 13 R-03, SH. 3 OF 13 R-2 & SH. 4 OF 13 R-2

NOZZLE	ELEVATION		ORIENT-TATION	PROJECTION FROM CL		REMARK
	REQD.	FOUND		REQD.	FOUND	
S1 NPS 4 X 300 CLASS X LWNRF	252	253	180°	505	505/507	FROM SH. FLG. MK2
S2 NPS 4 X 300 CLASS X LWNRF	5550	5552	0°	505	506/508	FROM NOZZLE S1
SR NO.	DISCRIPTION			REQ.	ACT.	
1	DISTANCE BETWEEN SH. FLG. TO DISHED END TL			6228	6231	
2	DISTANCE BETWEEN TWO SUPPORTS			4000	4002	
3	ELEVATION OF FIX SUPPORT FROM FLG. MK2			1100	1103	
4	TOTAL HEIGHT OF SUPPORTS			410	410/411	
5	ELEVATION OF NAME PLATE BKT FROM FLG. MK2			252	251	
6	FIX SUPPORT HOLE & SLIDING SUPPORT SLOT DIMENSION			ø 27 X (ø27 X 54)	ø 27 X (ø27 X 55)	
7	2Nos GROUNDING LUG WELDED ON EACH FIX & SLIDING SUPPORTS - FOUND AS PER DRAWING					
8	ALL DIMENSIONS ARE IN MM					

→ VISUAL INSPECTION OF SALES OIL TANK HEATER (MAIN SHELL ASSEMBLY) & ALL WELDS INSPECTION HAS BEEN CARRIED OUT AND FOUND SATISFACTORY.

QCE		INSP. AUTHORITY	
DATE	27/12/2013	DATE	27/12/2013



Witnessed
 Reviewed
JOE AFONSO
 Exchanger Industries Limited
 FEB 07 2014



PATELS AIRTEMP (INDIA) LTD.

FINAL DIMENSION REPORT FOR CHANNEL ASSEMBLY

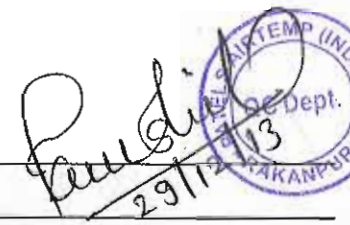

S.O. NO. : PEX-71413	DATE : 29/12/2013
P.O. NO. : 98998	DATE : 8/7/2013
CLIENT : M/s. EXCHANGER INDUSTRIES LTD.	INSP. AUTH. : AI/EI
JOB DETAILS : SALES OIL TANK HEATER	EI JOB NO : 13-3353A
MFG. SRL. No : EXE-1352	ITEM NO. : 104-E-135
CODE : ASME SEC-VIII, DIV-1 ED-2010, ADD-2011a & TEMA CLASS -"R" 9TH EDITION & API 660	DRG. NO. : 13-3353A/B SH. 1 OF 13 R-03, SH. 3 OF 13 R-2 & SH. 4 OF 13 R-2

	NOZZLE	ELEVATION		ORIENT-TATION	PROJECTION FROM CL		REMARK
		REQD.	FOUND		REQD.	FOUND	
T1	NPS 4 X 300 CLASS X LWNRF	245	247	0°	505	505/508	FROM CH. FLG. MK1
T2	NPS 4 X 300 CLASS X LWNRF	245	247	180°	505	506/507	FROM CH. FLG. MK1

SR NO.	DISCRIPTION	REQ.	ACT.
1	TOTAL LENGTH BETWEEN DISHED END TL TO CH. FLG.	567	570
2	2NOS LIFTING LUGS ARE WELDED ON CHANNEL ASSEMBLY AT 60° & 300° - FOUND AS PER DRAWING		
3	ALL DIMENSIONS ARE IN MM		

4. Partition plate & pipe welded as per AS BUILT DRAWING

→ VISUAL INSPECTION OF SALES OIL TANK HEATER (CHANNEL ASSEMBLY - INTERNAL & EXTERNAL BOTH SIDE) & ALL WELDS INSPECTION HAS BEEN CARRIED OUT AND FOUND SATISFACTORY.

QCE		INSP. AUTHORITY	
DATE	29/12/2013	DATE	29/12/2013 AI





IN CHARGE
08/01/2013

Witnessed
 Reviewed
A FONSO

Exchanger Industries Limited

JAN 04 2014



PATELS AIRTEMP (INDIA) LTD.

FINAL DIMENSION REPORT FOR MAIN SHELL ASSEMBLY

S.O. NO. : PEX-71413	DATE : 27/12/2013
P.O. NO. : 98998	DATE : 8/7/2013
CLIENT : M/s. EXCHANGER INDUSTRIES LTD.	INSP. AUTH. : AI/EI
JOB DETAILS : SALES OIL TANK HEATER	EI JOB NO : 13-3353B
MFG. SRL. No : EXE-1353	ITEM NO. : 104-E-136
CODE : ASME SEC-VIII, DIV-1 ED-2010, ADD-2011a & TEMA CLASS -"R" 9TH EDITION & API 660	DRG. NO. : 13-3353A/B SH. 1 OF 13 R-03, SH. 3 OF 13 R-2 & SH. 4 OF 13 R-2

NOZZLE	ELEVATION		ORIENT-TATION	PROJECTION FROM CL		REMARK
	REQD.	FOUND		REQD.	FOUND	
S1 NPS 4 X 300 CLASS X LWNRF	252	252	180°	505	507/508	FROM SH. FLG. MK2
S2 NPS 4 X 300 CLASS X LWNRF	5550	253	0°	505	505/508	FROM NOZZLE S1
SR NO.	DISCRIPTION			REQ.	ACT.	
1	DISTANCE BETWEEN SH. FLG. TO DISHED END TL			6228	6232	
2	DISTANCE BETWEEN TWO SUPPORTS			4000	4001	
3	ELEVATION OF FIX SUPPORT FROM FLG. MK2			1100	1102	
4	TOTAL HEIGHT OF SUPPORTS			410	410/411 400/411	<i>E</i>
5	ELEVATION OF NAME PLATE BKT FROM FLG. MK2			252	251	
6	FIX SUPPORT HOLE & SLIDING SUPPORT SLOT DIMENSION			∅ 27 X (∅ 27 X 54)	∅ 27 X (∅ 27 X 55)	
7	2Nos GROUNDING LUG WELDED ON EACH FIX & SLIDING SUPPORTS - FOUND AS PER DRAWING					
8	ALL DIMENSIONS ARE IN MM					

→ VISUAL INSPECTION OF SALES OIL TANK HEATER (MAIN SHELL ASSEMBLY) & ALL WELDS INSPECTION HAS BEEN CARRIED OUT AND FOUND SATISFACTORY.

QCE *Ravindra*
DATE 27/12/2013



INSP. AUTHORITY *[Signature]*
DATE 27/12/2013
AI



Witnessed
 Reviewed
JOE AFONSO

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PATELS AIRTEMP (INDIA) LTD.

FINAL DIMENSION REPORT FOR CHANNEL ASSEMBLY

S.O. NO. : PEX-71413	DATE : 29/12/2013
P.O. NO. : 98998	DATE : 8/7/2013
CLIENT : M/s. EXCHANGER INDUSTRIES LTD.	INSP. AUTH. : AI/EI
JOB DETAILS : SALES OIL TANK HEATER	EI JOB NO : 13-3353B
MFG. SRL. No : EXE-1353	ITEM NO. : 104-E-136
CODE : ASME SEC-VIII, DIV-1 ED-2010, ADD-2011a & TEMA CLASS -"R" 9TH EDITION & API 660	DRG. NO. : 13-3353A/B SH. 1 OF 13 R-03, SH. 3 OF 13 R-2 & SH. 4 OF 13 R-2

	NOZZLE	ELEVATION		ORIENT-TATION	PROJECTION FROM CL		REMARK
		REQD.	FOUND		REQD.	FOUND	
T1	NPS 4 X 300 CLASS X LWNRF	245	246	0°	505	504/507	FROM CH. FLG. MK1
T2	NPS 4 X 300 CLASS X LWNRF	245	245	180°	505	505/508	FROM CH. FLG. MK1

SR NO.	DISCRIPTION	REQ.	ACT.
1	TOTAL LENGTH BETWEEN DISHED END TL TO CH. FLG.	567	569
2	2NOS LIFTING LUGS ARE WELDED ON CHANNEL ASSEMBLY AT 60° & 300° - FOUND AS PER DRAWING		
3	ALL DIMENSIONS ARE IN MM		

4. Partition plate & pipe welded as per AS BUILT DRG.

→ VISUAL INSPECTION OF SALES OIL TANK HEATER(CHANNEL ASSEMBLY - INTERNAL & EXTERNAL BOTH SIDE) & ALL WELDS INSPECTION HAS BEEN CARRIED OUT AND FOUND SATISFACTORY.

QCE		INSP. AUTHORITY	
DATE	29/12/2013	DATE	29/12/2013

(N.C. Jain)
08/01/2014

Witnessed
 Reviewed
A FONSO

Exchanger Industries Limited

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 JAN 04 2014



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments		
104-E-135, 104-E-136	JPI REV 5 - INFORMATION		
Review Status Codes	Project / Req Title	CNRL – Kirby North phase 1	
<input type="checkbox"/> 1 - Work May Proceed <input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated <input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture <input checked="" type="checkbox"/> 4 - STOP WORK per attached written instructions <input type="checkbox"/> 5 - Review Not Required: Work may proceed <small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small>	Supplier	Exchanger Industries	
	Doc. Description	EXCHANGER - PATELS - MATERIAL IDENTIFICATION REPORT - PEX 71413 - 13-3353	
	Vendor Document No.	PAT MTR - 13-3353	
	Client Document No.	VP088996-M017-00005	
	Purchase Order No.	Doc Cat.	Issue
CE416040-CC088996-00	M017	0	
BY : _____	Categories	M725	
DATE : _____	Date Received	04/08/2014	



PATELS AIRTEMP (INDIA) LTD.

MATERIAL IDENTIFICATION REPORT

SO NO.	: PEX 71413	DATE	: 30/10/2013
PO NO.	: 98998	DATE	: 8/7/2013
CLIENT	: EXCHANGER INDUSTRIES (CANADA)	INSP. AUTH	: AI / EI
JOB DETAILS	: SALES OIL TANK HEATER	DRG. NO.	: 13-3353 A/B REV-02
CODE	: ASME SEC VIII DIV 1 ED 2010+Add 2011a	MFR. SR. NO.	: EXE 1352 & EXE 1353
ITEM NO	: 104-E-135/136	EI JOB NC	: 13-3353 A/B

PN	DETAILS	SIZE	QTY.	MATERIAL AS PER DRG.	MATERIALS USED	HEAT NO.	T.C. DETAILS
101	MAIN SHELL	14T X 1241 DL.	2	SA 516 GR 70	SA 516 GR 70		
	CYLINDER	6094 MM LG					
	381 ID	(IN 3 CORSES)					
101	MAIN SHELL	14T X 1241 DL.	2	SA 516 GR 70	SA 516 GR 70	H-142095	STEEL AUTHORITY
S1	CYLINDER	2500 MM LG				P-1291544/1	OF INDIA LIMITED
	381 ID						T.C NO : RCL/MTL /PLM/80203804
							DT : 27/07/2012
101	MAIN SHELL	14T X 1241 DL.	2	SA 516 GR 70	SA 516 GR 70	H-142095	..... DO
S3	CYLINDER	2500 MM LG				P-1291544/1	
	381 ID						

Witnessed
 Reviewed
JOE AFONSO
(Signature)
Exchanger Industries.
OCT 30 2013

(Signature)
 25/10/2013

(Signature)
 30/10/2013

(Signature)
N. C. Jain
 JE - Insp.
INSP. AUTH. & DATE

PLANNING ENGINEER & DATE

QCE & DATE



STEEL AUTHORITY OF INDIA LIMITED
BHILAI STEEL PLANT
RESEARCH & CONTROL LAB (MECHANICAL TESTING LAB)

Page No. 1 of 1
MTL-REQ-2

STEEL MAKER'S CERTIFICATE OF MANUFACTURE & RESULTS OF TESTS
WORK TEST CERTIFICATE

To
BM BSO MUMBAI

SWASTICK CHAMBERS 1ST FLOOR SION TROMBAY ROAD CHEMBUR

T.C. No. : RCL/MTL/PLM/80203804
T.C. Date : 27.07.2012
SALES ORDER NO : 1100086251
DA NO. : 80203804
DA Date : 27.07.2012
Wagon No. / Trailer No. : SECR21141124561

Heat Treatment : Normalised
(a) Temp : 900°C-920°C
(b) Time : 1 minute/mm of Thickness

Process of Manufacture : Basic Oxygen Converter Continuous Cast
Killed Steel
NORMALISED

Specification : ASME SA516/SA516M GR 70-2010(2011a)
ASME SA20/SA20M-2010(2011a)

We hereby certify that the materials as mentioned below against the respective heat numbers have satisfied the requirements of chemical composition and / or mechanical testes of the respective specification (s), as found in the respective sample selected from them

TEST RESULTS

SECTION (NOMINAL SIZE)			Heat No.	Plate No. / Pc. No.	MECHANICAL PROPERTIES									Bend Test	M. Dia
THICK	WIDTH	LENGTH			YS	UTS	%E	CHARPY V NOTCH (L) Impact Values (J)							
mm	mm	mm			MPa	MPa	GL *	I1	I2	I3	Iavg	*C			
14	2500	12500	142095	1291540/2	396	540	23	48	46	42	45	-20	O.K.	3 T	
14	2500	12500	142095	1291541/2	404	537	23	42	40	40	41	-20	O.K.	3 T	
14	2500	12500	142095	1291544/1	417	583	24	42	36	38	39	-20	O.K.	3 T	
14	2500	12500	142095	1291544/2	---	---	---	---	---	---	---	---	---	---	

Heat No.	CHEMICAL COMPOSITION (LADLE ANALYSIS)														
	C	S	P	Mn	Si	Al	Cu	Cr	Ni	Mo	Nb	V	Ti	N ₂	CE
	%	%	%	%	%	%	%	%	%	%	%	%	%	ppm	%
142095	0.22	0.016	0.018	1.16	0.21	0.022	<0.02	<0.015	<0.015	<0.015	<0.010	<0.010	<0.005	68	0.41

T.C. Issued For 3.560 MTS. of
Against Challan No. 9009x(456)
dated 18.08.12

* GL in 200 mm mm

Total Pieces Page / Sales Order : 4 / 4 Total Pieces / TC : 18

The Material supplied conforms to the standard rolling and weight tolerances.

Note :

All the plate surfaces & dimension checked by BSP & each plate bears a stamp thus.

ULTRASONIC TEST AS PER ASTM A 578 Level B : Satisfactory & level of acceptance as per TDC.

Witnessed
 Reviewed
JOE AFONSO

Exchanger Industries.
OCT 30 2013

Authorised Signatory
SAIL/CMO/BSO

G TAMRAKAR
Authorised Signatory
Research & Control Laboratory
Bhilai Steel Plant

JE - 125

MTC Reviewed
Rushil
30/10/2013

Signature
12/11/2013



PATELS AIRTEMP (INDIA) LTD.

MATERIAL IDENTIFICATION REPORT

SO NO. : <u>PEX 71413</u>	DATE : <u>12/08/2013</u>
PO NO. : <u>98998</u>	DATE : _____
CLIENT : <u>EXCHANGER INDUSTRIES (CANADA)</u>	INSP. AUTH : <u>AI / XXX / Jacobs/EI R</u>
JOB DETAILS : <u>SALES OIL TANK HEATER</u>	DRG. NO. : <u>13-3353 A/B REV-02</u>
CODE : <u>ASME SEC VIII DIV 1 ED 2010+Add 2011a</u>	MFR. SR. NO. : <u>EXE 1352 & EXE 1353</u>
ITEM NO : <u>104-E-135/136</u>	EI JOB NC : <u>13-3353 A/B</u>

PN	DETAILS	SIZE	QTY.	MATERIAL AS PER DRG.	MATERIALS USED	HEAT NO.	T.C. DETAILS
101	MAIN SHELL	14T X 1241 DL.	2	SA 516 GR 70	SA 516 GR 70		
	CYLINDER	6094 MM LG		N			
	381 ID	(IN 3 CORSES)					
101	MAIN SHELL	14T X 1241 DL.	2	SA 516 GR 70	SA 516 GR 70	H-11K20301	ALCHEVSK & IRON
S1	CYLINDER	2500 MM LG		N		P-211	STEEL WORKS
	381 ID						T.C NO : 61633
							DT : 30/01/2011
101	MAIN SHELL	14T X 1241 DL.	2	SA 516 GR 70	SA 516 GR 70	H-11K20301	..... DO
S2	CYLINDER	1094 MM LG		N		P-211	
	381 ID						
101	MAIN SHELL	14T X 1241 DL.	2	SA 516 GR 70	SA 516 GR 70	H-11K20301	..... DO
S3	CYLINDER	2500 MM LG		N		P-211	
	381 ID						

Reviewed
Approved
22/10/13
JAYESH BHATT
 Exchanger Industries.

Patel
12/08/2013

Rungtil
12/08/13

PLANNING ENGINEER & DATE QCE & DATE INSP. AUTH. & DATE



PATELS AIRTEMP (INDIA) LTD.

MATERIAL IDENTIFICATION REPORT

SO NO. : <u>PEX 71413</u>	DATE : <u>12/08/2013</u>
PO NO. : <u>98998</u>	DATE : _____
CLIENT : <u>EXCHANGER INDUSTRIES (CANADA)</u>	INSP. AUTH : <u>AI / 107 / Jacobs/EIR</u>
JOB DETAILS : <u>SALES OIL TANK HEATER</u>	DRG. NO. : <u>13-3353 A/B REV-02</u>
CODE : <u>ASME SEC VIII DIV 1 ED 2010+Add 2011a</u>	MFR. SR. NO. : <u>EXE 1352 & EXE 1353</u>
ITEM NO : <u>104-E-135/136</u>	EI JOB NC : <u>13-3353 A/B</u>

PN	DETAILS	SIZE	QTY.	MATERIAL AS PER DRG.	MATERIALS USED	HEAT NO.	T.C. DETAILS
401	TUBESHEET	56T X 534 OD	2	SA 516 GR 70 50 THK	SA 516 GR 70 56 THK	Y 936507 264022/1/1	ARCELOR MITTAL T.C NO : 20310676 DT : 04/10/2012
102	SHELL HEAD 381 ID	14T X 580 ø	2	SA 516 GR 70 N	SA 516 GR 70 N	H-6739 P-5449/10	AZOVSTAL & IRON STEEL WORKS T.C NO : 09-15290 DT : 15/06/2012
302	CH. HEAD 381 ID	14T X 580 ø	2	SA 516 GR 70 N	SA 516 GR 70 N	H-6739 P-5449/10	..... DO
	COUPAN PLATE	14T X 150 X 300	1	SA 516 GR 70 N	SA 516 GR 70 N	H-6739 P-5449/10	..... DO
301	CH. SHELL CYLINDER 381 ID	14T X 1241 DL. 324 MM LG	2	SA 516 GR 70 N	SA 516 GR 70 N	H-6739 P-5449/10	..... DO

Reviewed [Signature] 22/10/13
Reviewed [Signature]
JAYESH BHATT
 Exchanger Industries

<u>A Patel</u> 12/08/2013 PLANNING ENGINEER & DATE	<u>[Signature]</u> 12/08/13 QCE & DATE	INSP. AUTH. & DATE
---	---	-------------------------------



ЛАО «МК «АЗОВСТАЛЬ»
PJSC «AZOVSTAL IRON & STEEL WORKS»

СЕРТИФИКАТ КАЧЕСТВА № 09-15290
QUALITY CERTIFICATE No

Лист 2 of 2
Date 15.06.2012

Листов 2
Sheets

1, пр. Ленінська, м. Ізюм, Україна, пош. 650 (629) 57-72-00

Протокол прийомочних испытаний
Inspection report

EN 10204-3.2
Contract No: 400712-0830
Contract No: 400712-0830
Заказчик: PJSC «AZOVSTAL IRON & STEEL WORKS»
Customer: PJSC «AZOVSTAL IRON & STEEL WORKS»
Видовий код: EN 10204-3.2
Кількість товарів: 12
Quantity of goods: 12

Назва товару: Прокат товстих пластин
Description of goods: Heavy plates
Матеріал: ASME SA516-70 MT
Grade of Steel: LTV
Нормативний документ: ASME SA516-70 MT
Normative document: ASME SA516-70 MT

Виробничий процес: Конверсійний процес
Steelmaking process: Made by the BOF process
Стан поставки: Нормалізований
Delivery condition: Normalized
Маркування: 920 °C 1.2 mm/min
Marking: 920 °C 1.2 mm/min

Масштаб: 1:1
Scale: 1:1
Цілі: ТРИЗЕЛІЗОВАНА СТАЛЬ
Purpose: THREE GREEN STRIPES

Позиція Item No	Планировка Cast No	Партія № Test No/ Product No	Размери мм Dimensions, mm			Масса т(шт) Mass, t (pcs)
			Толщина Thickness	Ширина Width	Длина Length	
4	6739	3-5,7,8,9,10,11,12,13,14	14	2500	12000	3,297
4						32,970
Итого Total						39,564

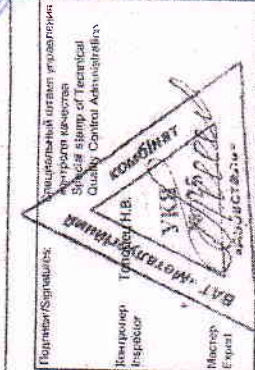
МТР Revisited
Kundlicha Dept.
12.10.2013

Результаты испытаний
Test results

Партія № Test No/ Product No	Товщина Thickness	Ширина Width	Длина Length	Текст дефекта Defect description	Текст дефекта Defect description		0,2% VOl. Offset 0,2% VOl. Offset	Гр. прокатки Rolling direction	Відсоток Impact energy 1	Відсоток Impact energy 2	Відсоток Impact energy 3	Відсоток Impact energy 4	
					№	Відсоток Impact energy							
1	14	2500	12000				415	545	40				
2	10	10	L	-46			142	163	148	151			601
3	14	38	T	+20									501
4	14	10	L	-46			431	550	36				501
5	14	38	T	+20									501
6	14	10	L	-46			499	510	40				501
7	14	38	T	+20									501
8	14	10	L	-46			403	540	36				501
9	14	38	T	+20									501
10	14	10	L	-46			415	168	160	154			501
11	14	38	T	+20			415	545	36				501
12	14	10	L	-46			188	153	150	160			501

Хімічний склад, %
Chemical composition, %

Планировка Cast No	C	Mn	Si	S	P	Cr	Ni	Cu	Ti	Mo	Nb	V	N	As	Se
6739	17	112	29	4	14	4	20	3	30	<5	15	<5	7	<5	38



Важко підтвердити, що продукція відповідає вимогам, вказаним у контракті. Підтверджується, що продукція відповідає вимогам, вказаним у контракті, якщо тільки не буде вказано інакше.

Reviewed
Checked
Ishkova
Eckhardts
Ishkova





PATELS AIRTEMP (INDIA) LTD.

MATERIAL IDENTIFICATION REPORT

SO NO. : PEX 71413	DATE : 17/10/2013
PO NO. : 98998	DATE : 08/07/2013
CLIENT : EXCHANGER INDUSTRIES (CANADA)	INSP. AUTH : AI
JOB DETAILS : SALES OIL TANK HEATER	DRG. NO. : 13-3353 A/B REV-02
CODE : ASME SEC VIII DIV 1 ED 2010+Add 2011a	MFR. SR. NO. : EXE 1352 & EXE 1353
ITEM NO : 104-E-135/136	EI JOB NO : 13-3353 A/B

PN	DETAILS	SIZE	QTY.	MATERIAL AS PER DRG.	MATERIALS USED	GROUP NO.	T.C. DETAILS
303	CHANNEL	57T X 524 OD	2	SA 105 <i>N</i>	SA 105	2064 A4	J.A.V.FORGINGS PVT.LTD
	FLANGE	381 ID X 83 HT					T.C NO : 6329
	MK1						DT : 10/10/2013
103	SHELL	57T X 524 OD	2	SA 105 <i>N</i>	SA 105	2064 A4	..... DO
	FLANGE	381 ID X 83 HT					
	MK2						
501	FLANGE	NPS 4 X CL. 300	8	SA 105 <i>N</i>	SA 105	2064 B2	J.A.V.FORGINGS PVT.LTD
	S1,S2	RF LWN X 345 LG					T.C NO : 6328
	T1,T2	ID = 101.6 MM					DT : 10/10/2013
		WT = 22.2 MM					
	<input checked="" type="checkbox"/> Witnessed <input type="checkbox"/> Reviewed JOE ALFONSO Exchanger Industries Limited NOV 15 2013						

 PLANNING ENGINEER & DATE	 QCE & DATE	 INSP. AUTH. & DATE
------------------------------	----------------	------------------------



J. A. V. FORGINGS PVT.LTD.

An ISO - 9001 Company

Works: 169-170, Village Bhakri, Badkhal Pali Road, Faridabad-121004
PH.:0129-2480275, 2480046, FAX: 0129-2481750, e-mail:javforge@satyam.net.in

WORKS TEST CERTIFICATE

FORMAT No.	JAV/QC/19
ISSUE No.	4
DATE	07/05/2012

SHEET 1 OF 2

Certificate No. : - 6328		DATE : - 10.10.2013	
Purchaser:	M/s. PATELS AIRTEMP (INDIA) LTD	Inspection Authority	J.A.V. FORGINGS PVT LTD
PO. No.	PAT/PEX71413/609/PO.EX-212 DT-09.09.2013	Date of Final Inspection	10.10.2013
AMD No.	E-MAIL DT 09.10.2013	Project	-----
Dimension:	AS PER ASME B16.5 (2013)	Material Specification	SA 105M OF ASME SEC II PART A ED 2010 + AD 2011a
Certificate Type	AS PER EN - 10204 PARA 3.1 (2004)	Tech. Specification No.	TPS-PEX-71413/03 REV-0
Order Status	COMPLETE	Approved QAP. No	-----

ITEM No.	Description	Group No.	Qty.	Heat Treatment	Item status
01	4 NPS x CLASS 300 # LWNRF 345 MML x ID=101.6 MM x WT = 22.2 MM (125-150 AARH)	2064B2	08	NORMALISED AT 900°C, SOAKING TIME 4.0 HRS, STILL AIR COOL.	COMPLETE

CHEMICAL COMPOSITION %

Analysis	Group No.	Lab No.	Cast No.	C	Mn	P	S	Si	Ni	Cr	Mo	Cu	V	Al	AA	BB	CE
		REQD		MIN.	---	0.60	---	0.10	---	---	---	---	---	---	---	---	---
				MAX.	0.35	1.05	0.035	0.040	0.35	0.40	0.30	0.12	0.40	0.08	1.00	0.32	---
PA	2064B2	130911	12E011013	0.20	0.91	0.025	0.015	0.23	<0.02	<0.02	<0.02	<0.02	<0.02	0.025	0.10	0.04	0.36
MA			12E011013	0.21	0.92	0.023	0.014	0.22	0.011	0.01	0.0007	0.01	0.001	0.025	0.03	0.02	0.36

$$CE = C + Mn / 6 + (Cr + Mo + V) / 5 + (Ni + Cu) / 15$$

$$AA = Ni + Cr + Mo + Cu + V$$

$$BB = Cr + Mo$$

PA = PRODUCT ANALYSIS REPORT

MA = MILL TEST REPORT



Reviewed

Reviewed
OCT. 17 2013

Reviewed
JE - 125

Witnessed
 Reviewed
JOE ALFONSO
Exchanger Industries Limited

NOV 15 2013

Reviewed
J.A.V. FORGINGS PVT. LTD.
Jaiveer Singh
MANAGER Q.C.

(INSPECTION AUTHORITY)

(MANAGER QUALITY CONTROL)

CORRESPONDENCE ADDRESS:- PLOT NO.5, SECTOR-6, MATHURA ROAD, FARIDABAD-121006



J. A. V. FORGINGS PVT.LTD.







An ISO – 9001 Company

Works: 169-170, Village Bhakri, Badkhal Pali Road, Faridabad-121004
 PH.:0129-2480275, 2480046, FAX: 0129-2481750, e-mail:javforge@satyam.net.in

WORKS TEST CERTIFICATE

FORMAT No.	JAV/QC/19
ISSUE No.	4
DATE	07/05/2012

SHEET 2 OF 2

Certificate No.: - 6328										DATE : - 10.10.2013				
MECHANICAL PROPERTIES														
Group No.	Direction of Test Specimen	Gauge Diameter (MM)	Gauge Lenth (MM)	YS MPa (N/MM ²) BY 0.2% Offset Method	UTS Mpa (N/MM ²)	Elong % on 4 D	Red. In Area %	Hardness BHN	Bend Test Angle of bent 180° Size = 19mmT x 25.4mmW Mandreal R= 6.35mm	Charpy 'V' Notch Impact Test Temp. °C				
										Individual	Average			
REQD.			4 x DIA	250.00 MIN.	485.00 MIN.	22.00 MIN.	30.00 MIN.	187 MAX.	-----	-----	-----			
2064B2	TANGENTIAL	8.77	35.00	348	526	25.43	36.29	156, 159	-----	-----	-----			
2064B2	LONGITUDNAL	12.69	50.00	342	522	33.00	62.22	156, 159	-----	-----	-----			
Other Test	Ultrasonic Test		Wet Fluorescent Magnetic Particle Examination			Liquid Penetrant Test			Intergranular Corrosion	Micro Test				
Test Standard														
Act. Level	N/A		N/A			N/A			N/A	N/A				
Results														
Identification: ITEM NO. /SR. NO. – JAV – SIZE – SPECI – G. NO. – B16.5														
Certified that the above items have been manufactured, inspected & found acceptable as per the Specification/Purchase order requirements														
Remarks:-														
<ol style="list-style-type: none"> THE FORGINGS ARE MANUFACTURED, SAMPLED, TESTED AND INSPECTED IN ACCORDINDANCE WITH THE REQUIREMENTS OF MATERIAL SPECIFICATION AND APPLICABLE SUPLEMENTRY REQUIREMENTS AS PER CLINT'S PURCHASE ORDER AND TEST RESULT HAS BEEN FOUND TO MEET APPLICABLE REQUIREMENTS. ALL TESTING/INSPECTION DONE BY CALIBRATED EQUIPMENTS. ABOVE MATERIAL MANUFACTURED AS PER LATEST APPLICABLE SPECIFICATION UNLESS OTHERWISE SPECIFIED. ALL FORGINGS FREE FROM INJURIOUS DEFECTS & NO WELD REPAIRED HAVE BEEN PERFORMED. USED MATERIAL IS FULLY KILLED & FINE GRAIN STEEL. 														
<i>Reviewed!</i>  			<input type="checkbox"/> Witnessed <input checked="" type="checkbox"/> Reviewed JOE ALFONSO  Exchanger Industries Limited						NOV 15 2013  			 MANAGER Q.C.		
(INSPECTION AUTHORITY)						(MANAGER QUALITY CONTROL)								

CORRESPONDENCE ADDRESS:- PLOT NO.5, SECTOR-6, MATHURA ROAD, FARIDABAD-121006



J. A. V. FORGINGS PVT.LTD.

An ISO - 9001 Company

Works: 169-170, Village Bhakri, Badkhal Pali Road, Faridabad-121004
 PH.:0129-2480275, 2480046, FAX: 0129-2481750, e-mail:javforge@satyam.net.in

WORKS TEST CERTIFICATE

FORMAT No.	JAV/QC/19
ISSUE No.	4
DATE	07/05/2012

SHEET 1 OF 2

Certificate No.: - 6329		DATE: - 10.10.2013	
Purchaser:	M/s. PATELS AIRTEMP (INDIA) LTD	Inspection Authority	J.A.V. FORGINGS PVT LTD
PO. No.	PAT/PEX71413/610/PO.EX-211 DT-09.09.2013	Date of Final Inspection	10.10.2013
AMD No.	E-MAIL DT 09.10.2013	Project	-----
Dimension:	AS PER DRG	Material Specification	SA 105M OF ASME SEC II PART A ED 2010 + AD 2011a
Certificate Type	AS PER EN - 10204 PARA 3.1 (2004)	Tech. Specification No.	TPS-PEX-71413/04 REV-0
Order Status	COMPLETE	Approved QAP. No	-----

ITEM No.	Description	Group No.	Qty.	Heat Treatment	Item status
01	CHANNEL FLANGE (MK1) AS PER DRG NO- 13-3353A/B SHEET 5 OF 13 R00 57 MM THK x 524 MM OD x 381 MM ID x 83 MM HT (125-150 AARH)	2064A4	02	NORMALISED AT 900°C, SOAKING TIME 4.0 HRS, STILL AIR COOL.	COMPLETE
02	SHELL FLANGE (MK2) AS PER DRG NO- 13-3353A/B SHEET 5 OF 13 R00 57 MM THK x 524 MM OD x 381 MM ID x 83 MM HT (125-150 AARH)	2064A4	02		COMPLETE

CHEMICAL COMPOSITION %

Analysis	Group No.	Lab No.	Cast No.	C	Mn	P	S	Si	Ni	Cr	Mo	Cu	V	Al	AA	BB	CE
		REQD		MIN.	---	0.60	---	0.10	---	---	---	---	---	---	---	---	---
				MAX.	0.35	1.05	0.035	0.040	0.35	0.40	0.30	0.12	0.40	0.08	---	1.00	0.32
PA	2064A4	130907	Q4-46	0.21	0.93	0.025	0.015	0.25	<0.02	0.07	<0.02	<0.02	<0.02	0.028	0.15	0.09	0.39
MA			Q4-46	0.21	0.94	0.022	0.010	0.24	0.01	0.07	0.01	0.01	0.003	0.028	0.10	0.08	0.38

$$CE = C + Mn / 6 + (Cr + Mo + V) / 5 + (Ni + Cu) / 15$$

$$AA = Ni + Cr + Mo + Cu + V$$

$$BB = Cr + Mo$$

PA = PRODUCT ANALYSIS REPORT

MA = MILL TEST REPORT

Witnessed

Reviewed

JOE ALFONSO

Joe Alfonso
Exchanger Industries Limited

NOV 15 2013

Reviewed
Prakash
 17.10.2013



(INSPECTION AUTHORITY)

(MANAGER QUALITY CONTROL)

CORRESPONDENCE ADDRESS:- PLOT NO.5, SECTOR-6, MATHURA ROAD, FARIDABAD-121006



J. A. V. FORGINGS PVT.LTD.

An ISO – 9001 Company

Works: 169-170, Village Bhakri, Badkhal Pali Road, Faridabad-121004
 PH.:0129-2480275, 2480046, FAX: 0129-2481750, e-mail:javforge@satyam.net.in

WORKS TEST CERTIFICATE

FORMAT No.	JAV/QC/19
ISSUE No.	4
DATE	07/05/2012

SHEET 2 OF 2

Certificate No.: - 6329										DATE : - 10.10.2013	
MECHANICAL PROPERTIES											
Group No.	Direction of Test Specimen	Gauge Diameter (MM)	Gauge Length (MM)	YS MPa (N/MM ²) BY 0.2% Offset Method	UTS Mpa (N/MM ²)	Elong % on 4 D	Red. In Area %	Hardness BHN	Bend Test Angle of bent 180° Size = 19mmT x 25.4mmW Mandrel R= 6.35mm	Charpy 'V' Notch Impact Test Temp. _____ °C Size 10x10x55mm, 2mm 'V' Notch	
										Individual	Average
REQD.			4 x DIA	250.00 MIN.	485.00 MIN.	22.00 MIN.	30.00 MIN.	187 MAX.	-----	-----	-----
2064A4	TANGENTIAL	12.52	50.00	352	516	33.00	66.93	152, 149	-----	-----	-----
Other Test	Ultrasonic Test			Wet Fluorescent Magnetic Particle Examination			Liquid Penetrant Test		Intergranular Corrosion		Micro Test
Test Standard											
Acct. Level	N/A			N/A			N/A		N/A		N/A
Results											
Identification: ITEM NO. /SR. NO. – JAV – SIZE – SPECI – G. NO. – DRG NO.											
Certified that the above items have been manufactured, inspected & found acceptable as per the Specification/Purchase order requirements											
Remarks:-											
<ol style="list-style-type: none"> 1. THE FORGINGS ARE MANUFACTURED, SAMPLED, TESTED AND INSPECTED IN ACCORDINDANCE WITH THE REQUIREMENTS OF MATERIAL SPECIFICATION AND APPLICABLE SUPLEMENTRY REQUIREMENTS AS PER CLINT'S PURCHASE ORDER AND TEST RESULT HAS BEEN FOUND TO MEET APPLICABLE REQUIREMENTS. 2. ALL TESTING/INSPECTION DONE BY CALIBRATED EQUIPMENTS. 3. ABOVE MATERIAL MANUFACTURED AS PER LATEST APPLICABLE SPECIFICATION UNLESS OTHERWISE SPECIFIED. 4. ALL FORGINGS FREE FROM INJURIOUS DEFECTS & NO WELD REPAIRED HAVE BEEN PERFORMED. 5. USED MATERIAL IS FULLY KILLED & FINE GRAIN STEEL. 											
<div style="display: flex; justify-content: space-between; align-items: flex-end;"> <div style="width: 30%;"> <p><i>Reviewed</i></p> <p><i>Reviewed</i></p> <p><i>Oct 17 2013</i></p> </div> <div style="width: 30%; text-align: center;"> <p><i>Reviewed</i></p> </div> <div style="width: 30%; text-align: right;"> <p><input type="checkbox"/> Witnessed</p> <p><input checked="" type="checkbox"/> Reviewed</p> <p>JOE ALFONSO</p> <p>Exchanger Industries Limited</p> <p>NOV 15 2013</p> </div> </div>											
(INSPECTION AUTHORITY)						(MANAGER QUALITY CONTROL)					



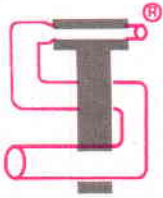
PATELS AIRTEMP (INDIA) LTD.

MATERIAL IDENTIFICATION REPORT

SO NO. : <u>PEX 71413</u>	DATE : _____
PO NO. : <u>98998</u>	DATE : <u>8/7/2013</u>
CLIENT : <u>EXCHANGER INDUSTRIES (CANADA)</u>	INSP. AUTH : <u>AI</u>
JOB DETAILS : <u>SALES OIL TANK HEATER</u>	DRG. NO. : <u>13-3353 A/B REV-02</u>
CODE : <u>ASME SEC VIII DIV 1 ED 2010+Add 2011a</u>	MFR. SR. NO. : <u>EXE 1352 & EXE 1353</u>
ITEM NO : <u>104-E-135/136</u>	EI JOB NC : <u>13-3353 A/B</u>

PN	DETAILS	SIZE	QTY.	MATERIAL AS PER DRG.	MATERIALS USED	HEAT NO.	T.C. DETAILS
402	U-TUBES	19.05 MM OD	4	SA 179	SA 179	13040603	SAINEST TUBES
		14 BWG MIN. THK					PRIVATE LIMITED
		6040 MM ST.LG					T.C NO : 7548/13-14
							DT : 01/11/2013
402	U-TUBES	19.05 MM OD	4	SA 179	SA 179	13040603	..... DO
		14 BWG MIN. THK					
		6066 MM ST.LG					
402	U-TUBES	19.05 MM OD	94	SA 179	SA 179	13040603	..... DO
		14 BWG MIN. THK					
		6096 MM ST.LG					
					<input checked="" type="checkbox"/> Witnessed		
					<input type="checkbox"/> Reviewed		
					JOE ALFONSO		
					<i>Joe Alfonso</i>		
					Exchanger Industries Limited		
						NOV 15 2013	

 _____ PLANNING ENGINEER & DATE	 _____ QCE & DATE	 _____ INSP. AUTH. & DATE
--	------------------------------------	--



SAINEST TUBES PVT. LTD.

(AN ISO 9001/TS 16949/ISO 14001/OHSAS 18001/PED CERTIFIED COMPANY)

PRECISION SEAMLESS CARBON STEEL TUBES MAKERS

WORKS : 3329, PHASE - IV, G.I.D.C., CHHATRAL - 382729. DIST. GANDHINAGAR (GUJARAT)

Ph : 0091-2764-232242, 234128 FAX : 0091-2764-232207 E-MAIL : sainest@sainest.com

FORMAT No. STPL/INS.FTC/21

PAGE 01 OF 01

MILL TEST CERTIFICATE (AS PER EN 10204 TYPE 3.1)

CUSTOMER	M/s. PATELS AIRTEMP (INDIA) LIMITED, RAKANPUR.	S.O.NO.	7548
P.O.NO. & DATE	PAT/PEX-71413/606/PO.EX-203, DTD: 31.08.2013	T.C.NO.	7548/13-14
PRODUCT	C.S.SEAMLESS, COLD DRAWN, FULLY KILLED, ANNEALED 'U' TUBES.	DATE	01/11/2013

APPROVED QAP NO: STPL/QAP/7548/13-14, REV.01 DTD: 16.09.2013

P.O. SR. NO.	SPECIFICATION	OD MM	THK (MIN.) MM	LEG LENGTH MM	RADIUS IN MM	NO.OF PCS.	TOTAL MTRS.	100% HYDRO TEST	ITEM STATUS
1.	SA 179	19.05	14 BWG	6040	40.00	04	--	70 BAR	COMPLETE
2.	SA 179	19.05	14 BWG	6066	40.00	04	--	70 BAR	COMPLETE
3.	SA 179	19.05	14 BWG	6096	36.00	14	--	70 BAR	COMPLETE
	SA 179	19.05	14 BWG	6096	54.00	12	--	70 BAR	COMPLETE
	SA 179	19.05	14 BWG	6096	71.50	16	--	70 BAR	COMPLETE
	SA 179	19.05	14 BWG	6096	90.00	12	--	70 BAR	COMPLETE
	SA 179	19.05	14 BWG	6096	108.00	12	--	70 BAR	COMPLETE
	SA 179	19.05	14 BWG	6096	125.50	12	--	70 BAR	COMPLETE
	SA 179	19.05	14 BWG	6096	143.50	12	--	70 BAR	COMPLETE
	SA 179	19.05	14 BWG	6096	162.00	04	-	70 BAR	COMPLETE
TOTAL						102 Nos.			

SA 179 OF ASME SEC.II PART A-EDITION 2010 ADDENDA 2011a & AS PER DOC No: TPS-PEX-71413/06 REV.01

P.O. SR. NO.	CHEMICAL COMPOSITION (%)											
		C	Mn	P	S	Si	Mo	Cr	V	Ni	Cu	Al
--	HEAT NO.	* S	0.06 TO 0.18	0.27 TO 0.63	0.035 Max.	0.035 Max.	-	-	-	-	-	-
1 TO 3	013040603	H	0.10	0.43	0.016	0.003	0.21	--	--	--	--	--
		P	0.102	0.436	0.014	0.004	0.219	-	--	--	-	0.011

* S: AS PER SPECIFICATION

H: AS PER HEAT ANALYSIS

P: AS PER PRODUCT ANALYSIS

PHYSICAL TESTING			MECHANICAL TESTING			
P.O. SR. NO.	FLARING	FLATTENING	HARDNESS (72 HRB MAX.)	TENSILE STRENGTH [47 KSI = 325 Mpa Min.]	YIELD STRENGTH [26 KSI = 180 Mpa Min.]	%ELONGATION GL...50.....MM [35%Min.]
1 TO 3.	OK	OK	60 TO 64 HRB	(59.47 KSI) 410.04 (59.69 KSI) 411.57	(40.88 KSI) 281.90 (44.92 KSI) 309.74	50.0% 46.0%

MARKING: EACH TUBE STENCILLED AS

STPL, SIZE, SPECIFICATION, HT. No., P.O.No., [P.A.I.L.] & R: mm

HEAT TREATMENT:

ANNEALED AT THE TEMP. OF 650 °C (+20 °C -0 °C) AFTER COLD DRAWING.

REMARKS:

- 100% VISUAL & DIMENSIONAL INSPECTION CARRIED OUT BY 'STPL' & 10% QTY. WITNESSED BY 'PAIL' SURVEYOR FOUND SATISFACTORY.
- PHYSICAL TEST CHECKED BY 'STPL' & WITNESSED BY 'PAIL' SURVEYOR FOUND SATISFACTORY.
- 100% HYDRO TEST CARRIED OUT BY 'STPL' ON 'U' TUBES WITH 2 MINUTES HOLDING TIME & 10% QTY. WITNESSED BY 'PAIL' SURVEYOR RESULT FOUND SATISFACTORY.
- S.R. DONE ON ALL TUBES AT 'U' BEND PORTION PLUS 152 mm (MIN.) ON EACH LEG LENGTH AT THE TEMP 635 °C +/- 18 °C WITH 60 MINUTES SOAKING TIME & WITNESSED BY 'PAIL' SURVEYOR FOUND SATISFACTORY.
- MOCK-UP TEST FOR INNER MOST TWO RADIUS CHECKED AT 0°, 30°, 60° & 90° FOR OVALITY & THINING & IT IS WITHIN LIMITS AS PER P.O. REQUIREMENTS (TEMA RCB 2.31) CHECKED BY 'STPL' & WITNESSED BY 'PAIL' SURVEYOR FOUND SATISFACTORY.
- 'U' BENDING DONE AS PER P.O. REQUIREMENTS AND 100% QTY. CHECKED BY STPL & ON THE TEMPLATES FOR RADIUS AND LEG LENGTH & 10% QTY. CHECKED BY 'PAIL' SURVEYOR FOUND OK.

Reviewed
JOE ALFONSO

Exchange Industries Limited

NOV 15 2013

INSPECTION BY : P.A.I.L.

SURVEYOR SIGN: _____

WE HEREBY CERTIFY THAT THE MATERIAL HEREIN DESCRIBED HAS BEEN TESTED IN ACCORDANCE TO ABOVE ORDER SIZE & SPECIFICATION REQUIREMENT



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments			
104-E-135, 104-E-136	JPI REV 5 - INFORMATION			
Review Status Codes	Project / Req Title	CNRL – Kirby North phase 1		
<input type="checkbox"/> 1 - Work May Proceed <input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated <input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture <input type="checkbox"/> 4 - STOP WORK per attached written instructions <input type="checkbox"/> 5 - Review Not Required: Work may proceed <small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small>	Supplier	Exchanger Industries		
	Doc. Description	EXCHANGER - PATELS - MATERIAL IDENTIFICATION REPORT - PEX 71413 - NON PRESSURE - 13-3353		
	Vendor Document No.	13-3353 NON PRESSURE MTR		
	Client Document No.	VP088996-M017-00017		
	Purchase Order No.	Doc Cat.	Issue	
	CE416040-CC088996-00	M017	0	
BY : _____	Categories			
DATE : _____	Date Received	04/16/2014		



PATELS AIRTEMP (INDIA) LTD.

MATERIAL IDENTIFICATION REPORT

SO NO. : PEX 71413	DATE :
PO NO. : 98998	DATE : 8/7/2013
CLIENT : EXCHANGER INDUSTRIES (CANADA)	INSP. AUTH : AI
JOB DETAILS : SALES OIL TANK HEATER	DRG. NO. : 13-3353 A/B REV-03
CODE : ASME SEC VIII DIV 1 ED 2010+Add 2011a	MFR. SR. NO. : EXE 1352 & EXE 1353
ITEM NO : 104-E-135/136	EI JOB NO : 13-3353 A/B

PN	DETAILS	SIZE	QTY.	MATERIAL AS PER DRG.	MATERIALS USED	HEAT NO.	T.C. DETAILS
306	PARTITION	10T X 149 X	2	SA 516 GR 70	SA 516 GR 70	H-7373	AZOVSTAL IRON &
	PLATE	381				P-5928/14	STEEL WORKS
							T.C NO : 09-17484
							DT : 13/07/2012
307	PARTITION	10T X 212 X	2	SA 516 GR 70	SA 516 GR 70	H-7373	..... DO
	PLATE	381				P-5928/14	
309	PARTITION	10T X 295 X	2	SA 516 GR 70	SA 516 GR 70	H-7373	..... DO
	PLATE	553				P-5928/14	
201	WRAPER	10T X 152 W	4	SA 516 GR 70	SA 516 GR 70	H-7373	..... DO
	PLATE	660 LG				P-5928/14	
202	BASE PLATE	10T X 102 W	2	SA 516 GR 70	SA 516 GR 70	H-7373	..... DO
	FIXED SUPP.	400 LG				P-5928/14	
203	BASE PLATE	10T X 102 W	2	SA 516 GR 70	SA 516 GR 70	H-7373	..... DO
	SLIDING SUP	400 LG				P-5928/14	
205	RIB PLATE	10T X 88 X	4	SA 516 GR 70	SA 516 GR 70	H-7373	..... DO
		186 LG				P-5928/14	

RECEIVED
 APR 16 2014
 JACOBS CANADA INC.
 DOCUMENT CONTROL

A Patel
 15/09/2013
 PLANNING ENGINEER & DATE

Shub
 15/09/13
 QCE & DATE

INSP. AUTH. & DATE



PATELS AIRTEMP (INDIA) LTD.

MATERIAL IDENTIFICATION REPORT

SO NO. : PEX 71413	DATE :
PO NO. : 98998	DATE : 8/7/2013
CLIENT : EXCHANGER INDUSTRIES (CANADA)	INSP. AUTH : AI
JOB DETAILS : SALES OIL TANK HEATER	DRG. NO. : 13-3353 A/B REV-02
CODE : ASME SEC VIII DIV 1 ED 2010+Add 2011a	MFR. SR. NO. : EXE 1352 & EXE 1353
ITEM NO : 104-E-135/136	EI JOB NO : 13-3353 A/B

PN	DETAILS	SIZE	QTY.	MATERIAL AS PER DRG.	MATERIALS USED	HEAT NO.	T.C. DETAILS
602	EI NAME	6T X 165W X	2	SA 516 GR 70	SA 516 GR 70	H-11K12681	ALCHEVSK IRON &
	PLATE BKT.	165 LG				P-1323	STEEL WORKS
							T.C NO : 67940
							DT : 29/06/2011
601	EI NAME	6T X 25 W	4	SA 516 GR 70	SA 516 GR 70	H-11K12681	..... DO
	PLATE BKT.	90 LG				P-1323	
310	LIFTINGLUG	14T X 76 X 156	4	SA 516 GR 70	SA 516 GR 70	H-6739	AZOVSTAL & IRON
				AS PER DRG.		P-5449/10	STEEL WORKS
							T.C NO : 09-15290
							DT : 15/06/2012
204	SUPPORT	14T X 457 X	4	SA 516 GR 70	SA 516 GR 70	H-6739	..... DO
	PLATE	816 LG		AS PER DRG.		P-5449/10	

 15/09/2013 PLANNING ENGINEER & DATE	 15/09/13 QCE & DATE	_____ INSP. AUTH. & DATE
--	----------------------------	-----------------------------

УКРАИНА
UKRAINE



ПАО "АЛЧЕВСКИЙ МЕТАЛЛУРГИЧЕСКИЙ КОМБИНАТ"
PJSC "ALCHEVSK IRON & STEEL WORKS"

14252 г. Алчевск, ул. Шмидта, 4
Tel.: (06442) 7-34-25 7-33-20 7-33-82
Факс: (06442) 7-33-76

14252 г. Алчевск, ул. Шмидта, 4
Tel.: (06442) 7-34-25 7-33-20 7-33-82
Факс: (06442) 7-33-76

ЛАБОРАТОРНЫЙ СЕРТИФИКАТ КАЧЕСТВА № 67940
MILL'S QUALITY CERTIFICATE № 67940

Дата 29.06.2011
Date 29.06.2011

Свидетельство о приемочных испытаниях
Inspection certificate EN 10204/3.2

№ заказа № 2006-207/1шт-026/0109-Су-997
№ производственного заказа № 4170

Заказчик: Корпорация "Индустриальный Союз Донбасса"
"DM Sons Metals Pvt. Ltd. Mumbai"

Customer: Corporation "Industrial Union of Donbass" "DM Sons Metals Pvt. Ltd. Mumbai"

Вариант № 60623030
LOT 1

Наименование товара: Горячекатаные стальные листы
Description of goods: HOT-ROLLED STEEL PLATES

Марка стали: SAs16-7D MT LTV
Standard: ASME SA516/SA516M-07
ASTM A20/A20M-09
positive tolerance according to thickness

Состояние поставки: нормализованный сплав, удельное время нагрева
Delivery condition: normalized 690°-950°C fully killed "specific time heating 1.5-2.5 min/mm"

№ позиции Item	Номера литейков Cast No	Номера листов Test No	Размеры, мм Dimensions, mm			Количество товара, шт/мест Quantity, pcs	Теоретический вес, тн Theoretical weight, tn
			Толщина Thickness	Ширина Width	Длина Length		
2	11K23061	1237, 1238	8	2500	12000	2	3,768
1	11K12680	1399, 1400, 1401, 1402	6	2500	10000	4	4,712
1	11K12681	1321, 1322, 1323, 1324, 1325, 1326, 1327, 1328, 1329, 1330, 1332, 1333, 1334, 1335, 1336, 1337, 1338, 1339, 1340, 1341, 1342, 1343, 1344, 1345, 1346, 1347, 1348, 1349, 1350, 1351, 1352, 1353, 1354, 1355, 1356, 1357, 1358, 1360, 1361, 1362, 1363, 1364, 1365, 1366, 1367, 1368	6	2500	10000	46	54,188
Total quantity (pcs)			Total theoretical weight (tn)			62,668	

Handwritten signature and date: 29/06/11

WITNESSED
07.07.2011
SURVEYOR TO
ENGINEERING
BUREAU FRANK
INTERNATIONAL
BRIBANOV

Выплавка конвертерным способом производства
Steelmaking process: basic oxygen steel making

Марка стали Steel grade	Химический состав, % Chemical composition %						
	C	Mn	Si	S	P	Cr	Ni
11K12680	21	114	32	13	11	3.7	2.5
11K12680	21	113	32	13	10	3.7	2.5
11K12681	21	117	38	15	11	4.4	2.8
11K12681	21	116	36	13	11	4.2	2.8
11K23061	21	113	34	12	17	2.6	2.9
11K23061	22	112	34	14	18	2.7	2.9

Описание испытаний: Сп. 11K23061, 11K12681 - product analysis
РЕЗУЛЬТАТЫ ИСПЫТАНИЙ TEST RESULTS

№ листа Sheet No	Размеры, мм Dimensions, mm		Способ обработки Treatment			Температура Temp	Усп. проб Yield point	Предел прочности Tensile strength	Относ. удлинение Elongation	Средн. значение Average	100g Energy Absorption	Значения Values	Вид Type			
	Толщина Thickness	Ширина Width	Акс. Long	Норм. Norm	Плоск. Flat											
1237	8	38	T			+20					4	68	73	62	67	set
	8	40	T			+20	374	534	27.0							
1238	7.5	10	L			+20					4	58	53	52	55	set
	7.5	10	L			+20	370	532	25.0							
1399	6	38	T			+20					4	72	62	69	66	set
	6	40	T			+20	368	525	27.0							
1400	6	38	T			+20					4	71	68	72	70	set
	6	40	T			+20	373	529	26.0							
1401	6	38	T			+20					4	75	72	63	70	set
	6	40	T			+20	369	531	25.0							

Маркировка: SAs16-7D MT LTV, размеры, мм, марка, № листа, DM Sons Metals Pvt. Ltd. Mumbai, India, S2550, 06.06.2011
Marking: SAs16-7D MT LTV, dimensions, mm, grade, No. sheet, DM Sons Metals Pvt. Ltd. Mumbai, India, S2550, 06.06.2011

Клеймо: № листа, марка стали, MT LTV, тов. проб, марка, К. штамп, ©, заводской идентификационный номер (ИД)
Stamp: No. sheet, grade of steel, MT LTV, mark of the works, K stamp, ©, Plant identification number (ID)

Цифровая маркировка: 06.06.2011, 06.06.2011
Digital marking: 06.06.2011, 06.06.2011

Handwritten signature and stamp of the Inspection Company.



Handwritten signature and date: 07.07.2011



ПАО «МК «АЗОВСТАЛЬ»
PJSC «AZOVSTAL IRON & STEEL WORKS»

СЕРТИФИКАТ КАЧЕСТВА № 09-15290
QUALITY CERTIFICATE No 09-15290

OT 15.06.2012
Date 15.06.2012
Лист 2 из 2
Sheet of 2
Листов 2
Steels

1, пр. Дзержинська, с.Азарівка, 81502, УКРАЇНА, факс: +380 (0)93 52-73-00

1, Liberty st, Morigor, 81502, UKRAINE, fax: 090 (0)93 52-73-00

Протокол приемочных испытаний
Inspection report EN 10204-3.2

Контракт № 102061/61-Св.1829
Contract No 102061/61-Св.1829
Заказной лист № 400712-0830
Manufacturer's production order No 400712-0830

Reference No
Заказчик "M/S D.M. Son's Metal"
Customer "M/S D.M. Son's Metal"

Вид № RW - Car No
Количество товара, шт.
Quantity of goods, pcs 12

Наименование товара
Description of goods
Прокат листовой Heavy plates
Марка стали ASME SA516-70 HT
Grade of Steel LTV
Нормативный документ ASME SA516/SA516M-2011a
ASME SA20/SA20M-2011a
EN 10029-2010 class B
DIN EN 10163-2-2005 class A-3
ASME SA578/SA578M-10 level B
ASTM E290-2009
as per customer's specification

Технология
Steelmaking process
Компьютерный способ прокатки Made by the CGR Process

Состояние поставки
Delivery condition
Нормализован Normalized 920 °C 1.2 min/min

Маркировка
Marking
ASME SA516-70 HT LTV, WEIGHT, 1, DIMENSIONS, mm, CAST NO, TEST NO, PLATE NO, AZOVSTAL, MADE IN UKRAINE, D.M. SON'S METAL

Цветная маркировка
Color marking
THREE GREEN STRIPES

Позиция Item No	Плиты № Cast No	Партия №/ Идентификационный № Test No/ Product No	Размеры, мм Dimensions, mm			Кол-во листов Quantity, pcs	Масса, т(кг) Mass, t	
			Толщина Thickness	Ширина Width	Длина Length		Нetto листа Netto plate	Нetto листов Netto plates
4	6739	5449/ 3,5,7,8,9,10, 11,12,13,14	14	2500	12000	10	3,287	32,970
4						10		32,970

03.12.13

Signature



№ п/п No	Идентификационный № Листа Plate No	Толщина Thickness mm	Ширина Width mm	Результат Испытания Test Result	Температура Температура °C	0.2% Угол отклонения 0.2% Yield Point Elongation %	Предел прочности Tensile strength MPa	Предел текучести Yield strength MPa	Энергия удара Impact energy J	Энергия удара Impact energy J	Энергия удара Impact energy J	Энергия удара Impact energy J	Энергия удара Impact energy J	Энергия удара Impact energy J	Энергия удара Impact energy J	Энергия удара Impact energy J	Энергия удара Impact energy J	Энергия удара Impact energy J	Энергия удара Impact energy J	Результаты испытаний Test results		
																				mm	mm	mm
1	5449/1,12	14	2500	T	-20	415	245	40													EM	
2	5449/11,12	10	10	L	-40				142	163	149	101										
3	5449/11,12	14	35	T	+20																	
4	5449/13,14	14	12,5	T	+20	431	250	30														
5	5449/13,14	10	10	L	-40				143	140	143	142										EM
6	5449/13,14	14	35	T	+20																	
7	5449/3	14	12,5	T	+20	426	240	40														
8	5449/3	14	35	T	+20				150	150	145	150										EM
9	5449/3	14	35	T	+20																	
10	5449/5	14	12,5	T	+20	407	200	30														
11	5449/5	10	10	L	-40				155	140	145	147										EM
12	5449/5	14	35	T	+20																	
13	5449/7,8	14	12,5	T	+20	403	240	30														
14	5449/7,8	10	10	L	-40				143	150	140	154										EM
15	5449/7,8	14	35	T	+20																	
16	5449/10	14	12,5	T	+20	445	240	30														
17	5449/10	10	10	L	-40				155	153	140	140										EM
18	5449/10	14	35	T	+20																	

Плиты № Cast No	Химический состав, % Chemical composition, %															
	C	Mn	Si	S	P	Cr	Mo	Cu	Ni	Al	As					
1 6739	17	112	29	4	14	4	20	3	30	<5	<0.5	16	<5	7	<5	30

We hereby confirm that the products specified in this quality certificate have been tested and comply with contract requirements. Подтверждаем, что продукция, указанная в настоящем сертификате качества, испытана и соответствует условиям контракта.

Масса Total 12 39.564



ПАО «МН «АЗОВСТАЛЬ»
PJSC «AZOVSTEEL IRON & STEEL WORKS»

СЕРТИФИКАТ КАЧЕСТВА № 19-17484
QUALITY CERTIFICATE No

От Date 13.07.2012 Лист Sheet 3 из of 4 Листов Sheets

1 пр. Перевозчик в Мариуполь: 87-900 УСРАИНА Факс: 380 (629) 52-70-00

1, Leroyvuln, Mariupol 47509, UKRAINE. fax: 380 (629) 52 70 00

Протокол приемочных испытаний
Inspection report EN 10204-3.2

Контракт № 10008101-Cn.1029
Contract No LOT 1

Заказной лист № 400712-0830
Manufacturer's production order No

Заказчик "M/s D.H. Son's Metal"
Customer

Взвешивание 67859884
RW - Car No

Количество товара, шт
Quantity of goods, pcs 27

Наименование товара
Description of goods

Прокат талстолистовой
Heavy plates

Марка стали ASME SA516-70 MT
Grade of Steel LTV

Нормативный документ
Normative document

ASME SA516/SA516M-2011a
ASME SA20/SA20M-2011a
EN 10029:2010 class N
DIN EN 10163-3:2005 class A-3
ASME SAS 78/SA578M-10 level B
ASTM E290-2009
as per customer's specification

Установка Steelmaking process

Компьютерный способ прокатки
Made by the Web-Process

Состояние поставки Normalized
Delivery condition

930 x 1.2 mm/mm

Маркировка ASME SA516-70 MT LTV, WEIGHT, T, DIMENSIONS, mm, CAST No, TEST No, PLATE No,
Marking AZOVSTEEL, MADE IN UKRAINE, D.H. SON'S METAL.

Цветная маркировка THREE GREEN STRIPES.
Color marking

Позиция Item No	Плавка № Cast No	Партия № Издание № Test No/ Product No	Размеры, мм Dimensions, mm			Количество, шт Quantity, pcs	Масса, т(м) Mass, t	
			Толщина Thickness	Ширина Width	Длина Length		Нетто листа Netto plate	Нетто листов Netto plates
2	7373	5928/ 11,12,13,14, 15,16,17,18	10	2500	12000	8	2.355	18.840
2						8		18.840
5	6739	5444/ 13	16	2500	12000	1	3.768	3.768
5						1		3.768

Результаты испытаний
Test results

№ п/п № партии Плавка № Cast No Test No/ Product No	Толщина Thickness mm	Ширина Width mm	Маркировка Grade	Температура Температура Temp. (°C)	Сила Strength N/mm²	Растяжение Elongation	Удлинение в 0.2% Elongation 0.2% (A _{0.2})	Скорость деформации Strain rate	Ударная вязкость Charpy impact energy J	Ударная вязкость Charpy impact energy J	Ударная вязкость Charpy impact energy J	Ударная вязкость Charpy impact energy J	Ударная вязкость Charpy impact energy J	Ударная вязкость Charpy impact energy J	
															mm
1	5928/11,12	10	12.5	T	+20	403	555	25							sat
1	5928/11,12	10	10	L	-46				126	124	137	130			
3	5928/13,14	10	38	T	+20										sat
4	5928/13,14	10	12.5	T	+20	409	545	39							sat
5	5928/13,14	16	16	L	-46				126	141	140	136			
6	5928/13,14	10	38	T	+20										sat
7	5928/13,14	10	12.5	T	+20	402	535	41							sat
8	5928/15,16	10	10	L	-46				142	137	139	137			
9	5928/15,16	10	38	T	+20										sat
10	5028/17,18	10	12.5	T	+20	409	545	39							sat
11	5425/17,18	10	10	L	-46				134	136	140	140			
12	5928/17,18	10	38	T	+20										sat
13	5444/13	16	12.5	T	+20	285	525	39							sat
14	5444/13	10	10	L	-46				115	125	126	123			
15	5444/13	16	38	T	+20										sat

Химический состав, %
Chemical composition, %

Плавка № Cast No	C	Mn	Si	S	P	Cr	Ni	Cu	Al	Ti	Mg	Nb	V	N	As	Se
1 7373	19	107	26	2	9	4	21	3	43	<5	<0.5	12	<5	6	<5	39
2 6739	17	112	29	4	14	4	20	3	30	<5	<0.5	15	<5	7	<5	38

03/12/13

Signature

Signature: _____
 Специальный штамп
 Специальный штамп
 Специальный штамп
 Специальный штамп

Контроль инспектор
 Контроль инспектор
 Контроль инспектор
 Контроль инспектор

Масштаб
 Масштаб

We hereby confirm that the products specified in this quality certificate have been tested and comply with contract requirements. Подтверждаем, что продукция, указанная в настоящем сертификате качества, испытана и соответствует условиям контракта

This Section is Not Applicable to this ITEM number.

NOTES:-

- 1) 100% MT LIFTING LUG WELDS
- 2) MDMT FOR LIFTING LUGS & SUPPORTS TO BE -45°C (-49°F)
- 3) NO WELDING AFTER HYDRO TEST
- 4) MPI OR LPI ARE STRICKES TEMPORARY ATTACHMENTS
- 5) IMPACT TESTING EXEMPT PER UG-20(f)(1-5).

NOTES- 1) ALL DIMENSIONS ARE IN MM. UNLESS OTHERWISE SPECIFIED.
2) REF. DRG. NO. - 13-2353A/B DATED:- 17 JULY 2013

RADIOGRAPHY- RTI CHANNEL & RTI SHELL
MDMT-29°C, PWHT- NA

WELDING PLAN

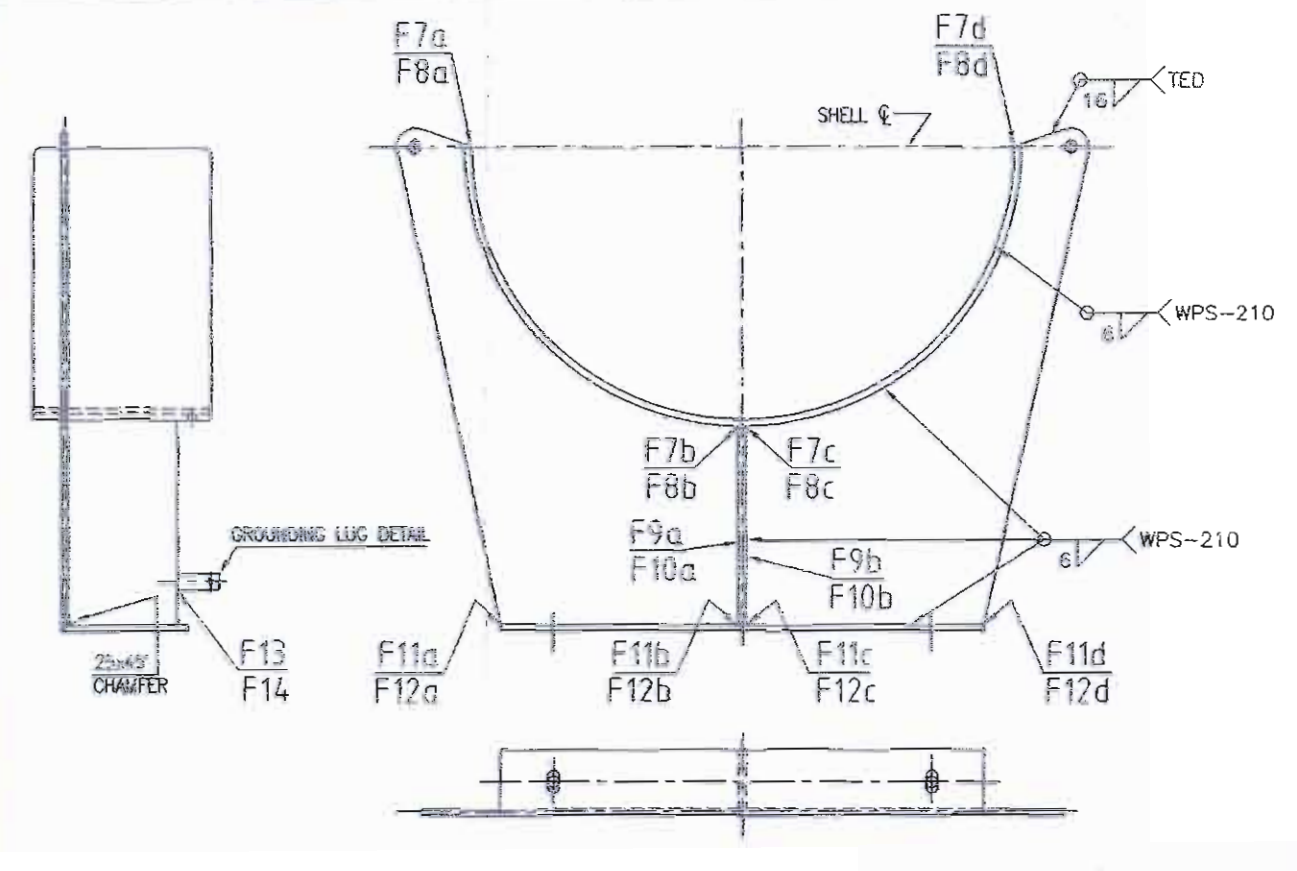
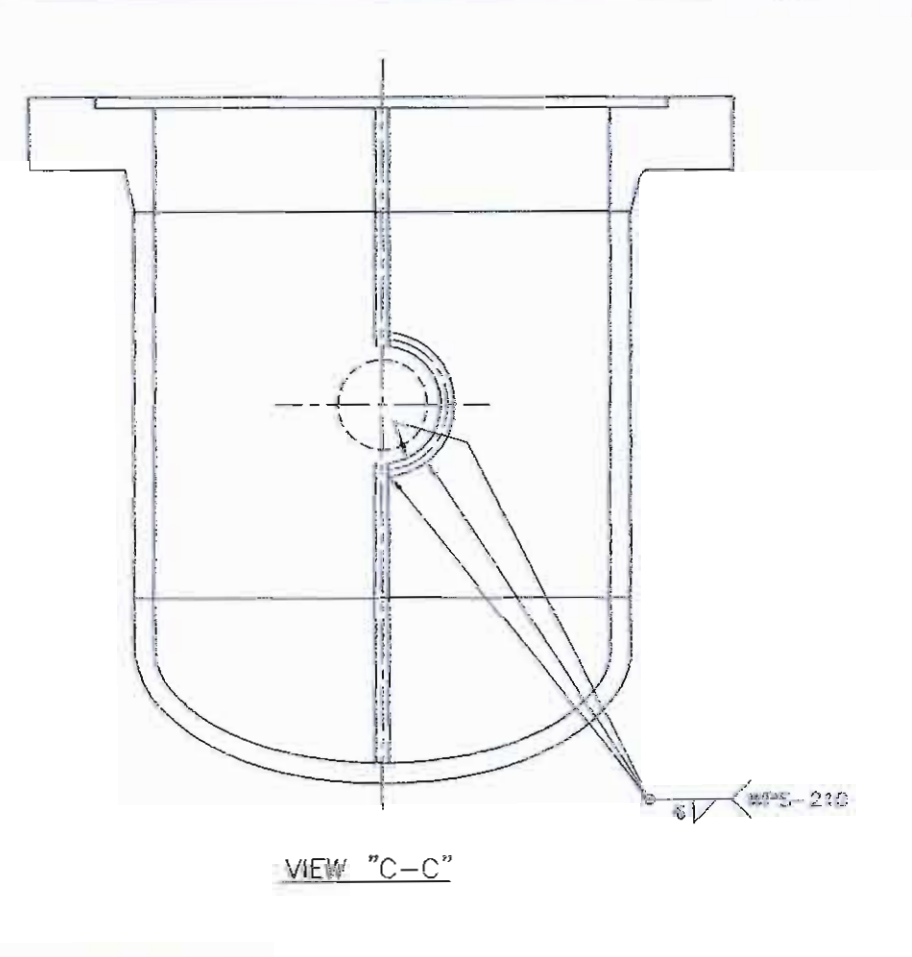
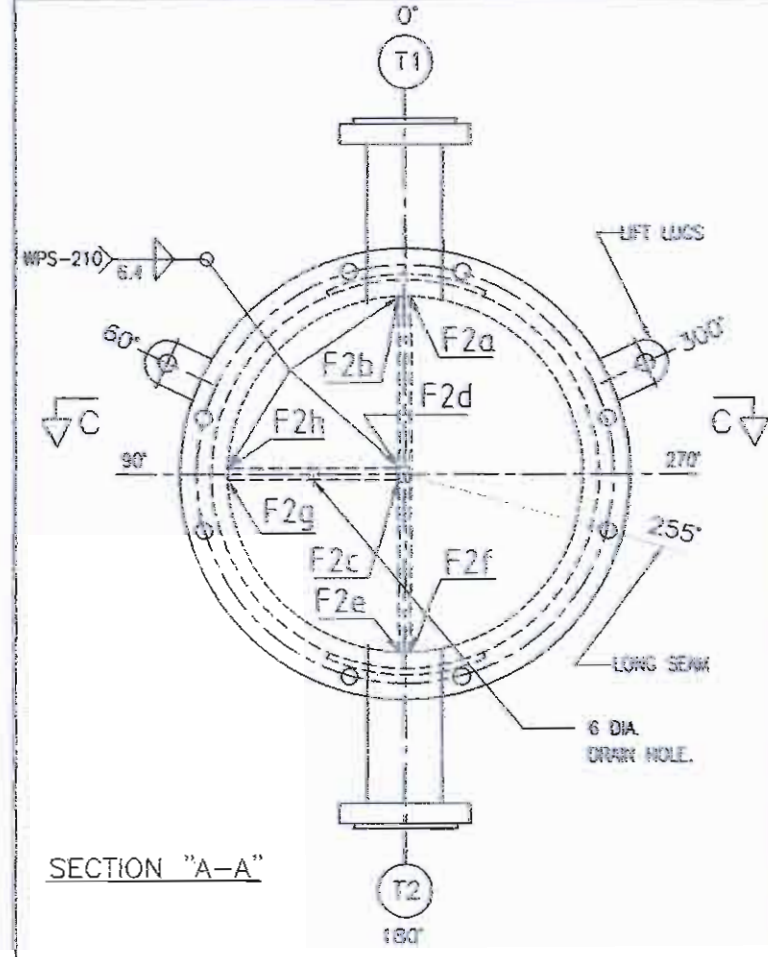
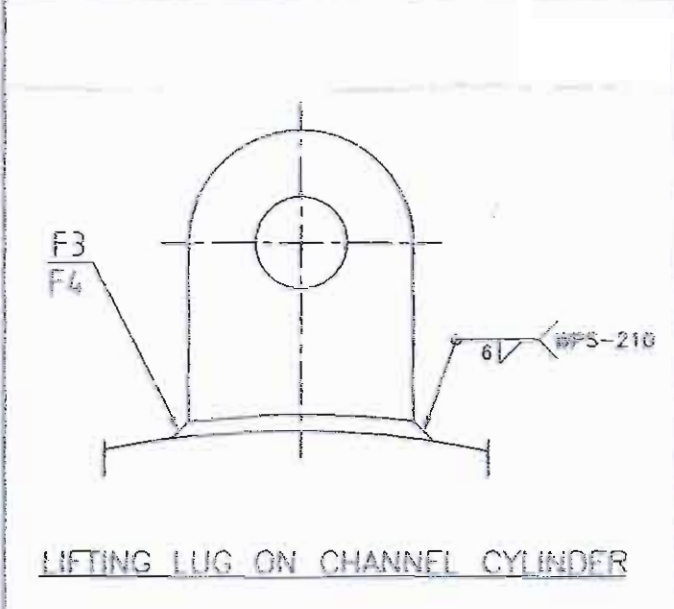
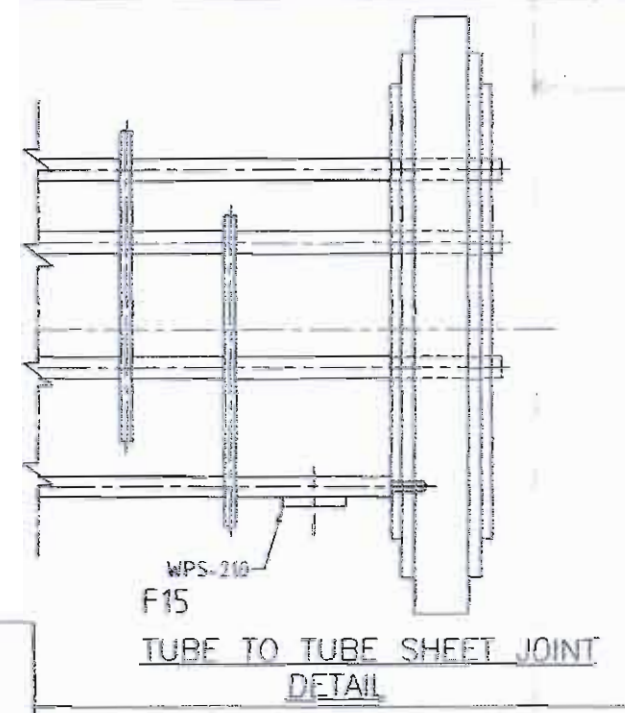
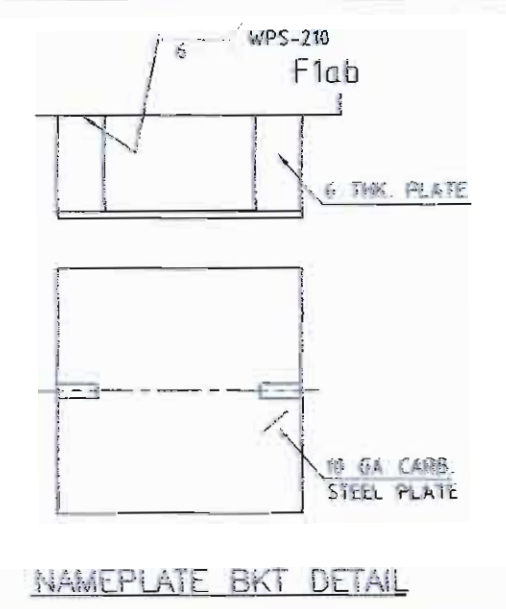
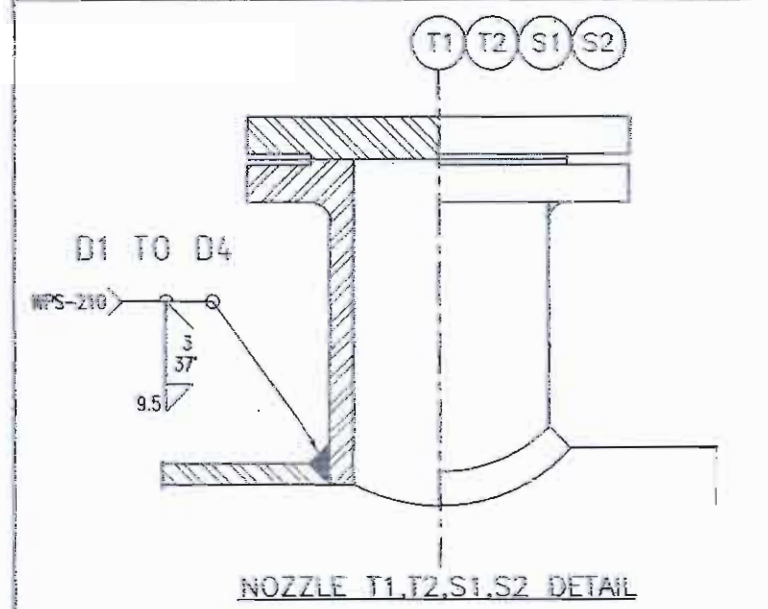
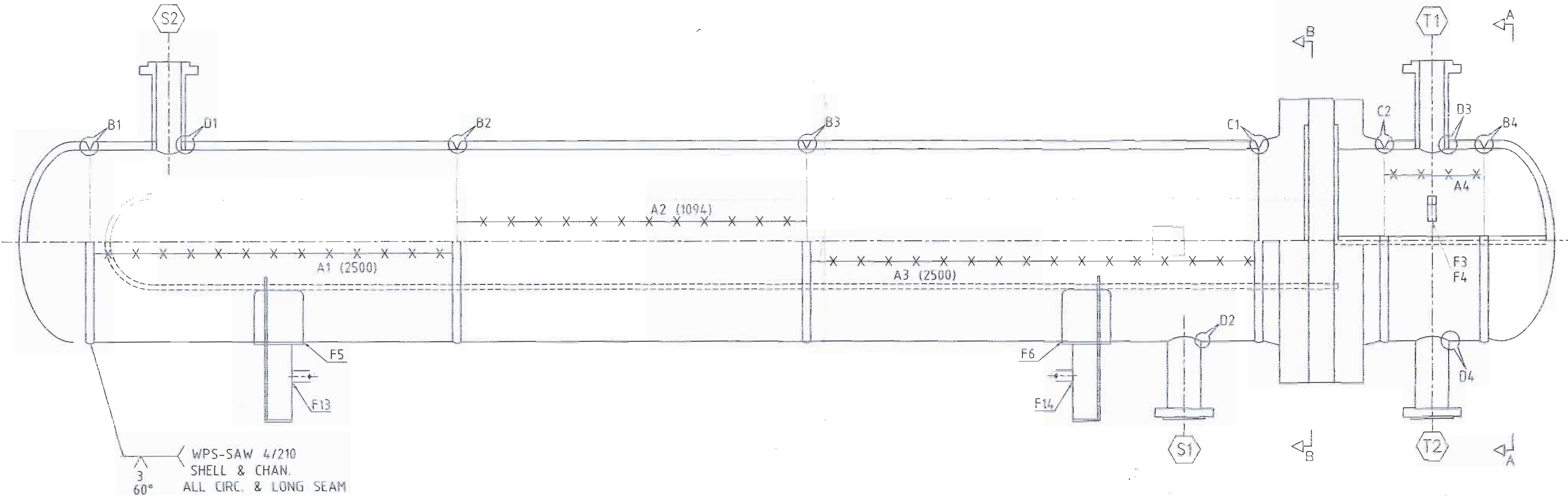
DETAILS OF JOINT	CAT OF JOINT	JOINT NO.	TYPE OF JOINT	WELD DETAIL	MATERIAL	THK (MM)	WELDING PROCESS	PWHT	CONSUMABLE	SHIELDING GAS	WPS NO.	PQR NO.	RT	UT	PT	MT	PRODUCTION C.P.	WELDERS STAMP NO. EXE-1352	WELDERS STAMP NO. EXH-1353
MAIN SHELL LONG SEAM	A	A1,A2,A3	1	AS PER DRG	SA 516 GR 70 (N) SA 516 GR 70 (N)	14	GTAW SMAW SAW	NA	ER 70S.2 E 7018 EH14/F7A4	ARGON	210 R.0 SAW4 R.1	210/1 SAW4/1	RT1	-	-	-	-	W-37 W-105 OP-1	W-37 W-105 OP-1
MAIN SHELL/DISH CIR SEAM	B	B1	1	AS PER DRG	SA 516 GR 70 (N) SA 516 GR 70 (N)	14	GTAW SMAW SAW	NA	ER 70S.2 E 7018 EH14/F7A4	ARGON	210 R.0 SAW4 R.1	210/1 SAW4/1	RT1	-	-	-	-	W-37 W-105 OP-1	W-37 W-105 OP-1
MAIN SHELL /MAIN SHELL CIR SEAM	B	B2,B3	1	AS PER DRG	SA 516 GR 70 (N) SA 516 GR 70 (N)	14	GTAW SMAW SAW	NA	ER 70S.2 E 7018 EH14/F7A4	ARGON	210 R.0 SAW4 R.1	210/1 SAW4/1	RT1	-	-	-	-	W-37 W-105 OP-1	W-37 W-105 OP-1
MAIN SHELL TO FLANGE CIR SEAM	C	C1	1	AS PER DRG	SA 516 GR 70 (N) SA 105 (N)	14	GTAW SMAW SAW	NA	ER 70S.2 E 7018 EH14/F7A4	ARGON	210 R.0 SAW4 R.1	210/1 SAW4/1	RT1	-	-	-	-	W-37 W-105 OP-1	W-37 W-105 OP-1
CHANNEL SHELL LONG SEAM	A	A4	1	AS PER DRG	SA 516 GR 70 (N) SA 516 GR 70 (N)	14	GTAW SMAW SAW	NA	ER 70S.2 E 7018 EH14/F7A4	ARGON	210 R.0 SAW4 R.1	210/1 SAW4/1	RT1	-	-	-	-	W-37 W-105 OP-1	W-37 W-105 OP-1
CHANNEL SHELL/FLANGE CIR SEAM	C	C2	1	AS PER DRG	SA 516 GR 70 (N) SA 105 (N)	14	GTAW SMAW SAW	NA	ER 70S.2 E 7018 EH14/F7A4	ARGON	210 R.0 SAW4 R.1	210/1 SAW4/1	RT1	-	-	-	-	W-37 W-105 OP-1	W-37 W-105 OP-1
CHANNEL SHELL /DISH CIR SEAM	B	B4	1	AS PER DRG	SA 516 GR 70 (N) SA 516 GR 70 (N)	14	GTAW SMAW SAW	NA	ER 70S.2 E 7018 EH14/F7A4	ARGON	210 R.0 SAW4 R.1	210/1 SAW4/1	RT1	-	-	-	-	W-37 W-105 OP-1	W-37 W-105 OP-1
NOZZLE S1,S2 (4") ON MAIN SHELL & T1,T2 ON CH SHELL WITHOUT R.PAD WELDING	D	D1,D2,D3,D4	7	AS PER DRG	SA 516 GR 70 (N) SA 105 (N)	14/22.2	GTAW SMAW	NA	ER 70S.2 E 7018 E 7018-1	-	210 R.0	210/1	-	-	-	-	-	W-37 W-105	W-37 W-105
NAME PLATE BRACKET ON MAIN SHELL WELDING	-	F1ab	-	AS PER DRG	SA 516 GR 70 (N) SA 516 GR 70 (N) SA 516 GR 70 (N)	14/6	SMAW	NA	E 7018-1	-	210R.0	210/1	-	-	-	-	-	W-105	W-105
PASS PARTITION ON PLATE ON CH SHELL WITH PIPE WELDING	-	F2a TO h	-	AS PER DRG	SA 516 GR 70 (N) SA 105 CR E	14/10	SMAW	NA	E 7018-1	-	210R.0	210/1	-	-	-	-	-	W-105	W-105
LIFTING LUG ON CH SHELL WELDING	-	F3,F4	-	AS PER DRG	SA 516 GR 70 (N) SA 516 GR 70 (N)	14/10	SMAW	NA	E 7018-1	-	210R.0	210/1	-	-	-	YES	-	W-105	W-105
WRAPPER PLATE TO MAIN SHELL WELDING	-	F5,F6	-	AS PER DRG	SA 516 GR 70 N & T SA 516 GR 70 N & T	14/10	SMAW	NA	E 7018-1	-	210R.0	210/1	-	-	-	-	-	W-105	W-105
WRAPPER PLATE TO SUPPORT PLATE & STIFFNER PLATE WELDING	-	F7a TO d F8 a TO d	-	AS PER DRG	SA 516 GR 70 N & T SA 516 GR 70 N & T	10/14	SMAW	NA	E 7018-1	-	210R.0	210/1	-	-	-	-	-	W-105	W-105
SUPPORT PLATE / STIFFNERS PLATE WELDING	-	F9 ab F10ab	-	AS PER DRG	SA 516 GR 70 N & T SA 516 GR 70 N & T	10/14	SMAW	NA	E 7018-1	-	210R.0	210/1	-	-	-	-	-	W-105	W-105
BASE PLATE TO SUPPORT PLATE STIFFNERS PLATE WELDING	-	F11 a TO d F12 a TO d	-	AS PER DRG	SA 516 GR 70 N & T SA 516 GR 70 N & T	10/14	SMAW	NA	E 7018-1	-	210R.0	210/1	-	-	-	-	-	W-105	W-105
GROUNDING LUG'S TO SUPPORT PLATE WELDING	-	F13,F14	-	AS PER DRG	SA 516 GR 70 N & T IS 2062 GR E 250 BR	10/10	SMAW	NA	E 7018-1	-	210R.0	210/1	-	-	-	-	-	W-105	W-105
IMPINGEMENT PLATE WELDING	-	F15	-	AS PER DRG	IS 2062 GR E 250 BR SA 179	6	SMAW	NA	E 7018-1	-	210R.0	210/1	-	-	-	-	-	W-105	W-105
SEAL TUBE TO BOLT WELDING	-	F16	-	AS PER DRG	IS 2062 GR E 250 BR SA 179	AS PER DRG	SMAW	NA	E 7018-1	-	210R.0	210/1	-	-	-	-	-	W-105	W-105

Reviewed
Sub
AI
04/09/13

SIGN *[Signature]*
DATE *30/08/2013*
WELDING ENGINEER
PAIL

24

ISSUE FOR APPROVAL	26/08/2013	U.B.P.	D.P.P.
REVISION	DATE	REV. BY	CHD. BY
CUSTOMER			
CONSULTANT			
P.O.NO. : 98998	DATED : -		
TITLE : WELD PLAN SALES OIL TANK HEATER	DRAWN <i>[Signature]</i>	CHECKED U.B.P.	26/08/2013
	APPROVED D.P.P.		
ITEM NO. : 104-E-195/136	QTY-1 UNIT	SHEET NO	DRG.NO.
MFR'S SR.NO. : EXE-1352,1353	SCALE-INT'S	1 OF 2	WP/PEX-71412-1
			REV 0



Reviewed
[Signature]
 0410913

SIGN *[Signature]*
 DATE *30/08/2013*
 WELDING ENGINEER
 PAIL

25

0	ISSUE FOR APPROVAL	26/08/2013	U.B.P.	D.P.P.
R.NO.	REVISION	DATE	REV. BY	CHD. BY
CUSTOMER				
CONSULTANT				
CANADIAN NATURAL RESOURCES LTD. FOR: KIRBY NORTH PHASE 1				
PATEL'S AIRTEMP (INDIA) LTD. PLOT NO : 805,806,807,810 RAKANPUR-382 721 TALUKA : KALOL, DIST : GANDHINAGAR, GUJARAT, INDIA.				
P.O.NO. : 98908				
DATED : -				
TITLE : WELD PLAN SALES OIL-TANK HEATER			DRAWN	<i>[Signature]</i> 26/08/2013
			CHECKED	U.B.P.
			APPROVED	D.P.P.
ITEM NO. : 104-E-405/136			QTY:-1 UNIT	SHEET NO
MFR'S DRWG. : EXE-1952,1953			SCALE:-NTS	2 OF 2
			DRG.NO.	REV
			WP/PEX-71413-1	0



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments
101-E-110;101-E-111;101-E-112;101-E-113;101-E-114;101-E-115;101-E-120;101-E-121;101-E-210;101-E-225;101-E-226;101-E-240;101-E-241;101-E-450;101-E-451;102-E-610;102-E-613;102-E-655;103-E-080;103-E-190;103-E-290;103-E-390;103-E-490;103-E-590;103-E-705;106-E-707;104-E-135;104-E-136;107-E-305	JPI REV 2 - VERIFICATION

Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1
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- and*
- 1 - Work May Proceed
 - 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated
 - 3 - Revise and Resubmit: DO NOT Proceed with Manufacture
 - 4 - STOP WORK per attached written instructions
 - 5 - Review Not Required: Work may proceed

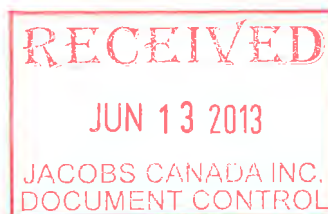
SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.

Supplier	Exchanger Industries
Doc. Description	EXCHANGER - WELD PROCEDURE PQR C17 GMAW- SMAW - SAW
Vendor Document No.	WPS PQR C-17
Client Document No.	VP088996-M600-00001

Purchase Order No.	Doc Cat.	Issue
CE416040-CC088996-00	M600	0A

BY : <u>SYED SHAH</u>	Categories	
DATE : <u>JUNE 27, 2013</u>	Date Received	06/13/2013

Exchanger Industries Limited 5505 - 52 Street SE, Calgary, Alberta, T2C 2W8		Document Description	WPS C17 rev 0
Customer:	Canadian Natural Resources Limited		WPS Revision #: 0
Project:	Kirby North phase 1		Date: June 10, 2013
PO #	CE416040-CC-088996-00		EI Job: 13-3343 to 3355
Client No.		Doc. Cat:	
Item No:			
Client Spec:	00-STD-MW-0032-R4 Welding of pressure equipment		
Notes Specific For The Referenced Jobss			
1	<p>CNRL has indicated that procedure qualification record (PQR) RMD-1A attached to this welding procedure (WPS) C-17 rev 0 is not applicable for welding of low temp service vessels built from "Normalized" material as per ASME VIII, div. 1, UG84(h)(2). -Exchanger Industries has checked and confirmed that the material (HT# 342669-65836) used for PQR RMD-1A is in fact in the "Normalized" condition as shown on the MTR attached to the PQR. Further to this the materials listed in the bill of material (dwg. 13-3343A/B/C/D/E/F) for project 13-3343 are listed as "N" therefore making their thermal condition the same as that used in the PQR and acceptable for -46°C service.</p>		
2			
3			
4			
5			



VP088996- M600-0001



**EXCHANGER
INDUSTRIES
LIMITED**

5505 52nd Street SE, Calgary, Alberta T2C 2W8
Telephone (403) 238-0166 Fax (403) 279-8242 Website: www.exchangerindustries.com

WELDING PROCEDURE SPECIFICATION NO.: C17 (Rev. 0)
WELDING PROCEDURE QUALIFICATION RECORD NO.(S): RMD-1A, RMD-2A,
M6A-7, C5-1, A56AC-1, A56AC-3, A56AC-4

QUALIFIED FOR

Base Metal (Typical): Std. Appl.: P1 to P1
Notch Appl.: P1 Groups 1 & 2 to P1 Groups 1 & 2
(SA 333 Gr. 6, SA 350 Gr. LF2, SA 420 WPL6, SA 516 Gr. 70, etc.)
Process(es): GMAW / SMAW / SAW **Weld Types:** GROOVE & FILLET
Position: GMAW & SMAW: ALL POSITIONS SAW: FLAT & HORIZONTAL
Diameter: ALL DIAMETERS
Filler Metal: Std. Appl.: GMAW: ER70S-6 SMAW: E7018, E7018-1 SAW: F7AX-EM14K
Notch Appl.: GMAW: ER70S-6 SMAW: E7018-1 SAW: F7A6/8-EM14K

BASE METAL CONDITIONS & GROOVE THICKNESS RANGE QUALIFIED:

STANDARD APPLICATIONS AS WELDED

NOTCH TOUGHNESS APPLICATIONS TO -46°C (-50°F) AS WELDED

BASE METAL THICKNESS RANGE - ASME Section IX

Thinner Material: 4.8 to 50.8 mm (0.188 to 2.00 in.) inclusive

Thicker Material: 4.8 to 203 mm (0.188 to 8.00 in.) inclusive

COMBINED DEPOSITED WELD METAL THICKNESS

ASME B31.1 & ASME SECT. I 19.1 mm (0.750 in.) maximum

ASME B31.3 19.1 mm (0.750 in.) maximum

ASME SECT. VIII, DIV.1 38.1 mm (1.50 in.) maximum

ABSA

**SAFETY CODES ACT - PROVINCE OF ALBERTA
WELDING PROCEDURE**

Reg. No. WP 317.2

Spec. No. C17

Weld Process GMAW / SMAW / SAW

Mat. Gr. P No. Gr. 1+2 to P No. Gr. 1+2

Elec. Gr. F No. 6+4+6 A No. 1

Th. Qual. For 203 mm (THICK) P.W.M.T. NO

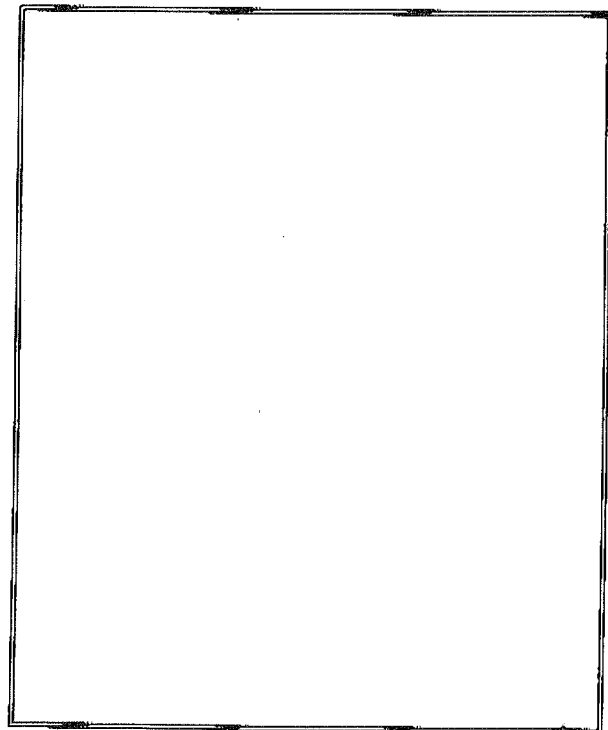
50.8 mm (THINNER)

MIN TH. QUAL. 4.8 mm C.V.N. -46°C

vr. 12, Mo. 8, Day 10, Signed [Signature]

**R. ROSEBERG, P. ENG.
WELDING SPECIALIST**

PROVINCIAL REGISTRATION



QW-482 WELDING PROCEDURE SPECIFICATION (WPS)

Exchanger Industries Limited

Welding Procedure Specification No. C17 (Rev. 0) Date August 1, 2012
 Supporting PQR No. (s) RMD-1A, RMD-2A, M6A-7, C5-1, A56AC-1, A56AC-3, A56AC-4
 Welding Process(es) GMAW / SMAW / SAW Type(s) Semi-auto. / Manual / Machine

JOINTS (QW-402)

Joint Design All ASME groove & fillet, reference construction drawing for joint details, where joint details are not specified, refer to figures 1 to 15 attached.
 Root Opening As per attached typical groove designs, see figures 1 to 15 attached.
 Backing With or without Retainers Not required

BASE METALS (QW-403)

P-Number Std. Appl.: P1 To P-Number P1
 P-Number Notch Appl.: P1 Groups 1 & 2 To P-Number P1 Groups 1 & 2
 Thickness Range: Groove See cover page for thickness qualified by governing code
 Fillet All base metal thicknesses
 Base Metal See cover page
 Pipe Diameter Ranges: Groove All diameters Fillet All diameters
 Deposited Weld Metal (Per pass) GMAW: 3.51 mm (0.138 in.) maximum
 SMAW & SAW: 12.7 mm (0.500 in.) maximum

FILLER METALS (QW-404)

	GMAW	SMAW	SAW
Specification No. (SFA)	SFA 5.18	SFA 5.1	SFA 5.17
AWS No. (Class)	ER70S-6	E7018, E7018-1	EM14K
	Notch Appl.: ER70S-6	E7018-1	EM14K
F-No.	F6	F4	F6
A-No.	A1,*	A1	A1
Size	See Table #1	See Table #1	See Table #1
Filler Metal Product Form	Solid wire	N/A	Solid wire
Supplementary Fillers	Without	N/A	Without
Electrode - Flux Classification	N/A	N/A	Std. Appl.: F7AX-EM14K Notch Appl.: F7A6/8-EM14K
Flux Type	N/A	N/A	Neutral
Recrushed slag	<u>Must be tested and meet ASME Section II, Part C SFA 5.17 requirements</u>		
Deposited Weld Metal Thickness Range:			
Groove	3.51 mm max.**	38.1 mm max.**	38.1 mm max.**
Groove	(0.138 in.) max.**	(1.50 in.) max.**	(1.50 in.) max.**
Fillet	---	All fillet sizes	All fillet sizes
Other	<u>* ER70S-6 shall meet the chemical composition requirements of ASME Sec.II, Part C</u>		
Other	<u>** Combined deposited weld metal thickness shall not exceed 19.1 mm (0.750 in.) for ASME B31.1 & B31.3 and 38.1 mm (1.50 in.) for ASME Section VIII, Div.1</u>		

POSITION (QW-405)

Position of Groove & Fillet GMAW & SMAW: All positions SAW: Flat & Horizontal
 Weld Progression Std. Appl.: GMAW: Vertical up or down SMAW: Vertical up SAW: N/A
 Notch Appl.: GMAW: Vertical down SMAW: Vertical up SAW: N/A

PREHEAT (QW-406)

Preheat Temperature (Minimum) See attached preheat sheet
 Interpass Temperature (Maximum) Std. Appl.: 315°C (600°F) Notch Appl.: 260°C (500°F)
 Preheat Maintenance See attached preheat sheet prior to welding. Preheat maintenance is not required if welding is interrupted or after the completion of welding unless required by the code of construction.

POST WELD HEAT TREATMENT (QW-407)

Temperature Range None Time Range N/A

GAS (QW-408)

Specification No. (SFA) SFA 5.32 AWS No. (Class) SG-AC-25
 Shielding GMAW: 75% Argon, 25% CO₂, 10 - 25 liters per minute (20 - 50 cfph)
 Backing None Trailing Without

ELECTRICAL CHARACTERISTICS (QW-409)

Current GMAW & SMAW: DC SAW: AC
 Polarity GMAW & SMAW: Reverse, electrode positive SAW: N/A
 Amps See Table #1 Volts See Table #1
 Electrode Wire Feed Speed Amperage controlled, see Table #1

Maximum Heat Input For Notch Toughness Applications Only

Base Metal Thickness Range mm (in.)	GMAW kJ/mm (J/in.)	SMAW kJ/mm (J/in.)	SAW kJ/mm (J/in.)
4.8 (0.188) ≤ T < 9.52 (0.375)	0.67 (17,060)	2.21 (56,100)	1.32 (33,600)
9.52 (0.375) ≤ T < 12.7 (0.500)	0.67 (17,060)	2.21 (56,100)	2.20 (56,000)
12.7 (0.500) ≤ T < 15.9 (0.625)	0.78 (19,875)	2.72 (69,000)	2.20 (56,000)
15.9 (0.625) ≤ T ≤ 203 (8.00)	0.78 (19,875)	5.26 (133,714)	5.26 (133,636)

Mode of Metal Transfer GMAW: Short circuiting, waveform controlled (Miller RMD)
 Other Formula for GMAW (short circuiting, waveform controlled):
Heat Input kJ/mm (J/in.) = Power (J/s) x Arc time (s) / Weld Bead Length mm (in.)
Formula for SMAW & SAW:
Heat Input kJ/mm (J/in.) = Amps x Volts x 60 / Travel speed mm/min. (ipm)

TECHNIQUE (QW-410)

String or Weave GMAW & SMAW: Either SAW: String Travel Speed See Table #1
 Orifice or Gas Cup Size GMAW: 9.52 to 19.1 mm (0.375 to 0.750 in.) inclusive
 Initial & Interpass Cleaning Brushing, chipping or grinding as required
 Method of Back Gouging Air carbon arc, back-grind as required
 Oscillation GMAW & SMAW: N/A SAW: Without
 Contact Tube to Work Distance GMAW: 6.35 to 19.1 mm (0.250 to 0.750 in.) inclusive
SAW: 12.7 to 44.5 mm (0.500 to 1.75 in.) inclusive
 Multiple or Single Pass Per Side Std. Appl.: Either Notch Appl.: Multiple
 Multiple or Single Electrodes Single Electrode Spacing N/A
 Peening Not permitted Use of Thermal Processes N/A

TABLE 1 - WELDING PARAMETERS

Standard Applications

Process	Filler Metal	Diameter mm (in.)	Current & Polarity	Amps	Wire Feed Speed (ipm)	Power kJ/sec.	Volts	Travel Speed mm/min (i.p.m.)
*GMAW	ER70S-6	0.8 (0.030)	DCRP	70 - 130	80 - 250	1.0 - 2.5	13 - 21	64 - 254 (2.5 - 10)
*GMAW	ER70S-6	0.9 (0.035)	DCRP	80 - 180	150 - 350	1.2 - 3.5	14 - 22	89 - 381 (3.5 - 15)
*GMAW	ER70S-6	1.2 (0.045)	DCRP	110 - 220	200 - 500	1.4 - 4.0	15 - 23	102 - 625 (4.0 - 25)
SMAW	E7018, E7018-1	2.4 (3/32)	DCRP	60 - 110	---	---	18 - 26	18 - 300 (0.7 - 12)
SMAW	E7018, E7018-1	3.2 (1/8)	DCRP	90 - 150	---	---	19 - 28	28 - 350 (1.1 - 14)
SMAW	E7018, E7018-1	4.0 (5/32)	DCRP	110 - 220	---	---	20 - 28	36 - 400 (1.4 - 16)
SMAW	E7018, E7018-1	5.0 (3/16)	DCRP	160 - 320	---	---	21 - 30	56 - 500 (2.2 - 20)
SMAW	E7018, E7018-1	5.5 (7/32)	DCRP	240 - 350	---	---	22 - 32	86 - 550 (3.4 - 22)
SMAW	E7018, E7018-1	6.4 (1/4)	DCRP	300 - 400	---	---	22 - 32	107 - 550 (4.2 - 22)
SAW	F7AX-EM14K	2.0 (5/64)	AC	200 - 550	20 - 120	---	24 - 34	58 - 750 (2.3 - 30)
SAW	F7AX-EM14K	2.4 (3/32)	AC	250 - 650	30 - 140	---	25 - 36	81 - 812 (3.2 - 32)
SAW	F7AX-EM14K	3.2 (1/8)	AC	300 - 800	40 - 160	---	25 - 38	97 - 890 (3.8 - 35)
SAW	F7AX-EM14K	4.0 (5/32)	AC	350 - 1000	50 - 180	---	26 - 38	122 - 1015 (4.8 - 40)
SAW	F7AX-EM14K	5.0 (3/16)	AC	500 - 1200	60 - 200	---	28 - 38	188 - 1270 (7.4 - 50)

Note: 1) * Short circuiting, Waveform controlled (Miller RMD)
 2) Size of electrode, filler metal, number of passes, voltage, amperage, and travel speed will vary with position, joint thickness, joint type etc.

Notch Toughness Applications

Process	Filler Metal	Diameter mm	Current & Polarity	Amps	Wire Feed Speed (ipm)	Power kJ/sec.	Volts	Travel Speed mm/min (i.p.m.)
*GMAW	ER70S-6	0.8 (0.030)	DCRP	70 - 130	80 - 250	1.0 - 2.5	13 - 21	64 - 254 (2.5 - 10)
*GMAW	ER70S-6	0.9 (0.035)	DCRP	80 - 180	150 - 350	1.2 - 3.5	14 - 22	89 - 381 (3.5 - 15)
*GMAW	ER70S-6	1.2 (0.045)	DCRP	110 - 220	200 - 500	1.4 - 4.0	15 - 23	102 - 625 (4.0 - 25)
SMAW	E7018-1	2.4 (3/32)	DCRP	60 - 110	---	---	18 - 26	18 - 300 (0.7 - 12)
SMAW	E7018-1	3.2 (1/8)	DCRP	90 - 150	---	---	19 - 28	28 - 350 (1.1 - 14)
SMAW	E7018-1	4.0 (5/32)	DCRP	110 - 220	---	---	20 - 28	36 - 400 (1.4 - 16)
SMAW	E7018-1	5.0 (3/16)	DCRP	160 - 320	---	---	21 - 30	56 - 500 (2.2 - 20)
SMAW	E7018-1	5.5 (7/32)	DCRP	240 - 350	---	---	22 - 32	86 - 550 (3.4 - 22)
SMAW	E7018-1	6.4 (1/4)	DCRP	300 - 400	---	---	22 - 32	107 - 550 (4.2 - 22)
SAW	F7A6/8-EM14K	2.0 (5/64)	AC	200 - 550	20 - 120	---	24 - 34	58 - 750 (2.3 - 30)
SAW	F7A6/8-EM14K	2.4 (3/32)	AC	250 - 650	30 - 140	---	25 - 36	81 - 812 (3.2 - 32)
SAW	F7A6/8-EM14K	3.2 (1/8)	AC	300 - 800	40 - 160	---	25 - 38	97 - 890 (3.8 - 35)
SAW	F7A6/8-EM14K	4.0 (5/32)	AC	350 - 1000	50 - 180	---	26 - 38	122 - 1015 (4.8 - 40)
SAW	F7A6/8-EM14K	5.0 (3/16)	AC	500 - 1200	60 - 200	---	28 - 38	188 - 1270 (7.4 - 50)

Note: 1) * Short circuiting, Waveform controlled (Miller RMD)
 2) Welding parameters shall be adjusted to insure that the maximum heat input value specified in QW-409 above is not exceeded.

TYPICAL JOINT DESIGNS

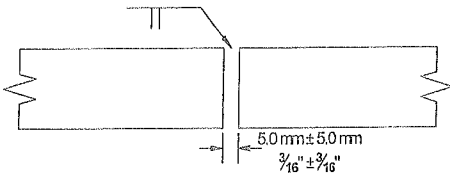


Fig. 1 Single Square Butt

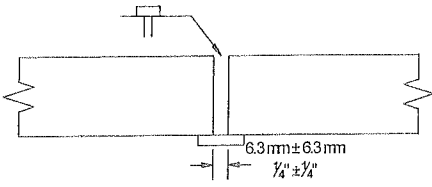


Fig. 2 Single Square Butt with Backing Strip

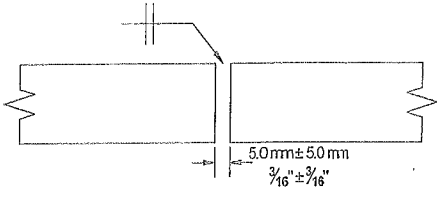


Fig. 3 Double Square Butt

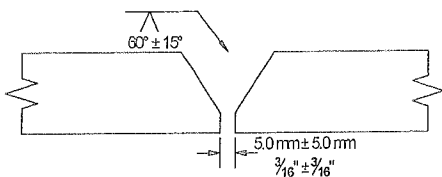


Fig. 4 Single Vee Butt

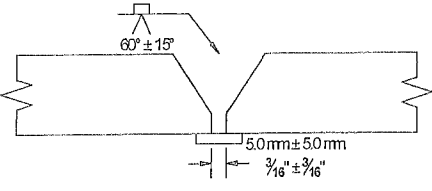


Fig. 5 Single Vee Butt with Backing Strip

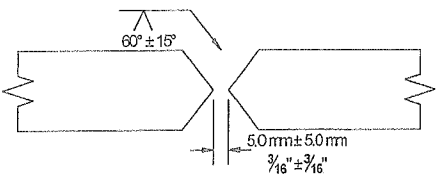


Fig. 6 Double Vee Butt

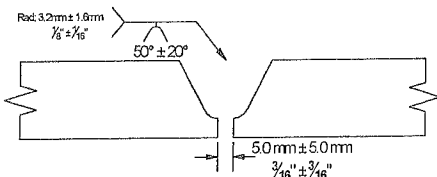


Fig. 7 Single U Butt

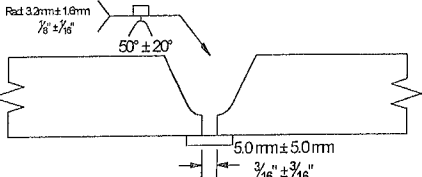


Fig. 8 Single U Butt with Backing Strip

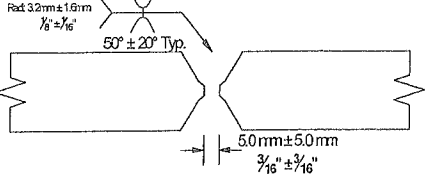


Fig. 9 Double U Butt

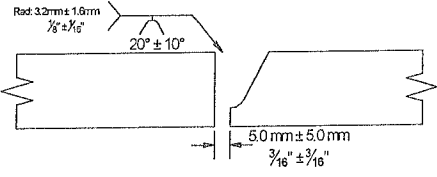


Fig. 10 Single J Butt

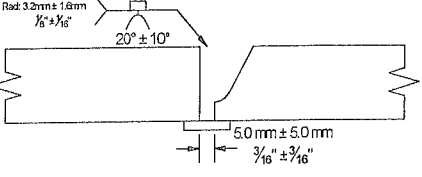


Fig. 11 Single J Butt with Backing Strip

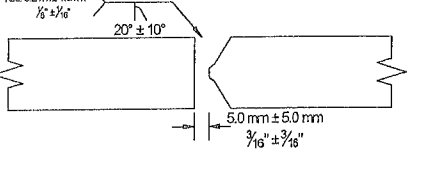


Fig. 12 Double J Butt

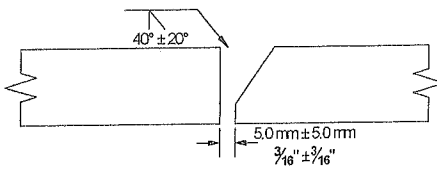


Fig. 13 Single Bevel Butt

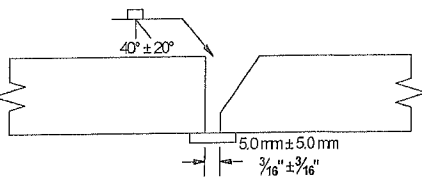


Fig. 14 Single Bevel Butt with Backing Strip

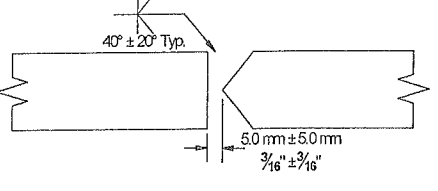


Fig. 15 Double Bevel Butt

Additional joint designs and internal misalignment on circumferential welds shall be within the dimensional limits stated on the approved construction drawing and / or the engineering design.

PREHEAT

P-No. 1

1. Welds joining pressure parts or attachments shall be preheated to not less than the minimum preheat temperatures stated in paragraph 5.
2. The preheat temperature shall be maintained during welding.
3. If welding is interrupted, the weld joint and adjacent areas shall be reheated to the minimum preheat temperature stated in paragraph 5, prior to the start of welding.
4. Preheat temperatures shall be checked by the welder or inspector, using temperature indicating crayons or other reputable methods.
5. Minimum preheating temperatures shall be as follows:

PRESSURE VESSELS IN ACCORDANCE WITH ASME SECTION VIII, DIV. 1

NOMINAL WALL THICKNESS	MINIMUM PREHEAT TEMPERATURE
0 to 31.8 mm (0 to 1.25 in)	10°C (50°F)
Over 31.8 mm (Over 1.25 in.)	93°C (200°F)
Over 25.4 mm (1.0 in.) & specified maximum carbon content in excess of 0.30%.	80°C (175°F)

- The conditions of UW-30 shall apply for base metal temperatures below 0°C (32°F).
- The preheat zone shall extend at least 50.8 mm (2.0 in.) beyond each edge of the weld.

PROCESS PIPING IN ACCORDANCE WITH ASME B31.3

NOMINAL WALL THICKNESS	MINIMUM SPECIFIED BASE METAL TENSILE STRENGTH	MINIMUM PREHEAT TEMPERATURE
< 25.4 mm (1.0 in.)	≤ 490 MPa (71 ksi)	10°C (50°F)
≥ 25.4 mm (1.0 in.)	All	80°C (175°F)
All	> 490 MPa (71 ksi)	80°C (175°F)

- The preheat zone shall extend at least 25.4 mm (1.0 in.) beyond each edge of the weld.
- The interruption of welding shall be subject to the requirements of paragraph 320.2.4.

POWER PIPING IN ACCORDANCE WITH ASME B31.1

&

POWER BOILERS IN ACCORDANCE WITH ASME SECTION I

NOMINAL WALL THICKNESS	MINIMUM PREHEAT TEMPERATURE
Over 25.4 mm (1.0 in.) & specified maximum carbon content in excess of 0.30%.	80°C (175°F)
All others	10°C (50°F)

- The preheat zone shall extend beyond each edge of the weld for at least 76.2 mm (3.0 in.) or 1.5 times the base metal thickness (as defined in paragraph 131.4.1), whichever is greater.

QW-483 PROCEDURE QUALIFICATION RECORD (PQR)

Exchanger Industries Limited

Procedure Qualification Record No. RMD-1A Date May 19, 2012
 Welding Procedure Specification No. C5 (Rev. 6)
 Welding Process(es) GMAW / SMAW Type(s) Semi-auto. / Manual

JOINTS (QW-402)

Type Butt joint, single vee groove, see next page

BASE METALS (QW-403)

Material Spec. SA 516 to SA 516 Type or Grade Gr. 60 to Gr. 70
 P-No. P1 Grp. 1 To P-No. P1 Grp. 2 Thickness 12.7 mm (0.500 in.)
 Heat No. 342669 - 65836 Other Plate
 Deposited Weld Metal (Per pass) Did not exceed 12.7 mm (0.500 in.)

FILLER METALS (QW-404)

	GMAW	SMAW
Specification No. (SFA)	<u>SFA 5.18</u>	<u>SFA 5.1</u>
AWS No. (Class)	<u>ER70S-6</u>	<u>E7018-1</u>
Filler Metal F-No.	<u>F6</u>	<u>F4</u>
Filler Metal A-No.	<u>A1*</u>	<u>A1</u>
Size of Electrode	<u>See attached sketch</u>	
Filler Metal Product Form	<u>Solid wire</u>	<u>N/A</u>
Supplementary Fillers	<u>Without</u>	<u>N/A</u>
Deposited Weld Metal Thickness	<u>3.18 mm (0.125 in.)</u>	<u>9.52 mm (0.375 in.)</u>
Trade Name	<u>Air Liquide, Blueshield LA S6</u>	<u>Blueshield LA 18 Plus</u>
Other	<u>*See attached chemical analysis report C12-846.1</u>	

POSITION (QW-405)

Position of Groove GMAW: Plate at 45° off flat SMAW: 3G
 Weld Progression GMAW: Vertical down SMAW: Vertical up

PREHEAT (QW-406)

Preheat Temperature 10°C (50°F) Interpass Temp. (Max.) 232°C (450°F)

POSTWELD HEAT TREATMENT (QW-407)

Temperature None Time N/A

GAS (QW-408)

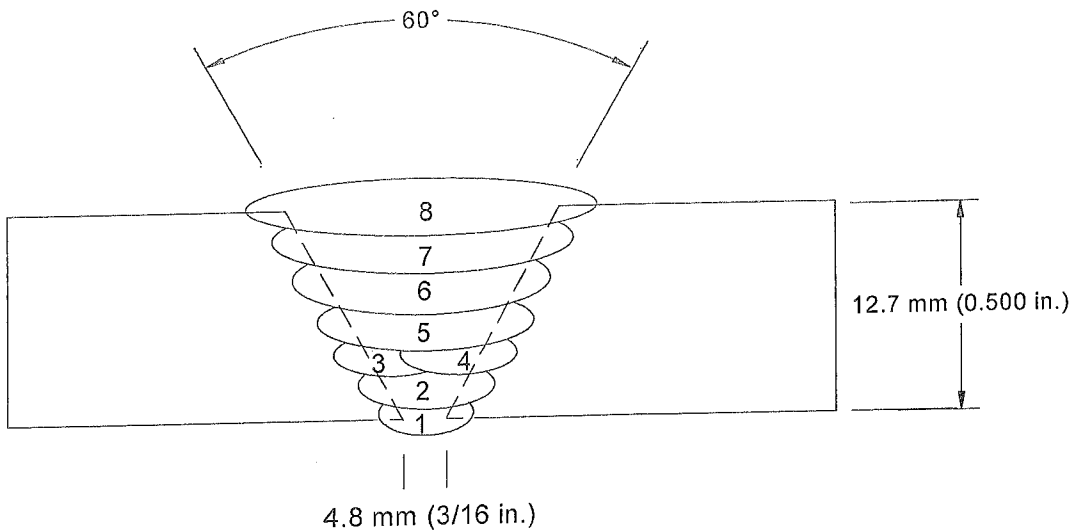
Specification No. (SFA) SFA 5.32 AWS No. SG-AC-25
 Shielding GMAW: 75% Argon, 25% CO₂, 15 liters per minute (30 cfph)
 Backing None Trailing Without

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct Polarity Reverse, electrode positive
 Amps See next page Volts See next page
 Maximum Heat Input GMAW: 0.78 kJ/mm (19,875 J/in.) SMAW: 2.72 kJ/mm (69,000 J/in.)
 Mode of Metal Transfer GMAW: Short circuiting, waveform controlled (Miller RMD)
 Other Formula for GMAW (short circuiting, waveform controlled):
Heat Input kJ/mm (J/in.) = Power (J/s) x Arc time (s) / Weld Bead Length mm (in.)
Formula for SMAW:
Heat Input kJ/mm (J/in.) = Amps x Volts x 60 / Travel speed mm/min. (ipm)

TECHNIQUE (QW-410)

String or Weave Weave Travel Speed See below
 Orifice or Gas Cup Size GMAW: 9.52 mm (0.375 in.) Peening None
 Initial & Interpass Cleaning Brushing, chipping & grinding to remove slag
 Oscillation N/A Method of Back Gouging Not used
 Tube to Work Distance GMAW: 9.52 mm (0.375 in.)
 Multiple or Single Pass Per Side Multiple Multiple or Single Electrodes Single
 Electrode Spacing N/A Use of Thermal Processes N/A



Welding Parameters

Pass	Process	Filler Metal	Diameter mm (in.)	Current & Polarity	Amperage Range	Voltage Range	Travel Speed i.p.m.
1	*GMAW	ER70S-6	0.9 (0.035)	DCRP	100 - 110	17 - 18	137 (5.4)
2 - 4	SMAW	E7018-1	2.4 (3/32)	DCRP	75 - 95	21 - 22	76 - 142 (3.0 - 5.6)
5 - 7	SMAW	E7018-1	3.2 (1/8)	DCRP	120 - 130	21 - 23	69 - 81 (2.7 - 3.2)
8	SMAW	E7018-1	3.2 (1/8)	DCRP	110 - 120	21 - 23	56 (2.2)

* Short circuiting - Waveform controlled (Miller RMD)

***GMAW (Miller RMD) Heat Input Parameters**

Pass	Power kJ/sec.	Weld Bead Length mm (in.)	Arc Time Sec.	Heat Input kJ/mm (J/in.)	Wire Feed Speed ipm
1	1.8	610 (24.0)	265	0.78 (19,875)	200

TENSILE TEST (QW-150)

Specimen No.	Width mm (in.)	Thickness mm (in.)	Area Sq. mm (Sq. in.)	Ultimate Load N (lbs.)	Ultimate Stress Mpa (Psi)	Character & Fracture Location
T1	19.1 (0.752)	11.9 (0.469)	227 (0.352)	119 244 (26,800)	525 (76,100)	Partial Cup & Cone Parent metal (Gr. 60)
T2	19.1 (0.752)	11.8 (0.465)	225 (0.349)	118 641 (26,700)	526 (76,300)	Partial Cup & Cone Parent metal (Gr. 60)

GUIDED BEND TEST (QW-160)

Type & Figure No.	Result	Type & Figure No.	Result
QW-462.2, TSB - S1	Pass	QW-462.2, TSB - S3	Pass
QW-462.2, TSB - S2	Pass	QW-462.2, TSB - S4	Pass

CHARPY IMPACT TOUGHNESS

Type of Test Charpy V-Notch Orientation Transverse
 Test Temperature -46°C (-50°F) Specimen Size 10 X 10 mm (0.394 X 0.394 in.)

Specimen No.	Notch Location	Impact Values J (ft. lbs)
W2.1	Weld Metal	134 (99.0)
W2.2	within 1/16 in.	48.0 (35.4)
W2.3	of root	107 (78.6)
W3.1	Gr. 60 - HAZ	>141 (>104)
W3.2	Gr. 60 - HAZ	93.6 (69.0)
W3.3	Gr. 60 - HAZ	>141 (>104)
X3.1	Gr. 70 - HAZ	104 (76.8)
X3.2	Gr. 70 - HAZ	>141 (>104)
X3.3	Gr. 70 - HAZ	>141 (>104)


OTHER TESTS

Vickers Hardness Survey - see attached lab test report # C12-846.1
Weld Root Chemical Analysis - see attached laboratory test report # C12-846.1

Welders Name Sean MacFarlane Certificate File No. W-25683
 Tests Conducted By Ludwig Associates Ltd.
 Laboratory Test No. C12-846.1

We certify the statements in this record are correct and that the test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Manufacturer EXCHANGER INDUSTRIES LIMITED

Date JUNE 20, 2012 Certified by 



LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Exchanger Industries Limited
5505 - 52 Street S.E.
Calgary, Alberta
T2C 2W8

Laboratory Test No.: C12-846.1
Date: May 24, 2012

Attention: Danette Korchinski

PQR Number: RMD-1A
Material: SA 516 Gr. 60 to SA 516 Gr. 70 (Heat No.: 342669 - 65836)
Thickness: 12.7 mm (0.500 in.)
Thermal Condition: As welded

TENSILE TEST QW-150

SAMPLE NUMBER	T1 QW-462.1(a)	T2 QW-462.1(a)
WIDTH mm (in)	19.1 (0.752)	19.1 (0.752)
THICKNESS mm (in)	11.9 (0.469)	11.8 (0.465)
AREA sq mm (sq in)	227 (0.352)	225 (0.349)
ULT. LOAD N (lbs)	119 244 (26,800)	118 641 (26,700)
UTS MPa (psi)	525 (76,100)	526 (76,300)
FRACTURE TYPE	Partial Cup & Cone	Partial Cup & Cone
FRACTURE LOCATION	Parent Metal (SA 516 Gr. 60)	Parent Metal (SA 516 Gr. 60)

GUIDED-BEND TEST QW-160

SAMPLE WIDTH:	9.52 mm (0.375 in.)	SAMPLE THICKNESS:	12.7 mm (0.500 in.)
PLUNGER SIZE:	38.1 mm (1.50 in.)	YOKE SIZE:	60.3 mm (2.375 in.)
QW-462.2	Side Bend	Side Bend	Side Bend
SAMPLE NUMBER(S)	S1	S2	S3
RESULTS	Pass	Pass	Pass

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section IX, 2010 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. Samples associated with this report will be discarded in 45 days.

Laboratory Test Conducted By: _____

Claire Robinson, T.T. / Dan Nguyen, C.E.T.





LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Exchanger Industries Limited
5505 - 52 Street S.E.
Calgary, Alberta
T2C 2W8

Laboratory Test No.: C12-846.1
Date: May 24, 2012

Attention: Danette Korchinski

PQR Number: RMD-1A
Material: SA 516 Gr. 60 to SA 516 Gr. 70 (Heat No.: 342669 - 65836)
Thickness: 12.7 mm (0.500 in.)
Thermal Condition: As welded

CHARPY V-NOTCH IMPACT TEST

Machine: Satec, SI-1C SN:1363 Specimen Size: 10 x 10 mm (0.394 x 0.394 in.)
Capacity: 325 J (240 ft-lbf) Orientation: Transverse
Verified Range: 1.7 - 141.3 J (1.3 - 104.2 ft-lbf) Test Temp.: -46°C (-50°F)

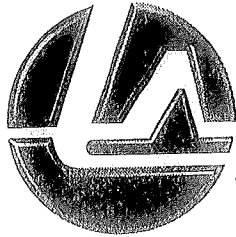
Specimen Number	Notch Location	Impact Values	
		Joules	(ft-lbf)
W2.1	Weld Metal	134	(99.0)
W2.2	within 1/16 in.	48.0	(35.4)
W2.3	of root	107	(78.6)
W3.1	Gr. 60 HAZ	>141	(>104)
W3.2	Gr. 60 HAZ	93.6	(69.0)
W3.3	Gr. 60 HAZ	>141	(>104)
X3.1	Gr. 70 HAZ	104	(76.8)
X3.2	Gr. 70 HAZ	>141	(>104)
X3.3	Gr. 70 HAZ	>141	(>104)

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section VIII, Div. 1, UG-84 – 2010 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. **Samples associated with this report will be discarded in 45 days.**

Laboratory Test Conducted By: _____


Claire Robinson, T.T. / Dan Nguyen, C.E.T.





LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Exchanger Industries Limited
5505 - 52 Street S.E.
Calgary, Alberta
T2C 2W8

Laboratory Test No.: C12-846.1
Date: May 23, 2012

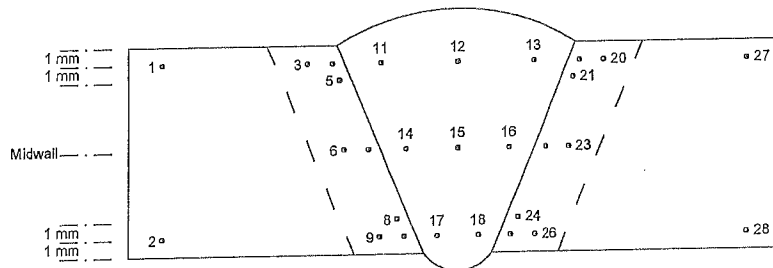
Attention: Danette Korchinski

PQR Number: RMD-1A
Material: SA 516 Gr. 60 to SA 516 Gr. 70 (Heat No.: 342669 - 65836)
Thickness: 12.7 mm (0.500 in.)
Thermal Condition: As welded

HARDNESS TEST

Type of Test: Vickers 10 kg (HV10)

Instrument: Mitutoyo AVK-C1



SA 516 Gr. 60				Weld Metal		SA 516 Gr. 70			
Parent Metal		HAZ				HAZ		Parent Metal	
1	162	3	173	11	195	19	196	27	155
2	160	4	188	12	178	20	172	28	161
		5	187	13	183	21	188		
		6	163	14	167	22	162		
		7	166	15	168	23	156		
		8	168	16	167	24	168		
		9	170	17	157	25	163		
		10	163	18	164	26	160		

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E384-10^{e2} and ANSI/NACE MR0175/ISO 15156-2:2009(E). The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. Samples associated with this report will be discarded in 45 days.

Laboratory Test Conducted By: _____


Eric Dacyk, C.E.T. / Dan Nguyen, C.E.T.



LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Exchanger Industries Limited
5505 - 52 Street S.E.
Calgary, Alberta
T2C 2W8

Laboratory Test No.: C12-846.1
Date: May 24, 2012

Attention: Danette Korchinski

PQR Number: RMD-1A
Material: SA 516 Gr. 60 to SA 516 Gr. 70 (Heat No.: 342669 - 65836)
Thickness: 12.7 mm (0.500 in.)
Thermal Condition: As welded
Test Location: ER70S-6 weld metal root pass

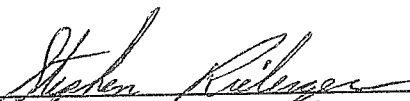
CHEMICAL ANALYSIS (% by weight)

Instrument Type: Shimadzu PDA-7000 Optical Emission Spectrometer

Carbon	0.08
Manganese	1.11
Sulphur	0.010
Phosphorus	0.007
Silicon	0.58
Chromium	0.03
Nickel	0.03
Molybdenum	<0.01
Copper	0.06
Vanadium	<0.01

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E415-08. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. **Samples associated with this report will be discarded in 45 days.**

Laboratory Test Conducted By: _____


Michelle Marien, T.T. / Steve Rieberger, C.E.T.



DILLINGER HUTTE

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+AL-1995 + AS PER ISO 10474:1991
MATERIAL TEST REPORT (MTR)

A10 Advice of dispatch No. / Date of dispatch
351793-04.02.10

A08 Manufacturer's order / A03 Certificate No.
352257-001

Sheet
7/

A05 Established inspecting body / A06 Purchaser / Final receiver
EDMONTON STEEL, EDMON / EDMONTON STEEL, EDMON

B01 Product
HOT ROLLED PLATES

B02 Steel design
SA516-70

B03 Any suppl requirements
ASME II-A:07-A09
DILL-HOE-1-R25-2009-12-04

A07 No. / A04 No.
ED10546-11010-ER

A07 No.
SA20-S5

B01-599 Description of the product

B14 Item No.	B09 Number of pieces	B10 Thickness	B11 Length	B12 Theoretical mass, KG	B13 Product delivery condition	B02 Heat No.	B04 Rolled plate No. / Test No.	B05 Purchase certificate number
02	1	0,5000 x	96,50000 x	480,00000	N	342183	55529-02	
02	1	0,5000 x	96,50000 x	480,00000	N	342182	55529-03	
02	1	0,5000 x	96,50000 x	480,00000	N	342183	55530-01	
02	1	0,5000 x	96,50000 x	480,00000	N	342183	55530-02	
02	1	0,5000 x	96,50000 x	480,00000	N	342183	55530-03	
02	1	0,5000 x	96,50000 x	480,00000	N	342183	55550-01	
02	1	0,5000 x	96,50000 x	480,00000	N	342183	55550-02	
02	1	0,5000 x	96,50000 x	480,00000	N	342183	55550-03	
02	1	0,5000 x	96,50000 x	480,00000	N	342183	55551-01	
02	1	0,5000 x	96,50000 x	480,00000	N	342183	55551-02	
02	1	0,5000 x	96,50000 x	480,00000	N	342183	55551-03	
02	1	0,5000 x	96,50000 x	480,00000	N	342183	55552-01	
02	1	0,5000 x	96,50000 x	480,00000	N	342183	55552-02	
#:	70			208530				
03	1	0,5000 x	120,50000 x	480,00000	N	342669	65835-01	
03	1	0,5000 x	120,50000 x	480,00000	N	342669	65835-02	
03	1	0,5000 x	120,50000 x	480,00000	N	342669	65835-03	
03	1	0,5000 x	120,50000 x	480,00000	N	342669	65836-01	
03	1	0,5000 x	120,50000 x	480,00000	N	342669	65836-02	
03	1	0,5000 x	120,50000 x	480,00000	N	342669	65837-01	
03	1	0,5000 x	120,50000 x	480,00000	N	342669	65837-02	
03	1	0,5000 x	120,50000 x	480,00000	N	342669	65837-03	
03	1	0,5000 x	120,50000 x	480,00000	N	342669	65847-01	

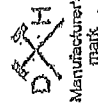
1/2 50516 60 70
342669 - 65836

PL
June 6, 2012

CPL-66

A04 Z01Z02Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

DM-System Certification as per ISO 9004



Manufacturer's mark

3pink

ADP

B. MUELLER
Test House Manager

AG der Dillinger Hüttenwerke
Postfach 1530, D-66748 Dillingen/Saar
Inspection department

Inspector's stamp
Date: 04.02.10

PP



Erläuterungen siehe Rückseite/Explications voir au verso (See reverse for explanations (www.dillinger.de/certificates))

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991
 MATERIAL TEST REPORT (MTR)

A03 Established inspecting body / A08 Purchaser EDMONTON STEEL, EDMONTON A07.1 No. ED10546-J1010-ER
 Final receiver EDMONTON STEEL, EDMONTON A07.2 No. SA20-S5

B01 Steel design. SA516-70
 B03 Any suppl. ASME-IT-A: 07+A09 requirements DIL-HUT-1:R25-2009-12-04

A10 Advice of dispatch No./ Date of dispatch 351793-04.02.10
 A08 Manufacturer's order / A09 Certificate No. 352257-001
 B03 Product: HOT ROLLED PLATES
 Sheet 12/...

C10-C29 Tensile test

B14. S07.2 Item No.	B07.1 Roll plate Test No.	B05 Reference (heat) treatment	C01 C02 C03 C10 C11		C12	C13	C18	A % LO-SIN
			KI Q	RT				
02	342181	67928	KI Q	RT	73,2	73,2	28	28
02	342181	67950	KI Q	RT	74,4	74,4	29	29
02	342183	55528	KI Q	RT	74,5	74,5	25	25
02	342183	55529	KI Q	RT	74,2	74,2	25	25
02	342183	55530	KI Q	RT	74,8	74,8	28	28
02	342183	55550	KI Q	RT	75,3	75,3	30	30
02	342183	55551	KI Q	RT	75,1	75,1	25	25
02	342183	55552	KI Q	RT	74,4	74,4	27	27
03	342669	65835	KI Q	RT	73,5	73,5	27	27
03	342669	65836	KI Q	RT	73,2	73,2	27	27
03	342669	65837	KI Q	RT	74,4	74,4	29	29
03	342670	65763	KI Q	RT	73,8	73,8	27	27
03	342670	65765	KI Q	RT	73,4	73,4	27	27
03	342670	65776	KI Q	RT	72,9	72,9	25	25
03	342671	65654	KI Q	RT	73,7	73,7	28	28
03	342671	65657	KI Q	RT	73,8	73,8	28	28
03	342671	65674	KI Q	RT	72,5	72,5	27	27
03	342671	65683	KI Q	RT	73,8	73,8	27	27
03	342671	65684	KI Q	RT	74,7	74,7	27	27
03	342671	65686	KI Q	RT	73,2	73,2	27	27
03	342671	65695	KI Q	RT	74,4	74,4	27	27
03	342671	65696	KI Q	RT	73,7	73,7	27	27
03	342671	65696	KI Q	RT	74,1	74,1	27	27

A04 Z01Z02Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.
 QM-System: Certification as per ISO 9001

AG der Dillinger Hüttenwerke
 Postfach 1580, D-66748 Dillingen/Saar
 Inspection department

APB
 E. MUELLER
 Test House Manager

Inspector's stamp Date 04.02.10 PP 1




Erfahrungen, siehe Rückseite/Explications voir au verso/See reverse for explanations. (www.dillinger.de/certificate)

A02	INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004	A10	Advice of dispatch No. Date of dispatch	Sheet
	INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991		351793-04.02.10	15/
A05	MATERIAL TEST REPORT (MTR)	A08	Manufacturer's order Certificate No.	
	EDMONTON STEEL, EDWON A07.1 No. ED10546-J1010-ER		352257-001	
	EDMONTON STEEL, EDWON A07.2 No. SA20-SS		801 Product	
			HOT ROLLED PLATES	

C30-C39 Hardness test

B04 Item No.	B07.2 Heat No.	B07.3 Roll plate/ Test No.	B05 Reference (heat) treatment	C04 C02/C01	C03 Temp. GMP	C33 Testing method	C35 C31 Individual values	C32 Mean Value
02	342183	55551		KL O	RT	HBW 10/3000	HB 148 150	149
02	342183	55552		KL O	RT	HBW 10/3000	HB 150 150	150
03	342669	65835		KL O	RT	HBW 10/3000	HB 145 145	145
03	342669	65836		KL O	RT	HBW 10/3000	HB 157 154	155
03	342669	65837		KL O	RT	HBW 10/3000	HB 150 155	151
03	342669	65847		KL O	RT	HBW 10/3000	HB 144 147	145
03	342670	65763		KL O	RT	HBW 10/3000	HB 153 152	154
03	342670	65765		KL O	RT	HBW 10/3000	HB 146 149	147
03	342670	65776		KL O	RT	HBW 10/3000	HB 154 150	150
03	342671	65654		KL O	RT	HBW 10/3000	HB 151 151	151
03	342671	65657		KL O	RT	HBW 10/3000	HB 145 146	145
03	342671	65674		KL O	RT	HBW 10/3000	HB 154 153	152
03	342671	65683		KL O	RT	HBW 10/3000	HB 145 145	145
03	342671	65684		KL O	RT	HBW 10/3000	HB 154 150	152
03	342671	65686		KL O	RT	HBW 10/3000	HB 151 151	151
03	342671	65695		KL O	RT	HBW 10/3000	HB 149 149	149
03	342671	65696		KL O	RT	HBW 10/3000	HB 144 145	145

A04		 B. MUELLER Test House Manager	AG der Dillinger-Hüttenwerke Postfach 1680, D-66748-Dillingen/Saar Inspection department
A01 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.		Inspection's stamp	Date 04.02.10

QM-System: Certification as per ISO 9001

Manufacturer's mark



DILLINGER HÜTTE

Entwürfen, siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004

INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991

MATERIAL TEST REPORT (MTR)

A10 Advice of dispatch No./
Date of dispatch

351793-04.02.10

A06 Manufacturer's order/
A03 Certificate No.

352257-001

Sheet

18/...

A05 Established inspecting body

A06 Purchaser

EDMONTON STEEL, EDMON

A07.1 No. ED10546-J1010-ER

Final receiver

EDMONTON STEEL, EDMON

A07.2 No.

HOT ROLLED PLATES

B02/ Steel design SA516-70

B03 Any suppl. ASME-III-A:07+A09

requirements DIL-HUE-1:R25-2009-12-04

SA20-S5

C40-C49 Impact test

S14 Item No.	B07.2 Seat No.	B07.1 Rollplate Test No.	B05 Reference (heat) treatment	C01	C02 CP1	C03 Temp. GR.F.	C41 Width of test piece	C40 Type of test piece	C44 Testing method	C45 Energy	C42 Individual values AV-F1,LF	C43 Mean value
02	342183	55550		KL	LV	-51	CHP-V	CHP-V	AV 193	195	198	195
02	342183	55551		KL	LV	-51	CHP-V	CHP-V	AV 199	198	198	198
03	342183	55552		KL	LV	-51	CHP-V	CHP-V	AV 214	198	203	205
03	342669	65835		KL	LV	-51	CHP-V	CHP-V	AV 162	195	201	186
03	342669	65836		KL	LV	-51	CHP-V	CHP-V	AV 125	105	203	144
03	342669	65837		KL	LV	-51	CHP-V	CHP-V	AV 195	122	189	169
03	342669	65847		KL	LV	-51	CHP-V	CHP-V	AV 125	190	190	168
03	342670	65763		KL	LV	-51	CHP-V	CHP-V	AV 204	208	208	207
03	342670	65765		KL	LV	-51	CHP-V	CHP-V	AV 192	212	207	204
03	342670	65776		KL	LV	-51	CHP-V	CHP-V	AV 118	119	127	121
03	342671	65654		KL	LV	-51	CHP-V	CHP-V	AV 127	147	131	135
03	342671	65657		KL	LV	-51	CHP-V	CHP-V	AV 142	118	75	112
03	342671	65674		KL	LV	-51	CHP-V	CHP-V	AV 223	200	204	209
03	342671	65683		KL	LV	-51	CHP-V	CHP-V	AV 194	124	154	157
03	342671	65684		KL	LV	-51	CHP-V	CHP-V	AV 226	124	226	192
03	342671	65686		KL	LV	-51	CHP-V	CHP-V	AV 219	161	223	201
03	342671	65695		KL	LV	-51	CHP-V	CHP-V	AV 130	219	208	185
03	342671	65696		KL	LV	-51	CHP-V	CHP-V	AV 216	152	218	195

A04



Manufacturer's mark

Z017020203 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

QMS-System: Certification as per ISO 9001

S. Müller

B. MUELLER
Test House Manager



AG der Dillinger Hüttenwerke
Postfach 1680, D-66748 Dillingen/Saar
Inspection department

Inspector's stamp

Date 04.02.10

PP

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DILLINGER HÜTTE

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991
 MATERIAL TEST REPORT (MTR)

A03 Steel design: SA516-70
 A04 Any suppl. requirements: ASME-II-A:07+A09
 DILL-HUE-1:R25-2009-12-04

A05 Established inspecting body: A06 Purchaser: EDMONTON STEEL, EDMON A07.1 No. ED10546-J1010-ER
 DH: Final receiver: EDMONTON STEEL, EDMON A07.2 No. SA20-S5

A08 Manufacturer's order/ A09 Certificate No.: 352257-001
 E01 Product: NOT ROLLED PLATES

A10 Advice of dispatch No./ Date of dispatch: 351793-04-02-10

Sheet: 19/

C70-C99 Chemical composition % - Heat analysis:

Heat	C70	C	Si	Mn	P	S	N	Al	Ca	Fe	Cr	Ni	Cu	Mg	Mo	Co	W	Nb	Bi	As	Se	Te	Sn	Pb	Th	U	Other	
342179	Y	0,175	0,316	1,16	0,012	0,0012	0,0060	0,030	0,008	0,043	0,031	0,001	0,001	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
342181	Y	0,174	0,329	1,17	0,011	0,0008	0,0055	0,022	0,007	0,031	0,032	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
342183	Y	0,173	0,325	1,17	0,011	0,0007	0,0064	0,028	0,007	0,042	0,035	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
342669	Y	0,166	0,367	1,17	0,009	0,0012	0,0063	0,030	0,009	0,037	0,037	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
342670	Y	0,164	0,369	1,18	0,009	0,0011	0,0060	0,018	0,006	0,026	0,026	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
342671	Y	0,168	0,387	1,19	0,009	0,0012	0,0062	0,026	0,007	0,032	0,032	0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000

C94 Heat analysis: Carbon equivalent / Alloying restrictions

Heat	CE	Al	Ca	Fe	Cr	Ni	Cu	Mg	Mo	Co	W	Nb	Bi	As	Se	Te	Sn	Pb	Th	U	Other							
342179	0,0007	0,0024	0,032	0,11	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04
342181	0,0001	0,0017	0,030	0,09	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04
342183	0,0001	0,0015	0,031	0,11	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04
342669	0,0002	0,0017	0,037	0,11	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05
342670	0,0001	0,0017	0,038	0,08	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03
342671	0,0002	0,0023	0,037	0,10	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04

A04 20120203 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.
 QM-System: Certification as per ISO 9001

Manufacturer's mark:

Inspector's stamp:

Test House Manager: B. MUELLER

Inspector's stamp:

Date: 04.02.10

AG der Dillinger Hüttenwerke
 Postfach 1580, D-66748 Dillingen/Saar
 Inspection department

Sheet: 19/



DILLINGER HÜTTE

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A10 Advice of dispatch No./ Date of dispatch 351793-04.02.10	A08 Manufacturer's order/ A09 Certificate No. 352257-001	Sheet 22
A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A07.1 No. ED10546-J1010-ER A07.2 No. SA20-S5
A05 Established inspecting body DH	A06 Purchaser Final receiver EDMONTON STEEL, EDMON EDMONTON STEEL, EDMON	B01 Product HOT ROLLED PLATES
B02 Steel design SA516-70	B03 Any suppl. requirements ASME-II-A:07+A09 DIL-HUE-1:R25-2009-12-04	

D01 Marking and identification, surface appearance, shape and dimensional properties

ITEM NO.: 01-03

RESULT OF MARKING; SURFACE, SHAPE AND DIMENSIONS: NO REMARKS

SURFACE AS PER ASME-SA20

THICKNESS AS PER ASME-SA20

LENGTH AND WIDTH AS PER ASME-SA20

FLATNESS AS PER 1/2-ASME-SA20



A04 2012/20203 We hereby certify that the above mentioned materials have been delivered in accordance with the terms of order.
QM-System: Certification as per ISO 9001

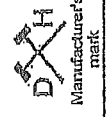
AG der Dillinger Hüttenwerke
 Postfach 1580, D-66748 Dillingen/Saar
 Inspection department

Spink
B. MUELLER
 Test House Manager

ADP
 Inspector's stamp

Date: 04.02.10

PP 1





DILLINGER HÜTTE

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991
 MATERIAL TEST REPORT (MTR)
 A05 Established inspecting body A06 Purchaser
 EDMONTON STEEL, EDMONTON A07.1 No. ED10546-J1010-ER
 EDMONTON STEEL, EDMONTON A07.2 No. SA20-S5
 A08 Manufacturer's order
 A09 Certificate No. 351793-04.02.10
 A10 Advice of dispatch No./Date of dispatch 351793-04.02.10
 A11 Product HOT ROLLED PLATES
 Sheet 7/

B01 Steel design. SA516-60
 B03 Any suppl. requirements ASME-II-A:07-A09.
 DIL-HUB-1.R25-2009-12-04

B04 B99 Description of the product

B44 Item No.	B45 No. of pieces	B46 Thickness	B47 Width	B48 Length	B49 Mass	B50 Theoretical mass	B51 Product delivery condition	B52 Mark No.	B53 Rolled plate No./Test No.	B54 Purchaser article number
02	1	0,5000 X	96,50000 X	480,00000 X	2979	2979	N	342183	55529-02	
02	1	0,5000 X	96,50000 X	480,00000 X	2979	2979	N	342183	55529-03	
02	1	0,5000 X	96,50000 X	480,00000 X	2979	2979	N	342183	55530-01	
02	1	0,5000 X	96,50000 X	480,00000 X	2979	2979	N	342183	55530-02	
02	1	0,5000 X	96,50000 X	480,00000 X	2979	2979	N	342183	55530-03	
02	1	0,5000 X	96,50000 X	480,00000 X	2979	2979	N	342183	55550-01	
02	1	0,5000 X	96,50000 X	480,00000 X	2979	2979	N	342183	55550-02	
02	1	0,5000 X	96,50000 X	480,00000 X	2979	2979	N	342183	55550-03	
02	1	0,5000 X	96,50000 X	480,00000 X	2979	2979	N	342183	55551-01	
02	1	0,5000 X	96,50000 X	480,00000 X	2979	2979	N	342183	55551-02	
02	1	0,5000 X	96,50000 X	480,00000 X	2979	2979	N	342183	55551-03	
02	1	0,5000 X	96,50000 X	480,00000 X	2979	2979	N	342183	55552-01	
02	1	0,5000 X	96,50000 X	480,00000 X	2979	2979	N	342183	55552-02	
03	70				208530					
03	1	0,5000 X	120,50000 X	480,00000 X	3720	3720	N	342669	65835-01	
03	1	0,5000 X	120,50000 X	480,00000 X	3720	3720	N	342669	65835-02	
03	1	0,5000 X	120,50000 X	480,00000 X	3720	3720	N	342669	65835-03	
03	1	0,5000 X	120,50000 X	480,00000 X	3720	3720	N	342669	65836-01	
03	1	0,5000 X	120,50000 X	480,00000 X	3720	3720	N	342669	65836-02	
03	1	0,5000 X	120,50000 X	480,00000 X	3720	3720	N	342669	65837-01	
03	1	0,5000 X	120,50000 X	480,00000 X	3720	3720	N	342669	65937-02	
03	1	0,5000 X	120,50000 X	480,00000 X	3720	3720	N	342669	65837-03	
03	1	0,5000 X	120,50000 X	480,00000 X	3720	3720	N	342669	65847-01	

1/2 SA 516 Gr. 60

342 669 = 65836

19. June 6/12

CPL-66

A04 20120203 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.
 Dillinger Hütte
 Manufacturer's mark
 B. MUELLER
 Test House Manager
 Inspector's stamp
 Date 04.02.10
 AG der Dillinger Hüttenwerke
 Postfach 1500, D-66748 Dillingen/Saar
 inspection department
 A01



DILLINGER HÜTTE

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991
MATERIAL TEST REPORT (MTR)

A10 Advice of dispatch No./
Date of dispatch:
351793-04.02.10

A08 Manufacturer's order/
A03 Certificate No.
352257-001

Steel

A05 Established inspecting body
A06 Purchaser
EDMONTON STEEL, EDMONTON A07.1 No. ED10546-J1010-ER
Final receiver
EDMONTON STEEL, EDMONTON A07.2 No.
SA20-SS

DH
A02 Steel design: SA516-60
A03 Any suppl. requirements: ASME-II-A:07+A09
DIL-HUB-1:R25-2009-12-04

E01 Product
HOT ROLLED PLATES

C10-C29 Tensile test

E14 Item No.	E07.1 Heat No.	E05 Ref. plate Test No.	E05 Reference (heat) treatment	C01		C02		C03		C10		C11		C12 Rm	C13 A % LG-BRN	C14-C15
				Kl	Q	RT	GR.F.	RT	KSI	RT	GR.F.	RT	GR.F.				RT	GR.F.
02	342181	67928		Kl	Q	RT		49,0		RT		73,2		28		
02	342181	67950		Kl	Q	RT		50,0		RT		74,4		29		
02	342183	55528		Kl	Q	RT		50,5		RT		74,5		25		
02	342183	55529		Kl	Q	RT		50,6		RT		74,2		25		
02	342183	55530		Kl	Q	RT		50,9		RT		74,8		28		
02	342183	55550		Kl	Q	RT		50,9		RT		75,3		30		
02	342183	55551		Kl	Q	RT		51,8		RT		75,1		25		
02	342183	55552		Kl	Q	RT		50,5		RT		74,4		27		
03	342669	65835		Kl	Q	RT		49,3		RT		73,5		27		
03	342669	65836		Kl	Q	RT		49,0		RT		73,2		27		
03	342669	65837		Kl	Q	RT		50,0		RT		74,4		29		
03	342669	65847		Kl	Q	RT		49,7		RT		73,8		27		
03	342670	65763		Kl	Q	RT		49,2		RT		73,4		27		
03	342670	65765		Kl	Q	RT		48,9		RT		72,9		25		
03	342670	65776		Kl	Q	RT		49,3		RT		73,7		28		
03	342671	65654		Kl	Q	RT		49,3		RT		73,8		28		
03	342671	65657		Kl	Q	RT		46,8		RT		72,5		27		
03	342671	65674		Kl	Q	RT		49,3		RT		73,8		27		
03	342671	65683		Kl	Q	RT		51,2		RT		74,7		27		
03	342671	65684		Kl	Q	RT		49,9		RT		73,2		27		
03	342671	65686		Kl	Q	RT		50,2		RT		74,4		27		
03	342671	65695		Kl	Q	RT		49,9		RT		73,7		27		
03	342671	65696		Kl	Q	RT		49,4		RT		74,1		27		

A04 Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.



AG-System: Certification as per ISO 9001

B. MOELLER
Test House Manager



AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
inspection department

Inspector's stamp
Date 04.02.10

PP 1



Erhäuterungen siehe Rückseite/Explications voir au verso/See reverses for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991
 MATERIAL TEST REPORT (MTR)
 A05 Established inspecting body AUS Purchaser EDMONTON STEEL, EDMON A071 No. ED10546-J1010-ER
 DH Final receiver EDMONTON STEEL, EDMON A072 No. SA20-S5

A10 Advice of dispatch No./ Date of dispatch 351793-04.02.10

A08/ Manufacturer's order/ A03 - Certificate No. 352257-001

A09 Product HOT ROLLED PLATES

Sheet 15/...

C30-C39 Hardness test

B072 Item No.	B072 Heat No.	B074 Rollplate/ Test No.	B05 Reference (heat) treatment	C01 C02/C04	C03 Temp. GR-F	C03 Testing method	C35 Individual values	C39 Mean value
02	342183	55550		KL O	RT	HBW 10/3000	148	150
02	342183	55551		KL O	RT	HBW 10/3000	150	150
02	342183	55552		KL O	RT	HBW 10/3000	150	150
03	342669	65835		KL O	RT	HBW 10/3000	145	145
03	342669	65836		KL O	RT	HBW 10/3000	154	155
03	342669	65837		KL O	RT	HBW 10/3000	155	151
03	342669	65847		KL O	RT	HBW 10/3000	144	145
03	342670	65763		KL O	RT	HBW 10/3000	152	154
03	342670	65765		KL O	RT	HBW 10/3000	149	147
03	342670	65776		KL O	RT	HBW 10/3000	150	150
03	342671	65654		KL O	RT	HBW 10/3000	151	151
03	342671	65657		KL O	RT	HBW 10/3000	146	145
03	342671	65674		KL O	RT	HBW 10/3000	153	152
03	342671	65683		KL O	RT	HBW 10/3000	145	145
03	342671	65684		KL O	RT	HBW 10/3000	150	152
03	342671	65686		KL O	RT	HBW 10/3000	151	151
03	342671	65695		KL O	RT	HBW 10/3000	149	149
03	342671	65696		KL O	RT	HBW 10/3000	144	145

Z01Z02Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

QMI-System: Certification as per ISO 9001

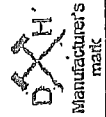
Spitz
 B. WUELLER
 Test House Manager



AG der Dillinger Hüttenwerke
 Postfach 1590, D-66743 Dillingen/Saar
 Inspection department

Inspector's stamp Date 04.02.10

PP 1



A04



DILLINGER HÜTTE

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004

INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991

MATERIAL TEST REPORT (MTR)

A05 Established inspecting body A06 Purchaser EDMONTON STEEL, EDMON A07: No: ED10546-J1010-ER

DH Final receiver EDMONTON STEEL, EDMON A07:2 No. SA20-S5

BO2 Steel design SA516-60

BO3 Any suppl. ASME-III-A:07+A09

requirements DIL-HDE-1-R25-2009-12-04

A08 Manufacturer's order A03 Certificate No.

352257-001

B01 Product

HOT ROLLED PLATES

A10 Advice of dispatch No./ Date of dispatch

351793-04.02.10

Sheet

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C40-C49 Impact test

B14 Item No.	B07:2 Heat No.	B07:4 Roll plate Test No.	B05 Reference (heat) treatment	C01	C02/ CVI	C03 Temp. GR.F.	C04 Width of test piece	C40 Type of test piece	C44 Testing method	C45 Energy	C42 Individual values AV=FLIEF	C43 Mean value
02	342183	55550		K1	IV	-51	51	CHP-V		AV 193	195	198
02	342183	55551		K1	IV	-51	51	CHP-V		AV 199	198	198
02	342183	55552		K1	IV	-51	51	CHP-V		AV 211	198	203
03	342669	65835		K1	IV	-51	51	CHP-V		AV 162	195	201
03	342669	65836		K1	IV	-51	51	CHP-V		AV 125	105	203
03	342669	65837		K1	IV	-51	51	CHP-V		AV 195	122	189
03	342669	65847		K1	IV	-51	51	CHP-V		AV 125	190	190
03	342670	65763		K1	IV	-51	51	CHP-V		AV 204	208	208
03	342670	65765		K1	IV	-51	51	CHP-V		AV 192	212	207
03	342670	65776		K1	IV	-51	51	CHP-V		AV 118	119	127
03	342671	65654		K1	IV	-51	51	CHP-V		AV 127	147	131
03	342671	65657		K1	IV	-51	51	CHP-V		AV 142	75	112
03	342671	65674		K1	IV	-51	51	CHP-V		AV 223	200	204
03	342671	65683		K1	IV	-51	51	CHP-V		AV 194	154	157
03	342671	65684		K1	IV	-51	51	CHP-V		AV 226	124	226
03	342671	65686		K1	IV	-51	51	CHP-V		AV 219	161	223
03	342671	65695		K1	IV	-51	51	CHP-V		AV 130	218	208
03	342671	65696		K1	IV	-51	51	CHP-V		AV 216	152	218

Z01Z02/203 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

QMI-System: Certification as per ISO 9001



Manufacturer's mark

S. Müller

B. MUELLER
Test House Manager

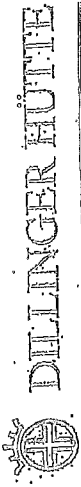


AG der Dillinger Hüttenwerke
Postfach 1380, D-66748 Dillingen/Saar
inspection department

Inspector's stamp

Date 04.02.10

PP



A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991
 MATERIAL TEST REPORT (MTR)
 A05 Established inspecting body A08 Purchaser EDMONTON STEEL, EDMON A07.4 No. ED10546-J1010-ER
 DH. Final receiver EDMONTON STEEL, EDMON A07.2 No. SA20-S5
 B02 Steel design SA516-60
 B03 Any suppl. ASME-II-A:07+A09
 requirements DIL-HUE-1:R25-2009-12-04

A10 Advice of dispatch No./Date of dispatch
 351793-04.02.10
 A08/Manufacturer's order/A03 Certificate No.
 352257-001
 B01 Product
 HOT ROLLED PLATES

Sheet
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C70-C99 Chemical composition % - Heat analysis

	C	SI	MN	P	S	N	CU	MO	NI	CR	V	MB	SN	TI
B07.2 Heat														
342179	Y	0,175	0,316	1,16	0,012	0,0012	0,030	0,008	0,043	0,031	0,001	0,000	0,001	0,002
342181	Y	0,174	0,329	1,17	0,011	0,0008	0,022	0,007	0,031	0,032	0,000	0,000	0,001	0,003
342183	Y	0,173	0,325	1,17	0,011	0,0007	0,028	0,007	0,042	0,035	0,000	0,000	0,000	0,003
342669	Y	0,166	0,367	1,17	0,009	0,0012	0,030	0,009	0,037	0,037	0,000	0,000	0,001	0,003
342670	Y	0,164	0,369	1,18	0,009	0,0011	0,018	0,006	0,026	0,028	0,000	0,000	0,001	0,003
342671	Y	0,168	0,387	1,19	0,009	0,0012	0,026	0,007	0,032	0,032	0,001	0,000	0,002	0,003

C94 Heat analysis Carbon equivalent/ Alloying restrictions

	CA	AL-T
B07.2 Heat		
342179	0,0024	0,032
342181	0,0017	0,030
342183	0,0015	0,031
342669	0,0017	0,037
342670	0,0017	0,038
342671	0,0023	0,037

	FO-02=	FO-02=	FO-02=	FO-02=	FO-02=	FO-02=	FO-55=	FO-55=	FO-55=	FO-55=	FO-55=	FO-78=	FO-78=	FO-78=	FO-78=	FO-91=	FO-91=	FO-91=	
B07.2 Heat																			
342179	0,38	0,38	0,38	0,38	0,38	0,38	0,11	0,09	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	
342181	0,38	0,38	0,38	0,38	0,38	0,38	0,11	0,09	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	
342183	0,38	0,38	0,38	0,38	0,38	0,38	0,11	0,09	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	
342669	0,37	0,37	0,37	0,37	0,37	0,37	0,11	0,08	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	
342670	0,37	0,37	0,37	0,37	0,37	0,37	0,08	0,08	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	
342671	0,38	0,38	0,38	0,38	0,38	0,38	0,10	0,10	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	

A04 201Z02Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.
 QM-System: Certification as per ISO 9001
 AG der Dillinger Hüttenwerke
 Postfach 1590, D-66748 Dillingen/Saar
 inspection department
 B. MOELLER
 Test House Manager
 Inspector's stamp
 Date 04.02.10
 PP 1



Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

<p>A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991. MATERIAL TEST REPORT (MTR)</p>	<p>A10 Advice of dispatch No./ Date of dispatch 351793-04.02.10</p>	<p>A03 Manufacturer's order/ A03 Certificate No. 352257-001 B04 Product HOT ROLLED PLATES</p>
<p>A05 Established inspecting body DH</p>	<p>A06 Purchaser Final receiver</p>	<p>EDMONTON STEEL, EDMON A07.1 No. ED10546-J1010-ER EDMONTON STEEL, EDMON A07.2 No. SA20-SS</p>
<p>B02 Steel design. SA516-60</p>	<p>B03 Any suppl. requirements</p>	<p>ASME-II-A: 07+A09 DIL-HOE-1: R25-2009-12-04.</p>

D04 Marking and identification, surface appearance, shape and dimensional properties

ITEM NO.: 01-03
 RESULT OF MARKING, SURFACE, SHAPE AND DIMENSIONS: NO REMARKS
 SURFACE AS PER ASME-SA20
 THICKNESS AS PER ASME-SA20
 LENGTH AND WIDTH AS PER ASME-SA20
 FLATNESS AS PER 1/2-ASME-SA20



<p>A04</p>	<p>Z01Z02Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order. QM-System: Certification as per ISO 9001</p>
<p>Manufacturer's mark </p>	<p>Inspector's stamp B. MUELLER Test House Manager Date 04.02.10</p>
<p>AG der Dillinger-Hüttenwerke Postfach 1500, D-66748 Dillingen/Saar Inspection department</p>	<p>ADP Date 04.02.10 PP 1</p>

QW-483 PROCEDURE QUALIFICATION RECORD (PQR)

Exchanger Industries Limited

Procedure Qualification Record No. RMD-2A Date May 19, 2012
 Welding Procedure Specification No. C5 (Rev. 6)
 Welding Process(es) GMAW / SMAW Type(s) Semi-auto. / Manual

JOINTS (QW-402)

Type Butt joint, single vee groove, see next page

BASE METALS (QW-403)

Material Spec. SA 333 to SA 350 Type or Grade Gr. 6 to Gr. LF2
 P-No. P1 Grp. 1 To P-No. P1 Grp. 2 Thickness 6.32 mm (0.249 in.)
 Diameter 168.3 mm (6.625 in.) O.D. Other Schedule 40 m/c to 0.249 in.
 Heat Number 84680 to 560184
 Deposited Weld Metal (Per pass) Did not exceed 12.7 mm (0.500 in.)

FILLER METALS (QW-404)

	GMAW	SMAW
Specification No. (SFA)	<u>SFA 5.18</u>	<u>SFA 5.1</u>
AWS No. (Class)	<u>ER70S-6</u>	<u>E7018-1</u>
Filler Metal F-No.	<u>F6</u>	<u>F4</u>
Filler Metal A-No.	<u>A1*</u>	<u>A1</u>
Size of Electrode	<u>See attached sketch</u>	
Filler Metal Product Form	<u>Solid wire</u>	<u>N/A</u>
Supplementary Fillers	<u>Without</u>	<u>N/A</u>
Deposited Weld Metal Thickness	<u>2.54 mm (0.100 in.)</u>	<u>3.78 mm (0.149 in.)</u>
Trade Name	<u>Air Liquide, Blueshield LA S6</u>	<u>Blueshield LA 18 Plus</u>
Other	<u>*See attached chemical analysis report C12-846.1</u>	

POSITION (QW-405)

Position of Groove GMAW: Pipe rolled with nozzle tip at 30° from top SMAW: 5G
 Weld Progression GMAW: Vertical down SMAW: Vertical up

PREHEAT (QW-406)

Preheat Temperature 10°C (50°F) Interpass Temp. (Max.) 232°C (450°F)

POSTWELD HEAT TREATMENT (QW-407)

Temperature None Time N/A

GAS (QW-408)

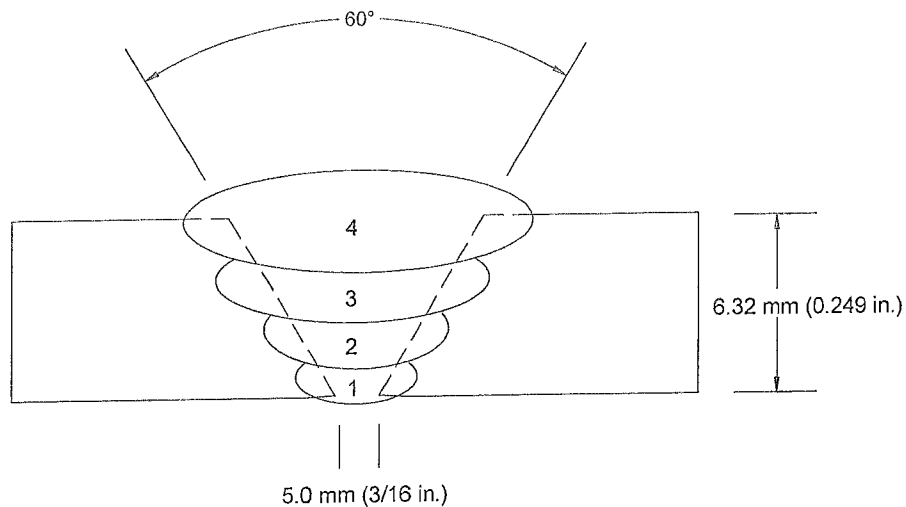
Specification No. (SFA) SFA 5.32 AWS No. SG-AC-25
 Shielding GMAW: 75% Argon, 25% CO₂, 15 liters per minute (30 cfph)
 Backing None Trailing Without

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct Polarity Reverse, electrode positive
 Amps See next page Volts See next page
 Maximum Heat Input GMAW: 0.67 kJ/mm (17,060 J/in.) SMAW: 2.21 kJ/mm (56,100 J/in.)
 Mode of Metal Transfer GMAW: Short circuiting, waveform controlled (Miller RMD)
 Other Formula for GMAW (short circuiting, waveform controlled):
Heat Input kJ/mm (J/in.) = Power (J/s) x Arc time (s) / Weld Bead Length mm (in.)
Formula for SMAW:
Heat Input kJ/mm (J/in.) = Amps x Volts x 60 / Travel speed mm/min. (ipm)

TECHNIQUE (QW-410)

String or Weave Weave Travel Speed See below
 Orifice or Gas Cup Size GMAW: 9.52 mm (0.375 in.) Peening None
 Initial & Interpass Cleaning Brushing, chipping & grinding to remove slag
 Oscillation N/A Method of Back Gouging Not used
 Tube to Work Distance GMAW: 9.52 mm (0.375 in.)
 Multiple or Single Pass Per Side Multiple Multiple or Single Electrodes Single
 Electrode Spacing N/A Use of Thermal Processes N/A



Welding Parameters

Pass	Process	Filler Metal	Diameter mm (in.)	Current & Polarity	Amperage Range	Voltage Range	Travel Speed i.p.m.
1	*GMAW	ER70S-6	0.9 (0.035)	DCRP	100 - 110	18	140 (5.5)
2	SMAW	E7018-1	2.4 (3/32)	DCRP	80 - 90	21 - 23	84 (3.3)
3	SMAW	E7018-1	2.4 (3/32)	DCRP	80 - 90	21 - 23	109 (4.3)
4	SMAW	E7018-1	2.4 (3/32)	DCRP	80 - 90	21 - 23	51 (2.0)

* Short circuiting - Waveform controlled (Miller RMD)

***GMAW (Miller RMD) Heat Input Parameters**

Pass	Power kJ/sec.	Weld Bead Length mm (in.)	Arc Time Sec.	Heat Input kJ/mm (J/in.)	Wire Feed Speed ipm
1	1.9	597 (23.5)	211	0.67 (17,060)	200

TENSILE TEST (QW-150)

Specimen No.	Width mm (in.)	Thickness mm (in.)	Area Sq. mm (Sq. in.)	Ultimate Load N (lbs.)	Ultimate Stress Mpa (Psi)	Character & Fracture Location
T1	19.0 (0.748)	5.04 (0.198)	95.8 (0.148)	49 087 (11,000)	513 (74,300)	Partial Cup & Cone Parent metal (SA 333 Gr. 6)
T2	19.1 (0.752)	4.84 (0.191)	92.4 (0.143)	47 503 (10,700)	514 (74,500)	Partial Cup & Cone Parent metal (SA 333 Gr. 6)

GUIDED BEND TEST (QW-160)

Type & Figure No.	Result	Type & Figure No.	Result
QW-462.3a, TRB - R1	Pass	QW-462.3a, TFB - F1	Pass
QW-462.3a, TRB - R2	Pass	QW-462.3a, TFB - F2	Pass

CHARPY IMPACT TOUGHNESS

Type of Test Charpy V-Notch Orientation Transverse
 Test Temperature -48°C (-55°F) Specimen Size 10 X 5 mm (0.394 X 0.197 in.)

Specimen No.	Notch Location	Impact Values J (ft. lbs)
B2.1	Weld Metal	42.3 (31.2)
B2.2	within 1/16 in.	33.9 (25.0)
B2.3	of root	26.8 (19.8)
B3.1	Gr. 6 - HAZ	53.7 (39.6)
B3.2	Gr. 6 - HAZ	67.8 (50.0)
B3.3	Gr. 6 - HAZ	85.7 (63.2)
C3.1	Gr. LF2 - HAZ	32.0 (23.6)
C3.2	Gr. LF2 - HAZ	31.7 (23.4)
C3.3	Gr. LF2 - HAZ	35.8 (26.4)

OTHER TESTS

Vickers Hardness Survey - see attached lab test report # C12-846.2

Welders Name Cenon Tumolva Certificate File No. W-13950
 Tests Conducted By Ludwig Associates Ltd.
 Laboratory Test No. C12-846.2

We certify the statements in this record are correct and that the test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Manufacturer EXCHANGER INDUSTRIES LIMITED

Date JUNE 20, 2012 Certified by 



LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Exchanger Industries Limited
5505 - 52 Street S.E.
Calgary, Alberta
T2C 2W8

Laboratory Test No.: C12-846.2
Date: May 29, 2012

Attention: Danette Korchinski

PQR Number: RMD-2A
Material: SA 333 Gr. 6 to SA 350 Gr. LF2 (Heat No.: 84680 to 560184)
Size: 114.3 mm (4.50 in.) O.D. x 6.32 mm (0.249 in.) w.t.
Thermal Condition: As welded

TENSILE TEST QW-150

SAMPLE NUMBER	T1 QW-462.1(b)	T2 QW-462.1(b)
WIDTH mm (in)	19.0 (0.748)	19.1 (0.752)
THICKNESS mm (in)	5.04 (0.198)	4.84 (0.191)
AREA sq mm (sq in)	95.8 (0.148)	92.4 (0.143)
ULT. LOAD N (lbs)	49 087 (11,000)	47 503 (10,700)
UTS MPa (psi)	513 (74,300)	514 (74,500)
FRACTURE TYPE	Partial Cup & Cone	Partial Cup & Cone
FRACTURE LOCATION	Parent Metal (SA 333 Gr. 6)	Parent Metal (SA 333 Gr. 6)

GUIDED-BEND TEST QW-160

SAMPLE WIDTH:	38.1 mm (1.50 in.)	SAMPLE THICKNESS:	6.32 mm (0.249 in.)
PLUNGER SIZE:	25.1 mm (0.990 in.)	YOKE SIZE:	41.1 mm (1.62 in.)
QW-462.3(a)	Root Bend	Root Bend	Face Bend
SAMPLE NUMBER(S)	R1	R2	F1
RESULTS	Pass	Pass	Pass

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section IX, 2010 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. Samples associated with this report will be discarded in 45 days.

Laboratory Test Conducted By: _____


Claire Robinson, T.T. / Dan Nguyen, C.E.T.





LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Exchanger Industries Limited
5505 - 52 Street S.E.
Calgary, Alberta
T2C 2W8

Laboratory Test No.: C12-846.2
Date: May 25, 2012

Attention: Danette Korchinski

PQR Number: RMD-2A
Material: SA 333 Gr. 6 to SA 350 Gr. LF2 (Heat No.: 84680 to 560184)
Size: 114.3 mm (4.50 in.) O.D. x 6.32 mm (0.249 in.) w.t.
Thermal Condition: As welded

CHARPY V-NOTCH IMPACT TEST

Machine: Satec, SI-1C SN:1363 Specimen Size: 10 x 5 mm (0.394 x 0.197 in.)
Capacity: 325 J (240 ft-lbf) Orientation: Transverse
Verified Range: 1.7 - 141.3 J (1.3 - 104.2 ft-lbf) Test Temp.: -48°C (-55°F)

Specimen Number	Notch Location	Impact Values	
		Joules	(ft-lbf)
B2.1	Weld Metal within 1/16 in. of root	42.3	(31.2)
B2.2		33.9	(25.0)
B2.3		26.8	(19.8)
B3.1	Gr. 6 HAZ	53.7	(39.6)
B3.2		67.8	(50.0)
B3.3		85.7	(63.2)
C3.1	Gr. LF2 HAZ	32.0	(23.6)
C3.2		31.7	(23.4)
C3.3		35.8	(26.4)

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section VIII, Div. 1, UG-84 – 2010 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. **Samples associated with this report will be discarded in 45 days.**

Laboratory Test Conducted By: _____

Eric Dacyk, C.E.T. / Dan Nguyen, C.E.T.





LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Exchanger Industries Limited
5505 - 52 Street S.E.
Calgary, Alberta
T2C 2W8

Laboratory Test No.: C12-846.2
Date: May 25, 2012

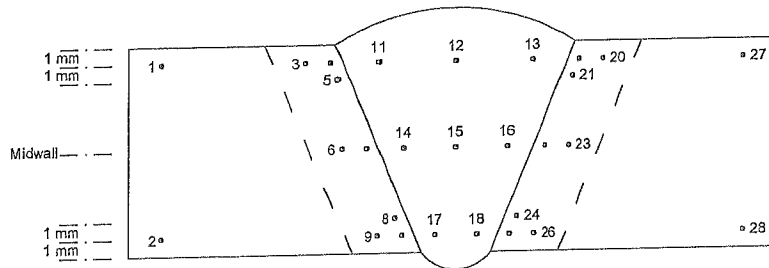
Attention: Danette Korchinski

PQR Number: RMD-2A
Material: SA 333 Gr. 6 to SA 350 Gr. LF2 (Heat No.: 84680 to 560184)
Size: 114.3 mm (4.50 in.) O.D. x 6.32 mm (0.249 in.) w.t.
Thermal Condition: As welded

HARDNESS TEST

Type of Test: Vickers 10 kg (HV10)

Instrument: Mitutoyo AVK-C1



SA 333 Gr. 6				Weld Metal		SA 350 Gr. LF2			
Parent Metal		HAZ				HAZ		Parent Metal	
1	174	3	199	11	184	19	186	27	170
2	168	4	189	12	185	20	168	28	156
		5	180	13	178	21	170		
		6	171	14	164	22	167		
		7	176	15	162	23	172		
		8	172	16	169	24	176		
		9	172	17	160	25	171		
		10	178	18	160	26	168		

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E384-10²² and ANSI/NACE MR0175/ISO 15156-2:2009(E). The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. **Samples associated with this report will be discarded in 45 days.**

Laboratory Test Conducted By: _____


Eric Dacyk, C.E.T. / Dan Nguyen, C.E.T.



INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

Customer / Cliente: VAN LEEUWEN PIPE & TUBE (CANADA) INC

Number / Número: 025625
Date / Día: December 04, 2011

Siderca S.A. C.
Dr. Jorge A. Simón 22A
(22000000A) Campana
Buenos Aires, Argentina
(54)3640 433-100 tel

Manufacturing Process / Proceso de Manufactura:
SEAMLESS HOT ROLLED

Product Type / Tipo de Producto:
CARBON STEEL FOR LOW TEMPERATURE SERVICE

Customer's Reference / Ref. del Cliente:
450014036-00021

Manufacturer's Works Order N° / Orden de Fabricación:
5088878

Schedule / Código:
1040

Surface / Superficie:
HOT BARE (EXT VARNISHED)

Standard or Specification / Normas o Especificaciones:
ASTM/A516 A516A333+CSA Z245.1-07 CATH \$SP\$P40374/1+NACE MR0175/0-103+IPRO LP-304

Ends / Extremos:
BEVELLED AT 30 DEG, ASTM

Dimensions / Dimensiones:
6.578 X 0.280 INCH
168.30 X 7.11 MM

Steel Grade / Grado de acero:
1187359 CAT II SS

Normal Weight / Peso Nominal:
18.97 LBS/FT
28.28 KGS/M

Length / Longitud:
NIF 11800 mm

Quantity / Cantidad: 48 Pcs/tpz
1847.83 FT
563.22 MTS

TENSILE TEST / ENSAYO DE TENSION

Heat N° Colada N°	Sample N° Muestra N°	Zone Zona	Lot N° Lote N°	Pipe N° Tubo N°	Specimen condition Condición de la probeta		Specimen dimensions Dimensiones de la probeta		Test temp Temp. ensayo	Y.S. Eul 0.50 %	U.T.S. Y.S./U.T.S		Elongation / Alargamiento				
					Ls	Sc	Type	Ort			Size	Section	Req.	Min.	Max.	Lo	2 ⁿ	Min.	Max.
84679	1741652	E2	49858	8	B	AM	SS	L	24.84 x 6.88	174.78	RT	436	511	4.85	50.8	33.0	36.6
84679	1741684	E1	49858	29	B	AM	SS	L	25.10 x 7.15	180.20	RT	435	510	4.85	50.8	33.0	34.1
84680	1740770	E1	49851	5	B	AM	SS	L	25.07 x 7.57	180.56	RT	465	534	4.87	50.8	33.0	34.9
84680	1740773	E2	49851	22	B	AM	SS	L	24.89 x 7.38	184.43	RT	428	507	4.84	50.8	33.0	37.9
84680	1740788	E2	49851	45	B	AM	SS	L	25.04 x 6.97	175.24	RT	441	512	4.88	50.8	33.0	36.4
84680	1740781	E1	49851	55	B	AM	SS	L	24.85 x 6.87	167.09	RT	431	503	4.88	50.8	33.0	36.4
84680	1740795	E2	49851	35	B	AM	SS	L	25.01 x 6.95	174.53	RT	448	524	4.86	50.8	33.0	35.6
84680	1741571	E2	49856	10	B	AM	SS	L	25.02 x 6.92	171.33	RT	447	523	4.86	50.8	33.0	34.7
84680	1741578	E1	49856	30	B	AM	SS	L	25.10 x 6.89	173.65	RT	460	533	4.87	50.8	33.0	33.3
84680	1741581	E1	49857	3	B	AM	SS	L	25.11 x 7.12	179.52	RT	438	517	4.84	50.8	33.0	37.0
84680	1741642	E1	49857	2B	B	AM	SS	L	24.92 x 7.43	185.91	RT	422	501	4.84	50.8	33.0	34.9

CG-3
GAPS sel 40
ASTM A333 Gr. 6
ASME SA333 Gr. 6
CSA Z245.1 Gr. 359
HE #84680
Rec'd May 18, 2012
STH

AM: As manufactured / Según proceso de fabricación
B: Body / Cuerpo
E1 / E2: Ends of Sampling / Extremos de Muestra
L: Longitudinal / Longitudinal
Lo: Initial length / Longitud inicial
Ls: Locallon of sample / Ubicación de la muestra
Max: Maximum / Máximo
Min: Minimum / Mínimo
Ort: Obtained / Obtenido
Ort: Orientation / Orientación
Req. Max: Required maximum / Máximo requerido
Req: Required / Requerido
RT: Room temperature / Temperatura ambiente
Sc: Specimen condition / Condición de la probeta
Ss: Strip specimen / Muestra rectangular

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APPROVED BY

FORG3171



Tenaris

INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

Customer / Cliente: VAN LEEUWEN PIPE & TUBE (CANADA) IN

Number / Número: 635625

Page / Página: 2 / 3

Date / Día: December 14, 2011

Customer's Reference / Ref. del Cliente: 45101408

Manufacturer's Works Order N° / Orden de Fabricación: 50858718

Siderca S.A.I.C
D. Jorge A. Simoni 250
19200 (740) Compañera
Buenos Aires, Argentina
Tel: 3469 4333 100 Int.

Manufacturing Process / Proceso de Manufactura: SEAMLESS HOT ROLLED

Product Type / Tipo de Producto: CARBON STEEL FOR LOW TEMPERATURE SERVICE

Steel Grade / Grado de acero: 16MNS5 CAT II SS

Quantity / Cantidad: 48 Pcs/pz

1847.83 FT

563.22 MTS

35300 LB

14042 KG

Customer's Order Item / Orden Cliente - Item: 45101408-00021

Manufacturer's Reference / Ref. del Cliente: 45101408

Surface / Superficie: INT BARE / EXT VARNISHED

Ends / Extremos: BEVELLED AT 30 DEG. ASTM

Nominal Weight / Peso Nominal: 10.97 LB/FT

28.28 KG/M

CHEMICAL COMPOSITION / COMPOSICION QUIMICA

Composition % / Composición %

Heat N° Colecta N°	Sample N° Muestra N°	Lot N° Lote N°	Pipe N° Tubo N°	H	Max	Min	Composition % / Composición %																							
							C	Mn	Si	Cr	Mo	Al sol	S	P	Ni	V	Cu	Al	Sh	As	Nb	Ti	Pb	Sb	Co	Zn	Bi	Ga	B	N	Mg	W	Ce-1	Ce-2
84679	1741652	49858	8	9	105	25	6	4	2	1	12	35	3	74	23	6	3	15	4	1	2	20	22	10	2	44	5	20	29	22
84679	1741654	49853	29	9	107	26	6	4	3	1	10	26	2	50	24	5	3	15	3	1	2	20	22	14	2	45	4	20	28	20
84680	1740791	49831	65	9	105	25	6	4	3	1	11	23	3	52	25	5	3	16	4	1	1	20	22	16	2	46	4	20	29	23
84680	1741573	49857	30	9	105	25	6	4	3	1	11	23	2	50	25	5	3	15	3	1	2	20	22	19	2	52	6	20	28	22
84680	1741571	49855	5	9	105	25	6	4	3	1	11	23	2	50	25	5	3	15	3	1	2	20	22	20	2	50	5	20	29	22
84680	1740795	49831	10	9	104	24	6	4	3	1	11	29	2	68	25	6	3	16	3	1	2	20	22	14	2	55	3	20	28	21
84680	1741642	49857	23	9	108	25	6	4	3	1	10	26	2	49	23	5	3	15	3	1	2	20	22	14	2	53	3	20	26	20
84680	1740773	49831	22	9	104	25	6	4	3	1	11	38	2	73	21	7	4	15	3	1	2	20	22	18	2	53	4	10	29	22
84680	1740770	49831	5	9	106	25	6	4	3	1	10	25	2	50	24	6	3	16	3	1	2	20	22	18	2	50	4	10	29	23
84680	1740785	49831	45	9	105	25	6	4	3	1	10	27	2	51	23	5	3	15	3	1	2	20	22	18	2	56	4	10	28	22

Ce-1: C+(Mn/6)+(Cr+Mo+V)/5+(Ni+Cu)/15

Ce-2: C+(Mn/6)+(Si/2)+(Cu/15)+(Ni/20)+(Cr+Mo+V+Nb)/5+(S/B)

H: Heat / Colecta

M: Maximum / Máximo

Min: Minimum / Mínimo

P: Product / Producto

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FOR03171



INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

Number / Número: **635625**

Date / Día: **December 14, 2011**

Pages / Páginas: **3 / 8**

Soldeira S.A.I.C.
 Dr. 4535/A, Smpm 1 253
 Buenos Aires, Argentina
 Tel: 5411 4389 4331 00 141

Customer / Cliente: **VAN LEEUWEN PIPE & TUBE (CANADA) INC**

Product Type / Tipo de Producto: **CARBON STEEL FOR LOW TEMPERATURE SERVICE**

Customer's Order Item / Orden Cliente - Item: **45901408-00021**

Customer's Reference / Ref. del Cliente: **45901408**

Manufacturer's Works Order N° / Orden de Trabajo: **50886716**

Surface / Superficie: **INT BARE / EXT VARINISHED**

Ends / Extremos: **BEVELLED AT 40 DEG. ASTM**

Nominal Weight / Peso Nominal: **18.97 LEFT**

Weight / Peso: **38.36 KG**

Steel Grade / Grado de acero: **1/81359 GAY II SS**

Quantity / Cantidad: **48 Pcs/pe**

Length / Longitud: **11800 MM**

Schedule / Cédula: **040**

Dimensions / Dimensiones: **6 5/8 X 0.280 INCH**

Dimensions / Dimensiones: **168.30 X 7.11 MM**

Standard or Specification / Normas o Especificaciones: **ASTM A 537B / CSA Z245.1-07 CAT III SSPS 093741-1-NACE MR0175103-1 PRO LP-005**

SEAMLESS HOT ROLLED

SEAMLESS HOT ROLLED

SEAMLESS HOT ROLLED

SEAMLESS HOT ROLLED

SEAMLESS HOT ROLLED

SEAMLESS HOT ROLLED

SEAMLESS HOT ROLLED

SEAMLESS HOT ROLLED

SEAMLESS HOT ROLLED

SEAMLESS HOT ROLLED

THROUGH WALL HARDNESS / DUREZA EN EL ESPESOR

Heat N° Código N°	Sample N° / Zona Muestra N° / Zona	E1	E2	Individuals / Individuales				Average / Promedio				Hardness type HV10 Tipo de dureza	ID	3	4	AVG.	Var.	
				Min	Max	Var	Min	Max	Var	1	2							3	4	1	2	3	4	AVG.	Var.
84679	1741652	E2	B	162.0	156.0	153.0	168.0	157.3	158.0	160.0	162.0	162.0	162.0	158.5	155.0	160.0	156.3	2.3
84680	1741684	E1	B	163.0	159.0	164.0	165.0	162.0	158.0	165.0	167.0	166.0	166.0	164.0	165.0	167.0	166.0	1.3
84680	1740770	E1	B	169.0	167.0	162.0	166.0	166.0	165.0	167.0	169.0	168.0	167.5	168.0	166.0	166.0	166.0	2.3
84680	1740775	E2	B	162.0	153.0	154.0	165.0	166.0	161.0	162.0	161.0	166.0	165.0	160.0	162.0	162.0	160.5	4.5
84680	1740791	E1	B	161.0	158.0	161.0	161.0	160.3	159.0	163.0	163.0	163.0	160.0	160.0	160.0	160.0	159.3	1.0
84680	1740795	E2	B	158.0	165.0	160.0	162.0	163.8	158.0	163.0	163.0	163.0	160.0	160.0	160.0	160.0	154.5	9.3
84680	1741571	E1	B	158.0	166.0	165.0	165.0	162.8	163.0	167.0	168.0	168.0	164.0	163.0	165.0	162.0	163.0	4.5
84680	1741578	E1	B	163.0	159.0	164.0	165.0	162.8	168.0	167.0	165.0	166.0	164.0	163.0	165.0	162.0	163.0	1.3
84680	1741581	E1	B	161.0	158.0	160.0	166.0	162.8	163.0	167.0	168.0	168.0	163.0	161.0	161.0	162.0	163.0	1.3
84680	1741642	E1	B	149.0	143.0	150.0	151.0	148.3	145.0	145.0	147.0	150.0	149.5	148.0	145.0	148.0	149.0	1.3

Avg: Average / Promedio
 B: Body / Cuerpo
 E1 / E2: Ends of Sampling / Extremos de Muestra
 ID: Internal diameter / Diámetro interno
 Lc: Location of sample / Ubicación de la muestra
 Max: Maximum / Máximo
 Min: Minimum / Mínimo
 MW: Middle wall / Centro
 OD: Outside diameter / Diámetro externo
 Quant: Quantity / Cantidad
 Var: Variation / Variedad

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FOR03171



INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

Number / Número: 035625

Date / Día: December 14, 2011

Page / Página: 4 / 8

Customer / Cliente: VAN LEEUWEN PIPE & TUBE (CANADA) IN
 Manufacturing Process / Proceso de Manufactura: SEAMLESS HOT ROLLED
 Standard or Specification / Normas o Especificaciones: ASTM A53A S33+CSA Z245.1-07 CATH SSPSP003741+NAACE MR0175103+PRO LP-006

Customer's Order Item / Orden Cliente - Item: 45004406-00124

Product Type / Tipo de Producto: CARBON STEEL FOR LOW TEMPERATURE SERVICE

Manufacturer's Works Order N° / Orden de Fabricación: 50590710

Surface / Superficie: INT BARE TEXT VARNISHED

Ends / Extremos: BEVELLED AT 30 DEG. ASTM

Nominal Weight / Peso Nominal: 12.57 LB/FT

28.26 KG/M

Quantity / Cantidad: 48 Pcs/pz

1847.83 FT

563.22 MTS

Steel Grade / Grado de acero: 1/61359 CAT II SS

Length / Longitud: MF 11800 mm

Schedule / Gredite: 1040

Dimensions / Dimensiones: 6 5/8 X 0.288 INCH

169.30 X 7.11 MM

IMPACT TEST / ENSAYO DE IMPACTO

Heat N° Cofecha N°	Sample N° Muestra N°	Lot N° Lote N°	Pipe N° Tubo N°	Orientation/Orientación: T		Temp: -45		Unit / Unidad: J			Shear area / Área de corte %							
				Sc	La	T.T	Size / Tamaño	Ind. Min. Req.	Req. Min. Avg.	14	1	2	3	1	2	3	Avg.	
84679	1741684	49856	20	B	AM	-45	10.0 x 5.0	137.0	141.0	164.0	147.3	100	100	100	100	100	100	100
84680	1740770	49851	5	B	AM	-45	10.0 x 5.0	166.0	164.0	166.0	165.3	100	100	100	100	100	100	100
84680	1741578	49856	30	B	AM	-45	10.0 x 5.0	124.0	141.0	133.0	132.7	100	100	100	100	100	100	100
84680	1741581	49857	5	B	AM	-45	10.0 x 5.0	184.0	146.0	144.0	149.3	100	100	100	100	100	100	100

AM: As manufactured / Según proceso de fabricación

Avg: Average / Promedio

B: Body / Cuerpo

Ind. Min. Req: Individual Minimum Required /

Req: Minimum Required /

Req. Min. Avg: Required minimum average / Promedio

Sc: Specimen condition / Condición de la probeta

T.T: Test temperature / Temperatura de ensayo

Unit / Unidad: J

Heat N° Cofecha N°	Sample N° Muestra N°	Lot N° Lote N°	Pipe N° Tubo N°	Orientation/Orientación: L		Temp: -52		Unit / Unidad: J			Req. Min. Avg: 9			
				Sc	La	T.T	Size / Tamaño	Ind. Min. Req.	Req. Min. Avg.	7	3	Avg.		
84679	1741684	49856	20	B	AM	-52	10.0 x 5.0	173.0	164.0	170.0	169.0	100	100	100
84680	1740770	49851	5	B	AM	-52	10.0 x 5.0	155.0	165.0	158.0	159.3	100	100	100
84680	1741578	49856	30	B	AM	-52	10.0 x 5.0	170.0	167.0	171.0	169.3	100	100	100
84680	1741581	49857	5	B	AM	-52	10.0 x 5.0	161.0	166.0	147.0	158.0	100	100	100

AM: As manufactured / Según proceso de fabricación

Avg: Average / Promedio

B: Body / Cuerpo

Ind. Min. Req: Individual Minimum Required /

Req: Minimum Required /

Req. Min. Avg: Required minimum average / Promedio

Sc: Specimen condition / Condición de la probeta

T.T: Test temperature / Temperatura de ensayo

Unit / Unidad: J

This certificate is issued by a computerized system and it is valid only electronic signature. On the original certificate the trade-mark green colored "Tenaris" is stamped. In case the owner of the original certificate would release a copy of it, his must attest the conformity to the original one taking upon himself the responsibility for any unlawful or not allowed use. Any alteration in the original certificate will be subjected to the law.

FOR08171



INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

Number / Número: **635625**
 Page / Página: **5 / 8**

Date / Día: **December 14, 2011**

Customer's Reference / Ref. del Cliente:
45007408

Manufacturer's Works Order N° / Orden de Compra:
50989748

Customer / Cliente: **VAN LEEUWEN PIPE & TUBE (CANADA) IN**

Product Type / Tipo de Producto:
CARBON STEEL FOR LOW TEMPERATURE SERVICE

Steel Grade / Grado de acero:
1.8359 CAT II SS

Quantity / Cantidad: **48 Pcs/pz**
1847.83 FT
563.22 MTS

Length / Longitud:
040

Schedule / Cédula:
040

Dimensions / Dimensiones:
Ø 57.6 X 6.28Ø INCH
1.58.30 X 7.71 MM

Standard or Specification / Normas o Especificaciones:
ASTM/A516/A516M/A516-04

Surfaces / Superficies:
INT BARE / EXT VARNISHED

Ends / Extremos:
BEVELLED AT 30 DEG. ASTM

Nominal Weight / Peso Nominal:
18.97 LB/FT
23.28 KG/M

Manufacturer's Works Order N° / Orden de Compra:
50989748

Surfaces / Superficies:
INT BARE / EXT VARNISHED

Ends / Extremos:
BEVELLED AT 30 DEG. ASTM

Nominal Weight / Peso Nominal:
18.97 LB/FT
23.28 KG/M

Manufacturer's Works Order N° / Orden de Compra:
50989748

Surfaces / Superficies:
INT BARE / EXT VARNISHED

Ends / Extremos:
BEVELLED AT 30 DEG. ASTM

Nominal Weight / Peso Nominal:
18.97 LB/FT
23.28 KG/M

IMPACT TEST / ENSAYO DE IMPACTO

L: Longitudinal / Longitudinal

Temp: Temperatura / Temperatura

FLATTENING TEST / ENSAYO DE APLASTAMIENTO

L: Longitudinal / Longitudinal

Temp: Temperatura / Temperatura

HYDROSTATIC TEST / PRUEBA HIDRAULICA

L: Location of samples / Ubicación de la muestra

Temp: Temperatura / Temperatura

Heat N° / Colada N°	Lot N° / Lote N°	Sample N° / Muestra N°	Result / Resultado
84680	49831	1740791	Good / Bueno
84680	49831	1740795	Good / Bueno
84680	49857	1741642	Good / Bueno

Heat N° / Colada N°	Lot N° / Lote N°	Sample N° / Muestra N°	Result / Resultado
84680	49831	1740788	Good / Bueno
84680	49831	1740791	Good / Bueno
84680	49831	1740795	Good / Bueno
84680	49857	1741571	Good / Bueno

Heat N° / Colada N°	Lot N° / Lote N°	Sample N° / Muestra N°	Result / Resultado
84680	49858	1741682	Good / Bueno
84680	49858	1741684	Good / Bueno
84680	49831	1740770	Good / Bueno
84680	49831	1740773	Good / Bueno

B: Body / Cuerpo

L: Location of samples / Ubicación de la muestra

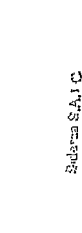
B: Body / Cuerpo

Pressure / Presión	Time / Tiempo	Results / Resultados
Value / Valor	Seconds / Segundos	Satisfactory / Satisfactorio
P=8t	5	

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the trademark green colored "Tennis" is stamped. In case the owner of the original certificate would release a copy of it, the most attest its conformity to the original one falling upon himself the responsibility for any misuse or not allowed use. Any alteration and/or falsification will be subject to the law.

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FOR03171



INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

Customer / Cliente: VAN LEEUWEN PIPE & TUBE (CANADA) IN

Number / Número: 635625

Date / Día: December 14, 2011

Page / Página: 6 / 8

Customer's Order Item / Orden Cliente - Item: 45001408

Customer's References / Ref. del Cliente: 45001408

Manufacturer's Works Order N° / Orden de Trabajo: 50886718

Surface / Superficie: INT BARE / EXT VARNISHED

Ends / Extremos: BEVELLED AT 30 DEG. ASTM

Nominal Weight / Peso Nominal: 15.97 LB/FT

26.25 KG/M

Product Type / Tipo de Producto: CARBON STEEL FOR LOW TEMPERATURE SERVICE

Steel Grade / Grado de acero: 16Mn55 CAT II SS

Quantity / Cantidad: 48 Pcs/pz

35500 LB

1647.85 FT

563.22 MTS

Length / Longitud: MF 11800 mm

Schedule / Cédula: 040

ASTM/A516 AS4333+CSA Z245.1-07 CAT II SSPSP00374/1+VANCE MROV75/0103+IPRO LP-006

Standard or Specification / Normas o Especificaciones:

SEAMLESS HOT ROLLED

Dimensions / Dimensiones:

8 5/8 X 0.280 INCH

168.30 X 7.11 mm

Heat treatment / Tratamiento térmico: Pipe / Tubo

Quench media of heat treatment process / Medio de enfriamiento del tratamiento térmico: WATER

Temperature Scale / Escala de Temperatura: Celsius

Temperature / Temperatura

800

685

Condition / Condición

PIPE RESIDUAL MAGNETISM / Magnetismo remanente de tubo

End protectors / Protector de extremo

30 GAUSS

NON LIFTABLE CLOSED PLASTIC PROTECTOR FOR FLAT / BEVELLED PIPE SUPPLIER METALCENTRO.

SPECIAL REQUIREMENTS / REQUERIMIENTOS ESPECIALES

SUPPLEMENTARY INFORMATION / INFORMACION SUPLEMENTARIA

MANUFACTURED BY TENARIS SIDERCA

ACIERAGE PROCESS

STEEL MAKING PROCESS: E.A.F.L.F. AND CONTINUOUS CASTING - FULL ALUMINIUM KILLED AND FINE GRAIN PRACTICE

THE LF PRACTICE INCLUDES ARGON RINSE AND A FINAL INJECTION OF CALCIUM SILICIDE WIRE FOR MICROINCLUSIONS SHAPE CONTROL.

Supplementary Information / Información Suplementaria

FABRICADO POR TENARIS SIDERCA

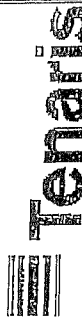
PROCESO DE ACERACION

FABRICACION DE ACERO: FUNDICION POR ARCO ELÉCTRICO Y COLADO CONTINUO - ACOERO CALMADO AL ALUMINIO

LA PRÁCTICA DE AFINO EN EL HORNO - CUCHARA INCLUYE AGITACION POR ARGON Y UNA INYECCION FINAL DE WIRE PARA LA PRÁCTICA DE SILICIO DE CALCIO PARA OBTENER UNA FORMA GLOBULAR DE EVENTUALES MICROINCLUSIONES.

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FOR09171



INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

Customer / Cliente: VAN LEEUWEN PIPE & TUBE (CANADA) IN

Manufacturing Process / Proceso de Manufactura:
SEAMLESS HOT ROLLED

Product Type / Tipo de Producto:
CARBON STEEL FOR LOW TEMPERATURE SERVICE

Customer's Order Item / Orden Cliente - Item:
45007408-00021

Customer's Reference / Ref. del Cliente:
45007408

Number / Número:
635625

Date / Día: December 14, 2011

Page / Página:
7 / 8

Manufacturer's Works Order N° / Continente de Fabricación:
30886716

Surface / Superficie:
INT BARE (EXT VARNISHED)

Ends / Extremos:
BEVELLED AT 30 DEG. ASTM

Nominal Weight / Peso Nominal:
18.87 LB/FT

Weight / Peso:
28.28 KG/M

Steel Grade / Grado de acero:
1/6/359 CAT II SS

Quantity / Cantidad: 48 Pieces
1847.83 FT

Weight / Peso: 35300 LB
16012 KG

Length / Longitud:
W/F 1480 mm

Schedule / Cédula:
040

Standard / Norma:
ASTM/A515/A515M

SUPPLEMENTARY INFORMATION / INFORMACION SUPLEMENTARIA

Supplementary Information / Información Suplementaria

- *MATERIAL FREE FROM MERCURY CONTAMINATION.
- *ROLLING PROCESS*
- *MANUFACTURING PROCESS : SEAMLESS HOT ROLLED.
- *CONTROLS*
- *VISUAL AND DIMENSIONAL INSPECTION : SATISFACTORY.
- *MATERIAL CONDITIONS*
- *NOT REPAIRED BY WELDING.
- *STANDARDS*
- EDITION OF REGULATION: ASTM A 333-11
- EDITION OF REGULATION: ASME SA 333/2010
- EDITION OF REGULATION: NACE MR-01-03 EDITION 2010
- EDITION OF REGULATION: NACE MR 01-75 - ISO 15156-2 : 2009
- EDITION OF REGULATION : CSA Z245 : 2007

Additional Information / Información Adicional

NON DESTRUCTIVE TEST: SATISFACTORY.
INSPECTION METHODS: E.M.I. LONG. (EXT); NOTCH 5% (INT); NOTCH 10% + E.M.I. TRANSV. (EXT/JNT); NOTCH 10% + M.P.I. LONG./TRANSV. (EXT./INT.); ENDS + W.M.P.I. ON BEVELS.

Additional Information / Información Adicional

WALL THICKNESS MONITORING: U.T. LONGITUDINAL PATH.
ONE YELLOW BAND ON EACH END.

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INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

Customer / Cliente: VAN LEEUWEN PIPE & TUBE (CANADA) IN

Manufacturing Process / Proceso de Manufactura: SEAMLESS HOT ROLLED

Product Type / Tipo de Producto: CARBON STEEL FOR LOW TEMPERATURE SERVICE

Customer's Order-Item / Orden Cliente - Item: 45001408-00024

Standard or Specification / Normas o Especificaciones: ASTM/A516/A516M/A516S/A516T/A516W/A516X/A516Y/A516Z/A516AA/A516AB/A516AC/A516AD/A516AE/A516AF/A516AG/A516AH/A516AJ/A516AK/A516AL/A516AM/A516AN/A516AO/A516AP/A516AQ/A516AR/A516AS/A516AT/A516AU/A516AV/A516AW/A516AX/A516AY/A516AZ/A516BA/A516BB/A516BC/A516BD/A516BE/A516BF/A516BG/A516BH/A516BI/A516BJ/A516BK/A516BL/A516BM/A516BN/A516BO/A516BP/A516BQ/A516BR/A516BS/A516BT/A516BU/A516BV/A516BW/A516BX/A516BY/A516BZ/A516CA/A516CB/A516CC/A516CD/A516CE/A516CF/A516CG/A516CH/A516CI/A516CJ/A516CK/A516CL/A516CM/A516CN/A516CO/A516CP/A516CQ/A516CR/A516CS/A516CT/A516CU/A516CV/A516CW/A516CX/A516CY/A516CZ/A516DA/A516DB/A516DC/A516DD/A516DE/A516DF/A516DG/A516DH/A516DI/A516DJ/A516DK/A516DL/A516DM/A516DN/A516DO/A516DP/A516DQ/A516DR/A516DS/A516DT/A516DU/A516DV/A516DW/A516DX/A516DY/A516DZ/A516EA/A516EB/A516EC/A516ED/A516EE/A516EF/A516EG/A516EH/A516EI/A516EJ/A516EK/A516EL/A516EM/A516EN/A516EO/A516EP/A516EQ/A516ER/A516ES/A516ET/A516EU/A516EV/A516EW/A516EX/A516EY/A516EZ/A516FA/A516FB/A516FC/A516FD/A516FE/A516FF/A516FG/A516FH/A516FI/A516FJ/A516FK/A516FL/A516FM/A516FN/A516FO/A516FP/A516FQ/A516FR/A516FS/A516FT/A516FU/A516FV/A516FW/A516FX/A516FY/A516FZ/A516GA/A516GB/A516GC/A516GD/A516GE/A516GF/A516GG/A516GH/A516GI/A516GJ/A516GK/A516GL/A516GM/A516GN/A516GO/A516GP/A516GQ/A516GR/A516GS/A516GT/A516GU/A516GV/A516GW/A516GX/A516GY/A516GZ/A516HA/A516HB/A516HC/A516HD/A516HE/A516HF/A516HG/A516HH/A516HI/A516HJ/A516HK/A516HL/A516HM/A516HN/A516HO/A516HP/A516HQ/A516HR/A516HS/A516HT/A516HU/A516HV/A516HW/A516HX/A516HY/A516HZ/A516IA/A516IB/A516IC/A516ID/A516IE/A516IF/A516IG/A516IH/A516II/A516IJ/A516IK/A516IL/A516IM/A516IN/A516IO/A516IP/A516IQ/A516IR/A516IS/A516IT/A516IU/A516IV/A516IW/A516IX/A516IY/A516IZ/A516JA/A516JB/A516JC/A516JD/A516JE/A516JF/A516JG/A516JH/A516JI/A516JJ/A516JK/A516JL/A516JM/A516JN/A516JO/A516JP/A516JQ/A516JR/A516JS/A516JT/A516JU/A516JV/A516JW/A516JX/A516JY/A516JZ/A516KA/A516KB/A516KC/A516KD/A516KE/A516KF/A516KG/A516KH/A516KI/A516KJ/A516KK/A516KL/A516KM/A516KN/A516KO/A516KP/A516KQ/A516KR/A516KS/A516KT/A516KU/A516KV/A516KW/A516KX/A516KY/A516KZ/A516LA/A516LB/A516LC/A516LD/A516LE/A516LF/A516LG/A516LH/A516LI/A516LJ/A516LK/A516LL/A516LM/A516LN/A516LO/A516LP/A516LQ/A516LR/A516LS/A516LT/A516LU/A516LV/A516LW/A516LX/A516LY/A516LZ/A516MA/A516MB/A516MC/A516MD/A516ME/A516MF/A516MG/A516MH/A516MI/A516MJ/A516MK/A516ML/A516MN/A516MO/A516MP/A516MQ/A516MR/A516MS/A516MT/A516MU/A516MV/A516MW/A516MX/A516MY/A516MZ/A516NA/A516NB/A516NC/A516ND/A516NE/A516NF/A516NG/A516NH/A516NI/A516NJ/A516NK/A516NL/A516NM/A516NO/A516NP/A516NQ/A516NR/A516NS/A516NT/A516NU/A516NV/A516NW/A516NX/A516NY/A516NZ/A516OA/A516OB/A516OC/A516OD/A516OE/A516OF/A516OG/A516OH/A516OI/A516OJ/A516OK/A516OL/A516OM/A516ON/A516OO/A516OP/A516OQ/A516OR/A516OS/A516OT/A516OU/A516OV/A516OW/A516OX/A516OY/A516OZ/A516PA/A516PB/A516PC/A516PD/A516PE/A516PF/A516PG/A516PH/A516PI/A516PJ/A516PK/A516PL/A516PM/A516PN/A516PO/A516PP/A516PQ/A516PR/A516PS/A516PT/A516PU/A516PV/A516PW/A516PX/A516PY/A516PZ/A516QA/A516QB/A516QC/A516QD/A516QE/A516QF/A516QG/A516QH/A516QI/A516QJ/A516QK/A516QL/A516QM/A516QN/A516QO/A516QP/A516QQ/A516QR/A516QS/A516QT/A516QU/A516QV/A516QW/A516QX/A516QY/A516QZ/A516RA/A516RB/A516RC/A516RD/A516RE/A516RF/A516RG/A516RH/A516RI/A516RJ/A516RK/A516RL/A516RM/A516RN/A516RO/A516RP/A516RQ/A516RR/A516RS/A516RT/A516RU/A516RV/A516RW/A516RX/A516RY/A516RZ/A516SA/A516SB/A516SC/A516SD/A516SE/A516SF/A516SG/A516SH/A516SI/A516SJ/A516SK/A516SL/A516SM/A516SN/A516SO/A516SP/A516SQ/A516SR/A516SS/A516ST/A516SU/A516SV/A516SW/A516SX/A516SY/A516SZ/A516TA/A516TB/A516TC/A516TD/A516TE/A516TF/A516TG/A516TH/A516TI/A516TJ/A516TK/A516TL/A516TM/A516TN/A516TO/A516TP/A516TQ/A516TR/A516TS/A516TT/A516TU/A516TV/A516TW/A516TX/A516TY/A516TZ/A516UA/A516UB/A516UC/A516UD/A516UE/A516UF/A516UG/A516UH/A516UI/A516UJ/A516UK/A516UL/A516UM/A516UN/A516UO/A516UP/A516UQ/A516UR/A516US/A516UT/A516UU/A516UV/A516UW/A516UX/A516UY/A516UZ/A516VA/A516VB/A516VC/A516VD/A516VE/A516VF/A516VG/A516VH/A516VI/A516VJ/A516VK/A516VL/A516VM/A516VN/A516VO/A516VP/A516VQ/A516VR/A516VS/A516VT/A516VU/A516VV/A516VW/A516VX/A516VY/A516VZ/A516WA/A516WB/A516WC/A516WD/A516WE/A516WF/A516WG/A516WH/A516WI/A516WJ/A516WK/A516WL/A516WM/A516WN/A516WO/A516WP/A516WQ/A516WR/A516WS/A516WT/A516WU/A516WV/A516WW/A516WX/A516WY/A516WZ/A516XA/A516XB/A516XC/A516XD/A516XE/A516XF/A516XG/A516XH/A516XI/A516XJ/A516XK/A516XL/A516XM/A516XN/A516XO/A516XP/A516XQ/A516XR/A516XS/A516XT/A516XU/A516XV/A516XW/A516XX/A516XY/A516XZ/A516YA/A516YB/A516YC/A516YD/A516YE/A516YF/A516YG/A516YH/A516YI/A516YJ/A516YK/A516YL/A516YM/A516YN/A516YO/A516YP/A516YQ/A516YR/A516YS/A516YT/A516YU/A516YV/A516YW/A516YX/A516YY/A516YZ/A516ZA/A516ZB/A516ZC/A516ZD/A516ZE/A516ZF/A516ZG/A516ZH/A516ZI/A516ZJ/A516ZK/A516ZL/A516ZM/A516ZN/A516ZO/A516ZP/A516ZQ/A516ZR/A516ZS/A516ZT/A516ZU/A516ZV/A516ZW/A516ZX/A516ZY/A516ZZ

Steel Grade / Grado de acero: 1/8/359 CAT II SS

Quantity / Cantidad: 48 Pcs/Pz

Weight / Peso: 36300 LB / 16474.83 FT

Net Weight / Peso Nominal: 593.22 MTS / 16012 KGS

MARKING / MARCACION

Marking / Marcación

- @ = Monogram / Monogram API
- MM.YY = Mes / Año Month / Year
- YJ = Año / Time/Year Year / Quarter
- HNX-XXX = Coleada / Heat

Stencilling (Pipe) / Estampado (Tubo)

TENARIS SD MM.YY ASTM/A516-A516M-A516S-A516T-A516W-A516X-A516Y-A516Z-A516AA-A516AB-A516AC-A516AD-A516AE-A516AF-A516AG-A516AH-A516AJ-A516AK-A516AL-A516AM-A516AN-A516AO-A516AP-A516AQ-A516AR-A516AS-A516AT-A516AU-A516AV-A516AW-A516AX-A516AY-A516AZ-A516BA-A516BB-A516BC-A516BD-A516BE-A516BF-A516BG-A516BH-A516BI-A516BJ-A516BK-A516BL-A516BM-A516BN-A516BO-A516BP-A516BQ-A516BR-A516BS-A516BT-A516BU-A516BV-A516BW-A516BX-A516BY-A516BZ-A516CA-A516CB-A516CC-A516CD-A516CE-A516CF-A516CG-A516CH-A516CI-A516CJ-A516CK-A516CL-A516CM-A516CN-A516CO-A516CP-A516CQ-A516CR-A516CS-A516CT-A516CU-A516CV-A516CW-A516CX-A516CY-A516CZ-A516DA-A516DB-A516DC-A516DD-A516DE-A516DF-A516DG-A516DH-A516DI-A516DJ-A516DK-A516DL-A516DM-A516DN-A516DO-A516DP-A516DQ-A516DR-A516DS-A516DT-A516DU-A516DV-A516DW-A516DX-A516DY-A516DZ-A516EA-A516EB-A516EC-A516ED-A516EE-A516EF-A516EG-A516EH-A516EI-A516EJ-A516EK-A516EL-A516EM-A516EN-A516EO-A516EP-A516EQ-A516ER-A516ES-A516ET-A516EU-A516EV-A516EW-A516EX-A516EY-A516EZ-A516FA-A516FB-A516FC-A516FD-A516FE-A516FF-A516FG-A516FH-A516FI-A516FJ-A516FK-A516FL-A516FM-A516FN-A516FO-A516FP-A516FQ-A516FR-A516FS-A516FT-A516FU-A516FV-A516FW-A516FX-A516FY-A516FZ-A516GA-A516GB-A516GC-A516GD-A516GE-A516GF-A516GG-A516GH-A516GI-A516GJ-A516GK-A516GL-A516GM-A516GN-A516GO-A516GP-A516GQ-A516GR-A516GS-A516GT-A516GU-A516GV-A516GW-A516GX-A516GY-A516GZ-A516HA-A516HB-A516HC-A516HD-A516HE-A516HF-A516HG-A516HH-A516HI-A516HJ-A516HK-A516HL-A516HM-A516HN-A516HO-A516HP-A516HQ-A516HR-A516HS-A516HT-A516HU-A516HV-A516HW-A516HX-A516HY-A516HZ-A516IA-A516IB-A516IC-A516ID-A516IE-A516IF-A516IG-A516IH-A516II-A516IJ-A516IK-A516IL-A516IM-A516IN-A516IO-A516IP-A516IQ-A516IR-A516IS-A516IT-A516IU-A516IV-A516IW-A516IX-A516IY-A516IZ-A516JA-A516JB-A516JC-A516JD-A516JE-A516JF-A516JG-A516JH-A516JI-A516JJ-A516JK-A516JL-A516JM-A516JN-A516JO-A516JP-A516JQ-A516JR-A516JS-A516JT-A516JU-A516JV-A516JW-A516JX-A516JY-A516JZ-A516KA-A516KB-A516KC-A516KD-A516KE-A516KF-A516KG-A516KH-A516KI-A516KJ-A516KK-A516KL-A516KM-A516KN-A516KO-A516KP-A516KQ-A516KR-A516KS-A516KT-A516KU-A516KV-A516KW-A516KX-A516KY-A516KZ-A516LA-A516LB-A516LC-A516LD-A516LE-A516LF-A516LG-A516LH-A516LI-A516LJ-A516LK-A516LL-A516LM-A516LN-A516LO-A516LP-A516LQ-A516LR-A516LS-A516LT-A516LU-A516LV-A516LW-A516LX-A516LY-A516LZ-A516MA-A516MB-A516MC-A516MD-A516ME-A516MF-A516MG-A516MH-A516MI-A516MJ-A516MK-A516ML-A516MN-A516MO-A516MP-A516MQ-A516MR-A516MS-A516MT-A516MU-A516MV-A516MW-A516MX-A516MY-A516MZ-A516NA-A516NB-A516NC-A516ND-A516NE-A516NF-A516NG-A516NH-A516NI-A516NJ-A516NK-A516NL-A516NM-A516NO-A516NP-A516NQ-A516NR-A516NS-A516NT-A516NU-A516NV-A516NW-A516NX-A516NY-A516NZ-A516OA-A516OB-A516OC-A516OD-A516OE-A516OF-A516OG-A516OH-A516OI-A516OJ-A516OK-A516OL-A516OM-A516ON-A516OO-A516OP-A516OQ-A516OR-A516OS-A516OT-A516OU-A516OV-A516OW-A516OX-A516OY-A516OZ-A516PA-A516PB-A516PC-A516PD-A516PE-A516PF-A516PG-A516PH-A516PI-A516PJ-A516PK-A516PL-A516PM-A516PN-A516PO-A516PP-A516PQ-A516PR-A516PS-A516PT-A516PU-A516PV-A516PW-A516PX-A516PY-A516PZ-A516QA-A516QB-A516QC-A516QD-A516QE-A516QF-A516QG-A516QH-A516QI-A516QJ-A516QK-A516QL-A516QM-A516QN-A516QO-A516QP-A516QQ-A516QR-A516QS-A516QT-A516QU-A516QV-A516QW-A516QX-A516QY-A516QZ-A516RA-A516RB-A516RC-A516RD-A516RE-A516RF-A516RG-A516RH-A516RI-A516RJ-A516RK-A516RL-A516RM-A516RN-A516RO-A516RP-A516RQ-A516RR-A516RS-A516RT-A516RU-A516RV-A516RW-A516RX-A516RY-A516RZ-A516SA-A516SB-A516SC-A516SD-A516SE-A516SF-A516SG-A516SH-A516SI-A516SJ-A516SK-A516SL-A516SM-A516SN-A516SO-A516SP-A516SQ-A516SR-A516SS-A516ST-A516SU-A516SV-A516SW-A516SX-A516SY-A516SZ-A516TA-A516TB-A516TC-A516TD-A516TE-A516TF-A516TG-A516TH-A516TI-A516TJ-A516TK-A516TL-A516TM-A516TN-A516TO-A516TP-A516TQ-A516TR-A516TS-A516TT-A516TU-A516TV-A516TW-A516TX-A516TY-A516TZ-A516UA-A516UB-A516UC-A516UD-A516UE-A516UF-A516UG-A516UH-A516UI-A516UJ-A516UK-A516UL-A516UM-A516UN-A516UO-A516UP-A516UQ-A516UR-A516US-A516UT-A516UU-A516UV-A516UW-A516UX-A516UY-A516UZ-A516VA-A516VB-A516VC-A516VD-A516VE-A516VF-A516VG-A516VH-A516VI-A516VJ-A516VK-A516VL-A516VM-A516VN-A516VO-A516VP-A516VQ-A516VR-A516VS-A516VT-A516VU-A516VV-A516VW-A516VX-A516VY-A516VZ-A516WA-A516WB-A516WC-A516WD-A516WE-A516WF-A516WG-A516WH-A516WI-A516WJ-A516WK-A516WL-A516WM-A516WN-A516WO-A516WP-A516WQ-A516WR-A516WS-A516WT-A516WU-A516WV-A516WW-A516WX-A516WY-A516WZ-A516XA-A516XB-A516XC-A516XD-A516XE-A516XF-A516XG-A516XH-A516XI-A516XJ-A516XK-A516XL-A516XM-A516XN-A516XO-A516XP-A516XQ-A516XR-A516XS-A516XT-A516XU-A516XV-A516XW-A516XX-A516XY-A516XZ-A516YA-A516YB-A516YC-A516YD-A516YE-A516YF-A516YG-A516YH-A516YI-A516YJ-A516YK-A516YL-A516YM-A516YN-A516YO-A516YP-A516YQ-A516YR-A516YS-A516YT-A516YU-A516YV-A516YW-A516YX-A516YY-A516YZ-A516ZA-A516ZB-A516ZC-A516ZD-A516ZE-A516ZF-A516ZG-A516ZH-A516ZI-A516ZJ-A516ZK-A516ZL-A516ZM-A516ZN-A516ZO-A516ZP-A516ZQ-A516ZR-A516ZS-A516ZT-A516ZU-A516ZV-A516ZW-A516ZX-A516ZY-A516ZZ

Per el presente certificamos que el material aquí descrito ha sido fabricado, muestreado, ensayado e inspeccionado de acuerdo a los requisitos de su orden de compra. Este certificado no es, ni puede ser usado, como una declaración de origen.

CUSTOMER / THIRD PARTY

INSPECTION COMPANY / COMPAÑIA DE INSPECCION

Company Name: N/A / Employee Name: N/A

TENARIS QUALITY DEPARTMENT SIGNATURE

Signature of Quality Dept. Chief

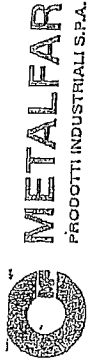
DEPTO. DE CERTIFICACION DE CALIDAD / PAOLINA Soledad

Signature of Quality Dept. Chief

CHIEF OF QUALITY CERTIFICATION DEPT. / RESPONSABLE DEL DEPTO. DE CERTIFICACION DE CALIDAD / AYERBO Eduardo

This certificate is issued by a computerized system and it is valid with electronic signatures. On the original certificate the trade-mark green colored "Tenaris" is stamped. In case the owner of the original certificate would release a copy of it, he must attest its conformity to the original one using upon himself the responsibility for any unlawful or not allowed use. Any alteration and/or falsification will be subjected to the law.

Este certificado se emite mediante sistema computarizado y es válido con firma electrónica. El certificado original posee impreso el logo Tenaris color verde. En caso de que el poseedor del certificado entregue una copia, deberá garantizar la conformidad con el original, haciéndose responsable por cualquier uso ilegítimo o prohibido. Cualquier alteración y/o falsificación estará sujeta a la ley.



SEDE AMMINISTRATIVA E STABILIMENTO:
 23861 CESSANA BRIANZA (LC) - Italy
 Via G. Pajani, 23
 Tel. +39 031.655441
 Fax +39 031.655149
 quality.mf@imms.com

PRODOTTI INDUSTRIALI S.P.A.
 STRAMPAGGIO A CALDO DI ACCIAI COMANI - LEGATI E INOSSIDABILI

CERTIFICATO DI COLLAUDO SECONDO EN 10204 - 3.1 INSPECTION CERTIFICATE
 Cardif. N. 5516
 DDT / Del Note N. 4207
 TRANSAWPI PIPING PRODUCTS LTD
 T3S 0A1 CALGARY, ALBERTA

Del/Dated 15.11.2011
 Del/Dated 14.11.2011
 Fatura / Invoice N. 3688
 Ns.Ord. / Our ref. N.
 Descr: F.F.F. clo TRANS AWPI PIPING PRODUCTS LTD
 9335 ENDEAVOR DRIVE S.E.
 T3S 0A1 CALGARY, ALBERTA

SALA PROVE E ANALISI MATERIALI / MATERIAL TEST DEPARTMENT

COD. COL. COLATA HEAT CODE HEAT	POS. ITEM 004	VS. ORDINE YOUR REFERENCE	DESCRIZIONE DESCRIPTION	CA	CA
560184	004	3755/TRANS AWPI	WIN 150 RF 6" STD LF2CL1	T3S 0A1	T3S 0A1
MATERIALE / MATERIAL	C%	S%	N%	M%	Mo%
ASTM A350 LF2 CL1/2	0,180	0,230	1,040	0,004	0,010
PROVETTA / TEST SPECIMEN	FORMA SHAPE	ROTTURA TENSILE STRENGTH	ALLUNGAMENTO ELONGATION	DUREZZA HARDNESS	CONTRAZIONE REDUCTION OF AREA
126,60	50,60	1	342,0	555,0	30,0
MATERIALE IN ACCORDO A / MATERIAL IN ACC. TO	TRATTAMENTO TERMICO / HEAT TREATMENT				
ASTM/A516 A 350/SA 350 III - 07 ASME CODE SECT. II, PART A, ED. 2010	NORMALIZED AT 930 C - COOLED IN STILL AIR				
CSA Z245.12 GRADE 248 CAT. II					

RESILLENZA / IMPACT TEST - JOULE/m ²	1	2	3	4	5	6	7	8	9	10
69	71	71	71	71	71	71	71	71	71	71

CONFORMITA' A: EN 10204-3.1
 DIM. ACCORDANCE TO: ASME/ANSI B16.5-2009
 VISIVO E DIMENS. VIS. & DIMENS. SATISFACTORY
 SVERNAMENTO NUMERAZ. SVERNAMENTO NUMERAZ. SVERNAMENTO NUMERAZ. SVERNAMENTO NUMERAZ. SVERNAMENTO NUMERAZ. SVERNAMENTO NUMERAZ.
 ORIGINE / ORIGIN: EUROPE
 FORNO / FURNACE: ELECTRIC FURNACE

Received Apr 4/12

NOTE: MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION NOTES: MATERIAL IN ACCORDANCE WITH NACE MR-0752003 ISO 15155-2009 MATERIAL IN ACCORDANCE WITH NACE MR-0103/2010	UFFICIO CONTROLLO QUALITA' / QUALITY CONTROL DEPARTMENT L. Sordi	ENTE UFFICIALE DI COLLAUDO / INSPECTION AUTHORITY	MARCHIO PRODUZIONE / MANUFACTURER'S SYMBOL
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QW-483 PROCEDURE QUALIFICATION RECORD (PQR)

Exchanger Industries Limited
Procedure Qualification Record No. M6A-7 Date May 12, 1999
PQR Revision(s) June 6, 2012, Format update and company name change,
PQR originally qualified by Exchanger Industries
(PQR originally certified by Malcolm Baxter)
Welding Procedure Specification No. C5 (Rev. 6)
Welding Process(es) SMAW Type(s) Manual

JOINTS (QW-402)

Type Butt joint, single vee groove, see next page

BASE METALS (QW-403)

Material Spec. SA 516 to SA 516 Type or Grade Gr. 60N to Gr. 70N
P-No. P1 Grp. 1 To P-No. P1 Grp. 2 Thickness 25.4 mm (1.00 in.)
Diameter N/A Other Plate

FILLER METALS (QW-404)

Specification No. (SFA) SFA 5.1 SFA 5.1
AWS No. (Class) E6010 E7018-1
Filler Metal F-No. F3 F4
Filler Metal A-No. A1 A1
Size of Electrode See attached sketch
Deposited Weld Metal Thickness 2.4 mm (0.094 in.) 23.0 mm (0.906 in.)

POSITION (QW-405)

Position of Groove 3G
Weld Progression N/A

PREHEAT (QW-406)

Preheat Temperature 66°C (150°F) Interpass Temp. (Max.) 260°C (500°F)

POSTWELD HEAT TREATMENT (QW-407)

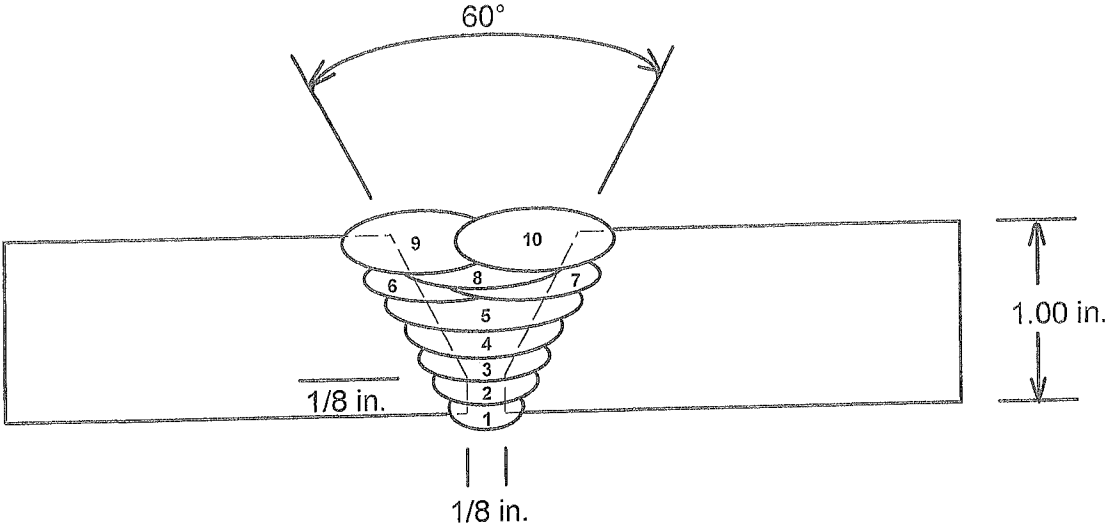
Temperature None Time N/A

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct Polarity Reverse, electrode positive
Amps See next page Volts See next page
Heat Input F3: 56 842 J/in. Max. F4: 133 714 J/in. Max.

TECHNIQUE (QW-410)

String or Weave F3: String F4: Both Travel Speed See next page
Multiple or Single Pass Per Side Multiple
Multiple or Single Electrodes Single



Pass	Process	Filler Metal	Diameter mm (in.)	Current & Polarity	Amperage Range	Voltage Range	Travel Speed mm/min (ipm.)
1	SMAW	E6010	3.2 (1/8)	DCRP	75	24	48 (1.9)
2	SMAW	E7018-1	2.4 (3/32)	DCRP	105	23	74 (2.9)
3 - 10	SMAW	E7018-1	3.2 (1/8)	DCRP	120 - 130	23 - 24	36 - 71 (1.4 - 2.8)

TENSILE TEST (QW-150)

Specimen No.	Width mm (in.)	Thickness mm (in.)	Area Sq. mm (Sq. in.)	Ultimate Load N (lbs.)	Ultimate Stress MPa (Psi)	Character & Fracture Location
T1	19.1 (0.752)	23.8 (0.937)	455 (0.705)	253 800 (57,100)	558 (81,000)	Partial cup & cone Parent metal (Gr. 60N)
T2	19.0 (0.748)	23.9 (0.941)	454 (0.704)	252 200 (56,700)	555 (80,600)	Partial cup & cone Parent metal (Gr. 60N)

GUIDED BEND TEST (QW-160)

Type & Figure No.	Result	Type & Figure No.	Result
QW-462.2, TSB - S1	Pass	QW-462.2, TSB - S3	Pass
QW-462.2, TSB - S2	Pass	QW-462.2, TSB - S4	Pass

CHARPY IMPACT TOUGHNESS

Type of Test Charpy V-Notch Orientation Transverse
 Test Temperature -46°C (-50°F) Specimen Size 10 X 10 mm

Specimen No.	Notch Location	Impact Values J (ft. lbs)
L2.1	Weld Metal	41.7 (30.8)
L2.2	Weld Metal	64.2 (47.4)
L2.3	Weld Metal	20.9 (15.4)
L3.1	Gr. 60N - HAZ	156 (115)
L3.2	Gr. 60N - HAZ	153 (113)
L3.3	Gr. 60N - HAZ	184 (136)
M3.1	Gr. 70N - HAZ	153 (113)
M3.2	Gr. 70N - HAZ	78.3 (57.8)
M3.3	Gr. 70N - HAZ	101 (74.8)

OTHER TESTS

See attached Vickers hardness survey - C99-375.3

Welders Name Bruce Hendry Certificate File No. W-6009
 Tests Conducted By Ludwig & Associates Ltd.
 Laboratory Test No. C99-375.3

We hereby recertify that the statements in this record have been revised in accordance with paragraph QW-200.2 and that the test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Manufacturer EXCHANGER INDUSTRIES LIMITED
PQR originally qualified by Exchanger Industries

Date JUNE 20, 2012 Certified by 



LUDWIG & ASSOCIATES LTD.

Materials and Welding Engineering LABORATORY TEST REPORT

CUSTOMER: EXCHANGER INDUSTRIES
P.O. Box 1107 Station "J"
Calgary, Alberta
T2A 6A8

Laboratory Test No.: C99-375.3
Date: May 27, 1999

Attention: Earl Stender

PQR Number: M6A-7
Material: SA 516 Gr. 60N to SA 516 Gr. 70N
Heat Number: 26037/195313-1 to 822376/91959101
Thickness: 25.4 mm (1.00 in.)
Thermal Condition: As Welded

TENSILE TEST QW-150

SAMPLE NUMBER	T1 QW-462.1(a)		T2 QW-462.1(a)	
	WIDTH mm (in)	19.1	(0.752)	19.0	(0.748)
THICKNESS mm (in)	23.8	(0.937)	23.9	(0.941)
AREA sq mm (sq in)	455	(0.705)	454	(0.704)
ULT. LOAD N (lbs)	253 800	(57,100)	252 200	(56,700)
UTS MPa (psi)	558	(81,000)	555	(80,600)
FRACTURE TYPE	Partial Cup & Cone		Partial Cup & Cone	
FRACTURE LOCATION	Parent Metal (SA 516 Gr. 60N)		Parent Metal (SA 516 Gr. 60N)	

GUIDED-BEND TEST QW-160

SAMPLE WIDTH: 9.52 mm (0.375 in.)		SAMPLE THICKNESS: 25.4 mm (1.00 in.)	
PLUNGER SIZE: 38.1 mm (1.50 in.)		YOKE SIZE: 60.3 mm (2.375 in.)	
QW-462.2	Side Bend	Side Bend	Side Bend
SAMPLE NUMBER(S)	S1	S2	S3
RESULTS	Pass	Pass	Pass

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section IX, 1998 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report.

Laboratory Test Conducted By: _____

Troy Drummond, T.T. / Sabine Heinemann, C.E.T.



LUDWIG & ASSOCIATES LTD.

Materials and Welding Engineering LABORATORY TEST REPORT

CUSTOMER: EXCHANGER INDUSTRIES
P.O. Box 1107 Station "J"
Calgary, Alberta
T2A 6A8

Laboratory Test No.: C99-375.3
Date: May 21, 1999

Attention: Earl Stender

PQR Number: M6A-7
Material: SA 516 Gr. 60N to SA 516 Gr. 70N
Heat Number: 26037/195313-1 to 822376/91959101
Thickness: 25.4 mm (1.00 in.)
Thermal Condition: As Welded

NOTCH-TOUGHNESS TEST

TYPE OF TEST: Charpy V-Notch
TEST TEMPERATURE: -46°C (-50°F)
ORIENTATION: Transverse
SPECIMEN SIZE: 10 x 10 mm

Specimen Number	Notch Location	Impact Values Joules (ft.lbs)	
L2.1	Weld Metal	41.7	(30.8)
L2.2	Weld Metal	64.2	(47.4)
L2.3	Weld Metal	20.9	(15.4)
L3.1	Gr. 60N - HAZ	156	(115)
L3.2	Gr. 60N - HAZ	153	(113)
L3.3	Gr. 60N - HAZ	184	(136)
M3.1	Gr. 70N - HAZ	153	(113)
M3.2	Gr. 70N - HAZ	78.3	(57.8)
M3.3	Gr. 70N - HAZ	101	(74.8)

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section VIII, Div. 1, UG-84, 1998 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report.

Laboratory Test Conducted By: _____

Sabine Heinemann, C.E.T.



LUDWIG & ASSOCIATES LTD.

Materials and Welding Engineering LABORATORY TEST REPORT

CUSTOMER: EXCHANGER INDUSTRIES
P.O. Box 1107 Station "J"
Calgary, Alberta
T2A 6A8

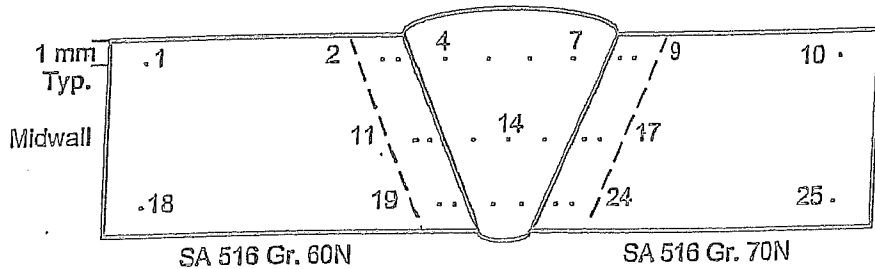
Laboratory Test No.: C99-375.3
Date: May 27, 1999

Attention: Earl Stender

PQR Number: M6A-7
Material: SA 516 Gr. 60N to SA 516 Gr. 70N
Heat Number: 26037/195313-1 to 822376/91959101
Thickness: 25.4 mm (1.00 in.)
Thermal Condition: As Welded

HARDNESS TEST

TYPE OF TEST: Vickers LOAD: 1000 g
INSTRUMENT TYPE: Buehler Micromet



1)	180 HV	8)	227 HV	15)	186 HV	22)	184 HV
2)	173 HV	9)	200 HV	16)	193 HV	23)	198 HV
3)	204 HV	10)	173 HV	17)	181 HV	24)	186 HV
4)	197 HV	11)	185 HV	18)	165 HV	25)	173 HV
5)	209 HV	12)	187 HV	19)	183 HV		
6)	201 HV	13)	181 HV	20)	181 HV		
7)	197 HV	14)	183 HV	21)	181 HV		

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E384 - 89 (Reapproved 1997). The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report.

Laboratory Test Conducted By: Sabine Heinemann
Troy Drummond, T.T. / Sabine Heinemann, C.E.T.

QW-483 PROCEDURE QUALIFICATION RECORD (PQR)

Exchanger Industries Limited
Procedure Qualification Record No. C5-1 Date May 20, 2004
PQR Revision(s) June 6, 2012, Format update and company name change,
PQR originally qualified by Exchanger Industries
(PQR originally certified by Malcolm Baxter)
Welding Procedure Specification No. C5 (Rev. 6)
Welding Process(es) GMAW / SMAW Type(s) Semi-automatic / Manual

JOINTS (QW-402)

Type Butt joint, single vee groove, see next page

BASE METALS (QW-403)

Material Spec. SA 516 to SA 516 Type or Grade Gr. 60N / Gr. 70N
P-No. P1 Grp.1 To P-No. P1 Grp.2 Diameter N/A
Thickness 22.2 mm (0.875 in.) to 38.1 mm (1.50 in.)
Other Plate product form

FILLER METALS (QW-404)

	GMAW	SMAW
Specification No. (SFA)	<u>SFA 5.18</u>	<u>SFA 5.1</u>
AWS No. (Class)	<u>ER70S-2</u>	<u>E7018-1</u>
Filler Metal F-No.	<u>F6</u>	<u>F4</u>
Filler Metal A-No.	<u>A1</u>	<u>A1</u>
Size of Electrode	<u>See attached sketch</u>	
Deposited Weld Metal Thickness	<u>3.18 mm (0.125 in.)</u>	<u>19.1 mm (0.750 in.)</u>

POSITION (QW-405)

Position of Groove GMAW: Special - Plate at 30° off flat SMAW: 3G
Weld Progression GMAW: Vertical down SMAW: Vertical Up

PREHEAT (QW-406)

Preheat Temperature 66°C (150°F) Interpass Temp. (Max.) 232°C (450°F)

POSTWELD HEAT TREATMENT (QW-407)

Temperature None Time N/A

GAS (QW-408)

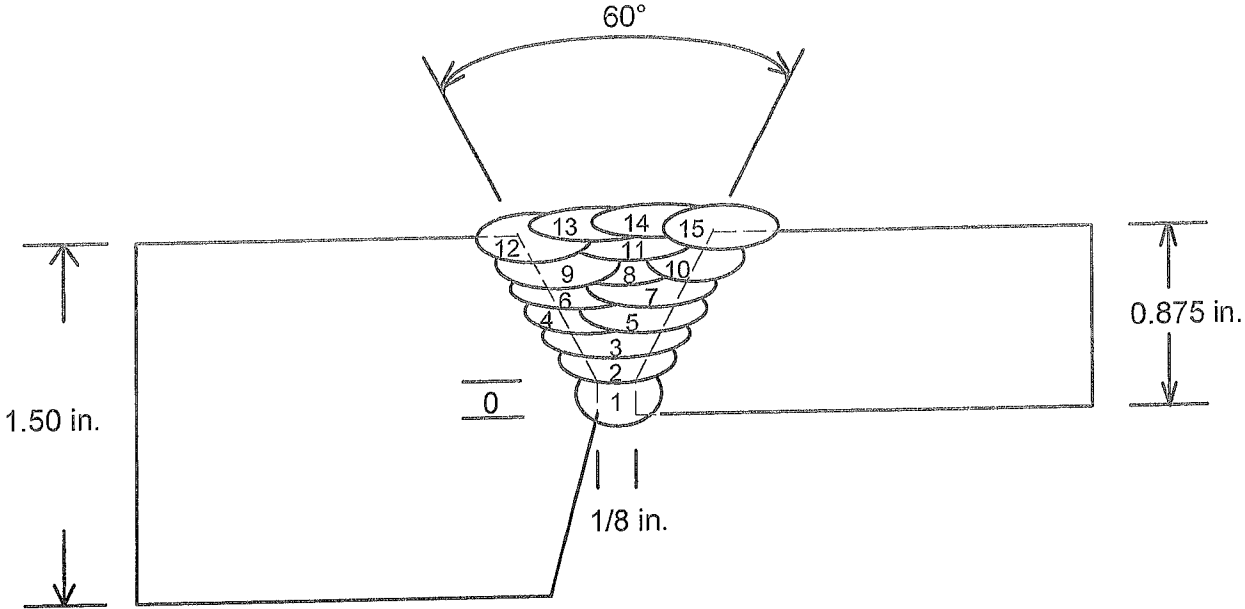
Specification No. (SFA) SFA 5.32 AWS No. (Class) SG-AC-25
Shielding 75% Argon, 25% CO₂, 11.5 liters per minute (23 cfph)
Backing None Trailing N/A

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct Polarity Reverse, electrode positive
Amps See next page Volts See next page
Heat Input N/A
Mode of Metal Transfer GMAW: Short circuiting arc

TECHNIQUE (QW-410)

String or Weave GMAW: Weave SMAW: Both Travel Speed See next page
Multiple or Single Pass Per Side GMAW: Single SMAW: Multiple
Multiple or Single Electrodes Single



Pass	Process	Filler Metal	Diameter mm (in.)	Current & Polarity	Amperage Range	Voltage Range	Travel Speed mm/min (i.p.m.)
1	GMAW	ER70S-2	0.9 (0.035)	DCRP	120	18	127 (5.0)
2-11	SMAW	E7018-1	3.2 (1/8)	DCRP	140	23	61 - 117 (2.4 - 4.6)
12-15	SMAW	E7018-1	3.2 (1/8)	DCRP	140	23	61 - 91 (2.4 - 3.6)

TENSILE TEST (QW-150)

Specimen No.	Width mm (in.)	Thickness mm (in.)	Area Sq. mm (Sq. in.)	Ultimate Load N (lbs.)	Ultimate Stress MPa (psi)	Character & Fracture Location
T1	19.1. (0.752)	21.3 (0.839)	407 (0.631)	213 900 (48,100)	526 (76,300)	Partial cup & cone Parent metal (Gr. 70N)
T2	19.0 (0.750)	21.3 (0.839)	406 (0.629)	214 700 (48,300)	526 (76,700)	Cup & cone Parent metal (Gr. 70N)

GUIDED BEND TEST (QW-160)

Type & Figure No.	Result	Type & Figure No.	Result
QW-462.2, TSB - S1	Pass	QW-462.2, TSB - S3	Pass
QW-462.2, TSB - S2	Pass	QW-462.2, TSB - S4	Pass

OTHER TESTS

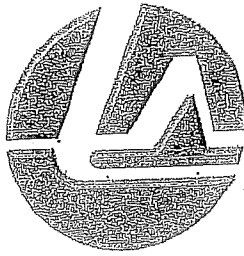
Vickers microhardness survey - see attached laboratory test report C04-566.1

Welders Name Harry Ramsumair Certificate File No. W-17585
 Tests Conducted By Ludwig & Associates Ltd.
 Laboratory Test No. C04-566.1

We hereby recertify that the statements in this record have been revised in accordance with paragraph QW-200.2 and that the test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

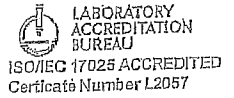
Manufacturer EXCHANGER INDUSTRIES LIMITED
PQR originally qualified by Exchanger Industries

Date JUNE 20, 2012 Certified by 



LUDWIG & ASSOCIATES LTD.

Materials and Welding Engineering



LABORATORY TEST REPORT

CUSTOMER: Exchanger Industries
P.O. Box 1107 Station "J"
Calgary, Alberta
T2A 6A8

Laboratory Test No.: C04-566.1
Date: May 25, 2004

Attention: Malcolm Baxter

PQR Number: C5-1
Material: SA 516 Gr. 60N to SA 516 Gr. 70N
Heat Numbers: 48905-71111 to 53847-98922
Thickness: 22.2 mm (0.875 in.) to 38.1 mm (1.50 in.)
Thermal Condition: As Welded

TENSILE TEST QW-150

SAMPLE NUMBER	T1 QW-462.1(a)		T2 QW-462.1(a)	
	WIDTH mm (in)	19.1	(0.752)	19.0
THICKNESS mm (in)	21.3	(0.839)	21.3	(0.839)
AREA sq mm (sq in)	407	(0.631)	406	(0.629)
ULT. LOAD N (lbs)	213 900	(48,100)	214 700	(48,300)
UTS MPa (psi)	526	(76,300)	526	(76,700)
FRACTURE TYPE	Partial Cup & Cone		Cup & Cone	
FRACTURE LOCATION	Parent Metal (Gr. 70N)		Parent Metal (Gr. 70N)	

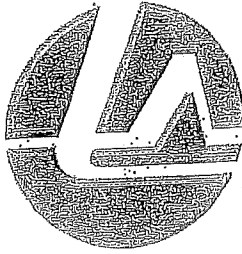
GUIDED-BEND TEST QW-160

SAMPLE WIDTH:	9.52 mm (0.375 in.)		SAMPLE THICKNESS:	22.2 mm (0.875 in.)	
	PLUNGER SIZE:	38.1 mm (1.50 in.)		YOKE SIZE:	60.3 mm (2.375 in.)
QW-462.2	Side Bend		Side Bend	Side Bend	Side Bend
SAMPLE NUMBER(S)	S1		S2	S3	S4
RESULTS	Pass		Pass	Pass	Pass

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section IX, 2001 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report.

Laboratory Test Conducted By: _____

Mark Fung, C.E.T. / Troy Lanz, C.E.T.



LUDWIG & ASSOCIATES LTD.

Materials and Welding Engineering

LABORATORY TEST REPORT

LABORATORY ACCREDITATION BUREAU
ISO/IEC 17025 ACCREDITED
Certificate Number L2057

CUSTOMER: Exchanger Industries
P.O. Box 1107 Station "J"
Calgary, Alberta
T2A 6A8

Laboratory Test No.: C04-566.1
Date: May 25, 2004

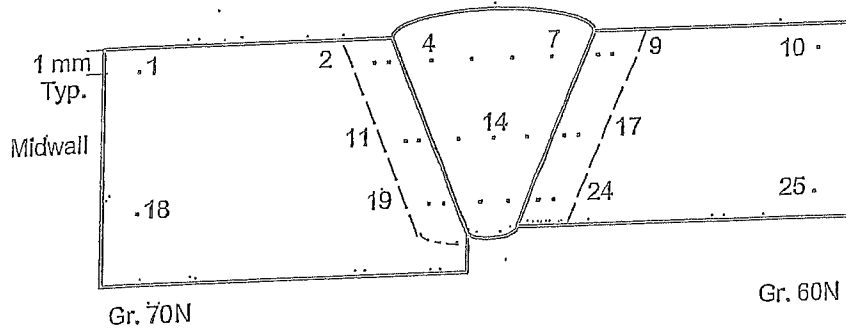
Attention: Malcolm Baxter

PQR Number: C5-1
Material: SA 516 Gr. 60N to SA 516 Gr. 70N
Heat Numbers: 48905-71111 to 53847-98922
Thickness: 22.2 mm (0.875 in.) to 38.1 mm (1.50 in.)
Thermal Condition: As Welded

HARDNESS TEST

TYPE OF TEST: Vickers
INSTRUMENT TYPE: Mitutoyo AVK-C1

LOAD: 500 g



1)	173 HV	8)	242 HV	15)	211 HV	22)	196 HV
2)	204 HV	9)	213 HV	16)	196 HV	23)	195 HV
3)	256 HV	10)	168 HV	17)	185 HV	24)	199 HV
4)	223 HV	11)	195 HV	18)	167 HV	25)	163 HV
5)	217 HV	12)	207 HV	19)	183 HV		
6)	192 HV	13)	218 HV	20)	189 HV		
7)	213 HV	14)	209 HV	21)	214 HV		

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E384 - 99. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report.

Laboratory Test Conducted By:

Troy Drummond, C.E.T. / Troy Lanz, C.E.T.

QW-483 PROCEDURE QUALIFICATION RECORD (PQR)

Exchanger Industries Limited

Procedure Qualification Record No. A56AC-1 Date May 31, 2007
PQR Revision June 6, 2012, Format update & company name change, PQR originally qualified by Exchanger Industries. Editorial change - current & polarity incorrectly reported in welding parameter table, should be AC instead of DCRP.(PQR originally certified by Earl Stender)
Welding Procedure Specification No. C5 (Rev. 6)
Welding Process(es) SAW Type(s) Machine

JOINTS (QW-402)

Type Butt joint, single vee groove welded from both sides, see next page

BASE METALS (QW-403)

Material Spec. SA 516 to SA 516 Type or Grade Gr. 60N to Gr. 70N
P-No. P1 Grp. 1 To P-No. P1 Grp. 2 Thickness 38.1 mm (1.50 in.)
Diameter N/A
Heat Number 87724 - 19909 to 0222D - 23364

FILLER METALS (QW-404)

Specification No. (SFA) SFA 5.17
Flux / Wire Classification F7A6-EM14K
Filler Metal F-No. F6
Filler Metal A-No. A1
Size of Electrode 0.125" & 0.156"
Deposited Weld Metal Thickness 38.1 mm (1.50 in.)
Trade Name Lincoln Electric: LA 71 wire / 880M flux

POSITION (QW-405)

Position of Groove 1G
Weld Progression N/A

PREHEAT (QW-406)

Preheat Temperature 93°C (200°F) Interpass Temp. (Max.) 260°C (500°F)

POSTWELD HEAT TREATMENT (QW-407)

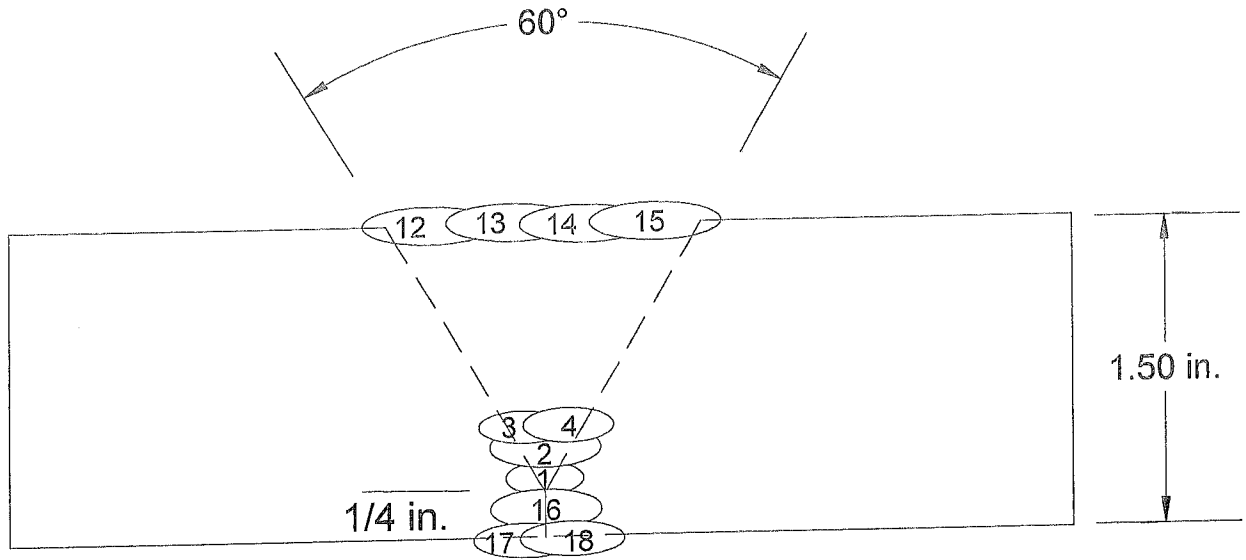
Temperature None Time N/A

ELECTRICAL CHARACTERISTICS (QW-409)

Current AC Polarity N/A
Amps See next page Volts See next page
Maximum Heat Input 133,636 J/in.

TECHNIQUE (QW-410)

String or Weave String Travel Speed See next page
Oscillation Without
Multiple or Single Pass Per Side Multipass
Multiple or Single Electrodes Single



Note: Back-gouged to sound metal prior to depositing pass # 16

Pass	Process	Filler Metal	Diameter in.	Current & Polarity	Amperage Range	Voltage Range	Travel Speed i.p.m.
1 & 2	SAW	F7A6-EM14K	0.125	AC	350	28	21
3	SAW	F7A6-EM14K	0.156	AC	500	29	18
4 & 5	SAW	F7A6-EM14K	0.156	AC	600	30	18
6	SAW	F7A6-EM14K	0.156	AC	650	32	14
7 - 11	SAW	F7A6-EM14K	0.156	AC	700	35	11
12 - 15	SAW	F7A6-EM14K	0.156	AC	700	35	16
16 - 18	SAW	F7A6-EM14K	0.156	AC	600	35	16

TENSILE TEST (QW-150)

Specimen No.	Width mm (in.)	Thickness mm (in.)	Area Sq. mm (Sq. in.)	Ultimate Load N (lbs.)	Ultimate Stress Mpa (Psi)	Character & Fracture Loc.
T1	19.0 (0.748)	37.7 (1.48)	716 (1.11)	377 500 (84,900)	527 (76,400)	Partial Cup & Cone Parent metal (Gr. 60N)
T2	19.0 (0.748)	37.6 (1.48)	714 (1.11)	378 900 (85,200)	530 (76,900)	Partial Cup & Cone Parent metal (Gr. 60N)

GUIDED BEND TEST (QW-160)

Type & Figure No.	Result	Type & Figure No.	Result
QW-462.2, TSB - S1	Pass	QW-462.2, TSB - S3	Pass
QW-462.2, TSB - S2	Pass	QW-462.2, TSB - S4	Pass

CHARPY IMPACT TOUGHNESS

Type of Test Charpy V-Notch Orientation Transverse
 Test Temperature -46°C (-50°F) Specimen Size 10 X 10 mm

Specimen No.	Notch Location	Impact Values J (ft. lbs)
B2.1	Weld Metal	47.5 (35.0)
B2.2	within 1/16 in.	17.4 (12.8)
B2.3	of surface	43.4 (32.0)
B3.1	Gr. 60N - HAZ	>172 (>127)
B3.2	Gr. 60N - HAZ	170 (125)
B3.3	Gr. 60N - HAZ	69.7 (51.4)
C3.1	Gr. 70N - HAZ	129 (94.8)
C3.2	Gr. 70N - HAZ	158 (113)
C3.3	Gr. 70N - HAZ	140 (103)

OTHER TESTS

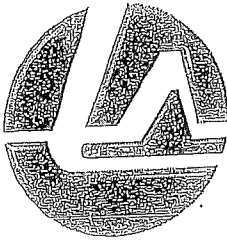
Vickers Hardness - see attached laboratory test report # C07-672.1
Weld Metal Chemistry Analysis - see attached laboratory test report # C07-672.1

Welders Name Ron Black Certificate File No. W-2359
 Tests Conducted By Ludwig & Associates Ltd.
 Laboratory Test No. C07-672.1

We hereby recertify that the statements in this record have been revised in accordance with paragraph QW-200.2 and that the test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Manufacturer EXCHANGER INDUSTRIES LIMITED
PQR originally qualified by Exchanger Industries

Date JUNE 20, 2012 Certified by [Signature]



LUDWIG & ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY ACCREDITATION BUREAU
ISO/IEC 17025 ACCREDITED
Certificate Number L2057

LABORATORY TEST REPORT

CUSTOMER: Exchanger Industries
5505 - 52nd Street S.E.
Calgary, Alberta
T2C 2W8

Laboratory Test No.: C07-672.1
Date: May 17, 2007

Attention: Malcolm Baxter

WPS Number:	A56AC	PQR Number:	A56AC-1
Material:	SA 516 Gr. 60N to SA 516 Gr. 70N (Heat No.: 87724-19909 to 0222D-23364)		
Thickness:	38.1 mm (1.50 in.)		
Thermal Condition:	As Welded		

TENSILE TEST QW-150

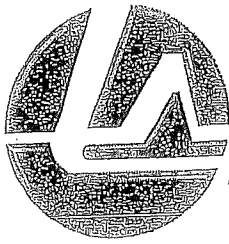
SAMPLE NUMBER	T1 QW-462.1(a)	T2 QW-462.1(a)
WIDTH mm (in)	19.0 (0.748)	19.0 (0.748)
THICKNESS mm (in)	37.7 (1.48)	37.6 (1.48)
AREA sq mm (sq in)	716 (1.11)	714 (1.11)
ULT. LOAD N (lbs)	377 500 (84,900)	378 900 (85,200)
UTS MPa (psi)	527 (76,400)	530 (76,900)
FRACTURE TYPE	Partial Cup and Cone	Partial Cup and Cone
FRACTURE LOCATION	Parent Metal (SA 516 Gr. 60N)	Parent Metal (SA 516 Gr. 60N)

GUIDED-BEND TEST QW-160

SAMPLE WIDTH:	9.52 mm (0.375 in.)	SAMPLE THICKNESS:	38.1 mm (1.50 in.)
PLUNGER SIZE:	38.1 mm (1.50 in.)	YOKE SIZE:	60.3 mm (2.375 in.)
QW-462.2	Side Bend	Side Bend	Side Bend
SAMPLE NUMBER(S)	S1	S2	S3
RESULTS	Pass	Pass	Pass

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section IX, 2004 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. Samples associated with this report will be discarded in 45 days.

Laboratory Test Conducted By: Sabine Heine
Inderjit Rai / Sabine Heine, C.E.T.



LUDWIG & ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Exchanger Industries
5505 - 52nd Street S.E.
Calgary, Alberta
T2C 2W8

Laboratory Test No.: C07-672.1
Date: May 18, 2007

Attention: Malcolm Baxter

WPS Number:	A56AC	PQR Number:	A56AC-1
Material:	SA 516 Gr. 60N to SA 516 Gr. 70N (Heat No.: 87724-19909 to 0222D-23364)		
Thickness:	38.1 mm (1.50 in.)		
Thermal Condition:	As Welded		

NOTCH-TOUGHNESS TEST

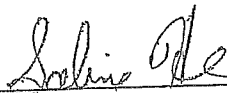
TYPE OF TEST: Charpy V-Notch
TEST TEMPERATURE: -46°C (-50°F)

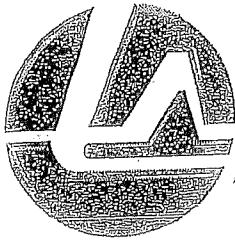
ORIENTATION: Transverse
SPECIMEN SIZE: 10 x 10 mm

Specimen Number	Notch Location	Impact Values Joules (ft.lbs)	
B2.1	Weld Metal within 1/16 in. of surface	47.5	(35.0)
B2.2		17.4	(12.8)
B2.3		43.4	(32.0)
B3.1	Gr. 60N - HAZ	>172	(>127)
B3.2		170	(125)
B3.3		69.7	(51.4)
C3.1	Gr. 70N - HAZ	129	(94.8)
C3.2		153	(113)
C3.3		140	(103)

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section VIII, Div. 1, UG-84 - 2004 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. Samples associated with this report will be discarded in 45 days.

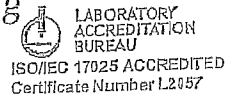
Laboratory Test Conducted By:


Karen Koens, R.E.T. / Sabine Heinemann, C.E.T.



LUDWIG & ASSOCIATES LTD.

Materials and Welding Consulting



LABORATORY TEST REPORT

CUSTOMER: Exchanger Industries
5505 - 52nd Street S.E.
Calgary, Alberta
T2C 2W8

Laboratory Test No.: C07-672.1
Date: May 16, 2007

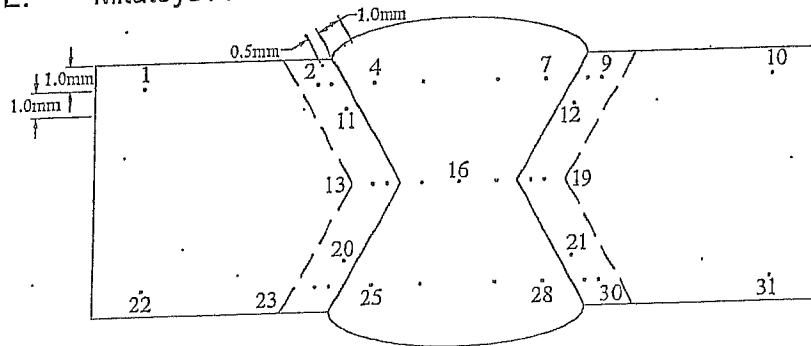
Attention: Malcolm Baxter

WPS Number: A56AC PQR Number: A56AC-1
Material: SA 516 Gr. 60N to SA 516 Gr. 70N (Heat No.: 87724-19909 to 0222D-23364)
Thickness: 38.1 mm (1.50 in.)
Thermal Condition: As Welded

HARDNESS TEST

TYPE OF TEST: Vickers
INSTRUMENT TYPE: Mitutoyo AVK-C1

LOAD: 1000 g

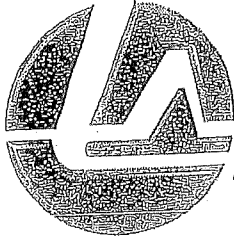


SA 516 Gr. 70N				SA 516 Gr. 60N			
1) 152 HV	8) 212 HV	15) 221 HV	22) 153 HV	29) 232 HV			
2) 210 HV	9) 188 HV	16) 217 HV	23) 209 HV	30) 188 HV			
3) 230 HV	10) 168 HV	17) 196 HV	24) 236 HV	31) 150 HV			
4) 214 HV	11) 223 HV	18) 188 HV	25) 224 HV				
5) 227 HV	12) 213 HV	19) 182 HV	26) 219 HV				
6) 197 HV	13) 198 HV	20) 233 HV	27) 214 HV				
7) 207 HV	14) 215 HV	21) 209 HV	28) 213 HV				

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E384 - 05a. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. Samples associated with this report will be discarded in 45 days.

Laboratory Test Conducted By: Simon Kirkland, T.T. / Sabine Heinemann, C.E.T.

JUN 06 2007



LUDWIG & ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY ACCREDITATION BUREAU
ISO/IEC 17025 ACCREDITED
Certificate Number L2057

LABORATORY TEST REPORT

CUSTOMER: Exchanger Industries
5505 - 52nd Street S.E.
Calgary, Alberta
T2C 2W8

Laboratory Test No.: C07-672.1
Date: May 22, 2007

Attention: Malcolm Baxter

WPS Number:	A56AC	PQR Number:	A56AC-1
Material:	SA 516 Gr. 60N to SA 516 Gr. 70N (Heat No.: 87724-19909 to 0222D-23364)		
Thickness:	38.1 mm (1.50 in.)		
Thermal Condition:	As Welded		
Test Location:	Weld Metal (EM14K Wire)		

CHEMICAL ANALYSIS

(% by weight)

Instrument Type: Shimadzu PDA-7000 Optical Emission Spectrometer

Carbon	0.10
Manganese	1.33
Sulphur	0.005
Phosphorus	0.010
Silicon	0.44
Copper	0.10

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM A751 - 01 specification. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. Samples associated with this report will be discarded in 45 days.

Laboratory Test Conducted By: Sabine Heinemann
Sabine Heinemann, C.E.T.

QW-483 PROCEDURE QUALIFICATION RECORD (PQR)

Exchanger Industries Limited

Procedure Qualification Record No. A56AC-3 Date May 31, 2007
PQR Revision June 6, 2012, Format update & company name change, PQR originally qualified by Exchanger Industries. Editorial change - current & polarity incorrectly reported in welding parameter table, should be AC instead of DCRP.(PQR originally certified by Earl Stender)
Welding Procedure Specification No. C5 (Rev. 6)
Welding Process(es) SAW Type(s) Machine

JOINTS (QW-402)

Type Butt joint, square butt welded from both sides, see next page

BASE METALS (QW-403)

Material Spec. SA 516 to SA 516 Type or Grade Gr. 60N to Gr. 70N
P-No. P1 Grp. 1 To P-No. P1 Grp. 2 Thickness 9.52 mm (0.375 in.)
Diameter N/A
Heat Number 18926 - 543243 to 64843 - 603453

FILLER METALS (QW-404)

Specification No. (SFA) SFA 5.17
Flux / Wire Classification F7A6-EM14K
Filler Metal F-No. F6
Filler Metal A-No. A1
Size of Electrode 0.125"
Deposited Weld Metal Thickness 9.52 mm (0.375 in.)
Trade Name Lincoln Electric: LA 71 wire / 880M flux

POSITION (QW-405)

Position of Groove 1G
Weld Progression N/A

PREHEAT (QW-406)

Preheat Temperature 10°C (50°F) Interpass Temp. (Max.) 260°C (500°F)

POSTWELD HEAT TREATMENT (QW-407)

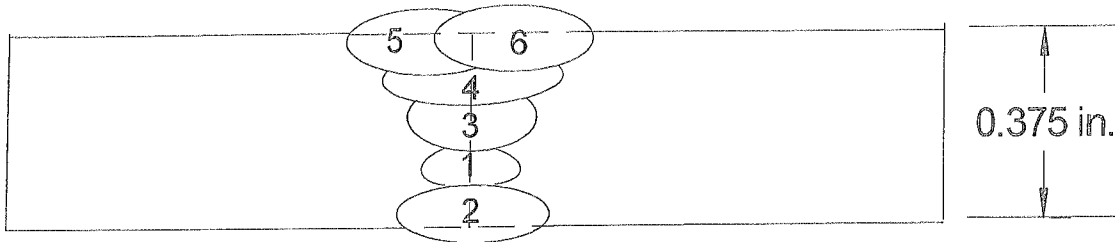
Temperature None Time N/A

ELECTRICAL CHARACTERISTICS (QW-409)

Current AC Polarity N/A
Amps See next page Volts See next page
Maximum Heat Input 56,000 J/in.

TECHNIQUE (QW-410)

String or Weave String Travel Speed See next page
Oscillation Without
Multiple or Single Pass Per Side Multipass
Multiple or Single Electrodes Single



Note: Back-gouged to sound metal prior to depositing pass # 3

Pass	Process	Filler Metal	Diameter in.	Current & Polarity	Amperage Range	Voltage Range	Travel Speed i.p.m.
1	SAW	F7A6-EM14K	0.125	AC	350	32	20
2	SAW	F7A6-EM14K	0.125	AC	400	35	16
3	SAW	F7A6-EM14K	0.125	AC	330	32	20
4	SAW	F7A6-EM14K	0.125	AC	350	32	16
5 & 6	SAW	F7A6-EM14K	0.125	AC	400	35	15

CHARPY IMPACT TOUGHNESS

Type of Test Charpy V-Notch Orientation Transverse
 Test Temperature -46°C (-50°F) Specimen Size 10 X 8 mm

Specimen No.	Notch Location	Impact Values J (ft. lbs)
H2.1	Weld Metal	164 (121)
H2.2	within 1/16 in.	146 (108)
H2.3	of surface	>172 (>127)
H3.1	Gr. 60N - HAZ	>172 (>127)
H3.2	Gr. 60N - HAZ	>172 (>127)
H3.3	Gr. 60N - HAZ	>172 (>127)
I3.1	Gr. 70N - HAZ	>172 (>127)
I3.2	Gr. 70N - HAZ	54.2 (40.0)
I3.3	Gr. 70N - HAZ	>172 (>127)

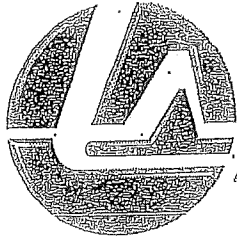
OTHER TESTS

Welders Name Ron Black Certificate File No. W-2359
 Tests Conducted By Ludwig & Associates Ltd.
 Laboratory Test No. C07-674.2R1

We hereby recertify that the statements in this record have been revised in accordance with paragraph QW-200.2 and that the test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Manufacturer EXCHANGER INDUSTRIES LIMITED
PQR originally qualified by Exchanger Industries

Date JUNE 20, 2012 Certified by 



LUDWIG & ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Exchanger Industries
5505 - 52nd Street S.E.
Calgary, Alberta
T2C 2W8

Laboratory Test No.: C07-674.2R1
Date: May 18, 2007
Revision Date: May 25, 2007

Attention: Malcolm Baxter

WPS Number: A56AC PQR Number: A56AC-3
Material: SA 516 Gr. 60N to SA 516 Gr. 70N (Heat No.: 18926-543243 to 64843-603453)
Thickness: 9.52 mm (0.375 in.)
Thermal Condition: As Welded

NOTCH-TOUGHNESS TEST


TYPE OF TEST: Charpy V-Notch
TEST TEMPERATURE: -46°C (-50°F)

ORIENTATION: Transverse
SPECIMEN SIZE: 10 x 8 mm

Specimen Number	Notch Location	Impact Values Joules (ft.lbs)	
H2.1	Weld Metal	164	(121)
H2.2	within 1/16 in.	146	(108)
H2.3	of surface	>172	(>127)
H3.1	Gr. 60N - HAZ	>172	(>127)
H3.2	Gr. 60N - HAZ	>172	(>127)
H3.3	Gr. 60N - HAZ	>172	(>127)
I3.1	Gr. 70N - HAZ	>172	(>127)
I3.2	Gr. 70N - HAZ	54.2	(40.0)
I3.3	Gr. 70N - HAZ	>172	(>127)

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section VIII, Div. 1, UG-84 - 2004 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. Samples associated with this report will be discarded in 45 days.

Laboratory Test Conducted By: _____


Karen Koens, R.E.T. / Sabine Heinemann, C.E.T.

QW-483 PROCEDURE QUALIFICATION RECORD (PQR)

Exchanger Industries Limited

Procedure Qualification Record No. A56AC-4 Date May 31, 2007
PQR Revision June 6, 2012, Format update & company name change, PQR originally qualified by Exchanger Industries. Editorial change - current & polarity incorrectly reported in welding parameter table, should be AC instead of DCRP.(PQR originally certified by Earl Stender)
Welding Procedure Specification No. C5 (Rev. 6)
Welding Process(es) SAW Type(s) Machine

JOINTS (QW-402)

Type Butt joint, square butt welded from both sides, see next page

BASE METALS (QW-403)

Material Spec. SA 516 to SA 516 Type or Grade Gr. 60N to Gr. 70N
P-No. P1 Grp. 1 To P-No. P1 Grp. 2 Thickness 6.32 mm (0.249 in.)
Diameter N/A
Heat Number 18926 - 543243 to 64843 - 603453

FILLER METALS (QW-404)

Specification No. (SFA) SFA 5.17
Flux / Wire Classification F7A6-EM14K
Filler Metal F-No. F6
Filler Metal A-No. A1
Size of Electrode 0.125"
Deposited Weld Metal Thickness 6.32 mm (0.249 in.)
Trade Name Lincoln Electric: LA 71 wire / 880M flux

POSITION (QW-405)

Position of Groove 1G
Weld Progression N/A

PREHEAT (QW-406)

Preheat Temperature 10°C (50°F) Interpass Temp. (Max.) 260°C (500°F)

POSTWELD HEAT TREATMENT (QW-407)

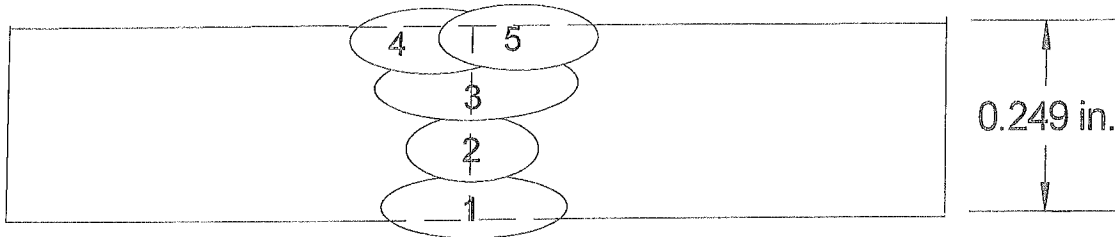
Temperature None Time N/A

ELECTRICAL CHARACTERISTICS (QW-409)

Current AC Polarity N/A
Amps See next page Volts See next page
Maximum Heat Input 33,600 J/in.

TECHNIQUE (QW-410)

String or Weave String Travel Speed See next page
Oscillation Without
Multiple or Single Pass Per Side Both multiple and single
Multiple or Single Electrodes Single



Note: Single pass deposited on backside of square butt joint, followed by back grinding to sound metal prior to depositing pass No(s). 2 to 5.

Pass	Process	Filler Metal	Diameter in.	Current & Polarity	Amperage Range	Voltage Range	Travel Speed i.p.m.
1	SAW	F7A6-EM14K	0.125	AC	350	32	20
2	SAW	F7A6-EM14K	0.125	AC	300	30	24
3	SAW	F7A6-EM14K	0.125	AC	330	32	20
4 & 5	SAW	F7A6-EM14K	0.125	AC	350	32	20

CHARPY IMPACT TOUGHNESS

Type of Test Charpy V-Notch Orientation Transverse
 Test Temperature -48°C (-55°F) Specimen Size 10 X 5 mm

Specimen No.	Notch Location	Impact Values J (ft. lbs)
J2.1	Weld Metal	122 (90.0)
J2.2	within 1/16 in.	77.6 (57.2)
J2.3	of surface	81.4 (60.0)
J3.1	Gr. 60N - HAZ	59.4 (43.8)
J3.2	Gr. 60N - HAZ	46.1 (34.0)
J3.3	Gr. 60N - HAZ	46.6 (34.4)
K3.1	Gr. 70N - HAZ	29.8 (22.0)
K3.2	Gr. 70N - HAZ	133 (98.0)
K3.3	Gr. 70N - HAZ	141 (104)

OTHER TESTS

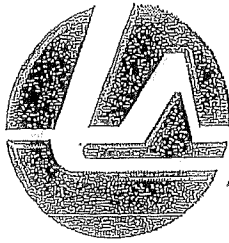
- - -

Welders Name Ron Black Certificate File No. W-2359
 Tests Conducted By Ludwig & Associates Ltd.
 Laboratory Test No. C07-674.3R1

We hereby recertify that the statements in this record have been revised in accordance with paragraph QW-200.2 and that the test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Manufacturer EXCHANGER INDUSTRIES LIMITED
PQR originally qualified by Exchanger Industries

Date JUNE 20, 2012 Certified by 



LUDWIG & ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Exchanger Industries
5505 - 52nd Street S.E.
Calgary, Alberta
T2C 2W8

Laboratory Test No.: C07-674.3R1
Date: May 18, 2007
Revision Date: May 22, 2007

Attention: Malcolm Baxter

WPS Number: A56AC PQR Number: A56AC-4
Material: SA 516 Gr. 60N to SA 516 Gr. 70N (Heat No.: 18926-543243 to 64843-603453)
Thickness: 6.32 mm (0.249 in.)
Thermal Condition: As Welded

NOTCH-TOUGHNESS TEST


TYPE OF TEST: Charpy V-Notch
TEST TEMPERATURE: -48°C (-55°F)

ORIENTATION: Transverse
SPECIMEN SIZE: 10 x 5 mm

Specimen Number	Notch Location	Impact Values Joules (ft.lbs)	
J2.1	Weld Metal	122	(90.0)
J2.2	within 1/16 in.	77.6	(57.2)
J2.3	of surface	81.4	(60.0)
J3.1	Gr. 60N - HAZ	59.4	(43.8)
J3.2	Gr. 60N - HAZ	46.1	(34.0)
J3.3	Gr. 60N - HAZ	46.6	(34.4)
K3.1	Gr. 70N - HAZ	29.8	(22.0)
K3.2	Gr. 70N - HAZ	133	(98.0)
K3.3	Gr. 70N - HAZ	141	(104)

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section VIII, Div. 1, UG-84 -- 2004 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. Samples associated with this report will be discarded in 45 days.

Laboratory Test Conducted By: _____


Karen Koens, R.E.T. / Sabine Helnemann, C.E.T.



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments			
101-E-110;101-E-111;101-E-112;101-E-113;101-E-114;101-E-115;101-E-120;101-E-121;101-E-210;101-E-225;101-E-226;101-E-240;101-E-241;101-E-450;101-E-451;102-E-610;102-E-613;102-E-655;103-E-080;103-E-190;103-E-290; 103-E-390; 103-E-490; 103-E-590; 103-E-705; 103-E-707; 104-E135; 104-E-136; 107-E-305	JPI REV 1 - COORDINATION			
Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1		
<p><i>See</i> <input checked="" type="checkbox"/> 1 - Work May Proceed</p> <p><input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated</p> <p><input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture</p> <p><input type="checkbox"/> 4 - STOP WORK per attached written instructions</p> <p><input type="checkbox"/> 5 - Review Not Required: Work may proceed</p> <p><small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small></p>	Supplier	Exchanger Industries		
	Doc. Description	EXCHANGER - WELD PROCEDURE PQR C2 GMAW- FCAW		
	Vendor Document No.	WPS PQR C2		
	Client Document No.	VP088996-M600-00004		
	Purchase Order No.	Doc Cat.	Issue	
	CE416040-CC088996-00	M600	1	
BY : <u><i>R. Patel</i></u>	Categories			
DATE : <u><i>May 28th, 2013</i></u>	Date Received	05/08/2013		

QW-482 WELDING PROCEDURE SPECIFICATION (WPS)

Company Name EXCHANGER INDUSTRIES LIMITED By: Danette Korchinski
 Welding Procedure Specification No. C-2 Date July 21, 1995 Supporting PQR No. (s) C-2-1, C-2-2, C-2-3, C-2-4
 Revision No. 1 Date November 17, 2011
 Welding Process (es) G.M.A.W. / F.C.A.W. Type (s) Semi-Automatic

JOINTS (QW-402)

Joint Design All ASME approved joints. See construction drawing for joint details where applicable.

Backing (Yes) (No)

Backing Material (Type) Weld Metal where applicable.

(Refer to both backing and retainers)

Metal Nonfusing Metal No Retainers

Nonmetallic Other

Root Opening 0 - 1/4"

ASMA

**SAFETY CODES ACT - PROVINCE OF ALBERTA
WELDING PROCEDURE**

Reg. No. WP 317.2
 Spec. No. C-2 (REV 1)
 Weld Process GMAW/FCAW
 Mat. Gr. P No. 1 Gr 1+2 to P No. 1 Gr 1+2
 Elec. Gr. F No. 6+6 A No. 1
 Th. Qual. For 43.8mm P.W.H.T. NO
MIN Th. QVAL 6.3mm, CVN -46°C

Yr. 11 No. 12 Day 01 Signed [Signature]
 H. ROSENBERG, P.ENG.
 WELDING SPECIALIST

BASE METALS (QW-403)

P-No. 1 Group No. 1 & 2 to P-No. 1 Group No. 1 & 2

Thickness Range:

Non Impact tested .2495" - 1.728"

Base Metal: Groove **Impact tested .0625" - 1.728"** Fillet All

Pipe Dia. Range: Groove unlimited Fillet All

Other NO WELD PASS TO EXCEED 1/2" THICKNESS

FILLER METALS (QW-404)

	G.M.A.W. (Root Only)	F.C.A.W.
Spec. No. (SFA)	5.18	5.20
AWS No. (Class)	ER70S-2	E71T-1
F-No.	6	6
A-No.	1	1
Size of Filler Metals	.035"	.045"
Weld Metal		
Thickness Range:		
Groove	.1375" max	1.728" max.
Fillet	N/A	unlimited
Electrode-Flux (Class)	N/A	N/A
Flux Trade Name	N/A	N/A
Consumable Insert	N/A	N/A
Other	SOLID WIRE	FLUX CORED

vendor doc no. WPS PQR C2

VP088996-M600-00004

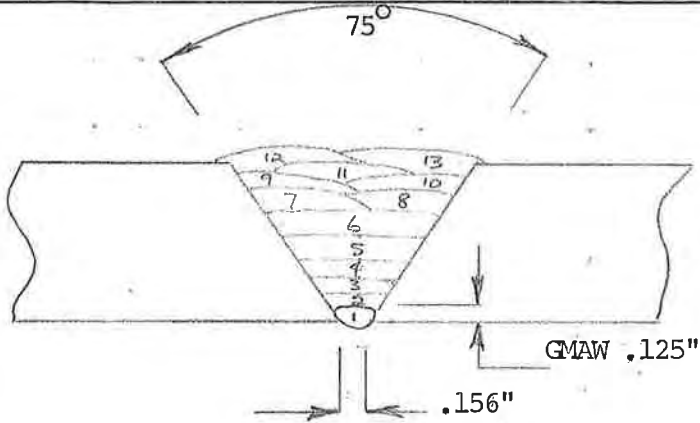
QW-483 SUGGESTED FORMAT FOR PROCEDURE QUALIFICATION RECORD (PQR)
 (See QW-200.2, Section IX, ASME Boiler and Pressure Vessel Code)
Record Actual Conditions Used to Weld Test Coupon.

Company Name EXCHANGER INDUSTRIES, A Division of Premetalco Inc.
 Procedure Qualification Record No. C-2-1 Date July 21, 1995
 WPS No. C-2
 Welding Process(es) GMAW & FCAW
 Types (Manual, Automatic, Semi-Auto.) Semi-automatic

JOINTS (QW-402)

TRAVEL SPEEDS

Pass #1 - GMAW @ 6".
 Pass #2&3 - FCAW @ 14".
 Pass #4 - FCAW @ 10".
 Pass #5&6 - FCAW @ 6.5".
 Pass #7-13 - FCAW @ 8".



All welding from bevel side.

Groove Design of Test Coupon

(For combination qualifications, the deposited weld metal thickness shall be recorded for each filler metal or process used.)

BASE METALS (QW-403)

Material Spec. SA-333 to SA-350
 Type or Grade 6 to LF2
 P-No. 1 Gr 1 to P-No. P-1 Gr 2
 Thickness of Test Coupon .864"
 Diameter of Test Coupon 6.625" O.D.
 Other _____

POSTWELD HEAT TREATMENT (QW-407)

Temperature none
 Time _____
 Other _____

FILLER METALS (QW-404)

	<u>GMAW</u>	<u>FCAW</u>
SFA Specification	<u>5.18</u>	<u>5.20</u>
AWS Classification	<u>* ER70S-2</u>	<u>E71T-1 **</u>
Filler Metal F-No.	<u>6</u>	<u>6</u>
Weld Metal Analysis A-No.	<u>1</u>	<u>1</u>
Size of Filler Metal	<u>.035"</u>	<u>.045"</u>
Other	<u>* = L-Tec 65</u>	
	<u>** = Hobart XL-525</u>	
Weld Metal Thickness	<u>.125"</u>	<u>.739"</u>

GAS (QW-408)

Blue shield # 8

Percent Composition

	<u>Gas(es)</u>	<u>(Mixture)</u>	<u>Flow Rate</u>
Shielding	<u>Ar-CO2</u>	<u>75-25</u>	<u>30 CFH</u>
Trailing	_____	_____	_____
Backing	_____	_____	_____

ELECTRICAL CHARACTERISTICS (QW-409)

Current direct
 Polarity reverse
 Amps. GMAW: 150 Volts 19
 Amps. FCAW: 230 Volts 26

Maximum heat input = 55,200 J/in.

POSITION (QW-405)

Position of Groove GMAW: 45 deg
FCAW: 1G
 Weld Progression (Uphill, Downhill) GMAW - downhill
 Other _____

TECHNIQUE (QW-410)

Travel Speed shown above in inches per minute.
 String or Weave Bead weave
 Oscillation n/a
 Multipass or Single Pass (per side) multipass
 Single or Multiple Electrodes single
 Other _____

PREHEAT (QW-406)

Preheat Temp. 60 deg F.
 Interpass Temp. 450 deg F.
 Other _____

QW-483 (Back)

PQR No. C-2-1

Tensile Test (QW-150)

Specimen No.	Width	Thickness	Area	Ultimate Total Load lb	Ultimate Unit Stress psi	Type of Failure & Location
T-1	.752"	.799"	601 sq.in.	40,100	66,700	partial cup&cone in P-1Gr1-B. M.
T-2	.764"	.787"	602 sq.in.	39,800	66,100	partial cup&cone in P-1Gr-1B.M.

Guided-Bend Tests (QW-160)

Type and Figure No.	Result
Side bend S-1	pass
Side bend S-2	pass
Side bend S-3	pass
Side bend S-4	pass

Toughness Tests (QW-170)

Specimen No.	Notch Location	Notch Type	Test Temp.	ft Impact lb values	Lateral Exp.		Drop Weight	
					% Shear	Mils	Break	No Break
A2.1	weld	vee	-50 degF	32.0				
A2.2	weld	vee	-50 degF	37.0				
A2.3	weld	vee	-50 degF	44.6				
A3.1	Gr1 HAZ	vee	-50 degF	>192				
A3.2	Gr1 HAZ	vee	-50 degF	126				
A3.3	Gr1 HAZ	vee	-50 degF	34.2				
B3.1	Gr2 HAZ	vee	-50 degF	33.0				
B3.2	Gr2 HAZ	vee	-50 degF	89.0				
B3.3	Gr2 HAZ	vee	-50 degF	72.6				

Specimens were 10 mm x 10 mm.

Other Tests

Type of Test Hardness tests per attached sheet.
 Deposit Analysis _____
 Other _____

Welder's Name Bruce Hendry File# W-6009 Stamp No. P
 Tests conducted by: Ludwig & Associates Ltd. Laboratory Test No. C95-460.1

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code. EXCHANGER INDUSTRIES,

5505 - 52 Street S.E.
 Manufacturer Calgary, AB T2A 6A8
Earl Stender
 By Chief Inspector *Earl Stender*

Date July 21, 1995

(Detail of record of tests are illustrative only and may be modified to conform to the type and number of tests required by the Code.)



LABORATORY TEST REPORT

CUSTOMER: EXCHANGER INDUSTRIES
P.O. Box 1107, Station "J"
Calgary, Alberta
T2A 6A8

Laboratory Test No.: C95-460.1
Date: July 21, 1995

Attention: Earl Stender

PQR Number: C-2-1 Job Number: 95-6405
Material: SA 333 Gr. 6 (Ht. No.: 38784) to SA 350 Gr. LF2 (Ht. No.: 403746)
Size: 168.3 mm (6.625 in.) O.D. x 21.95 mm (0.864 in.) w.t.
Thermal Condition: As Welded

TENSILE TEST (QW-150)

Table with 3 columns: SAMPLE NUMBER, T1, T2. Rows include WIDTH mm (in), THICKNESS mm (in), AREA sq mm (sq in), ULT. LOAD N (lbs), UTS MPa (psi), FRACTURE TYPE, and FRACTURE LOCATION.

GUIDED-BEND TEST (QW-160)

Table with 5 columns: SAMPLE WIDTH, PLUNGER SIZE, SAMPLE TYPE, SAMPLE NUMBER(S), RESULTS, SAMPLE THICKNESS, YOKE SIZE, and RESULTS.

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section IX, 1992 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report.

Laboratory Test Conducted By:

Signature of Patrick Voisin

Patrick Voisin, C.E.T.



LABORATORY TEST REPORT

CUSTOMER: EXCHANGER INDUSTRIES
P.O. Box 1107, Station "J"
Calgary, Alberta
T2A 6A8

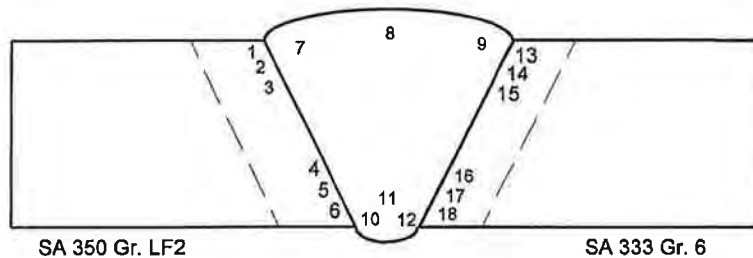
Laboratory Test No.: C95-460.1
Date: July 20, 1995

Attention: Earl Stender

PQR Number: C-2-1 **Job Number:** 95-6405
Material: SA 333 Gr. 6 (Ht. No.: 38784) to SA 350 Gr. LF2 (Ht. No.: 403746)
Size: 168.3 mm (6.625 in.) O.D. x 21.95 mm (0.864 in.) w.t.
Thermal Condition: As Welded

HARDNESS TEST

TYPE OF TEST: Rockwell **SCALE:** "B" scale
INSTRUMENT TYPE: Newage Digital Versitron



1)	87 HRB	5)	92 HRB	9)	93 HRB	13)	85 HRB	17)	84 HRB
2)	87 HRB	6)	89 HRB	10)	88 HRB	14)	80 HRB	18)	84 HRB
3)	88 HRB	7)	91 HRB	11)	86 HRB	15)	79 HRB		
4)	89 HRB	8)	91 HRB	12)	87 HRB	16)	84 HRB		

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E18 - 92. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report.

Laboratory Test Conducted By: _____

Pat Voisin

Patrick Voisin, C.E.T.

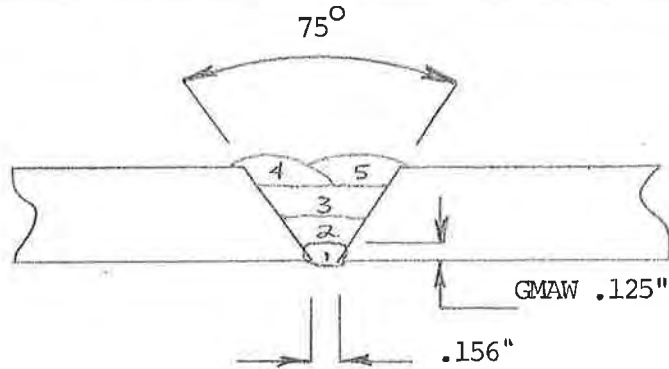
QW-483 SUGGESTED FORMAT FOR PROCEDURE QUALIFICATION RECORD (PQR)
(See QW-200.2, Section IX, ASME Boiler and Pressure Vessel Code)
Record Actual Conditions Used to Weld Test Coupon.

Company Name EXCHANGER INDUSTRIES, A Division of Premetalco Inc.
 Procedure Qualification Record No. C-2-2 Date July 6, 1996
 WPS No. C-2
 Welding Process(es) GMAW & FCAW
 Types (Manual, Automatic, Semi-Auto.) semi-automatic

JOINTS (QW-402)

TRAVEL SPEED

Pass #1 - GMAW @ 5.5"
 Pass #2 - FCAW @ 10"
 Pass #3 - FCAW @ 6"
 Pass #4 - FCAW @ 10"
 Pass #5 - FCAW @ 10"



All welding from bevel side.

Groove Design of Test Coupon

(For combination qualifications, the deposited weld metal thickness shall be recorded for each filler metal or process used.)

BASE METALS (QW-403)

Material Spec. SA-333 to SA-350
 Type or Grade 6 to LF2
 P-No. 1 Gr 1 to P-No. 1 Gr 2
 Thickness of Test Coupon .500"
 Diameter of Test Coupon 8.625" O.D.
 Other _____

POSTWELD HEAT TREATMENT (QW-407)

Temperature none
 Time _____
 Other _____

GAS (QW-408)

Blueshield #8

	Percent Composition		
	Gas(es)	(Mixture)	Flow Rate
Shielding	<u>Ar-CO2</u>	<u>75-25</u>	<u>30 CFH</u>
Trailing	_____	_____	_____
Backing	_____	_____	_____

FILLER METALS (QW-404)

	GMAW	FCAW
SFA Specification	<u>5.18</u>	<u>5.20</u>
AWS Classification	<u>* ER70S-2</u>	<u>E71T-1 **</u>
Filler Metal F-No.	<u>6</u>	<u>6</u>
Weld Metal Analysis A-No.	<u>1</u>	<u>1</u>
Size of Filler Metal	<u>.035"</u>	<u>.045"</u>
Other	<u>* = L-Tec 65</u>	
	<u>** = Hobart XL-525</u>	
Weld Metal Thickness	<u>.125"</u>	<u>.375"</u>

ELECTRICAL CHARACTERISTICS (QW-409)

Current direct
 Polarity reverse
 Amps. GMAW-130 Volts 20
 Amps. FCAW-240 Volts 26

Maximum heat input = 62,400 J/in.

POSITION (QW-405)

Position of Groove GMAW - 45°
FCAW - 1G
 Weld Progression (Uphill, Downhill) GMAW - downhill
 Other _____

TECHNIQUE (QW-410)

Travel Speed shown above in inches per minute.
 String or Weave Bead weave
 Oscillation n/a
 Multipass or Single Pass (per side) multipass
 Single or Multiple Electrodes single
 Other _____

PREHEAT (QW-406)

Preheat Temp. 60 deg F.
 Interpass Temp. 450 deg F.
 Other _____

QW-483 (Back)

PQR No. C-2-2

Tensile Test (QW-150)

Specimen No.	Width	Thickness	Area	Ultimate Total Load lb	Ultimate Unit Stress psi	Type of Failure & Location
n/a						

Guided-Bend Tests (QW-160)

Type and Figure No.	Result
n/a	

Toughness Tests (QW-170)

Specimen No.	Notch Location	Notch Type	Test Temp.	ft Impact lbs/values	Lateral Exp.		Drop Weight	
					% Shear	Mils	Break	No Break
I.2.1	weld	vee	-50 degF	16.4				
I.2.2	weld	vee	-50 degF	26.6				
I.2.3	weld	vee	-50 degF	18.0				
I.3.1	Gr1 HAZ	vee	-50 degF	191				
I.3.2	Gr1 HAZ	vee	-50 degF	122				
I.3.3	Gr1 HAZ	vee	-50 degF	94.0				
M3.1	Gr2 HAZ	vee	-50 degF	94.2				
M3.2	Gr2 HAZ	vee	-50 degF	125				
M3.3	Gr2 HAZ	vee	-50 degF	141				

Specimens were 10mm x 10 mm.

Other Tests

Type of Test _____
 Deposit Analysis _____
 Other _____

Welder's Name Branko Zjalic File# W-1170 Stamp No. K
 Tests conducted by: Ludwig & Associates Ltd. Laboratory Test No. C95-442.1

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

Manufacturer EXCHANGER INDUSTRIES
5505 - 52 Street S.E.
Calgary, Alberta T2A 6A8
 By Earl Stender
Chief Inspector

Date July 6, 1995

(Detail of record of tests are illustrative only and may be modified to conform to the type and number of tests required by the Code.)

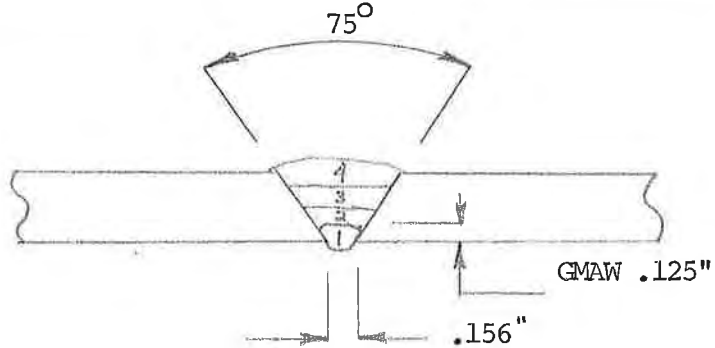
QW-483 SUGGESTED FORMAT FOR PROCEDURE QUALIFICATION RECORD (PQR)
 (See QW-200.2, Section IX, ASME Boiler and Pressure Vessel Code)
Record Actual Conditions Used to Weld Test Coupon.

Company Name EXCHANGER INDUSTRIES, A Division of Premetalco Inc.
 Procedure Qualification Record No. C-2-3 Date July 20, 1995
 WPS No. C-2
 Welding Process(es) GMAW & FCAW
 Types (Manual, Automatic, Semi-Auto.) semi-automatic

JOINTS (QW-402)

TRAVEL SPEEDS

Pass #1 - GMAW @ 6"
 Pass #2 - FCAW @ 13"
 Pass #3 - FCAW @ 8.5"
 Pass #4 - FCAW @ 7"



All welding from bevel side.

Groove Design of Test Coupon

(For combination qualifications, the deposited weld metal thickness shall be recorded for each filler metal or process used.)

BASE METALS (QW-403)
 Material Spec. SA-333 to SA-350 LF2
 Type or Grade 6 to LF2
 P-No. 1 Gr 1 to P-No. 1 Gr 2
 Thickness of Test Coupon .375"
 Diameter of Test Coupon 6.625" O.D.
 Other _____

POSTWELD HEAT TREATMENT (QW-407)
 Temperature none
 Time _____
 Other _____

FILLER METALS (QW-404)	GMAW	FCAW
SFA Specification	<u>5.18</u>	<u>5.20</u>
AWS Classification	<u>*ER70S-2</u>	<u>E71T-1 **</u>
Filler Metal F-No.	<u>6</u>	<u>6</u>
Weld Metal Analysis A-No.	<u>1</u>	<u>1</u>
Size of Filler Metal	<u>.035"</u>	<u>.045"</u>
Other	<u>* = I-Tec 65</u>	
	<u>** = Hobart XL-525</u>	
Weld Metal Thickness	<u>.125"</u>	<u>.250"</u>

GAS (QW-408) Blueshield #8

	Percent Composition		Flow Rate
	Gas(es)	(Mixture)	
Shielding	<u>Ar-CO2</u>	<u>75-25</u>	<u>30 CFH</u>
Trailing	_____	_____	_____
Backing	_____	_____	_____

ELECTRICAL CHARACTERISTICS (QW-409)
 Current direct
 Polarity reverse
 Amps. GMAW - 150 Volts 19
 Amps. FCAW - 230 Volts 26
 Maximum heat input = 51,257 J/in.

POSITION (QW-405) GMAW - 45 deg.
 Position of Groove FCAW - 1G
 Weld Progression (Uphill, Downhill) GMAW - downhill
 Other _____

TECHNIQUE (QW-410)
 Travel Speed shown above in inches per minutes
 String or Weave Bead weave
 Oscillation n/a
 Multipass or Single Pass (per side) multipass
 Single or Multiple Electrodes single
 Other _____

PREHEAT (QW-406)
 Preheat Temp. 60 deg F.
 Interpass Temp. 450 deg F.
 Other _____

QW-483 (Back)

PQR No. C-2-3

Tensile Test (QW-150)

Specimen No.	Width	Thickness	Area	Ultimate Total Load lb	Ultimate Unit Stress psi	Type of Failure & Location
n/a						

Guided-Bend Tests (QW-160)

Type and Figure No.	Result
n/a	

Toughness Tests (QW-170)

Specimen No.	Notch Location	Notch Type	Test Temp.	ft Impact lbs/values	Lateral Exp.		Drop Weight	
					% Shear	Mils	Break	No Break
C2.1	weld	vee	-50 degF	42.2				
C2.2	weld	vee	-50 degF	51.0				
C2.3	weld	vee	-50 degF	39.8				
C3.1	Gr1 HAZ	vee	-50 degF	110				
C3.2	Gr1 HAZ	vee	-50 degF	116				
C3.3	Gr1 HAZ	vee	-50 degF	103				
D3.1	Gr2 HAZ	vee	-50 degF	>192				
D3.2	Gr2 HAZ	vee	-50 degF	>192				
D3.3	Gr2 HAZ	vee	-50 degF	>192				

Specimens were 10 mm x 9 mm.

Other Tests

Type of Test _____
 Deposit Analysis _____
 Other _____

Welder's Name Bruce Hendry File# W-6009 Stamp No. P
 Tests conducted by: Ludwig & Associates Ltd. Laboratory Test No. C95-461.1

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

EXCHANGER INDUSTRIES,
 5505 - 52 Street S.E.
 Calgary, Alberta T2A 6A8
 Manufacturer Earl Stender
 By Earl Stender
 Chief Inspector

Date July 20, 1995

(Detail of record of tests are illustrative only and may be modified to conform to the type and number of tests required by the Code.)



LABORATORY TEST REPORT

CUSTOMER: EXCHANGER INDUSTRIES
P.O. Box 1107 Station "J"
Calgary, Alberta
T2A 6A8

Laboratory Test No.: C95-461.1
Date: July 20, 1995

Attention: Earl Stender

PQR Number: C-2-3 **Job Number:** 95-6405
Material: SA 333 Gr. 6 (Ht. No.: H20071) to SA 350 Gr. LF2 (Ht. No.: 82205)
Size: 168.3 mm (6.625 in.) O.D. x 9.53 mm (0.375 in.) w.t.
Thermal Condition: As Welded

NOTCH-TOUGHNESS TEST

TYPE OF TEST: Charpy V-Notch **ORIENTATION:** Transverse
TEST TEMPERATURE: -46°C (-50°F) **SPECIMEN SIZE:** 10 x 9 mm

Specimen Number	Notch Location	Impact Values Joules (ft.lbs)	
C2.1	Weld Metal	57.2	(42.2)
C2.2	Weld Metal	69.1	(51.0)
C2.3	Weld Metal	53.9	(39.8)
C3.1	P1 Grp.1 - HAZ	149	(110)
C3.2	P1 Grp.1 - HAZ	157	(116)
C3.3	P1 Grp.1 - HAZ	140	(103)
D3.1	P1 Grp.2 - HAZ	>261	(>192)
D3.2	P1 Grp.2 - HAZ	>261	(>192)
D3.3	P1 Grp.2 - HAZ	>261	(>192)

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section VIII, Div. I, UG-84, 1992 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report.

Laboratory Test Conducted By: Pat Voisin
Patrick Voisin, C.E.T.

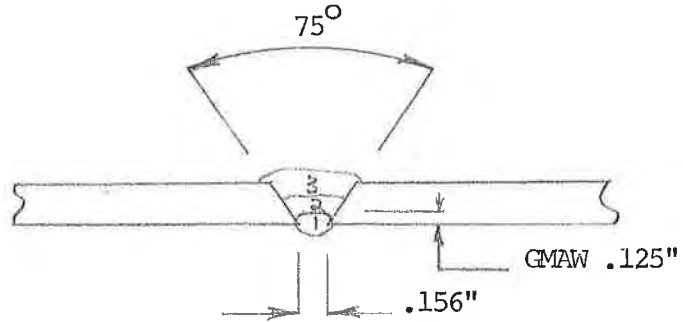
QW-483 SUGGESTED FORMAT FOR PROCEDURE QUALIFICATION RECORD (PQR)
(See QW-200.2, Section IX, ASME Boiler and Pressure Vessel Code)
Record Actual Conditions Used to Weld Test Coupon.

Company Name EXCHANGER INDUSTRIES, A Division of Premetalco Inc.
 Procedure Qualification Record No. C-2-4 Date July 21, 1995
 WPS No. C-2
 Welding Process(es) GMAW & FCAW
 Types (Manual, Automatic, Semi-Auto.) Semi-automatic

JOINTS (QW-402)

TRAVEL SPEEDS

Pass #1 - GMAW @ 5.5"
 Pass #2 - FCAW @ 13".
 Pass #3 - FCAW @ 10".



All welding from bevel side.

Groove Design of Test Coupon

(For combination qualifications, the deposited weld metal thickness shall be recorded for each filler metal or process used.)

BASE METALS (QW-403)

Material Spec. SA-333 to SA-350
 Type or Grade 6 to LF2
 P-No. 1 Gr 1 to P-No. 1 Gr 2
 Thickness of Test Coupon .2495"
 Diameter of Test Coupon 4.5" O.D.
 Other _____

POSTWELD HEAT TREATMENT (QW-407)

Temperature none
 Time _____
 Other _____

FILLER METALS (QW-404)

	GMAW	FCAW
SFA Specification	<u>5.18</u>	<u>5.20</u>
AWS Classification	<u>* ER70S-2</u>	<u>E71T-1 **</u>
Filler Metal F-No.	<u>6</u>	<u>6</u>
Weld Metal Analysis A-No.	<u>1</u>	<u>1</u>
Size of Filler Metal	<u>.035"</u>	<u>.045"</u>
Other	<u>* = Ir-Tec 65</u>	
	<u>** = Hobart XL-525</u>	
Weld Metal Thickness	<u>.125"</u>	<u>.1245"</u>

GAS (QW-408) Blueshield #8

	Percent Composition		
	Gas(es)	(Mixture)	Flow Rate
Shielding	<u>Ar-CO2</u>	<u>75-25</u>	<u>30 CFH</u>
Trailing	_____	_____	_____
Backing	_____	_____	_____

ELECTRICAL CHARACTERISTICS (QW-409)

Current direct
 Polarity reverse
 Amps. GMAW - 130 Volts 20
 Amps. FCAW - 240 Volts 26

Maximum heat input = 37,440 J/in.

POSITION (QW-405)

Position of Groove GMAW - 45 deg
FCAW - 1G
 Weld Progression (Uphill, Downhill) GMAW - downhill
 Other _____

TECHNIQUE (QW-410)

Travel Speed shown above in inches per minute.
 String or Weave Bead weave
 Oscillation n/a
 Multipass or Single Pass (per side) multipass
 Single or Multiple Electrodes single
 Other _____

PREHEAT (QW-406)

Preheat Temp. 60 deg F.
 Interpass Temp. 450 deg F.
 Other _____

QW-483 (Back)

PQR No. C-2-4

Tensile Test (QW-150)

Specimen No.	Width	Thickness	Area	Ultimate Total Load lb	Ultimate Unit Stress psi	Type of Failure & Location
n/a						

Guided-Bend Tests (QW-160)

Type and Figure No.	Result
n/a	

Toughness Tests (QW-170)

Specimen No.	Notch Location	Notch Type	Test Temp.	ft Impact lb values	Lateral Exp.		Drop Weight	
					% Shear	Mils	Break	No Break
E2.1	weld	vee	-55 degF	24.6				
E2.2	weld	vee	-55 degF	31.0				
E2.3	weld	vee	-55 degF	25.0				
E3.1	Gr1 HAZ	vee	-55 degF	73.8				
E3.2	Gr1 HAZ	vee	-55 degF	51.6				
E3.3	Gr1 HAZ	vee	-55 degF	52.2				
G3.1	Gr2 HAZ	vee	-55 degF	29.6				
G3.2	Gr2 HAZ	vee	-55 degF	31.4				
G3.3	Gr2 HAZ	vee	-55 degF	37.0				

Specimens were 10 mm x 5 mm.

Other Tests

Type of Test _____
 Deposit Analysis _____
 Other _____

Welder's Name Branko Zjalic ~~xxxxxx~~ File#: W-11170 Stamp No. K
 Tests conducted by: Ludwig & Associates Ltd. Laboratory Test No. C95-461.2

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

Manufacturer EXCHANGER INDUSTRIES
5505 - 52 Street S.E.
Calgary, Alberta T2A 6A8
 By Earl Stender
Chief Inspector *Earl Stender*

Date July 21, 1995

(Detail of record of tests are illustrative only and may be modified to conform to the type and number of tests required by the Code.)



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments			
103-E-705;103-E-707	JPI REV 1 - COORDINATION			
Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1		
<p><i>for</i></p> <input checked="" type="checkbox"/> 1 - Work May Proceed <input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated <input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture <input type="checkbox"/> 4 - STOP WORK per attached written instructions <input type="checkbox"/> 5 - Review Not Required: Work may proceed <small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small>	Supplier	Exchanger Industries		
	Doc. Description	EXCHANGER - PATELS - WELD PROCEDURES - WPS - 210 PQR - 210-1 - GTAW SMAW		
	Vendor Document No.	PAT WPS 210		
	Client Document No.	VP088996-M600-00021		
	Purchase Order No.	Doc Cat.	Issue	
	CE416040-CC088996-00	M600	1	
BY : <u>SYED SHAH</u>	Categories			
DATE : <u>JULY 19, 2013</u>	Date Received	07/09/2013		

RECEIVED

JUL 09 2013

JACOBS CANADA INC. DOCUMENT CONTROL

PATELS AIRTEMP (INDIA) LTD.

805-806, RAKANPUR-362721. TAL.: KALOL, DIST.: GANDHINAGAR (N.G.)

QW-482 WELDING PROCEDURE SPECIFICATION (WPS)

QW-201.1, Section IX, ASME Boiler and Pressure Vessel Code.

Company Name : PATELS AIRTEMP (INDIA) LTD. BY : U. B. PATEL
 Welding Procedure Specification No 210 Date : 26-11-2007 Supporting PQR No(s): 210/1
 Revision No. : 1 Date : 23-09-2012
 Welding Process(es): GTAW + SMAW Type(s) : MANUAL

JOINTS (QW-402)

Joints Design : As per the Requirement of Job
 Backing : GTAW NO: SMAW (COMBINED PROCESS) YES:
 Backing Material(Type): GTAW NO: SMAW: WELD METAL
 (Refer to both backing and retainers.)

BASE METALS (QW-403)

P. No. : 1 Group No.: 1 & 2 to P. NO.: 1 Group No.: 1 & 2
 OR
 Specification type and grade : _____
 To specification type and grade : _____
 OR
 Chem, analysis and Mech. Prop. : _____
 To Chem Analysis and Mech Prop. : _____
 Thickness range : _____
 Base Metal Groove : 12 MM to 24 MM With Impact Fillet : All Sizes
 5 MM to 24 MM Without Impact

Pipe Dia Range Groove : All Diameter Fillet : All Sizes

FILLER METALS (QW-404)	GTAW	SMAW
	Spec. No. (SFA)	5.18	5.1
AWS No. (Class)	ER 70 S-2 (SPL)	E 7018-1
F.No.	6	4
A.No.	1	1
Size of Filler Metals	2.4 MM	3.15, 4.0 mm
Weld Metals		
Thickness range		
Groove	4 MM	20 MM
Fillet	ALL SIZES	ALL SIZES
Electrode-Flux (class)	None	N.A
Flux Trade Name	None	N.A
Consumable Insert	None	N.A
Others (Product Form)	Bare (Solid)	N.A

SIGN *U. B. Patel*
 DATE 23/9/12
 WELDING ENGINEER
 PAIL

Filler Wire ER70S-2 2.4 MM Dia ER70S-2(SPL) Of Honnaver B NO 072501 Or Impact tested at MDMT -46°C
 Filler Wire used
 Electrode E 7018-1Ultimate 18 SPL Of Honnaver 3.15MM Dia B NO 7091393 4MM Dia B NO 7091522 or any
 equivalent brand to be used

QW-482 [BACK]												
						WPS No.: <u>210</u>	REV.: <u>1</u>					
POSITION (QW-405)					POSTWELD HEAT TREATMENT (QW-407)							
Position(s) of Groove : <u>3G</u>					PWHT : <u>NA</u>							
Welding Progression: <u>UP HILL FOR VERTICAL WELDING</u>					Temp. Range : <u>NA</u>							
<u>DOWN HILL NOT PERMITTED</u>					Time Limit : <u>NA</u>							
Position(s) of Fillet : <u>NA</u>												
Others : <u>NA</u>												
PREHEAT (QW-406)					GAS(QW-408)							
Preheat Temp. Min. <u>16⁰C Min.</u>					Shielding					Percent Composition		
Interpass Temp. Max. <u>150⁰C MAX</u>										Gas			Mixture		Flow Rate
Preheat Maintenance <u>N.A</u>					Welding			Single		10 to 14 ltrs/min		
					Grade Argon							
					Trailing			None		None		
					Backing			None		None		
ELECTRICAL CHARACTERISTICS (QW-409)												
Current AC or DC : <u>DC</u>			Polarity : <u>Reverse for SMAW Straight for GTAW</u>									
Amps : <u>See table below</u>			Volts (Range) <u>See table below</u>									
Tungsten Electrode Size and Type :			<u>3.0 mm dia 2% Thoriated</u>									
Mode of Metal Transfer for GMAW :			<u>N.A</u>									
Electrode wire feed speed range :			<u>N.A</u>									
TECHNIQUE (QW-410)												
Stringer or Weave Bead :			<u>STRINGER BEAD FOR GTAW / WEAWE FOR SMAW</u>									
			<u>Weave to be no more then 3 x electrode dia.</u>									
Orifice or Gas cup size :			<u>3/8" (10 mm) CUP SIZE CERAMIC NOZZLE FOR GTAW</u>									
Initial and interpass cleaning (Brushing, Grinding etc) :			<u>BRUSHING & GRINDING</u>									
Method of Back Gouging :			<u>No</u>									
Oscillation :			<u>N.A</u>									
Contact Tube to work Distance :			<u>N.A</u>									
Multiple or Single Pass (per side) :			<u>MULTIPASS</u>									
Multiple or single electrodes :			<u>Single Electrode</u>									
Travel speed (Range) :			<u>See Table below</u>									
Peening :			<u>Not Allowed</u>									
Other (Close to out Chamber) :			<u>N.A</u>									
Weld Layer	Process	Filler Metal		Current		Voltage	Travel Speed mm / Min	Heat input KJ/mm max	Remarks			
		Class	Dia (MM)	Type	Polarity					Amp./A		
<u>1</u>	<u>GTAW</u>	<u>ER70S.2(SPL)</u>	<u>2.4 MM</u>	<u>STRAIGHT</u>		<u>12 TO 18</u>	<u>40 TO 80</u>	<u>2.43</u>				
<u>2</u>	<u>SMAW</u>	<u>E 7018-1</u>	<u>3.15 MM</u>	<u>REVERSE</u>		<u>80 TO 110</u>	<u>22 TO 28</u>	<u>2.31</u>				
<u>3 & other</u>	<u>SMAW</u>	<u>E 7018-1</u>	<u>4 MM</u>	<u>REVERSE</u>		<u>140 TO 180</u>	<u>22 TO 28</u>	<u>3.78</u>				
<u>Final</u>	<u>SMAW</u>	<u>E 7018-1</u>	<u>3.15 MM</u>	<u>REVERSE</u>		<u>80 TO 110</u>	<u>22 TO 28</u>	<u>2.31</u>				
<div style="display: flex; justify-content: space-between;"> <div style="width: 30%;"> <p>Prepared By, <u>[Signature]</u> WELDING ENGINEER PATEL</p> </div> <div style="width: 30%; text-align: center;"> <p>Approved By, <u>[Signature]</u> DATE <u>23-09-2012</u> D. P. PATEL Q.C. MANAGER BHEL ANKIT WELDING ANKIT IMPORTANT W.P. SWPS-210 LRA 23sept12 Q.C. DEPARTMENT</p> </div> </div>												

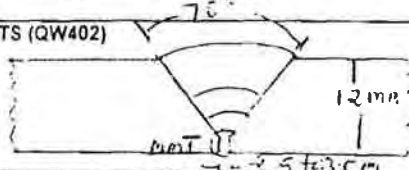
PATELS AIRTEMP (INDIA) LTD.

805-806, RAKANPUR-322 721, TAL. : KALOL. DIST. : GANDHINAGAR.

QW-483 PROCEDURE QUALIFICATION RECORD (PQR) (QW-200.2, Section IX ASME Boiler and Pressure Vessel Code) Record Actual Conditions Used to Weld Test Coupon

Company Name : PATELS AIRTEMP (INDIA) LTD.
 Procedure Qualification Record No. : 210/1 DATE 26-11-2007
 WPS No. : 210 Rev. 0
 Welding Process(es) : GTAW - SMAW
 Types (Manual, Automatic, Semi-automatic) : MANUAL

JOINTS (QW402)



BASE METALS (QW-403)	PREHEAT (QW-406)
Material Spec. : <u>SA 516 TO SA 516</u>	Preheat Temp : <u>30° C Min. Metal Temperature</u>
Type or Grade : <u>GR 60 TO GR 70</u>	Interpass Temp Max. : <u>150°C</u>
P.No. 1 Group No. 1 to P. No. 1 Group No. 2	Other : <u>N.A</u>
Thickness of Test Coupon : <u>12 MM</u>	POST WELD HEAT TREATMENT QW 407
Diameter of test coupon : <u>N.A</u>	Temp. : <u>N.A</u>
Other : <u>N.A</u>	Time : <u>N.A</u>
	Other : <u>N.A</u>

FILLER METAL (QW 404)	GTAW	SMAW	GAS (QW 408)																		
SFA Specification	5.18	5.1	Shielding <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="3">Percent Composition</th> </tr> <tr> <th>Gas</th> <th>Mixture</th> <th>Flow Rate</th> </tr> </thead> <tbody> <tr> <td>Welding</td> <td>Single</td> <td>12 Ltr/Min</td> </tr> <tr> <td>Grade Argon</td> <td></td> <td></td> </tr> <tr> <td>Trailing</td> <td>None</td> <td>None</td> </tr> <tr> <td>Backing</td> <td>None</td> <td>None</td> </tr> </tbody> </table>	Percent Composition			Gas	Mixture	Flow Rate	Welding	Single	12 Ltr/Min	Grade Argon			Trailing	None	None	Backing	None	None
Percent Composition																					
Gas	Mixture	Flow Rate																			
Welding	Single	12 Ltr/Min																			
Grade Argon																					
Trailing	None	None																			
Backing	None	None																			
AWS Classification	ER 70S-2 SPL	E 7018-1																			
Filler Metal No.	05	04	TECHNIQUE (QW 410) String or Weave Bead: <u>Stringer Bead for GTAW/Weave for SMAW</u> Oscillation : <u>--</u> Multipass or Single Pass(perside) : <u>Multipass</u> Single or Multiple Electrode: <u>Single Electrode</u> Orifice or Gas cup size : <u>3/8" (10 mm) Cup size ceramic nozzle</u> Initial and Interpass cleaning : <u>for GTAW</u> <u>Brushing & Grinding</u>																		
Weld Metal	01	01																			
Analysis A. No.																					
Size of Filler Metal	2.4 MM	3.15, 4 MM																			
Other																					
Weld metal Thickness	2 MM	10MM																			

POSITION (QW-405)	GAS (QW 408)
Position of Groove : <u>3 G</u>	
Weld progression (Uphill/Downhill) : <u>Up Hill</u>	
Other : <u>--</u>	

ELECTRICAL CHARACTERISTIC (QW-409)

Current : DC Polarity : Stright for GTAW reverse for SMAW
 Tungsten Electrode Size : 3 mm dia 2% Thoriated tungsten
 Reading as under:

RUN SR. NO.	FILLER METAL DIA (MM)	FILLER METAL SPECN.	CURRENT (AMPS)	VOLTAGE (V)	TRAVEL SPEED MM/MIN	HEAT INPUT KJ/CM
1	(GTAW for root only) 2.4 mm	ER 70S-2 (SPL)	160	15	40 mm / min	3.6
2	3.15 mm	E 7018-1	100	24	60 mm / min	2.4
3	4 mm	E 7018-1	150	25	50 mm / min	4.5
4	3.15 mm	E 7018-1	100	24	40 mm / min	3.6

Filler Wire ER70S-2 (SPL), 2.4 MM Dia ER70S-2 (SPL) of Honaver B No. 072501
 Electrode E 7018-1, Ultimate 18 SPL of Honaver 3.15 MM dia B No. 7091393 & 4 MM Dia B No. 7091522

27/11/07

NON-MANDATORY APPENDIX B
QW-483 [BACK]

PQR No. : 210/1

Tensile Test (QW-150)

Specimen No	Width mm	Thickness mm	Area mm ²	Ultimate Total Load N	Ultimate Unit Stress MPa	Type of failure & Location
T1	20.30	11.56	234.67	138000	588.10	Broken - SA 516 GR. 60 Parent Metal Fracture - Ductile
T2	21.00	11.73	246.33	141500	574.40	Broken - SA 516 GR. 60 Parent Metal Fracture - Ductile

As per M/s. PAT Report No. 199-V/2007 Dtd 24-11-2007

Guided Bend Test (QW-160)

	Type and Figure No. 462.3 (a)	RESULT
1	Root Bend RB1	Satisfactory
2	Root Bend RB2	Satisfactory
3	Face Bend FB1	Satisfactory
4	Face Bend FB2	Satisfactory

As per M/s. PAT Report No. 199-VJ2007 Dtd 24-11-2007

Toughness Test (QW-170)

Specimen No.	Notch Location	Specimen Size mm	Test Temp. °C	Impact Values in Joules			Average Value	Required Value
1	Weld	10 x 10	-45°C	18J	24J	28J	23.33J	-
2	HAZ (SA-516 GR 60)	10 x 10	-45°C	23J	26J	31J	26.67J	-
3	HAZ (SA-516 GR 70)	10 x 10	-45°C	60J	51J	66J	55.67J	-
								-

As per M/s. Met - Heat Engineers Pvt. Ltd's Report No. 55-V/2007 Dtd 20-11-2007

1. Visual Inspection After Root Run and Final Layer found Acceptable

Fillet-Weld Test (QW-180)

Result Satisfactory : Yes - N A - No Penetration into Parent Metal : Yes
No. Macro-Result

Other Tests

Type of Test : _____
Deposit Analysis : _____
Other : _____

Welder's Name : Dhardev Yadav Clock No. : Stamp No. : W37
Test Conducted by : U B Patel Laboratory Test No. :

We Certify that the statement in this record are correct and that the test welds were prepared & Tested in accordance with the requirement of Section IX of the ASME Code

Manufacturer: PATELS AIRTEMP (INDIA) LTD.

DATE: 26-11-2007

BY, [Signature]
26-11-07

[Signature]
30/11/07
LRA - A. BAD



MET - HEAT ENGINEERS PVT. LTD.

METALLURGICAL LABORATORY
ON APPROVED LIST OF VARIOUS GOVT. DEPARTMENTS
& PUBLIC SECTOR UNDERTAKINGS
(SINCE 1975)

MHEPL/FM/18

857/2, G.I.D.C.
INDUSTRIAL ESTATE, MAKARPURA,
VADODARA - 390 010
TELEFAX: 0265 - 2632374, 2643655
E-mail : info@metheat.com
Website : www.metheat.com

TEST REPORT

WO:11/570 SrNo.1 PI/ 7

Name of The Customer : PATELS AIRTEMP(INDIA)LTD. (UNIT-III)
805-806, RAKANPUR-382 721
VIA SOLA-BHADAJ VILLAGE
TAL-KALOL DIST-GANDHINAGAR
Test Report No. : 55-V /2007
Date. : 20/11/2007
Date of Receipt : 07/11/2007

Particulars of Sample Submitted: Welded Test PIECE OF 12MM THK PLATE

Material Specification : SA-516 GRADE-60:2004 To SA-516 GRADE-70:2004

Identification Of Sample : Stamped As 'PAT-2' Of LRA.ID:WPS-210

Type of Test Required : V Notch Charpy Impact Test at -46° C. By E-23:2002A
[MINUS FORTY SIX Degree Centigrade]

Customer's Reference No : CH NO:127 DT:5/11/07 REF:PAIL QC/PAIL/KPCL AHM NO:
0703007 PROCESS WELDING ROOT RUN WITH GTAW AND TES
T WITH SMAW POSITION:3G ATTN:D.P.PATEL MANAGER Q.C

Results :

Location	Size mm	Energy absorbed in Joules			Average Value	Required Value
		I	II	III		
Weld	10x10.00	18J	24J	28J	23.33J	
HAZ (SA-516 GR.60)	10x10.00	23J	26J	31J	26.67J	
HAZ (SA-516 GR.70)	10x10.00	60J	51J	56J	55.67J	



Revised at 20/11/07

20/11/07

Tested By

Authorised Signatory

Witnessed B

A. M. Dave (QM) / M. G. Dave (MD) / N. M. Dave (TM)

Note: (1) Sample(s) not drawn by MHEPL. The results relate only to the sample(s) tested.
(2) This Certificate shall not be reproduced, except in full, without the written approval of MHEPL.
(3) If balance material is available after testing, it will be retained for 15 days maximum. If customer wants to retain it for one month from this date, he has to inform in writing



WPS-210

MHEPL/FM/17

MET - HEAT ENGINEERS PVT. LTD.

METALLURGICAL LABORATORY
ON APPROVED LIST OF VARIOUS GOVT. DEPARTMENTS
& PUBLIC SECTOR UNDERTAKINGS
(SINCE - 1975)

857/2, G.I.D.C.
INDUSTRIAL ESTATE, MAKARPUR/
VADODARA - 390 010
TELEFAX : 0265 - 2632374, 264366
E-mail : info@metheat.com
Website : www.metheat.com

TEST REPORT (PHYSICAL)

WO:11/570 SrNo.1 PI/ 7

Name of The Customer : PATELS AIRTEMP(INDIA)LTD. (UNIT-III)
805-806, RAKANPUR-382 721
VIA SOLA-BHADAJ VILLAGE
TAL-KALOL DIST-GANDHINAGAR

PTR No. : 199-VJ/2007
Date. : 24/11/2007

Date of Receipt : 07/11/2007

Customer's Reference No : CH NO:127 DT:5/11/07 REF:PAIL QC/PAIL/KPCL AHM NO:
0703007 PROCESS WELDING ROOT RUN WITH GTAW AND TES
T WITH SMAW POSITION:3G ATTN:D.P.PATEL MANAGER Q.C
Material Specification : SA-516 GRADE-60:2004 To SA-516 GRADE-70:2004

Sr No.	Description of Material	Identification	Dia-Width mm	Thick mm	Cross Sectional Area mm ²	Yield Load	Yield Strength	Ultimate Load	Tensile Strength	Gauge Length mm	Final Length mm	Elongation %
						N	Required Minimum MPa	N	Required Minimum MPa			Require Minimum
199 VJ	Welded Test PIECE OF 12MM THK PLATE	Stamped as 'PAT-2' OF LRA	20.30	11.56	234.67	-	-	135000	568.1	Broken - Parent Metal Fracture-Ductile		
		ID:WPS-210										(SA-516 GR.60)
200 VJ	do	do T-2	21.00	11.73	246.33	-	-	141500	574.4	Broken - Parent Metal Fracture-Ductile		
												(SA-516 GR.60)
201 VJ	do	do RB-1	ROOT BEND TEST Satisfactory			Mandril Dia : 38.00 mm			Angle Of Bend 180.0 Deg			
202 VJ	do	do RB-2	ROOT BEND TEST Satisfactory			Mandril Dia : 38.00 mm			Angle Of Bend 180.0 Deg			
203 VJ	do	do FB-1	FACE BEND TEST Satisfactory			Mandril Dia : 38.00 mm			Angle Of Bend 180.0 Deg			
204 VJ	do	do FB-2	FACE BEND TEST Satisfactory			Mandril Dia : 38.00 mm			Angle Of Bend 180.0 Deg			

Method Of Testing : ASME SEC-IX : 2004.

The above results are meeting with physical requirements of ASME SECT-IX with respect of test carried out.

Reviewed by
[Signature]
30/11/07



Tested By

A. M. Dave (QM) / N. M. Dave (TM)
Authorised Signatory

Witnessed By

Note: (1) Sample(s) not drawn by MHEPL. The results relate only to the sample(s) tested.
(2) This Certificate shall not be reproduced, except in full, without the written approval of MHEPL.
(3) If balance material is available after testing, it will be retained for 15 days maximum. If customer wants to retain it for one month from the date of test report, it will be retained for one month from the date of test report.



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments			
101-E-450;101-E-451	JPI REV 1 - COORDINATION			
Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1		
<p><input checked="" type="checkbox"/> 1 - Work May Proceed</p> <p><input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated</p> <p><input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture</p> <p><input type="checkbox"/> 4 - STOP WORK per attached written instructions</p> <p><input type="checkbox"/> 5 - Review Not Required: Work may proceed</p> <p><small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small></p>	Supplier	Exchanger Industries		
	Doc. Description	EXCHANGER - PATELS - WELD PROCEDURES - WPS - SAW-4 - RR GTAW PLUS ONE RUN SMAW PLUS REST SAW		
	Vendor Document No.	PAT WPS SAW-4		
	Client Document No.	VP088996-M600-00030		
	Purchase Order No.	Doc Cat.	Issue	
	CE416040-CC088996-00	M600	1	
BY : <u>SYED SHAH</u>	Categories			
DATE : <u>JULY 22, 2013</u>	Date Received	07/11/2013		

PATELS AIRTEMP (INDIA) LTD.			
805-806, RAKANPUR-362721. TAL.: KALOL, DIST.: GANDHINAGAR (N.G.)			
QW-482 WELDING PROCEDURE SPECIFICATION (WPS)			
QW-200.1, Section IX, ASME Boiler and Pressure Vessel Code.			
Company Name	PATELS AIRTEMP (INDIA) LTD.		BY : <u>U.B. PATEL</u>
Welding Procedure Specification No:	<u>SAW 4, Dtd. 22-09-2012</u>		Supporting PQR No(s): <u>SAW 4/1, Rev. 01</u>
Revision No :	<u>01, Dtd. 05-10-2012</u>		
Welding Process(es):	<u>RR GTAW+ONE RUN SMAW+REST SAW</u>		Type(s) : <u>MANUAL / AUTOMATIC</u>
JOINTS (QW-402)			
JOINTS Design :	As per requirement of Job		
Backing	FOR SMAW YES	SAW YES	GTAW NO
Backing Material(Type):	NO WELD METAL		
(Refer to both backing and retainers)			
BASE METALS (QW-403)			
P No :	<u>1</u>	Group No. <u>1 & 2</u>	to P. NO. <u>1</u> Group No.: <u>1 & 2</u>
OR			
Specification type and grade	<u>SA 516 GR-60 10 MM</u>		
To specification type and grade	<u>SA 516 GR-70 10 MM</u>		
OR			
Chem, analysis and Mech. Prop.	_____		
To Chem Analysis and Mech Prop.	_____		
Thickness range	<u>10.00 MM to 20.00 MM WITH IMPACT</u>		
Base Metal	Groove : <u>5.00 MM to 20.00 MM WITHOUT IMPACT</u>	Fillet : <u>ALL SIZES</u>	
<u>No Pass is greater than 13.00 MM</u>			
Pipe Dia Range	Groove : <u>ALL DIAMETER</u>	Fillet : <u>ALL SIZES</u>	
FILLER METALS (QW-404)			
	GTAW	SMAW	SAW
Spec No. (SFA)	5.18	5.1	5.17
AWS No. (Class)	ER-70S-2	E 7018-1	F7A4 / EH 14
F.No	6	04	06
A.No	1	01	01
Size of Filler Metals	1 6	3.15 MM DIA	3 15 MM DIA
Weld Metals	2 00 MM	2.0 MM	6 MM
Thickness range	---		
Groove	4 00 MM	4.00 MM	12 MM
Fillet	ALL SIZE	ALL SIZES	ALL SIZES
Electrode-Flux (class)	N.A.	N.A.	F7A4 / EH 14
Flux Trade Name	N.A.	N.A.	OK Flux 10.71 L
Flux type	N.A.	N.A.	NEUTRAL
Allow flux	N.A.	N.A.	N.A.
Supplemental	N.A.	N.A.	N.A.
Alloy element	N.A.	N.A.	N.A.
Recrushed slag	N.A.	N.A.	NOT USED
Consumer insert	None	N.A.	N.A.
Filler wire product from	Bare(solid)	N.A.	N.A.
IMPACT at -29°C			

VPO 88996-M600-00030

SIGN U.B. Patel
 DATE 5/10/12
 WELDING ENGINEER
 PAIL

RECEIVED
 WROHIVANKIT WELDINGWANKITIMPORTANT W.P.SISAW 4
JUL 11 2013
 JACOBS CANADA INC.
 DOCUMENT CONTROL

WPS No : SAW 4 REV. : 01

POSITION (QW-405)		POSTWELD HEAT TREATMENT (QW-407)							
Position(s) of Groove	1 G for SAW, 3G for SMAW & GTAW	PWHT	NA						
Welding Progression	Flat for SAW all position for GTAW & SMAW Up hill for vertical welding Down hill not permitted	Temp. Range	NA						
Position(s) of Fillet :	ALL	Time Range	NA						
PREHEAT (QW-406)		GAS(QW-408)							
Preheat Temp Min	15°C Minimum Temp.	Percent Composition							
Interpass Temp Max	150°C Maximum Temp.								
Preheat Maintenance	NA	Shielding	Gas	Mixture	Flow Rate				
		Trailing	welding grade argon	single	10/14 lit/mit				
		Backing	NA	NA	NA				
ELECTRICAL CHARACTERISTICS (QW-409)									
Current AC or DC	DC	Polarity	Reverse for SMAW & SAW processes and Stright for GTAW						
Amps	See table below	Volts (Range)	See table below						
Tungsten Electrode Size and Type	3.00 mm thoriated tungsten used								
Mode of Metal Transfer for GMAW	N.A.								
Electrode wire feed speed range	1000mm to 2000mm/minute for SAW								
TECHNIQUE (QW-410)									
String or Weave Bead	Stringer bead								
	Weave to be no more than 3 x electrode dia.								
Orifice or Gas cup size	3.15 mm Dia copper nozzle used for SAW 10 mm size ciramic nozzle used for GTAW								
Initial and interpass cleaning (Brushing, Grinding etc)	BRUSHING, GRINDING & CHIPPING								
Method of Back Gouging	NO								
Oscillation	N.A.								
Contact Tube to work Distace	4.00 MM for SAW								
Multiple or Single Pass (per side)	Single pass for GTAW & SMAW, Multipass for SAW.								
Multiple or single electrodes	Single Electrode fo all processes								
Travel speed (Range)	See Table below								
Peening	Not allowed								
Electrode spacing	N.A.								
Manual or Automatic	manual and Semi automatic								
Use of thermal process	N.A.								
Close to out chamber	N.A.								
	Process	Filler Metal		Current		Travel Speed	Heat input	Remark	
		Class	Dia (MM)	Type	Polarity	Amp /A	Voltage	mm / Min	KJ/mm (max)
1	GTAW	ER-70S-2	1.60	STRIGHET		130 to 150	14 TO 18	70 to 80	2.16
2	SMAW	E 7018-1	3.15	Reverse		90 to 110	24 TO 26	60 to 70	2.21
3&Other	SAW	F7A4 /EH 14	3.15	Reverse		350 to 450	28 TO 36	350 to 400	2.15

Prepared By,

SIGN *[Signature]*

WELDING ENGINEER *[Signature]*

DATE *5.10.12*

WELDING ENGINEER

PA: L

Aproved By,

Q.C. MANAGER *[Signature]*

DATE *5.10.2012*

D. P. PATEL

MANAGER - QC

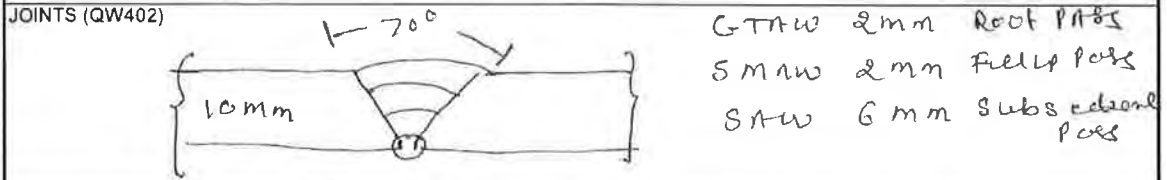
Q.C. DEPARTMENT

PATELS AIRTEMP (INDIA) LTD.

805-806, RAKANPUR-382 721, TAL. : KALOL. DIST. : GANDHINAGAR.

QW-483 PROCEDURE QUALIFICATION RECORD (PQR)
(QW-200.2, Section IX, ASME Boiler and Pressure Vessel Code)
Record Actual Variables Used to Weld Test Coupon

Company Name : PATELS AIRTEMP (INDIA) LTD.
 Procedure Qualification Record No. : SAW-4/1 DATE : 22-09-2012
 Revision No : 01 Dtd 05-10-2012
 WPS No. : SAW-4, Rev. 01, Dtd. 05-10-2012
 Welding Process(es): RR GTAW+ONE RUN SMAW+REST SAW
 Types (Manual, Automatic Semi-Auto): MANUAL / AUTOMATIC



BASE METALS (QW-403)			PREHEAT (QW-406)		
Material Spec	<u>SA-516</u>	<u>SA-516</u>	Preheat Temp	<u>30° C MIN. METAL TEMP.</u>	
Type or Grade	<u>GR-60</u>	<u>GR-70</u>	Interpass Temp Max. :	<u>150° C</u>	
P No.	<u>1 GR.1</u>	to P No <u>1 GR.2</u>	Other :	<u>NA</u>	
Thickness of Test Coupon	<u>10 MM</u>		POST WELD HEAT TREATMENT QW 407		
Diameter of test coupon	<u>NA</u>		PWHT	<u>NA</u>	
Other :	<u>NA</u>		Temp. :	<u>NA</u>	
			Time :	<u>NA</u>	
			Other :	<u>NA</u>	

FILLER METAL (QW 404)				GAS (QW 408)			
SFA Specification	GTAW	SMAW	SAW	Percent Composition			
	<u>5.18</u>	<u>5.1</u>	<u>5.17</u>	Gas	Mixture	Flow Rate	
AWS Classification	<u>ER-70S-2</u>	<u>E-7018</u>	<u>F7A4 / EH14</u>	welding grade argon	<u>SINGLE</u>	<u>12 lit / min</u>	
Filler Metal F No	<u>06</u>	<u>04</u>	<u>06</u>	Shielding	<u>NA</u>	<u>NA</u>	<u>NA</u>
Weld Metal Analysis A No	<u>01</u>	<u>01</u>	<u>01</u>	Trailing	<u>NA</u>	<u>NA</u>	<u>NA</u>
Size of Filler Metal	<u>1.6 MM</u>	<u>3.15 MM DIA</u>	<u>3.15 MM DIA</u>	Backing	<u>NA</u>	<u>NA</u>	<u>NA</u>
Other				TECHNIQE (QW 410)			
Weld metal / Thickness	<u>2.00 MM</u>	<u>2 MM</u>	<u>6 MM</u>	String or Weave Bead	<u>STRINGER BEAD</u>		
				Oscillation	<u>NA</u>		
				Multipass or Single Pass(perside)	<u>Single pass for GTAW / SMAW, Multipass for SAW.</u>		

POSITION (QW-405)		SINGLE ELECTRODE ALL PROCESSES	
Position of Groove	<u>1 G</u>	Single or Multiple Electrode:	<u>SINGLE ELECTRODE ALL PROCESSES</u>
Weld progression (Uphill, Downhill)	<u>Flat</u>	Orifice or Gas cup size :	<u>10.00 mm</u>
Other :	<u>NA</u>	Initial and interpass cleaning :	<u>BRUSHING, GRINDING & CHIPPING</u>

ELECTRICAL CHARACTERISTIC (QW-409)	
Current	<u>DC</u> Polarity : <u>REVERSE FOR SMAW,SAW PROCESSES & STRIGHT FOR GTAW</u>
Tungsten Electrode Size	<u>3.00 mm Thoriated tungsten used</u>
Reading as under:	

RUN SR. NO.	FILLER METAL DIA (MM)	FILLER METAL SPECN.	CURRENT (AMPS)	VOLTAGE (V)	TRAVEL SPEED MM / MINUTES	HEAT INPUT KJ/MM
1	1.6 MM	ER-70S-2	140	18	70	2.16
2	3.15 MM	E-7018-1	100	24	65	2.21
3	3.15 MM	F7A4 / EH14	430	30	360	2.15
4	3.15 MM	F7A4 / EH14	380	30	350	1.95

Filler wire for GTAW ER-70S-2 1.6 mm B.No. 114006 Honnaver make
 For SMAW Electrode E-7018-1 3.15mm B.No. 2051113 of Honnaver make
 Filler Wire for SAWF7A4-EH14 3.15 mm B.No. TU116953576 ESAB make

Tensile Test (QW-150)

Specimen No	Width mm	Thickness mm	Area mm ²	Ultimate Total Load N	Ultimate Unit Stress Mpa	Type of failure & Location
T1	20.40	10.05	205.02	111000	541.40	BROKEN PARENT METAL FRACTURE DUCTILE 70 SIDE
T2	20.30	10.01	203.20	110000	541.30	BROKEN PARENT METAL FRACTURE DUCTILE 70 SIDE

AS PER MET HEAT ENGINEERING PVT LTD. REPROT NO.398TG/2012 Dated-21/09/2012

Guided Bend Test (QW-160)

	Type and Figure No. 462 3(a)	RESULT
1	2 Nos. Root Bend	Acceptable AS PER SEC IX
2	2 Nos. Face Bend	Acceptable AS PER SEC IX

AS PER MET HEAT ENGINEERING PVT LTD. REPROT NO.398TG/2012 Dated-21/09/2012

Toughness Test (QW-170)

Specimen No	Notch Location	Specimen Size MM	Test Temp. °c	Impact Values (J)			Average Value
1	WELD	10 X 7.5	- 32°C	30	32	36	32.66
2	60 HAZ	10 X 7.5	- 32°C	104	110	120	111.33
3	70 HAZ	10 X 7.5	- 32°C	24	30	26	26.67
4	60 PARENT	10 X 7.5	- 32°C	130	142	160	144
5	70 PARENT	10 X 7.5	- 32°C	172	132	112	138.67

As per MET HEAT ENGINEERING PVT LTD REPORT NO 3-TS/2012 Dated 18/09/2012

HARDNESS (HBW)

1	WELD 2 MM FROM TOP GTAW	HBW	158	156	158
2	WELD 2 MM FROM TOP SAW	HBW	161	158	161
3	WELD 2 MM FROM TOP SMAW	HBW	156	153	150
4	HAZ 2 MM FROM TOP GTAW 60 SIDE	HBW	170	167	170
5	HAZ 2 MM FROM TOP SAW 60 SIDE	HBW	180	184	180
6	HAZ 2 MM FROM TOP SMAW 60 SIDE	HBW	177	174	177
7	HAZ 2 MM FROM BOTTOM GTAW 70 SIDE	HBW	174	170	174
8	HAZ 2 MM FROM BOTTOM SAW 70 SIDE	HBW	177	174	177
9	HAZ 2 MM FROM BOTTOM SMAW 70 SIDE	HBW	170	167	170
10	PARENT 60 SIDE	HBW	150	140	153
11	PARENT 70 SIDE	HBW	174	170	174

AS PER MET HEAT ENGINEERING REPROT NO.404-TG/2012 DATED 21/09/2012

Fillet-Weld Test (QW-180)

Result Satisfactory: Yes - N.A. - No Penetration into Parent Metal : Yes No

No. Macro-Result

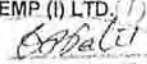
Other Tests

Type of Test : _____
 Deposit Analysis : _____
 Other : _____

Welder's Name : D.J.KUMBHAR Stamp No. : W-46
Mr. Devendra M. Patel - SAW SAW OP1

Test Conducted by : U B Patel Laboratory Test No. : _____

We Certify that the statement in this record are correct and that the test welds were prepared, welded and tested in accordance with the requirement of Section IX of the ASME Boiler and Pressure Vessel Code:

For PATELS AIRTEMP (I) LTD.

 MANAGER (Q. C.) 5-10-2012
 U. B. PATEL
 MANAGER QC
 Q.C. DEPARTMENT

WITNESS BY EI



MET - HEAT ENGINEERS PVT. LTD.

METALLURGICAL LABORATORY
ON APPROVED LIST OF VARIOUS GOVT. DEPARTMENTS
& PUBLIC SECTOR UNDERTAKINGS
(SINCE 1975)

MHEPL/FM/17

857/2, G.I.D.C.
INDUSTRIAL ESTATE, MAKARPURA,
VADODARA - 390 010.
TELEFAX : 0265-2632374, 2643655, 26480
6548715, 6548716
E-mail : info@metheat.com
Website : www.metheat.com

TEST REPORT (PHYSICAL)

WO:09/160 SrNo.2 PI/ 16 60-Cr

Name of The Customer **PATELS AIRTEMP (INDIA) LTD-AMBD**
805,6,7,8-810,RAKANPUR GIDC
VIA: SOLA-BHADAJ VILLAGE
TA:KALOL DIST-GANDHINAGAR

PTR No. : **398-TG/2012**
Date : **21/09/2012**

Date of Receipt : **12/09/2012**

Customer's Reference No: **REF.NO: PAT/ANKIT/WELD/WPS SAW/4/DT:5/9/12**

Material Specification **SA-516 GRADE-70:2010 To SA-516 GRADE-60:2010**

Sr No	Description of Material	Identification	Dia-Width mm	Thick mm	Cross Sectional Area mm ²	Yield Load	Yield Strength	Ultimate Load	Tensile Strength	Gauge Length mm	Final Length mm	Elongation
						N	MPa	N	MPa			Reqd Minir
398	Welded Test TG PIECE 10MM THK PLATE	PROCESS:GTAW 2MM+SMAW 2MM+ SAW 6MM	20.40	10.05	205.02	-	-	111000	541.4	Broken - Parent Met Fracture-Ductile		
		(SA-516 GR-70)										
399	do	WPS NO:SAW4 do T-2	20.30	10.01	203.20	-	-	110000	541.3	Broken - Parent Met Fracture-Ductile		
		(SA-516 GR-70)										
400	do	do RB-1	TRANS.ROOT BEND TEST Satisfactory			Mandril Dia : 38.00 mm Angle Of Bend 180.0						
TG			TRANS.ROOT BEND TEST Satisfactory			Mandril Dia : 38.00 mm Angle Of Bend 180.0						
401	do	do RB-2	TRANS.ROOT BEND TEST Satisfactory			Mandril Dia : 38.00 mm Angle Of Bend 180.0						
TG			TRANS.ROOT BEND TEST Satisfactory			Mandril Dia : 38.00 mm Angle Of Bend 180.0						
402	do	do FB-1	TRANS.FACE BEND TEST Satisfactory			Mandril Dia : 38.00 mm Angle Of Bend 180.0						
TG			TRANS.FACE BEND TEST Satisfactory			Mandril Dia : 38.00 mm Angle Of Bend 180.0						
403	do	do FB-2	TRANS.FACE BEND TEST Satisfactory			Mandril Dia : 38.00 mm Angle Of Bend 180.0						
TG			TRANS.FACE BEND TEST Satisfactory			Mandril Dia : 38.00 mm Angle Of Bend 180.0						

Method Of Testing : ASME SEC-IX : 2010.

The above results are meeting with physical requirements of ASME SECT-IX with respect of test carried out.



Tested By *A.M. Dave*

Authorised Signatory
A. M. Dave (QM) / M. G. Dave (MD) / N. M. Dave (TM)

Witnessed

Note : (1) Sample(s) not drawn by MHEPL. The results relate only to the sample(s) tested.
(2) This Certificate shall not be reproduced, except in full, without the written approval of MHEPL.
(3) If balance material is available after testing, it will be retained for 15 days maximum. If customer wants to retain it for one month from this date, he has to inform in writing or collect the same.
(4) While 'Met-Heat' has made their best endeavors to provide accurate and reliable information, Met-Heat is not responsible for any financial liability due to any act of omission or error.



MET - HEAT ENGINEERS PVT. LTD.

METALLURGICAL LABORATORY
ON APPROVED LIST OF VARIOUS GOVT. DEPARTMENTS
& PUBLIC SECTOR UNDERTAKINGS
(SINCE 1975)

MHEPL/FM/17

857/2, G.I.D.C.
INDUSTRIAL ESTATE, MAKARPURA,
VADODARA - 390 010.
TELEFAX : 0265-2632374, 2643655, 26480
6548715, 6548716
E-mail : info@metheat.com
Website : www.metheat.com

TEST REPORT (PHYSICAL)

WO:09/160 SrNo.2 PI/ 16 60-Cr-

Name of The Customer **PATELS AIRTEMP (INDIA) LTD-AMBD**
805,6,7,8-810,RAKANPUR GIDC
VIA: SOLA-BHADAJ VILLAGE
TA:KALOL DIST-GANDHINAGAR

PTR No. : **404-TG/2012**
Date : **21/09/2012**

Date of Receipt : **12/09/2012**

Customer's Reference No: **REF.NO: PAT/ANKIT/WELD/WPS SAW/4/DT:5/9/12**

Material Specification **SA-516 GRADE-70:20107 To SA-516 GRADE-60:2010**

Sr No.	Description of Material	Identification	Dia-Width mm	Thick mm	Cross Sectional Area mm ²	Yield Load	Yield Strength	Ultimate Load	Tensile Strength	Gauge Length mm	Final Length mm	Elongation
							Required Minimum		Required Minimum			Requi Minim

404 Welded Test
TG PROCESS:GTAW

PIECE 10MM THK
PLATE 2MM+SMAW 2MM+
SAW 6MM
WPS NO:SAW4

[DIA 2.5/187.500 KG.]

BRINELL HARDNESS @ Weld 2 MM FROM TOP GTAW HBW: 158,156,158
 @ Weld 2MM FROM TOP SAW HBW: 161,158,161
 @ Weld 2 MM FROM TOP SMAW HBW: 156,153,158
 @ HAZ 2 MM FROM TOP GTAW(SA-516 60) HBW: 170,167,170
 @ HAZ 2 MM FROM TOP SAW(SA-516 60) HBW: 180,184,180
 @ HAZ 2 MM FROM TOP SMAW(SA-516 60)HBW : 177,174,177
 @ HAZ 2 MM FROM BOTTOM GTAW(SA-516 GR70)HBW:174,170,17
 @ HAZ 2MM FROM BOTTOM SAW(SA-516 GR70)HBW: 177,174,177
 @ HAZ 2 MM FROM BOTTOM SMAW(SA-516 GR70)HBW: 170,167,1
 @ Parent (SA-516 GR-60) HBW : 150,148,153
 @ Parent (SA-516 GR-70) HBW : 174,170,174

Test : BRINELL HARDNESS TEST Test Method ASTM E-10:2000

The above results are Meeting with Physical requirements Specified by Customer

Tested By

Authorised Signatory
A. M. Dave (QM) / M. G. Dave (MD) / N. M. Dave (TM)

Witnessed B

Note : (1) Sample(s) not drawn by MHEPL. The results relate only to the sample(s) tested.
(2) This Certificate shall not be reproduced, except in full, without the written approval of MHEPL.
(3) If balance material is available after testing, it will be retained for 15 days maximum. If customer wants to retain it for one month from this date, he has to inform in writing or he collect the same.
(4) While 'Met-Heat' has made their best endeavors to provide accurate and reliable information, Met-Heat is not responsible for any financial liability due to any act of omission or error ma



MET - HEAT ENGINEERS PVT. LTD.

METALLURGICAL LABORATORY
ON APPROVED LIST OF VARIOUS GOVT. DEPARTMENTS
& PUBLIC SECTOR UNDERTAKINGS
(SINCE 1975)

MHEPL/PM/18

357/2, G.I.D.C.
INDUSTRIAL ESTATE, MAKARPURA,
VADODARA 390 010.
TELEFAX 0265-2632371, 2611055, 264861
E-mail info@metheat.com
Website www.metheat.com

TEST REPORT

WO:09/160 SrNo.2 PI/ 16 60-Cr

Name of The Customer: PATELS AIRTEMP (INDIA) LTD-AMBD
805.6.7.8-810, RAKANPUR GIDC
VIA: SOLA-BHADAJ VILLAGE
TA: KALOL DIST-GANDHINAGAR

Test Report No: 3-TS/2012
Date: 18/09/2012
Date of Receipt: 12/09/2012

Particulars of Sample Submitted: Welded TestPIECE 10MM THK PLATE

Material Specification: SA-516 GRADE-70:2010 To SA-516 GRADE-60:2010

Identification of Sample: PROCESS:GTAW(2MM)+SMAW(2MM)+SAW(6MM), WPS NO:SAW4

Type of Test Required: V Notch Charpy Impact Test at -32° C. By ASTM E-23:2007
[MINUS THIRTY TWO Degree Centigrade]

Customer's Reference No.: REF NO: PAT/ANKIT/WELD/WPS SAW4/DT:05/09/12

Results

Location	Size mm	Energy absorbed in Joules			Average Value	Required Value
		I	II	III		
Weld	10x 7.50	30J	32J	36J	32.66J	
HAZ (SA-516 GR-60)	10x 7.50	104J	110J	120J	111.33J	
HAZ (SA-516 GR-70)	10x 7.50	24J	30J	26J	26.67J	
Parent Metal (SA-516 GR-60)	10x 7.50	130J	142J	160J	144.00J	
Parent Metal (SA-516 GR-70)	10x 7.50	172J	132J	112J	138.67J	



Tested By

Authorised Signatory

A. M. Dave (QM) / M. G. Dave (MD) / N. M. Dave (TM)

Witnessed By

Note: (1) Sample(s) not drawn by MHEPL. This result relate only to the sample(s) tested.
(2) This Certificate shall not be reproduced, except in full, without the written approval of MHEPL.
(3) If below information is available, the testing shall be returned for 15 days maximum. If customer wants to retain the sample(s) from this date, he has to inform accordingly.
(4) While 'Met-Heat' has made their best endeavors to provide accurate and reliable information, Met-Heat is not responsible for any financial liability due to any act of omission or error made.

PATELS AIRTEMP (I) LTD.

WELDER STAMP NO	WELDER NAME	WELDING PROCESS
W37	Mr. DHARAMDEV YADAV	GTAW
OP1	Mr. DEVENDRA PATEL	SAW
W105	Mr. VIKAS KUMAR	SMAW

PATELS AIRTEMP (INDIA) LTD.

**QW-484A WELDER PERFORMANCE QUALIFICATIONS(WPQ)
QW-301, Section IX, ASME Boiler and Pressure Vessel Code.**

Welder's Name : Mr.DEVENDRA PATEL Identification no.- OP-1

Test Description

Identification of WPS followed : 357 R.0.0 Test Coupon Production Weld
Specification and type/grade or UNS of base metal(s):- SA-240 TP 304L TO SA-240 TP 304L Thickness 18 MM

Testing Variables and Qualification Limits

Welding Variables (QW-350)

Welding Process(es)
Type (ie; manual, semi-auto) used
Backing (with /without)
 Plate Pipe (enter diameter if pipe or tube)
Base metal P-Number to P-Number
Filler metal or electrode specification(s) (SFA) (info.only)
Filler metal or electrode classification(s) (info.only)
Filler Metal F-Number(s)
Consumable insert (GTAW or PAW)
Filler Metal Product Form(solid/metal or flux cored/powder) (GTAW or PAW)
Deposit thickness for each process
Process 1: SAW 3 layers min. YES NO
Process 2: 3 layers min. YES NO
Position Qualified (2G, 6G, 3F, etc.)
Vertical progression (uphill or downhill)
Type of fuel gas (OFW)
Inert gas backing (GTAW, PAW, GMAW)
Transfer mode (spray/globular or pulse to short circuit-GMAW)
GTAW current type/polarity (AC, DCEP, DCEN)

Actual values	Range qualified
SAW	SAW
SEMI AUTO	SEMI AUTO
With backing	With backing
Plate	Plate & pipe 73 mm O.D. & above
P8	P1 to P15F
5.9	---
ER-308L	---
F 6	ALL F-5
---	---
---	---
9 mm	18 mm
1 G	Groove : F(For Plate & Pipe Over 610MM OD) F :Pipe 73MM OD & above, Fillet : F
---	---
N.A	---
---	---
N.A	---
N.A	---

RESULTS

Visual Examination of Completed Weld (QW-302.4): **Found Satisfactory**
 Transverse face and root bends [QW-462.3(a)] Longitudinal bends [QW-462.3(b)] Side [QW-462.2]
 Pipe bend specimen, corrosion-resistant weld metal overlay [QW-462.5(c)]
 Plate bend specimen, corrosion-resistant weld metal overlay [QW-462.25(d)]
 Pipe specification, Macro test for fusion [QW-462.5(b)] Plate specification, Macro test for fusion [QW-462.5(e)]

Type	Result	As Per M/s. MET HEAT Report No.145-ZJ/2013 Dtd : 22/03/2013
4 Nos.Side bend SB-1,SB-2, SB-3,SB-4	SATISFACTORY AS PER SEC IX	

Alternative Volumetric Examination Results (QW-191): ACCEPTABLE RT or UT (check one)

Fillet weld -- fracture test (QW-181.2) NA Length and percent of defects NA

Fillet Weld in plate [QW-462.4(b)] Fillet Weld in pipe [QW-462.4(c)]

Macro examination (QW-184) NA Fillet size (in) NA x NA Concavity/convexity(in) NA

Other tests NA

Film or specimens evaluated by Mr.SUMAN Company PATELS AIRTEMP (INDIA) LTD.

Mechanical tests conducted by DIVINE LAB Laboratory test no. 145-ZJ/2013 Dtd: 22/03/2013.

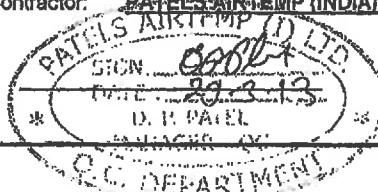
Welding supervised by: M.R.PATEL

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME BOILER AND PRESSURE VESSEL CODE.

Manufacturer or Contractor: PATELS AIRTEMP (INDIA) LTD.

Date: 20/03/2013

Certified by



PATELS AIRTEMP (INDIA) LTD.

805-806, RAKANPUR-362721, TAL.: KALOLI, DIST.: MEHSANA (N.G.)

QW-484 MANUFACTURER'S RECORD OF WELDER OR WPO-142

WELDING OPERATOR QUALIFICATION TEST (WPG)

QW-301, Section IX, ASME Boiler and Pressure Vessel Code.

Welder's Name : **Dharamvir Patel**

Clock No. :-

Stamp No.: **W 37**

Identification of WPS followed **144 R.0.1**
Base material(s) **SA 516 GR 70**

Test Description

Test Coupon Yes
Thickness **10 MM**

Production Weld ----

Testing Condition & Qualification Limits

Welding Variables (QW-350)

Welding Process(es)

Type (e; manual, semi-auto) used

Backing (metal, weld metal, double-welded, etc.)

Yes Plate **NO** Pipe (enter diameter if pipe or tube)

Base metal P- or S-Number to P- or S-Number

Filler metal or electrode specification(s) (SFA) (info. only)

Filler metal or electrode specification(s) (info. only)

Base Metal F-Number(s)

Consumable insert (GTAW or PAW)

Filler type (solid/metal or flux cored/powder) (GTAW or PAW)

Deposit thickness for each process

Process 1: GTAW 3 layers min. YES NO

Process 2: SMAW 3 layers min. YES NO

Position Qualified (2G, 6G, 3F, etc.)

Vertical progression (uphill or downhill)

Type of fuel gas (OFW)

Inert gas backing (GTAW, PAW, GMAW)

Transfer mode (spray/globular or pulse to short circuit-GMAW)

GTAW current type/polarity (AC, DCEP, DCEN)

Actual values	Range of qualified
GTAW / SMAW	GTAW / SMAW
MANUAL / MANUAL	MANUAL / MANUAL
GTAW without backing / SMAW with backing	GTAW with & without backing / SMAW with backing
Plate	Plate & pipe 2 7/8" O.D. & (72 MM) pipe
P1	P1 to P11
5.18 / 5.1	5.18 / 5.1
F6 / F4 With Backing	All F6 / F1, F7, F3 & C with Backing
SOLID FOR GTAW	
3 mm for GTAW	6 mm for GTAW
7 mm for SMAW	14 mm for SMAW
2 G	1 G - 2 G / Fillet All
Down Hill / Down Hill	Down Hill / Down Hill
None / NA	
DCEN / DCEP	DCEN / ---

Results

Visual Examination of Completed Weld (QW-302.4) Found Satisfactory outside & inside

Bend test; Transverse root and face (QW-462.3(a)); Longitudinal root and face (QW-462.3(b)); Side (QW-462.3(c))

Pipe bend specimen, corrosion-resistant overlay (QW-462.5(c)); Plate bend specimen, corrosion-resistant overlay (QW-462.5(d));

Macro test for fusion (QW-462.5(b)); Macro test for fusion (QW-462.5(e))

Type	Result	Type	Result	Type	Result
NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA

Alternative radiographic examination results (QW-191) Found Satisfactory

Fillet Weld Fracture test (QW-180) : **NA** Length & percent of defects : **NA**

Macro examination (QW-180) **NA** Fillet leg size (in) **NA** x **NA** Concavity/convexity (in) **NA**

Other tests **NA**

Film mor specimens evaluated by **DEEPAK PATEL**

Company **PATELS AIRTEMP (INDIA) LTD.**

Mechanical tests conducted by

Laboratory test no.

Welding supervised by **JATIN PATEL**

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

Organization **PATELS AIRTEMP (INDIA) LTD.**

Date: **01-04-2005**

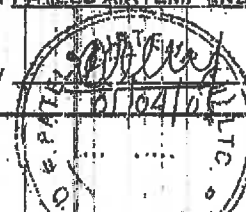
By 

HSB Global Standards

REVIEWED BY: 

SIGNATURE: 

DATE: **01/04/05**



PATEL'S AIRTEMP (INDIA) LTD.

**QW-484 MANUFACTURER'S RECORD OF WELDER OR
WELDING OPERATOR QUALIFICATION TEST (WPQ):
QW-301, Section IX, ASME Boiler and Pressure Vessel Code.**

Welder's Name : **Vikas Kumar**

Clock No. --

Stamp No.: **W105**

Identification of WPS followed **208 R.0.0**

Test Description

Test Coupon **Yes**

Production Weld ---

Base material(s) **SA 516 GR 70**

Thickness **14 MM**

Testing Condition & Qualification Limits

Welding Variables (QW-350)

Welding Process(es)

Type (ie: manual, semi-auto) used

Backing (metal, weld metal, double-welded, etc.)

Yes Plate NO Pipe (enter diameter if pipe or tube)

Base metal P- or S-Number to P- or S-Number

Filler metal or electrode specification(s) (SFA) (info. only)

Filler metal or electrode specification(s) (info. only)

Filler Metal F-Number(s)

Consumable insert (GTAW or PAW)

Filler type (solid/metal or flux cored/powder) (GTAW or PAW)

Deposit thickness for each process

Process 1: **SMAW**

3 layers min. YES NO

Process 2:

3 layers min. YES NO

Position Qualified (2G, 6G, 3F, etc.)

Vertical progression (uphill or downhill)

Type of fuel gas (OFW)

Inert gas backing (GTAW, PAW, GMAW)

Transfer mode (spray/globular or pulse to short circuit-GMAW)

GTAW current type/polarity (AC, DCEP, DCEN)

Actual values	Range qualified
SMAW	SMAW
MANUAL	MANUAL
SMAW with backing	SMAW with backing
Plate	Plate & pipe 73 mm O.D. & above
P1	P1 to P15F
E1	----
N.A	----
F4	ALL F4/F1, F3 & F6 WITH BACKING
N.A	----
N.A	----
14 mm	Maximum to be Welded
3 G	Groove: FV (For Plate & Pipe Over 610 mm OD)
	F: Pipe 73 mm OD & above
	Filllet: F, V, H
N.A	----
N.A	----
N.A	----
N.A	----
N.A	----

Results

Visual Examination of Completed Weld (QW-302.4) Found **Satisfactory**, both side

Bend test; Transverse root and face [QW-462.3(a)]; Longitudinal root and face [QW-462.3(b)]; Side [QW-462.2];

Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; Pipe bend specimen, corrosion-resistant overlay [QW-462.25(d)];

Macro test for fusion [QW-462.5(b)]; Macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result
NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA

Alternative radiographic examination results (QW-191) Found **Acceptable** as per PAT Report No. 85/2011 Dt. 15-02-2011

Macro Test:

Microstructure:

Fillet Weld-Fracture test (QW-180): **NA** Length & percent of defects: **NA**

Macro examination (QW-180) **NA** Fillet leg size (in) **NA** x **NA** Concavity/convexity (in) **NA**

Other tests **NA**

Film or specimens evaluated by **Suman Pathak**

Company **Patel's Airtemp (India) Ltd.**

Mechanical tests conducted by

Laboratory test no.

Welding supervised by: **U. B. PATEL**

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

Organization **PATEL'S AIRTEMP (INDIA) LTD.**

Date: **18-02-2011**

By

18-2-2011

Patel's Airtemp (India) Ltd. 104 W 105, Vikas Kumar



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments		
101-E-110;101-E-111;101-E-112;101-E-113;101-E-114;101-E-115;101-E-120;101-E-121;101-E-210;101-E-225;101-E-226;101-E-240;101-E-241;101-E-450;101-E-451;102-E-610;102-E-613;102-E-655;103-E-080;103-E-190;103-E-290;103-E-390;103-E-490;103-E-590;103-E-705;103-E-707;104-E-135;104-E-136;107-E-305	JPI REV 1 - COORDINATION		
Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1	
SN <input checked="" type="checkbox"/> 1 - Work May Proceed <input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated <input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture <input type="checkbox"/> 4 - STOP WORK per attached written instructions <input type="checkbox"/> 5 - Review Not Required: Work may proceed <small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small>	Supplier	Exchanger Industries	
	Doc. Description	EXCHANGER - WELD REPAIR PROCEDURE	
	Vendor Document No.	WELD REPAIR PROCEDURE	
	Client Document No.	VP088996-M601-00001	
	Purchase Order No.	Doc Cat.	Issue
CE416040-CC088996-00	M601	0	
BY : <u>SYED SHAH</u>	Categories		
DATE : <u>JULY 17, 2013</u>	Date Received	07/08/2013	



E.I Fabrication: Rev 0 May 5, 2005	WELD REPAIR PROCEDURE	Page 1 of 2
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1.0 Scope:

1.1 This procedure defines the method for the removal and repair by welding, of defects unacceptable to the contract fabrication requirements and ASME code.

2.0 Purpose:

2.1 To repair, by welding, unacceptable defects found by Visual, Dye Penetrant, Magnetic particle, Ultrasonic, Radiographic or other means of Non-Destructive Examination (NDE).

2.2 To perform repair by welding, use qualified groove welding procedure as shown on fabrication drawing.

3.0 Responsibility:

3.1 Quality Control shall be responsible for the determination of the defect location, the marking of the location, the Non-Destructive Examination of the repair, and the documentation of the repair in accordance with contract fabrication requirements and ASME Code.

3.2 Fabrication shall be responsible for the completion of the repair in accordance with the contract fabrication requirements.

4.0 Procedure:

4.1 The defect shall be accurately located by means of ultrasonic and/or radiographic tracing, or visibly if the NDE method used to detect the defect was a surface crack detection examination. The location shall be marked on the area of repair.

4.2 A determination shall be made as to the repair direction dependent on the accessibility of the defect.

4.3 Excavate the area of the defect by arc air gouging, disc grinding or other acceptable method until the defect has been located and removed.

4.4 The excavated area shall be inspected to verify complete defect removal by visual inspection or by other NDE methods as required by contract fabrication requirement.

4.5 Steps 4.3 and 4.4 shall be repeated until satisfied that the defect has been located and removed.

4.6 Clean the excavation thoroughly to remove all contaminants that may have been introduced during excavation or inspection as required.

4.7 A qualified welder shall carry out, the re-welding of the excavated area, using the consumables and parameters per a qualified, and project approved, Weld Procedure Specification (WPS).



Exchanger Industries

E.I Fabrication: Rev 0 May 5, 2005	WELD REPAIR PROCEDURE	Page 2 of 2
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- 4.8 The repaired area shall be examined by the same NDE method used to reveal the defect. Additional examination may be required in accordance with the contract specification.
- 4.9 Should the defect have been revealed after Post Weld Heat Treatment (PWHT), then the defective weld shall be re-heat treated before final inspection unless otherwise agreed with the customer.
- 4.10 Local stress relieving, when required shall be performed per the requirements of the applicable ASME codes and customer specifications when applicable.

5.0 **Documentation:**

- 5.1 Documentation of the repair, by welding, shall be completed as required by contract specification and ASME code.



CERTIFICATE

This is to certify that **Mr. Chetan V. Patel** has been certified as **NDE Level II (PT)** in accordance with PAT India Ltd. Written Practice : PAT/WP/01 Rev. 5 Date: 19-12-2011 for Qualification and Certification of NDE Personnel. He has demonstrated proficiency by successfully completing the General, Specific and Practical Examinations.

Pertaining details are as follows:

Method : **Liquid Penetrant Testing (PT)**
 Certification Level : **Level – II (Two)**
 Certificate No. : **14**
 Date Issued : **09-06-2012**
 Date Expires : **08-06-2015**

Examination	Total Marks	Minimum Required		Secured	
		Marks	%	Marks	%
General	40	28	70%	28	70%
Specific	20	14	70%	16	80%
Practical	40	28	70%	36	90%
Total / Composite	100	80	80%	80	80%
Result	Pass				

For, **PATELS AIRTEMP (INDIA) LTD.,**

D. P. Patel
D. P. Patel
Q.C. Manager

9-6-2012

Ashok J. Trivedi
Ashok J. Trivedi
NDE Level – III

9-6-2012



CERTIFICATE

This is to certify that **Mr. Sandip A. Patel** has been certified as **NDE Level II (PT)** in accordance with PAT India Ltd. Written Practice : PAT/WP/01 Rev. 5 Date: 19-12-2011 for Qualification and Certification of NDE Personnel. He has demonstrated proficiency by successfully completing the General, Specific and Practical Examinations.

Pertaining details are as follows:

Method : **Liquid Penetrant Testing (PT)**
 Certification Level : **Level – II (Two)**
 Certificate No. : **10**
 Date Issued : **09-06-2012**
 Date Expires : **08-06-2015**

Examination	Total Marks	Minimum Required		Secured	
		Marks	%	Marks	%
General	40	28	70%	30	75%
Specific	20	14	70%	17	85%
Practical	40	28	70%	33	82.5%
Total / Composite	100	80	80%	80	80.83%
Result	Pass				

For, **PATELS AIRTEMP (INDIA) LTD.,**

D.P. Patel
D. P. Patel
Q.C. Manager

9-6-2012

Ashok J. Trivedi
Ashok J. Trivedi
NDE Level – III

9-6-2012



CERTIFICATE

This is to certify that **Mr. Darshit I. Parikh** has been certified as **NDE Level II (PT)** in accordance with PAT India Ltd. Written Practice : PAT/WP/01 Rev. 5 Date: 19-12-2011 for Qualification and Certification of NDE Personnel. He has demonstrated proficiency by successfully completing the General, Specific and Practical Examinations.

Pertaining details are as follows:

Method : **Liquid Penetrant Testing (PT)**

Certification Level : **Level – II (Two)**


Certificate No. : **09**


Date Issued : **09-06-2012**

Date Expires : **08-06-2015**

Examination	Total Marks	Minimum Required		Secured	
		Marks	%	Marks	%
General	40	28	70%	29	72.5%
Specific	20	14	70%	17	85%
Practical	40	28	70%	36	90%
Total / Composite	100	80	80%	82	82.5%
Result	Pass				

For, **PATELS AIRTEMP (INDIA) LTD.,**


D. P. Patel
Q.C. Manager
 9.6.2012


Ashok J. Trivedi
NDE Level – III
 9-6-2012



ASME "U" / "U2" / "U3"
NATIONAL BOARD "NB" / "NB"
Member of : HTRI - USA

Regd. Office :
5th Floor, Kalpana Complex, Nr. Memnagar Fire Station, Navrangpura, Ahmedabad - 380 009, Gujarat, India.
Ph. : +91 79 27913694 / 95 / 96 Fax : +91 79 27913693 Email : project@patelsairtemp.co.in

Mumbai Office :
310, Oberoi Chambers-II, New Link Road, Dshiwara, Andheri (W), Mumbai - 400 053 India.
Phone : +91 22 26734162 / 63 Telefax : +91 22 26734162 Email : patbom@bom2.vsnl.net.in



CERTIFICATE

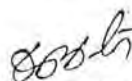
This is to certify that **Mr. Dhaval B. Patel** has been certified as **NDE Level II (PT)** in accordance with PAT India Ltd. Written Practice : PAT/WP/01 Rev. 5 Date: 19-12-2011 for Qualification and Certification of NDE Personnel. He has demonstrated proficiency by successfully completing the General, Specific and Practical Examinations.

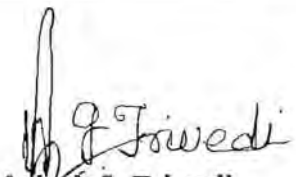
Pertaining details are as follows:

Method : **Liquid Penetrant Testing (PT)**
 Certification Level : **Level – II (Two)**
 Certificate No. : **13**
 Date Issued : **09-06-2012**
 Date Expires : **08-06-2015**

Examination	Total Marks	Minimum Required		Secured	
		Marks	%	Marks	%
General	40	28	70%	30	75%
Specific	20	14	70%	17	85%
Practical	40	28	70%	33	82.5%
Total / Composite	100	80	80%	80	80.83%
Result	Pass				

For, **PATELS AIRTEMP (INDIA) LTD.,**


D. P. Patel
 Q.C. Manager
 9-6-2012


Ashok J. Trivedi
 NDE Level – III
 9-6-2012



CERTIFICATE

This is to certify that **Mr. Tejaskumar V. Parmar** has been certified as **NDE Level II (PT)** in accordance with PAT India Ltd. Written Practice : PAT/WP/01 Rev. 5 Date: 19-12-2011 for Qualification and Certification of NDE Personnel. He has demonstrated proficiency by successfully completing the General, Specific and Practical Examinations.

Pertaining details are as follows:

Method : **Liquid Penetrant Testing (PT)**
 Certification Level : **Level – II (Two)**
 Certificate No. : **08**
 Date Issued : **09-06-2012**
 Date Expires : **08-06-2015**

Examination	Total Marks	Minimum Required		Secured	
		Marks	%	Marks	%
General	40	28	70%	34	85%
Specific	20	14	70%	16	80%
Practical	40	28	70%	36	90%
Total / Composite	100	80	80%	86	85%
Result	Pass				

For, **PATELS AIRTEMP (INDIA) LTD.,**

D. P. Patel
D. P. Patel
Q.C. Manager
 9.6.2012

Ashok J. Trivedi
Ashok J. Trivedi
NDE Level – III
 9-6-2012



PATELS AIRTEMP (INDIA) LTD.

Works :
 805, 806, 807, 810, RaKanpur 382 721,
 Via : Sola - Bhadaj Village, Ta. : Kalol,
 Dist. : Gandhinagar, Gujarat, India.
 Phone : +91 2764 286634 / 35, 286480 / 81
 Fax : +91 2764 286301
 Email : patad1@bsnl.in / works@patelsairtemp.com
 Website : www.patelsairtemp.com

CERTIFICATE

This is to certify that **Mr. Dhaval V. Patel** has been certified as **NDE Level - II (UT)** in accordance with PAT India Ltd. Written Practice : PAT/WP/01 Rev. 5 Date: 19-12-2011 for Qualification and Certification of NDE Personnel. He has demonstrated proficiency by successfully completing the General, Specific and Practical Examinations.

Pertaining details are as follows :-

Method : **Ultrasonic Testing (UT)**
 Certification Level : **Level – II (Two)**
 Certificate No. : **23**
 Date Issued : **18-09-2012**
 Date Expires : **17-09-2015**



EXAMINATION	Total Marks	Minimum Required		Secured	
		Marks	%	Marks	%
General	40	28	70%	32	80%
Specific	20	14	70%	18	90%
Practical	40	28	70%	38	95%
Total / Composite	100	80	80%	88	88.33%
Result	Pass				

For, PATELS AIRTEMP (INDIA) LTD.,

D. P. Patel
 18-09-12
D. P. Patel
 Q.C. - Manager

Ashok J. Trivedi
Ashok J. Trivedi
 NDE Level – III
 18-09-12



ASME "U" / "U2" / "S"
 NATIONAL BOARD "NB" / "R"
 Member of : HTRI - USA

Regd. Office :
 5th Floor, Kalpana Complex, Nr. Memnagar Fire Station, Navrangpura, Ahmedabad - 380 008, Gujarat, India.
 Ph. : +91 79 27913694 / 95 / 96 Fax : +91 79 27913693 Email : project@patelsairtemp.co.in

Mumbai Office :
 310, Oheroi Chambers-II, New Link Road, Oshiwara, Andheri (W), Mumbai - 400 053 India.
 Phone : +91 22 26734162 / 63 Telefax : +91 22 26734162 Email : patbom@bom2.vsnl.net.in

BAGCHI INSTITUTE OF NDT



Certificate of Proficiency

This is to certify that

MR. PATEL DHAVAL V.

has fulfilled the certification requirements and has demonstrated proficiency by successfully qualifying the examination, and is hereby certified to

NDT LEVEL II

in

ULTRASONIC TESTING

(Training course and examination for certification is as per the recommendations of ASNT document SNT - TC - IA - 2001...Edition)

Paper	Weightage	% Score
General	.3	82.5
Specific	.3	85
Practical	.4	87
Average Score		85.05%



CERTIFICATE NO. BiNDT/UT/1101

THIS CERTIFICATE IS ISSUED ON 09.08.2011 SHALL BE VOID ON 08.08.2011


Chairman




Candidate

TRAINING RECORDS

1. EDUCATIONAL QUALIFICATION : B.Sc	
2. EXPERIENCE IN NDT : 3 YEARS.	
3. TRAINING PERIOD : 29.07.2008 To 08.08.2008	
4. TRAINING HOURS : 80 HRS	
VISION EXAMINATION :	REMARKS
NEAR VISION	J2
COLOUR VISION	NORMAL



RENEWAL - I

<input type="checkbox"/>	BASED ON EXAMINATION	Validity extended till 07.08.2014
<input checked="" type="checkbox"/>	BASED ON RECORD	



RENEWAL - II

<input type="checkbox"/>	BASED ON EXAMINATION	
<input type="checkbox"/>	BASED ON RECORD	

RENEWAL - III

<input type="checkbox"/>	BASED ON EXAMINATION	
<input type="checkbox"/>	BASED ON RECORD	

BAGCHI INSTITUTE OF NDT

BiNDT

Certificate of Proficiency

This is to certify that

MR. DHAVAL V. PATEL

has fulfilled the certification requirements and has demonstrated proficiency by successfully qualifying the examination, and is hereby certified to

NDT LEVEL II

in

MAGNETIC PARTICLE TESTING

(Training course and examination for certification is as per the recommendations of ASNT document SNT - TC - IA - 2001... Edition)

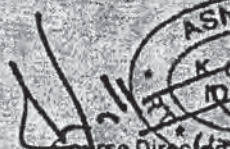
Paper	Weightage	% Score
General	.3	85
Specific	.3	85
Practical	.4	85
Average Score		85%



CERTIFICATE NO. BiNDT / MPT / 1083

THIS CERTIFICATE IS ISSUED ON 26.06.2008 SHALL BE VOID ON 25.06.2011


Chairman


Course Director
ASNT Level III


Candidate

ASNT. LEVEL III

K. CHATTERJEE
ID NO. 75843

MT * PT * ET

TRAINING RECORDS

1. EDUCATIONAL QUALIFICATION : B.Sc	
2. EXPERIENCE IN NDT : 3 YEARS	
3. TRAINING PERIOD : 22.06.2008 To 25.06.2008	
4. TRAINING HOURS : 32 HRS.	
VISION EXAMINATION :	REMARKS
NEAR VISION	32
COLOUR VISION	NORMAL



RENEWAL - I

<input type="checkbox"/>	BASED ON EXAMINATION	validity extended till 24.06.2014
<input checked="" type="checkbox"/>	BASED ON RECORD	



RENEWAL - II

<input type="checkbox"/>	BASED ON EXAMINATION	
<input type="checkbox"/>	BASED ON RECORD	

RENEWAL - III

<input type="checkbox"/>	BASED ON EXAMINATION	
<input type="checkbox"/>	BASED ON RECORD	



SERVING THE INDUSTRY SINCE-1973

PATELS AIRTEMP (INDIA) LTD.

Unit - III:

805 - 806, Rakanpur - 382 721, via: Sola Bhadaj Village.

Ta: Kalol, Dist.: Gandhinagar, Gujarat, India.

Ph: 02764-286634-35, 286480-81, 286280. Fax: 02764-286301.

E-mail: patad1@sancharnet.in , patelsairtemp@yahoo.co.in

Web site: www.patelairtemp.com

ASME "U" STAMP

AUTHORIZED COMPANY

NDE PERSONNEL CERTIFICATION AS PER WRITTEN PRACTICE NO.: PAT-QC/007 Rev. 04.

Name	:	Tejas V. Parmar		
NDE Method	:	Radiography Testing		
Level of Certification	:	II		
Training in NDE Method	:	Satisfactory Completed Total 80 Hours of Training in Radiography Testing as per Written Practice Number: PAT-QC/007 Rev. 04.		
Examination Result	:			
Examination		Marks Obtained	Minimum Marks Required	Remarks
General Examination.		90%	70.00%	PASSED
Specific Examination.		90%	70.00%	PASSED
Practical Examination.		92%	70.00%	PASSED
Composite		90.66%	80.00%	PASSED
Vision Examination:				
Near Vision Actuity	:	Able to read Jaeger font & size J2 from 30.5 cm distance with natural eyes .		
Color contrast Differentiation & Shades of Gray	:	Satisfactory (Tested with Ishihara Test Plates). Able to differentiate shades of gray		
Educational Background	:	M. Sc Physics		
Experience in NDE Method	:	24 Months of experience in Radiography Testing.		
Responsibilities Assigned:				
		1. Interpret Radiography films as per procedure \ reference standards.		
		2. Evaluate the Indicates for Acceptance.		
		3. Guide NDE Level I (Radiography Testing) Persons.		
		4. Report Radiography Test Results.		

NDE Level III - Training Instructor & Examiner

4-3-2008

Certifying Authority (Q. C. M.)

Certificate Number	:	PAT-QC-RT-II-09	Date of Issue	:	04-03-2008
Date of issue of Assignment	:	04-03-2008	Date of Expiry	:	03-03-2011

Next Vision Examination shall be conducted on or before:

S N	Date	Conducted On.	Ability to Read 'J2' At Distance of 30.5 cm.	Examiner
1.	03-03-2009			
2.				

Mumbai Office: 6, Milan, 189-191, Perin Nariman Street, Fort, Mumbai - 400 001, India.

Ph.: 022-22697874

Telefax: 022-2697245

E-mail: patbom@bom2.vsnl.net.in

Website: www.patelairtemp.com



NDE-RT

RE- CERTIFICATION

This is to certify that **Mr. Tejas V. Parmar** has been Re-certified as **NDE Level II (Two) in Radiographic Testing (RT)** in accordance with Written Practice No. PAT/WP/01 (Rev. 4) Dated : 21-12-2010 and based on documentary evidence - Letter of continuing satisfactory performance Ref. No. PAT / NDE Re-cert. / 03 Dt. 02-03-2011

Pertaining details are as follows :

Method : Radiographic Testing (RT)

Re-certification Level : II (Two)

Certificate No. : 03

Date of Issue : 02-03-2011

Date of Expiry : 01-03-2014

For Patels Airtemp (I) Limited

D.P. Patel
2-3-2011
D.P. Patel
Manager (QC)
Date:

Ashok J. Trivedi
Ashok J. Trivedi
NDE Level III
Date: 2-3-2011

Certificate No : RT-II/03-11/R-505

Enrolment No. :R174

Certificate of Proficiency

This is to certify that

Mr. Tejas V. Parmar

has met the certification requirements and has demonstrated proficiency
by qualifying certification examination and is hereby certified to

**NDT LEVEL II
IN
Radiographic Testing**

Training course and examination conducted as per the recommendations
of ASNT document SNT-TC-1A, 2006 Edition

	Issue Date	Expiration Date
1 st Re-Certification	03/03/2011	02/03/2016



COURSE DIRECTOR & EXAMINER
Yatin D Raval
ASNT Level III UT,RT,MT,PT.
Certificate No : 126375



Personnel Certification Record

Name : **Mr. Tejas V. Parmar**

Company Name : **Self**

Reference Document : **SNT-TC-1A, 2006 Edition**

Written Practice No : **ULTRA/CERTI/009-01**

Certificate No : **RT-II/03-11/R-505**

Method : **Radiographic Testing**

Level : **II**

Educational Background : **M.Sc. Physics**

Experience [NDE] : **5 Years**

Near vision Acuity : **J2**

Colour Contrast : **OK**

Total Training Hours : **Based on continuous technical performance**

	Issue Date	Expiration Date
Initial Certificate	: 04/03/2008	03/03/2011
1 st Re-Certification	: 03/03/2011	02/03/2016





Yatin D Raval
ASNT Level-III UT,RT,MT,PT
Certificate No : 126375



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments		
101-E-110;101-E-111;101-E-112;101-E-113;101-E-114;101-E-115;101-E-120;101-E-121;101-E-210;101-E-225;101-E-226;101-E-240;101-E-241;101-E-450;101-E-451;102-E-610;102-E-613;102-E-655;103-E-080;103-E-190;103-E-290;103-E-390;103-E-490;103-E-590;103-E-705;103-E-707;104-E-135;104-E-136;107-E-305	JPI REV 1 - COORDINATION		
Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1	
SM <input checked="" type="checkbox"/> 1 - Work May Proceed <input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated <input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture <input type="checkbox"/> 4 - STOP WORK per attached written instructions <input type="checkbox"/> 5 - Review Not Required: Work may proceed <small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small>	Supplier	Exchanger Industries	
	Doc. Description	EXCHANGER - PAT - MAGNETIC PARTICLE EXAMINATION PROCEDURE	
	Vendor Document No.	MT-01	
	Client Document No.	VP088996-M606-00008	
	Purchase Order No.	Doc Cat.	Issue
CE416040-CC088996-00	M606	5	
BY : <u>SYED SHAH</u>	Categories		
DATE : <u>JULY 17, 2013</u>	Date Received	07/08/2013	



	MT Procedure
	Procedure No.: PAT/AT/MT/01 (Rev.5) Dated: 05-08-2012
	Page 1 of 9

PROCEDURE FOR MAGNETIC PARTICLE EXAMINATION

1. SCOPE :

This document specifies the requirements and procedure to be adopted for magnetic particle examination of **weld edge prepared faces (bevel edges) of parent** material, weld joints and HAZ areas of pressure vessels/ heat exchangers and other equipments manufactured as per ASME Sec. VIII Div. 1 and Div. 2 for detection of surface and sub-surface discontinuities using yoke magnetization technique.

2. REFERENCE DOCUMENTS :

- 2.1. ASME – Sec V- SE-709 and Article 7 – 2010 Edition, 2011 Addenda.
- 2.2. ASME – Sec. VIII – Div.1. Appendix-6 - 2010 Edition, 2011 Addenda.
- 2.3. ASME – Sec. VIII – Div. 2. Part – 7, Para 7.5 .6 - 2010 Edition, 2011 Addenda.
- 2.4. ASME Sec. I, A-260 - 2010 Edition, 2011 Addenda.
- 2.5. ASME-B 31.1, 2007 Edition, Addenda 2009, 2011 Addenda.

3. TEST MATERIAL

Weld edge prepared faces (bevel edges) of parent material, weld joints and HAZ areas of pressure vessels/ Heat exchangers and other equipment of carbon and low alloy steels – Ferritic steel material.

4. AREAS OF TEST OBJECT TO BE EXAMINED

Weld edge prepared faces (bevel edges) of parent material, all accessible weld surfaces and 25 mm width portion on each side of weld, which will be considered as HAZ areas.


5. SURFACE CONDITION OF MATERIAL :

Satisfactory results are usually obtained when the surfaces are in as welded, as rolled as cast or as forged condition. Surface to be inspected shall be free from dust, rust, scale, weld spatters, weld ripples, etc. which may cause interpretation difficulties. If required wire brushing of surface shall be done to remove weld spatters etc. Care must be taken so that surface preparation method does not make surface further rough.

6. RESPONSIBILITIES AND OPERATOR'S QUALIFICATION:

6.1. Preparation of examination procedure/s

PAT Level III shall prepare and approve suitable examination procedure/s for Magnetic particle examination based on job requirement. The procedure shall be demonstrated to the satisfaction of AI prior to implementing on job.

	MT Procedure
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6.2. Performing Magnetic particle examination, interpretation and evaluation of results and preparing examination reports :

MT Level II person certified by Level III as per their PAT written practice shall perform magnetic particle examination, interpret and evaluate examination results and prepare examination report in MT Report Format enclosed with this procedure. Copy of all examination reports shall be maintained by MT Level II in respective job file.

7. EQUIPMENT :

7.1. Electromagnetic Yoke having both AC and DC power supply facilities :
Make : SIMS Model : Y AC/DC

7.2. Lifting capacity of Yoke : For AC Yoke – 4.5 Kgs / 10 Lbs.
For HWDC / DC Yoke : 18.1 kgs/ 40 Lbs.

7.3 Prior to use the magnetizing power of yoke shall be checked using a calibrated weight at the maximum pole spacing that shall be used. This check shall be made at least once every year or whenever the electromagnetic yoke has been damaged or repaired.

8. MAGNETIC POWDER

8.1. Dry visible magnetic powder red colour . Make : Magna Flux – 8 A
Non Magnetic White Contrast Coating shall not be used.

8.2. Temperature requirement for Ferro magnetic powder. Maximum allowable temperature for Ferro magnetic particles to be used shall be 600° F as per manufacturer's recommendation.

8.3 Average Particle size 180 Microns as specified by Magna Flux.


9. RESIDUAL FIELD INDICATOR :

Calibrated gauss meter – residual field indicator is required for checking the amount of residual magnetic field left in the material if requirement of demagnetization is specified in work order.

10. MAGNETISING CURRENT:

AC – If examination requirement is only to check surface discontinuities.

DC – If test requirement is to check sub-surface discontinuities.


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11. TEST TECHNIQUE :

Longitudinal Magnetisation using yoke and continuous technique.

Following steps and check points shall be followed for carrying out inspection.

- 11.1. Check and ensure lifting capacity of yoke at least once in a year. It must meet the above stated requirements.
- 11.2. Surface Preparation : Ensure adequate surface finish of job before start of examination as stated above in Para-5 - surface condition of materials.
- 11.3. Adjust pole spacing distance of poles of yoke from 75mm (3Inch) min to 200mm (8 Inch) max.
- 11.4. Place the yoke poles properly on the job so that it establishes maximum contact and creates adequate flux density in the area ***of interest that is weld edge prepared faces (bevel edges) of parent material, weld & HAZ.***
- 11.5. When it is necessary to verify the adequacy of magnetic field strength, it shall be verified using pie shaped magnetic particle field indicator.
- 11.6. Magnetize the weld in three directions as shown in the Figure 1. Apply Powder by spraying using a Spray Bulb while magnetizing in every direction and go on examining the weld using continuous technique giving minimum 10% over lap in each pass to ensure complete coverage.
- 11.7. Search for indication/s after giving each shot in each direction when the current is on. Minimum light intensity of 100 fc (1000 Lux) shall be used to ensure adequate sensitivity during the examination and evaluation of indications. One 60 Watt bulb hand lamp (Incandescent lamp) with 230 V power supply enclosed in a pan, held at a distance of 200 to 300mm from the examination surface shall be considered as satisfactory illumination to achieve the above illumination level. Illumination level shall be verified and demonstrated using a calibrated light intensity meter – Lux Meter one time. The same shall be documented and maintained on file. Light meter shall be calibrated once every year or when ever the meter is repaired or changed. If the light meter has not been in use for one year or more, calibration shall be done before being used.

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12. INDICATIONS:

12.1. Indications will be revealed by retention of magnetic particles. All such indications are not necessarily imperfections. Excessive surface roughness, magnetic permeability variations (such as at the edge of heat affected zone), etc may produce similar indications.

12.2. An indication is the evidence of a mechanical imperfection. Only indications with major dimensions greater than 1.5mm (1/16 Inch) shall be considered relevant.

12.2.1. A linear indication is one having a length greater than three times the width.

12.2.2. A rounded indication is one of the circular or elliptical shape with the length equal to or less than three times the width.

12.2.3. Any questionable or doubtful indication shall be re-examined to determine whether or not it is relevant.

13. ACCEPTANCE STANDARD:

Acceptance standard as specified in ASME Sec. VIII Div. 1, Appendix – 6 / ASME Sec. VIII Div. 2, Part – 7, Para – 7.5.6.2, ASME Sec. I – A-260 shall apply unless other more restrictive standards are specified for specific materials or applications.

13.1 All surfaces examined shall be free of:

13.1.1 Relevant linear indications

13.1.2 Four or more relevant rounded indications in a line separated by 1.5mm (1/16 Inch) or less, edge to edge.


13.1.3 Relevant rounded indications greater than 5mm (3/16 Inch).

13.1.4 An indication of an imperfection may be larger than the imperfection that causes it, however, the size of the indication is the basis for acceptance.

13.1.5 As per ASME B 31.1:

Ten or more rounded indications in any 3870 Sq. mm (6 Sq. Inch) of surface with the major dimension of this area not exceeding 150mm (6 Inch) with the area taken in the most unfavorable location relative to the indications being evaluated.

13.2 Crack like indications detected irrespective of surface conditions are un-acceptable.

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	Page 5 of 9

14. Marking and Repairing:

Spot/s or areas showing relevant defect indication/s shall be marked so that they can be identified properly and can be repaired.

15. Treatment of indication believed to be non-relevant:

Any indication which is believed to be non-relevant shall be regarded as an imperfection unless it is shown by re-examination by the same method or by the use of other non destructive testing method/s and/ or by surface conditioning that no unacceptable imperfection is present.

16. Examination of areas from which imperfections have been removed:

After a defect thought to have been removed and prior to making weld repairs, the area shall be examined by suitable method/s to ensure it has been removed or reduced to an acceptable sized imperfection.

17. Re-examination of repaired areas:

After repairs have been made, the repaired area shall be blended in the surrounding surface so as to avoid sharp notches, crevices, or corners and re-examined by the magnetic particle method and by all other method/s of examination that were originally required for the affected area except that, when the depth of repair is less than the radiographic sensitivity required, re-radiography may be omitted.

18. Retest:


All repaired areas shall be re-tested employing the same technique and steps.

19. Post Cleaning:

The examined surface shall be post cleaned using a clean dry cloth to remove Magnetic powder, etc. immediately after completion of inspection. The post cleaning technique shall not adversely affect the part.

20. Check the amount of residual field left in the material using a gauss meter/residual field indicator, if demagnetization is required as per QCP.

Demagnetization not required unless specified by work order.

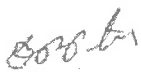
	MT Procedure
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	Dated: 05-08-2012
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21. Report:

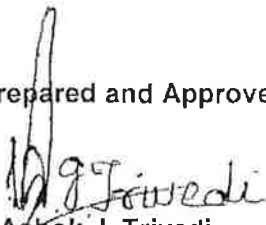
A detailed examination report as per the attached report format shall be prepared after examination.

- 22.** Requirements of magnetic particle examination procedure shall be as per Table T-721 of ASME Sec. V, Article 7 (Page No. 8) of the procedure. Requirements of AC yoke technique on coated ferritic component shall be as per Table I-721 of ASME Sec. V Article 7 (Page No. 9) of the procedure.
- 23.** Demonstration of the procedure to the satisfaction of AI shall be done prior to implementing on job.

Procedure Reviewed by,


D.P. Patel
Manager (QC)
PAT (I) Ltd.
05-08-2012

Procedure Prepared and Approved by,


Ashok J. Trivedi
NDE Level III
05-08-12


AI
6/8/2012
AI



MT Procedure

Procedure No.: PAT/AT/MT/01 (Rev.5)

Dated: 05-08-2012

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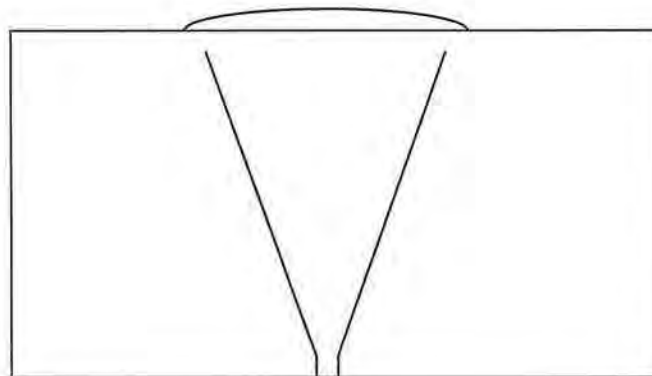
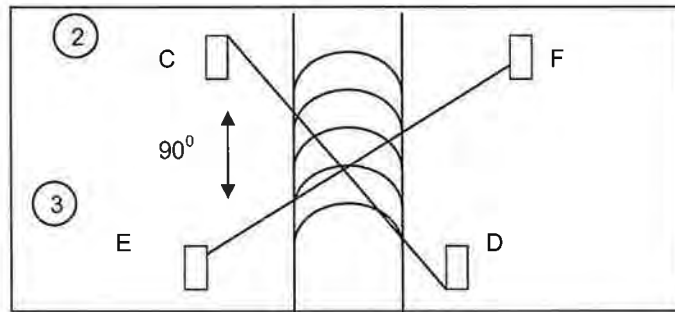
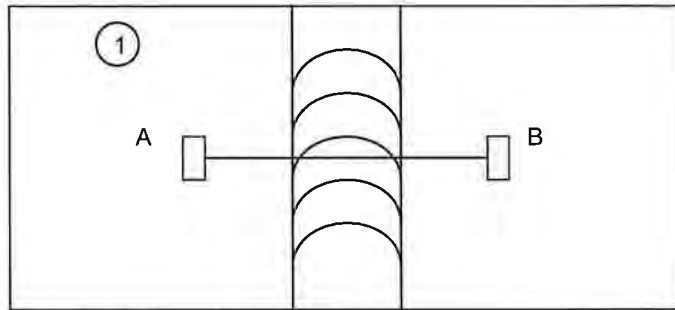


Fig. -1

POSITIONS OF POLES OF YOKE

FOR MAGNETISING WELD IN DIFFERENT DIRECTIONS



MT Procedure

Procedure No.: PAT/AT/MT/01 (Rev.5)

Dated: 05-08-2012


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**Table T-721 of ASME Section-V Article-7
REQUIREMENTS OF A MAGNETIC PARTICLE
EXAMINATION PROCEDURE**

Sr. No.	Requirement	Essential Variable	Non-essential Variable	Procedure Reference Para No.
1	Magnetizing Technique	X		11
2	Magnetizing current type or amperage outside range specified by this Article or as previously qualified	X		10
3	Surface preparation	X		5
4	Magnetic particles (fluorescent/visible, color, particle size, wet/dry)	X		8
5	Method of particle application	X		11.6
6	Method of excess particle removal	X		---
7	Minimum light intensity	X		11.7
8	Coating thickness greater than that qualified	X		8.1
9	Performance demonstration, when required	X		6.1, 23
10	Examination part surface temperature outside of the temperature range recommended by the manufacturer of the particles or a previously qualified	X		8.2
11	Shape or size of the examination object		X	1, 4
12	Equipment of the same type		X	7
13	Temperature (within those specified by manufacturer or as previously qualified)		X	8.2
14	Demagnetizing technique		X	20
15	Post examination cleaning technique		X	19
16	Personnel qualification requirements		X	6

Note :

1. A revised procedure shall be prepared and approved by Level III for any change in essential or non-essential variable/s.
2. Whenever any change is made in any of the essential variable/s, re-demonstration of the procedure to the satisfaction AI shall be done prior to implementing on job.
3. When ever any change is made in any of the non-essential variable/s re-demonstration of procedure to AI is not required.


	MT Procedure
	Procedure No.: PAT/AT/MT/01 (Rev.5)
	Dated: 05-08-2012
Page 9 of 9	

**Table I-721 of ASME Section-V Article-7
REQUIREMENTS OF AC YOKE TECHNIQUE ON COATED FERRITIC COMPONENT**

Sr. No.	Requirement	Essential Variable	Non-essential Variable	Procedure Reference Para No.
1	Identification of surface configuration to be examined, including coating material, maximum qualified coating thickness and product forms (e.g. base material or welded surface).	X		8.11, 3, 4,
2	Surface condition requirement and preparation methods.	X		5
3	Manufacturer and Model of AC yoke.	X		7
4	Manufacturer and type of magnetic particles.	X		8.1
5	Minimum and maximum pole separation.	X		11.3
6	Identification of steps in performing the examination.	X		11
7	Minimum light intensity and AC yoke lifting power requirements. (as measured in accordance with technique qualification)	X		11.7, 7.2, 7.3
8	Methods of identifying flaw indications and discriminating between flaw indications and false Or non-relevant indications (e.g. magnetic writing or particles held by surface irregularities).	X		15
9	Instructions for identification and confirmation of suspected flaw indications.	X		15
10	Method of measuring coating thickness.		X	8.1
11	Recording criteria.		X	14, 21
12	Personnel qualification requirements unique to this technique.		X	6
13	Reference to the procedure qualification records.		X	6, 23

Note :

1. A revised procedure shall be prepared and approved by Level III for any change in essential or non-essential variable/s.
2. Whenever any change is made in any of the essential variable/s, re demonstration of the procedure to the satisfaction AI shall be done prior to implementing on job.
3. When ever any change is made in any of the non-essential variable/s re-demonstration of procedure to AI is not required.

	MT Report
	Procedure No.: PAT/AT/MT/01 (Rev.)
	Dated:
	Page

MAGNETIC PARTICLE EXAMINATION REPORT

Procedure No.	:	PAT/AT/MT/01 (Rev.)	<i>Dt.</i>
Report No.	:		Date :
Job No.	:		
Drg. No.	:		
Reference / Identification :			
Test Date	:		
Test Material	:		Thickness: mm
Surface Condition	:		
Object	:	To check surface / sub-surface discontinuities.	
Test Equipment	:	Electromagnetic Yoke : Make :	Model :
Test Technique	:	Dry Continuous Technique	
Magnetizing Current	:	AC/DC	
Inspection Medium	:	Dry Ferromagnetic Powder Make: Magna Flux Colour: Red Colour:	
Lighting Equipment	:	60 W Bulb Hand Lamp (Incandescent lamp) with 230 V power supply enclosed in a pan held at a distance of mm from the examination surface.	
Reference	:	ASME Sec. V, Article 7	
Acceptance Standard	:	ASME Sec. VIII, Div. 1, Appendix – 6 ASME Sec. VIII, Div. 2, Part – 7, Para – 7.5.6.2 ASME Sec. I, A-260 - 2010 Edition. ASME-B 31.1, 2010 Edition.	
Result of calibration	:	For AC : 4.5 Kgs (10 Lbs.) at ____ pole spacing For DC:18.1 Kgs. (40 Lbs.) at ____ pole spacing.	
Maximum pole spacing during examination :			
Observations:			
Name of Operator			
Qualification :	MT Level II	Inspection Authority	
Sign.	Date :	Sign.	Date :



Jacobs Engineering Canada


Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments		
101-E-110;101-E-111;101-E-112;101-E-113;101-E-114;101-E-115;101-E-120;101-E-121;101-E-210;101-E-225;101-E-226;101-E-240;101-E-241;101-E-450;101-E-451;102-E-610;102-E-613;102-E-655;103-E-080;103-E-190;103-E-290;103-E-390;103-E-490;103-E-590;103-E-705;103-E-707;104-E-135;104-E-136;107-E-305	JPI REV 1 - COORDINATION		
Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1	
<div style="display: flex; align-items: flex-start;"> <div style="margin-right: 10px;"> <input checked="" type="checkbox"/> </div> <div> <p>1 - Work May Proceed</p> </div> </div> <div style="margin-top: 10px;"> <input type="checkbox"/> </div> <div> <p>2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated</p> </div> <div style="margin-top: 10px;"> <input type="checkbox"/> </div> <div> <p>3 - Revise and Resubmit: DO NOT Proceed with Manufacture</p> </div> <div style="margin-top: 10px;"> <input type="checkbox"/> </div> <div> <p>4 - STOP WORK per attached written instructions</p> </div> <div style="margin-top: 10px;"> <input type="checkbox"/> </div> <div> <p>5 - Review Not Required: Work may proceed</p> </div> <p style="font-size: small; margin-top: 10px;">SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</p>	Supplier	Exchanger Industries	
	Doc. Description	EXCHANGER - PAT - LIQUID PENETRANT EXAMINATION - PT - PROCEDURE	
	Vendor Document No.	PT	
	Client Document No.	VP088996-M606-00011	
	Purchase Order No.	Doc Cat.	Issue
CE416040-CC088996-00	M606	5	
BY: <u>SYED SHAH</u>	Categories		
DATE: <u>JULY 17, 2013</u>	Date Received	07/08/2013	

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JUL 08 2013
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 DOCUMENT CONTROL

	PT Procedure
	Procedure No.: PAT/AT/PT/01 (Rev. 5) Dated: 19-12-2011
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PROCEDURE FOR LIQUID PENETRANT EXAMINATION (PT)

1. SCOPE:

This document describes the requirements and procedure to be adopted for liquid penetrant examination of parent materials, weld joints and HAZ areas of 25 mm on each side of weld joint for detection of open surface discontinuities using solvent removable colour contrast (visible) penetrant and solvent suspended (non-aqueous) developer.

2. REFERENCE DOCUMENTS :

- 2.1 ASME-Sec. V- Article-6 – 2010 Edition, **2011 Addenda.**
- 2.2 ASME-Sec.V-SE-165 – 2010 Edition, **2011 Addenda.**
- 2.3 ASME-Sec.VIII-DIV.1 Appendix-8 – 2010 Edition, **2011 Addenda.**
- 2.4 **ASME-Sec. VIII-DIV. 2 Part 7-Para 7.5.7**, 2010 Edition, **2011 Addenda**
- 2.5 **ASME Sec. I, A-270**, 2010 Edition, **2011 Addenda.**
- 2.6 **ASME-B 31.1, 2007 Edition, Addenda 2010.**
- 2.7 **ASME Sec IX-QW- 195.2-** 2010 Edition, **2011 Addenda.**

3. TEST MATERIAL:

Weld joints and HAZ areas of welds, Parent material
 Material: C.S. /S.S. / Low alloy Steel / Duplex S.S. up to 200mm maximum thickness.
 Fresh procedure shall be prepared and approved by Level III for examination of other materials.

4. AREAS OF TEST OBJECT TO BE EXAMINED:

All accessible weld surface and 25 mm width portion on each side of weld which will be considered as HAZ areas. If the surface to be examined is large, the examination shall be carried out in parts/increments.

5. SURFACE CONDITION OF MATERIAL:

Surface to be examined shall be as rolled for plates or pipes, as welded for welds or back chipped / ground for welds. Examination surface shall be free from dust, rust, scale weld spatter, paint, uneven weld ripples, etc. which may block opening of discontinuities and which may cause interpretation difficulties. Care must be taken so that surface preparation steps do not make the surface further rough and do not block opening of discontinuities.

6. CONSUMABLES :

Make - P-Met High Tech, PMC Flaw Check	
Cleaner (Solvent)	PC-120
Penetrant (Solvent Removable Colour Contrast Penetrant)	PP-110 (Packed in Tin / Can. To be applied using brush)
Developer (Solvent Suspended Developer)	PD-130 B (Spray Can)

VP088996-M606-0011



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- 6.1 Intermixing of Penetrant materials from different families or different manufacturer shall not be permitted.
- 6.2 Demonstration of procedure with the above consumables shall be done to the satisfaction of AI prior to implementing on job.

7. MISCELLANEOUS ITEMS:

Clean - dry - lint free cotton cloth, brush, tools for achieving necessary surface finish.

8. RESPONSIBILITIES AND OPERATOR'S QUALIFICATIONS:

8.1 Preparation of examination procedure/s:

Level III shall prepare and approve suitable examination procedure/s for Penetrant examination based on job requirement.

8.2 Performing liquid penetrant examination, interpretation, evaluation of examination results and preparing reports:

PT Level I OR PT Level II person certified by Level III as per PAT Written Practice shall perform liquid penetrant examination. Only Level-II person shall interpret and evaluate results and prepare examination report as per the enclosed Report Format. All test reports shall be maintained by PT Level II in respective job file.

9. Following steps and checkpoints shall be followed for carrying out for examination :

9.1 Expiry date: Check expiry date of consumable materials.

9.2 Pre-cleaning: Pre-cleaning of surfaces can be done first using acetone and then using the recommended cleaner. Drying of the surface after pre-cleaning shall be done by normal evaporation. The recommended drying time shall be 1 minute minimum and 10 minutes maximum.

9.3 Penetrant application: Penetrant shall be applied by using a brush after evaporation of solvent from the surface. Ensure that complete area, which is to be inspected, is covered properly with penetrant.

9.4 Dwell Time: Minimum 10 minutes and maximum 20 minutes for temperature from 10 Deg. to 52 Deg. C (50 Deg. to 125 Deg. F)

9.5 Excess Penetrant Removal: After completion of dwell time, first wipe the excess penetrant from the job surface with a clean, dry, lint free cloth. Then remove the excess penetrant with a cloth



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moistened/dampened with a solvent. Do not use an excessive amount of solvent. Do not rub on the surface and do not over clean the surface so that penetrant from discontinuities can get removed. At the same time do not leave excess penetrant on the surface, which can create heavy background and can cause interpretation difficulties at a later stage. Flushing the surface with solvent for removing excess penetrant shall not be permitted.

- 9.6 **Drying After Excess Penetrant Removal:** Drying after excess penetrant removal shall be done by normal evaporation. Minimum drying time permitted 01 minute and maximum drying time permitted 10 minutes.
- 9.7 **Developer Application:** Shake aerosol spray can of solvent suspended developer properly and apply developer by spraying as soon as possible after evaporation and drying of the surface as stated above in 9.6 so that a thin and uniform coating of developer covers the entire examination surface properly.
- 9.8 **Development Time:** Development time for final interpretation begins as soon as the developer coating has dried. Development time shall be 10 minutes minimum and 30 minutes maximum. The operator shall observe bleed out of penetrant from discontinuities during the development time as it helps in interpreting and evaluating indications.
- 9.9 **Inspection:** Final interpretation shall be done not less than 10 minutes and not more than 30 minutes after drying of developer coating. Adequate illumination (not less than 1000 LUX) shall be required to ensure proper evaluation of indications. Hand lamp enclosed in pan having 60 W bulb (Incandescent Lamp) with 230 volt power supply held at a distance of 200 to 300 mm from the examination surface shall be considered as satisfactory illumination to achieve the above illumination level. Illumination level shall be verified using a calibrated light intensity meter - Lux Meter one time. The same shall be documented and maintained on file. Light meter shall be calibrated once every year or whenever the meter is repaired or changed.
- 9.10 An indication is the evidence of a mechanical imperfection. Only indications with major dimension greater than 1.5mm (1/16 Inch) shall be considered relevant.



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- 9.10.1 A linear indication is one having a length greater than three times the width.
 - 9.10.2 A rounded indication is one of the circular or elliptical shapes with the length equal to or less than three times the width.
 - 9.10.3 Any questionable or doubtful indication shall be re-examined to determine whether or not it is relevant.
- 10 **Acceptance Standard:** As per ASME Sec.VIII, Div-1, Appendix-.8 / ASME Section VIII, Div.-2, Part 7, Para 7.5.7.2. and ASME Section I- A 270. These acceptance standards shall apply unless other more restrictive standards are specified for specific materials or applications.
- 10.1 All surfaces to be examined shall be free of:
 - 10.1.1 Relevant linear indications
 - 10.1.2 Relevant rounded indications greater than 5mm (3/16 Inch)
 - 10.1.3 Four or more relevant rounded indications in a line separated by 1.5mm (1/16 Inch) or less, edge to edge.
 - 10.1.4 As per ASME B 31.1:

Ten or more rounded indications in any 3870 Sq. mm (6 Sq. Inch) of surface with the major dimension of this area not exceeding 150mm (6 Inch) with the area taken in the most unfavorable location relative to the indications being evaluated.
 - 10.2 Crack like indications detected, irrespective of surface conditions are unacceptable.
 - 10.3 An indication of an imperfection may be larger than the imperfection that causes it, however, the size of the indication is the basis for acceptance evaluation.
 - 10.4 As per ASME Sec IX-QW- 195.2- 2010 Edition Test Coupons for Welder's Qualifications for corrosion resistant overlay.
- 11 **Marking and Repairing:** Spot/s or areas showing relevant defect indication/s shall be marked so that they can be identified properly and can be repaired.
- 11.1 **Treatment of indications believed non-relevant:** Any indication which is believed to be non-relevant shall be regarded as an imperfection



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unless it is shown by re-examination by the same method or by the use of other nondestructive examination method and/or by surface conditioning that no unacceptable imperfection is present.

- 11.2 **Examination of areas from which defects have been removed:** After a defect is thought to have been removed and prior to making weld repairs, the area shall be examined by suitable methods to ensure it has been removed or reduced to an acceptably sized imperfection.
- 11.3 **Re-examination of repaired areas:** After repairs have been made, the repaired area shall be blended into the surrounding surface so as to avoid sharp notches, crevices, or corners and re-examined by the liquid penetrant method and by all other methods of examination that were originally required for the affected area, except that, when the depth of repair is less than the radiographic sensitivity required, re-radiography may be omitted.
- 12 **Retest:** All repaired areas shall be re-tested employing the same technique and steps.
- 13 **Post Cleaning:** The examined surfaces shall be post cleaned first using a clean dry cloth to remove developer powder, penetrant and then using a cleaner immediately after completion of examination. The post cleaning process shall not adversely affect the part.
- 14 **Report:** A detailed examination report as per the enclosed Report Format shall be prepared after examination. The report shall include record of rejectable indication if any. As a minimum the following shall be recorded in case of unacceptable indications :
 - 14.1 Type of indication- Linear/Rounded
 - 14.2 Location of indication
 - 14.3 Length or diameter of indication or aligned indications.
- 15 **Special Requirements:** For examination of Austenitic or Duplex SS, Titanium material and welds Chlorine plus Fluorine contents of penetrant material shall not exceed 1 % by weight. For examination of Nickel base alloy Sulfur content of penetrant material shall not exceed 1 % by weight. PAT shall specify the same while ordering consumables to be used for examination of the above materials Manufacturer of penetrant material shall ensure this before supplying consumables and shall also issue a test report/certificate to confirm the same



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along with batch number and test results. PAT shall store these items separately and shall use only for examination of above material.

16 Temperature Requirements:


16.1 Temperature of part surface to be examined as well as penetrant shall be from 10 Deg C to 52 Deg. C (50 Deg. to 125 Deg. F).

16.2 For liquid penetrant examination at temperature out side the above temperature range special material and processing technique may be required. Such examination will require procedure qualification and demonstration to AI prior to implementation on job.

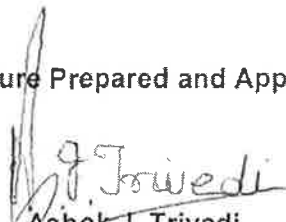
17 Requirements of liquid penetrant examination procedure shall be as per Table T-621 of ASME Sec. V. Article - 6. The same is shown on Page No.7. The procedure shall be re-demonstrated and certified by Level III whenever any change is made in any of the essential variable.

For Patels Airtemp (India) Limited:

Procedure Reviewed By,


D.P. Patel
Manager (QC)
19-12-2011

Procedure Prepared and Approved By,


Ashok J. Trivedi
NDE Level III
19-12-2011



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**TABLE T-621 OF ASME SEC. V ARTICLE - 6
REQUIREMENTS OF A LIQUID PENETRANT EXAMINATION PROCEDURE**

Sr. No.	Requirement	Essential Variable	Non-essential Variable	Procedure Reference Para No.
1	Identification of and any change in type or Family group of penetrant materials including developers, emulsifiers, etc.	X		6
2	Surface preparation (finishing and cleaning, including type of cleaning solvent)	X		5, 6, 9.2
3	Method of applying penetrant	X		9.3
4	Method of removing excess surface penetrant	X		9.5
5	Hydrophilic or lipophilic emulsifier concentration and dwell time in dip tank and agitation time for hydrophilic emulsifiers	X		N.A.
6	Hydrophilic emulsifier concentration in Spray application	X		N.A.
7	Method of applying developer	X		9.7
8	Minimum and maximum time period between steps and drying aids.	X		9.2, 9.3, 9.4, 9.6, 9.7, 9.8.
9	Decrease in penetrant dwell time	X		9.4
10	Increase in developer dwell time (interpretation time)	X		9.8,9.9
11	Minimum light intensity	X		9.9
12	Temperature outside 10 to 52 ⁰ C (50 to 125 ⁰ F) or as previously qualified	X		16
13	Performance demonstration, when required	X		6.2, 16.2, 17
14	Personnel qualification requirements		X	8
15	Materials, shapes or sizes to be examined and the extent of examination		X	3, 4,5
16	Post examination cleaning technique		X	13

- Note:
1. A revised procedure shall be prepared and approved by Level III for any change in essential or non-essential variable/s in the procedure.
 2. When ever any change is made in any of he essential variable/s, re-demonstration of the procedure to AI shall be required.
 3. When ever any change is made in any of the non-essential variable/s Re-demonstration of the procedure to AI is not required.

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LIQUID PENETRANT EXAMINATION REPORT

MATERIAL	REPORT No...	DATE
THICKNESS	DRAWING No.	
SURFACE CONDITION	CLIENT	
JOB No.	EQUIPMENT NAME	

Procedure No. : PAT/AT/PT/01 (Rev.) Dt.

Test Date :

Materials used for examination:

Make: P-Met, PMC Flaw Check

MATERIAL	I.D. No.	BATCH No.	EXPIRY DATE
Cleaner	PC-120		
Solvent Removable Visible Penetrant	PP-110		
Solvent Suspended Developer	PD-130 B		

Application Method	Penetrant applied by Brush Developer applied by Spray
Dwell Time	10 Minutes for Penetrant 10 Minutes for Developer
Drying of Solvent By normal evaporation	Drying Time : 3 Minutes
Lighting Equipment	60 W Bulb Hand Lamp (Incandescent Lamp) with 230 volt power supply enclosed in a pan held at a distance of _____ mm from the examination surface.
Acceptance Standard	ASME Section VIII Div. 1 Appendix-8 ASME Section VIII Div. 2, Part 7, Para 7.5.7.2 ASME B 31.1
Job Details	
Observation / Remarks	
Examination carried out by Name Sign. Date	Qualification Level : Level I / II
Interpretation & Evaluation done by Name Sign. Date	Qualification Level : Level II
Inspection Authority	Name Sign. Date



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments			
101-E-110;101-E-111;101-E-112;101-E-113;101-E-114;101-E-115;101-E-120;101-E-121;101-E-210;101-E-225;101-E-226;101-E-240;101-E-241;101-E-450;101-E-451;102-E-610;102-E-613;102-E-655;103-E-080;103-E-190;103-E-290;103-E-390;103-E-490;103-E-590;103-E-705;103-E-707;104-E-135;104-E-136;107-E-305	JPI REV 1 - COORDINATION			
Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1		
<p><input checked="" type="checkbox"/> 1 - Work May Proceed</p> <p><input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated</p> <p><input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture</p> <p><input type="checkbox"/> 4 - STOP WORK per attached written instructions</p> <p><input type="checkbox"/> 5 - Review Not Required: Work may proceed</p> <p><small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small></p>	Supplier	Exchanger Industries		
	Doc. Description	EXCHANGER - PAT - RADIOGRAPHIC EXAMINATION - RT - PROCEDURE		
	Vendor Document No.	RT		
	Client Document No.	VP088996-M606-00013		
	Purchase Order No.	Doc Cat.	Issue	
	CE416040-CC088996-00	M606	5	
BY : <u>SYED SHAH</u>	Categories			
DATE : <u>JULY 17, 2013</u>	Date Received	07/08/2013		



Procedure for Radiographic Examination (RT)

Procedure No.: PAT/AT/RT/01 (Rev. 5)

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1. SCOPE

This procedure specifies the requirements for examination of CS and SS weld joints of thickness from 6 mm to 60 mm using X-Rays or Gamma Rays (Ir 192) as a source of radiation for revealing and evaluating flaws within weld and HAZ-heat affected zone areas. For the thickness of less than 12 mm radiography using X-Rays is preferred. For thickness from 12mm to 19mm either X-Rays or Gamma Rays can be used and for thickness greater than 19mm Gamma rays shall be used. Any radiographic technique used shall demonstrate that required radiographic sensitivity - IQI image and density requirements have been obtained.

2. REFERENCE DOCUMENTS :

- 2.1. ASME Sec. V Article 2, 2010 Edition, **2011 Addenda.**
- 2.2. ASME Sec. VIII Div. 1, 2010 Edition, **2011 Addenda.**
- 2.3. ASME Sec. VIII Div. 2, 2010 Edition, **2011 Addenda.**
- 2.4. ASME Sec. IX., 2010 Edition, **2011 Addenda.**
- 2.5. ASME Sec. I, 2010 Edition, **2011 Addenda.**
- 2.6. ASME B 31.1, 2007 Edition, **2010 Addenda.**

3. RESPONSIBILITES AND OPERATOR'S QUALIFICATION :

3.1. Preparation of test procedure/s :

PAT Level III shall prepare and approve suitable examination procedure/s for radiographic examination based on job requirements.

3.2. Performing radiography examination, interpretation and evaluation of examination results and preparing examination reports

RT Level I / RT Level II person certified by Level III as per Written Practice shall prepare a Technique Sheet prior to shooting based on the procedure prepared by Level III and expose the film in accordance with Technique Sheet. Technique Sheet format is enclosed with the procedure. Only Level II shall interpret and evaluate examination results and prepare examination report as per enclosed RT Report Format (Radiograph Review Form). Copy of all examination reports shall be maintained by RT Level II in respective job file.

4. TEST MATERIAL :

Weld joints CS and SS on Pressure Vessels, Heat Exchangers and other equipments and parts. Thickness: From 6 mm to 60 mm.

For thickness/es outside the above specified range, the appropriate technique shall be developed prior to implementing on job.

5. SURFACE PREPARATION :



VP058996-M606-00013



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As far as possible weld will be radiographed with weld surface in as welded condition and no grinding will be done on welds. However if any significant surface irregularity is there on weld surface which may interfere with interpretation of radiographs that shall be removed. Weld surface irregularities on out side as well as if accessible on inside surface shall be removed using any suitable process so that image of indications from these irregularities on a radiograph may not be confused with indications from discontinuities. The finished surface of butt weld joints shall have a reasonably uniform crown with reinforcement not exceeding the limit specified in the Code.

6. SOURCE OF RADIATION :

Iridium—Ir 192 / X-Ray (Source strength for Gamma Ray & Voltage used for X-Ray must be specified in Technique Sheet.)

7. SOURCE STRENGTH :

1Ci to 25 Ci or more depending on availability and job requirement.

X-Ray equipment can be from 150 KV to 400 KV.

8. SIZE OF SOURCE :

2.5 mm Dia. x 0.6 mm Height if available or any other suitable size as supplied by Board of Radiation Isotope Technology, BARC, Mumbai. Size of source shall be as per certificate provided by origination of radiation source. Focal spot size of X-Ray beam shall be made available from the manufacturer of X-Ray equipment.

9. RADIOGRAPHY TECHNIQUE:

Single wall single image technique / Double wall single image technique/ Double wall double image technique depending upon accessibility and job requirements. Radiography report format covers details of radiography techniques.

10. OVER LAP: When continuous shots are taken minimum 25mm overlap shall be provided in each shot.

11. SFD ADJUSTMENT AND GEOMETRIC UN-SHARPNESS :

Any source to film distance (SFD) that would produce a radiograph of required quality level shall be used.



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For guidance the following Ug limits may be used:

Suitable SFD can be decided by Radiographer – Operator depending upon job requirement and radiography technique used so that proper image quality is obtained in radiograph having max. Geometrical un-sharpness (Ug) as follows:

Material Thickness in mm (Inch)	Ug maximum in mm (Inch)
Under 50 (2)	0.51 (0.020)
50 (2) through 75 (3)	0.76 (0.030)
Over 75 (3) through 100 (4)	1.02 (0.040)
Greater than 100 (4)	1.78 (0.070)

(ASME Section V Article 2)

12. IMAGE QUALITY INDICATOR (IQI) :

12.1. Material of IQI :

Material of IQI shall be of the same grade having same absorption characteristic as the specimen to be radiographed or having the grade with less radiation absorption characteristic than that of specimen to be radiographed.

12.2. Thickness of IQI :

12.2.1 Weld without Reinforcement: Thickness of IQI is based on nominal single wall thickness.

12.2.2 Weld with Reinforcement: Thickness of IQI is based on nominal single wall thickness + weld reinforcement. This reinforcement thickness must not exceed maximum permitted by Code under reference but need not be physically measured.

12.2.3 Weld joint with backing strip: For the purpose of calculation of thickness of IQI, thickness of backing strip shall not be considered.

12.3. Placement of IQI :

Wire type or hole type IQI as specified in Table T-276 (Page No.11) shall be used. The IQI shall be placed on the source side adjacent to the weld or on the weld of the part being inspected. When it is not possible to hand place the IQI on the part or weld towards source side then the IQI shall be placed on film side in contact with the part being examined with a lead letter "F" placed adjacent to the IQI. Wire type IQI shall be placed such that the length of the wires is perpendicular to the length of the weld. The IQI identification and when used the lead letter F shall not be in the area of interest except when geometric configuration makes it impractical.

No. of IQI :

12.3.1. At least one IQI per film for single exposure.

12.3.2. For cylindrical components where the source is placed on the axis of the



Procedure for Radiographic Examination (RT)

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component for a single exposure, at least 3 IQIs, spaced approx. 120° apart are required for the following condition :

- a) When complete circumference is radiographed using one or more film holders i.e. for panoramic exposures.
- b) When a section or sections of the circumference, where the length between the ends of the outer most section span 240° or more is radiographed using one or more film holders. If required additional films may have to be placed to maintain the required IQI spacing of 120° apart.

12.3.3. For cylindrical components where the source is placed on the axis of the component for a single exposure at least 3 IQIs with one placed at each end of the span of the circumference to be radiographed and one in approx. centre of the span are required for the following conditions :

- a) If the length of section of circumference is greater than 120° and less than 240° and is radiographed using either one or more film holders.
- b) When a section or sections of the circumference, where the length between the ends of the outermost sections span less than 240° is radiographed using more than one film holder.

12.3.4. Where longitudinal welds adjoining circumferential welds are radiographed simultaneously an additional IQI shall be placed on each longitudinal weld at the end of the section away from the junction of circumferential weld.

12.3.5. For spherical components where the source is placed at the centre of the component for a single exposure, at least 3 IQIs, spaced approx, 120° apart are required for the following conditions :

- a. When complete circumference is radiographed using one or more film holders i.e. for panoramic exposures.
- b. When a section or section of the circumference, where the length between the ends of the outer most section span 240° or more is radiographed using one or more film holders. If required additional films may have to be placed to maintain the required IQI spacing of 120° apart.

12.3.6. For spherical components where the source is placed at the centre of the component, at least 3 IQIs, with one placed at each end of the span of the circumference to be radiographed and one in approx. centre of the span are required.

- a) If the length of section of circumference is greater than 120° and less than 240° and is radiographed using one or more film holders.
- b) When a section or section of the circumference, where the length between the ends of the outermost sections span 240° or more is radiographed using one or more film holders. If required additional films may have to be placed



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to maintain the required IQI spacing of 120° apart.

- 12.3.7. For spherical components in (12.4.5) and (12.4.6) above, if other welds are radiographed simultaneously with circumferential welds one additional IQI shall be placed on each other weld.
- 12.3.8. For segments of a flat or curved (i.e., ellipsoidal, torispherical, toriconical, elliptical, etc.) component where the source is placed perpendicular to the center of a length of weld for a single exposure when using more than three film holders, at least three IQIs, one placed at each end of the radiographed span and one in the approximate center of the span, are required.
- 12.3.9. When an array of components in a circle is radiographed image of at least one IQI shall be visible in each film.
- 12.3.10. In order to maintain the continuity of records all radiographs exhibiting IQI that qualify the above techniques shall be retained.
- 12.3.11. If adequate number of required hole type IQI is not available, equivalent IQI as specified in Table T-283 (Page 13) may be utilized for additional coverage. A thinner or thicker hole type IQI than the required IQI may be used provided an equivalent are better IQI sensitivity is achieved as per Table T-283 (Page 13) and all other requirements are met.

13. Shim under hole type IQIs :

For hole type of IQI a shim of material radiographically similar to the weld metal shall be placed between the part and the IQI if needed, so that the radiographic density through out the area of interest is no more than -15% from (lighter than) the radiographic density through the designated IQI adjacent to the essential hole. Shim dimensions shall exceed the IQI dimensions such that the out line of at least 03 sides of IQI image shall be visible in the radiograph.

14. FILMS :

- 14.1. **Film Make and Type :**
Agfa Industrial X-Ray Film – D4 / D5 / D7. or
Kodak make – MX 125 / T 200 / AA 400 or
Laser Brand Film – NDT 4 / NDT 5 / NDT 7
- 14.2. **Film Size :**
75mm (3 Inch) width x 381mm (15 Inch) length or
100mm (4 Inch) width x 381mm (15 Inch) or as required.
- 14.3. Films must be checked for expiry date before use.
- 14.4. Films should not have any physical damage such as scratch, nail, marks, crimps, damage to gelatin layer, etc. which may result in non-relevant indication/s.
- 14.5. Films must be stored as per manufacturer's recommendations. When opened from cartoon, film should be loaded in between screens and cassettes under



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proper temperature and lighting conditions as recommended by film manufacturer.

15. INTENSIFYING SCREENS :

Lead intensifying screens shall be used. Thickness of lead screens 0.1 mm for both front and back screens. Screens must also be inspected for physical damage and cleanliness before loading films. There should not be entrapment of hair or any other foreign body particle in between film and screens which may result in non-relevant indication or interpretation difficulties at a later stage.

16. CAMERA (PROJECTOR) / EQUIPMENT :

A. Gamma Ray remote controlled operated camera :

Make	Model
Amar, UK	Amar Test 660 – Tech. OPS
BARC, Bombay	Rolly –1
USA	Spec. 2T
or Equivalent	

B. X-Ray Equipment :

Make	Model
Gamax India, Thane	XPLORER
Time Group Incorp. China	TFC 125C
or Equivalent	

17. DENSITY REQUIREMENTS :

17.1. *The transmitted film density through out the radiographic image of the body of the designated hole type IQI adjacent to the essential hole or adjacent to the essential wire of a wire type IQI and the area of interest shall be 1.8 minimum for single film viewing for radiographs taken with X-Ray and 2 minimum for radiographs taken with gamma ray source. For composite viewing of multiple film exposures, each film of the composite set shall have a minimum density of 1.3. The maximum density shall be 4 for either single or composite viewing. Density variations permitted in the area of interest : -15%, +30% compared to the density measured near required IQI, within the overall limits of 1.8/2 to 4.*

17.2. Density of a radiograph shall be measured using a calibrated densitometer. Densitometer shall be calibrated using a calibrated density strip having a valid



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calibration certificate. Calibration of densitometer and density strip shall be in accordance with steps specified for calibration of densitometer. **A tolerance of 0.05 is allowed for variations betn. densitometer readings. When calculating the allowable variation in density, the calculation may be rounded to the nearest 0.1 within the range specified i.e. 1.8 / 2 to 4.**

17.3. When shims are used with hole type IQIs, the +30% density restrictions may be exceeded and the minimum density requirements of 1.8 / 1.3 do not apply for the IQI, provided the required IQI sensitivity is met.

18. RADIOGRAPHY SENSITIVITY :

18.1. Each radiograph shall have sensitivity sufficient enough to display the hole IQI image and the required hole or the essential wire of wire IQI. The radiograph shall also display the IQI identifying numbers and letters. **If the designated hole type IQI image and essential hole or essential wire of a wire type IQI is not shown on any film in a multiple film technique, but do show in composite film viewing, interpretation shall be permitted only by composite film viewing.**

18.2. Sensitivity requirements are specified in Table No. T-276 on Page No. 11. Hole type IQI designation and hole diameters are specified in Table No. T-233.1 Page No.12. Wire IQI designation wire Dia. and wire identity are specified in Table No. T-233.2 on Page No.13.

18.3. Equivalent Hole Type IQI Sensitivity : A thinner or thicker hole type IQI may be substituted, provided an equivalent or better sensitivity as listed in Table T-283 is achieved and all other requirements of radiography are met. If the designated IQI and hole are not present in the table, the next thinner IQI row from the table may be used to establish the equivalent IQI sensitivity.

19. IDENTIFICATION OF RADIOGRAPH :

Each radiograph shall be identified as a minimum with following details:

19.1 Name / Logo / Code of manufacturer.

19.2 Date of Radiography.

19.3 Job No. or Serial No. of Vessel.

19.4 Weld Joint Reference.

19.5 Location / Segment No.

19.6 RS1—If re-shoot of weld is done 1st time.

19.7 RS2—If re-shoot of weld is done 2nd time.

19.8 R1—If radiograph taken after 1st repair.

19.9 R2—If radiograph taken after 2nd repair



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Using lead numbers and letters or writing with sketch pen. Such identification markings shall not block the area of interest.

20. LOCATION MARKER:

Location marker shall be placed in accordance with the requirements outlined in ASME Sec. V, Article -2, and as shown in sketch on Page No. 14. In any case, such identification details shall not obscure area of interest, and the location marker shall appear as permanent radiographic image on the film.

21. QUALITY OF RADIOGRAPH :

Each radiograph shall be free from mechanical, chemical or any other imperfection in the area of interest of the object being radiographed. Such blemishes include but are not limited to fogging, scratches, finger marks, crimps, dirt, static marks. Processing defects such as: Streaks, Chemical Stains, Water marks, etc.

22. BACK SCATTER :

22.1. A lead symbol of letter "B" with minimum dimensions of 13mm (½ Inch) height and 1.5mm (1/16 Inch) thickness shall be attached to the back of each exposure to determine if back scatter radiation is exposing the film.

22.2. If a light image of letter "B" appears on a darker background of the radiograph, protection from back scatter is insufficient and the radiograph shall be considered unacceptable. A dark image of letter "B" on a lighter background is acceptable.


23. FILM PROCESSING:

Chemicals required : Developer, Stop Bath, Fixer, Wetting agent/
Water spot preventing solution.

Make : Agfa make or other brands approved by PAT.

23.1. Mixing Chemicals :

- A. Manufacturers directions and formulas shall be followed for mixing chemicals. Chemicals shall be maintained at temperature as recommended by manufacturer. Containers used for mixing and storing chemicals must be thoroughly cleaned before and after use.
- B. Processing hangers, tanks shall be free from corrosion and chemical deposits. Chemicals shall not be used that have been stored longer than recommended. Solutions shall be stored in containers/tanks with floating lids and dust covers.
- C. Check thermometer and temp. controlling devices periodically to be sure that the process temps. are correct. Store all solutions at normal room temperature between 4 to 27 Deg. C (40 and 80 Deg. F).
- D. Process temp. should be checked at least once per shift. Keep the temp. of stop bath solution, fixer and water wash within ± 03 Deg. C (± 05 Deg. F) of developer temp. However for maintaining temp. of various

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chemicals manufacturers recommendations must be considered.

- E. Immersion time in each solution shall also include draining time and shall be as per the film / chemical manufacturer's recommendations. Agitate at specified intervals for the times recommended by the film or solution manufacturer. Add replenishment solution as required. Films shall be handled carefully during the processing cycle and allow adequate time for the film to sufficiently drain before transferring it to the next solution.

- F. When washing film wetting agents shall be added to prevent water spots and streaking during drying.

24. Viewing of radiographs : Fundamental requirements of a good film viewer :

- a) The illuminating source should not heat and damage film by fusion of gelatin.
- b) Heat filters must be placed between light source and diffusing glass.
- c) Light intensity on a viewing screen must be evenly distributed.
- d) Light source must be strong enough to penetrate high density films.
- e) Regulation of light intensity must be provided to permit adjustment for density of each radiograph and to view required IQI wire or hole.
- f) Film illuminator should have screen to restrict the illumination area to that under examination so that light from areas adjacent to the film shall not interfere with viewing.
- g) Foot switch should be provided to a viewer so that bright light can be switched off when exchanging film on a viewer.
- h) Film interpretation work shall be carried out in a partially darkened area. Before start of work about 05 minutes time shall be given to interpreter for adjustment of his eye for dark adaptation.


25. ACCEPTANCE STANDARDS :

- 25.1 As per ASME Section VIII Div. 1, Rules for Construction of Pressure Vessels - For examination of weld joints on pressure vessels :
 - 25.1.1 UW-51 for full radiographic examination.
 - 25.1.2 UW-52 for spot radiographic examination.

- 25.2 As per ASME Section VIII Div. 2, Alternative Rules for Construction of Pressure Vessels - Part 7, Para 7.5.3.2.

- 25.3 As per ASME Section IX – QW-191.1.2 for test coupons for welder's qualification.

- 25.4 As per ASME Section 1, PW-51 for Construction of Power Boilers.

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25.5 As per ASME B 31.1, Para136.4.5 for Pressure Piping.

26. EVALUATION BY MANUFACTURER :

RT Level II shall review radiograph, interpret and evaluate test results as per the applicable Code and shall prepare report. Radiography Technique Sheet, Report as well as Radiograph shall be submitted to AI.

27. PROCEDURE DEMONSTRATION :

Demonstration of density and IQI image requirements on film of production radiograph or technique radiograph shall be done to the satisfaction of AI.

28. REPORT :

A detailed report as per the enclosed RT Report Format (Radiograph Review Form) shall be prepared after examination. Preprinted formats may be used, provided the information as shown in the format is incorporated in the report.

29. MARKING AND REPAIRING :

Areas showing unacceptable indications on films shall be suitably marked on the job so that they can be identified properly and can be repaired.

30. RETEST :

All repaired areas shall be re-tested employing the same technique and steps.

31. SAFETY REQUIREMENTS :

The radiographer shall be conversant with the safety practices as required by BARC, Dept. of Atomic Energy, Govt. of India and shall always follow the same very strictly. Persons working in radiation areas shall be provided with the necessary personnel monitoring devices used for safety. Radiation survey meters shall be used for area monitoring. Unauthorized and non-radiographic personnel shall not be allowed to enter the areas.



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IQI SELECTION

Table T-276 (ASME Sec. V, Article 2)

Nominal Single - Wall Material Thickness Range mm (Inch)	IQI					
	Source Side			Film Side		
	Hole - Type Designation	Essential Hole	Wire - Type Essential Wire	Hole - Type Designation	Essential Hole	Wire - Type Essential Wire
Up to 6.4 incl. (0.25)	12	2 T	5	10	2 T	4
Over 6.4 through 9.5 (0.25 through 0.375)	15	2 T	6	12	2 T	5
Over 9.5 through 12.7 (0.375 through 0.50)	17	2 T	7	15	2 T	6
Over 12.7 through 19.0 (0.50 through 0.75)	20	2 T	8	17	2 T	7
Over 19.0 through 25.4 (0.75 through 1.00)	25	2 T	9	20	2 T	8
Over 25.4 through 38.1 (1.00 through 1.5)	30	2 T	10	25	2 T	9
Over 38.1 through 50.8 (1.5 through 2.00)	35	2 T	11	30	2 T	10
Over 50.8 through 63.5 (2.00 through 2.50)	40	2 T	12	35	2 T	11
Over 63.5 through 101.6 (2.50 through 4.00)	50	2 T	13	40	2 T	12
Over 101.6 through 152.4 (4.00 through 6.00)	60	2 T	14	50	2 T	13
Over 152.4 through 203.2 (6.00 through 8.00)	80	2 T	16	60	2 T	14
Over 203.2 through 254 (8.00 through 10.00)	100	2 T	17	80	2 T	16
Over 254 through 304.8 (10.00 through 12.00)	120	2 T	18	100	2 T	17
Over 304.8 through 406.4 (12.00 through 16.00)	160	2 T	20	120	2 T	18
Over 406.4 through 508.0 (16.00 through 20.00)	200	2 T	21	160	2 T	20



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HOLE TYPE IQI DESIGNATION, THICKNESS AND HOLE DIAMETERS

Table T-233.1 (ASME Sec. V, Article 2)

IQI Designation	IQI Thickness mm (Inch)	1T Hole Diameter mm (Inch)	2T Hole Diameter mm (Inch)	4T Hole Diameter Mm (Inch)
5	0.13 (0.005)	0.25 (0.010)	0.51 (0.020)	1.02 (0.040)
7	0.19 (0.0075)	0.25 (0.010)	0.51 (0.020)	1.02 (0.040)
10	0.25 (0.010)	0.25 (0.010)	0.51 (0.020)	1.02 (0.040)
12	0.32 (0.0125)	0.32(0.0125)	0.64 (0.025)	1.27 (0.050)
15	0.38 (0.015)	0.38 (0.015)	0.76 (0.030)	1.52 (0.060)
17	0.44 (0.0175)	0.44 (0.0175)	0.89 (0.035)	1.78 (0.070)
20	0.51 (0.020)	0.51(0.020)	1.02 (0.040)	2.03 (0.080)
25	0.64 (0.025)	0.64(0.025)	1.27 (0.050)	2.54 (0.100)
30	0.76 (0.030)	0.76 (0.030)	1.52 (0.060)	3.05 (0.120)
35	0.89(0.035)	0.89(0.035)	1.78 (0.070)	3.56 (0.140)
40	1.02 (0.040)	1.02(0.040)	2.03 (0.080)	4.06 (0.160)
45	1.14 (0.045)	1.14 (0.045)	2.29 (0.090)	4.57 (0.180)
50	1.27 (0.050)	1.27 (0.050)	2.54 (0.100)	5.08 (0.200)
60	1.52 (0.060)	1.52 (0.060)	3.05 (0.120)	6.10 (0.240)
70	1.78 (0.070)	1.78(0.070)	3.56 (0.140)	7.11 (0.280)
80	2.03 (0.080)	2.03 (0.080)	4.06 (0.160)	8.13 (0.320)
100	2.54 (0.100)	2.54 (0.100)	5.08 (0.200)	10.16 (0.400)
120	3.05 (0.120)	3.05(0.120)	6.10 (0.240)	12.19 (0.480)
140	3.56 (0.140)	3.56(0.140)	7.11 (0.280)	14.22 (0.560)
160	4.06 (0.160)	4.06 (0.160)	8.13 (0.320)	16.26 (0.640)
200	5.08 (0.200)	5.08 (0.200)	10.16 (0.400)	-----
240	6.10 (0.240)	6.10(0.240)	12.19.480)	-----
280	7.11 (0.280)	7.11 (0.280)	14.22 (0.560)	-----



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WIRE IQI DESIGNATION, WIRE DIAMETER, AND WIRE IDENTITY
Table T-233.2 (ASME Sec. V, Article 2)

SET A			SET B		
Wire Dia. (Inch)	Wire Dia. mm	Wire Identity	Wire Dia. (Inch)	Wire Dia. mm	Wire Identity
(0.0032)	0.08	1	(0.010)	0.25	6
(0.004)	0.10	2	(0.013)	0.33	7
(0.005)	0.13	3	(0.016)	0.41	8
(0.0063)	0.16	4	(0.020)	0.51	9
(0.008)	0.20	5	(0.025)	0.64	10
(0.010)	0.25	6	(0.032)	0.81	11

SET C			SET D		
Wire Dia. (Inch)	Wire Dia. mm	Wire Identity	Wire Dia. (Inch)	Wire Dia. mm	Wire Identity
(0.032)	0.81	11	(0.100)	2.54	16
(0.040)	1.02	12	(0.126)	3.20	17
(0.050)	1.27	13	(0.160)	4.06	18
(0.063)	1.60	14	(0.200)	5.08	19
(0.080)	2.03	15	(0.250)	6.35	20
(0.100)	2.54	16	(0.320)	8.13	21

EQUIVALENT HOLE TYPE IQI SENSITIVITY

Table T-283 (ASME Sec. V, Article 2)

Hole-Type Designation 2 T Hole	Equivalent Hole-Type Designations	
	1 T Hole	4 T Hole
10	15	5
12	17	7
15	20	10
17	25	12
20	30	15
25	35	17
30	40	20
35	50	25
40	60	30
50	70	35
60	80	40
80	120	60
100	140	70
120	160	80
160	240	120
200	280	140



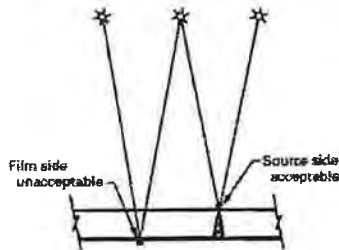
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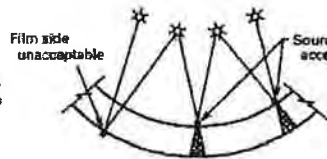
Dated: 19-12-2011

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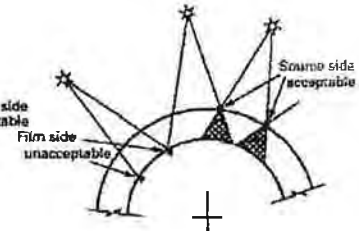
SKETCHES FOR PLACEMENT OF LOCATION MARKER



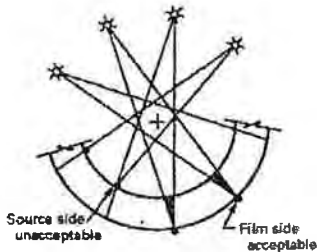
Flat component or longitudinal seam
[See T-275.1(a)(1)]
(See sketch (a) for alternate)
(a)



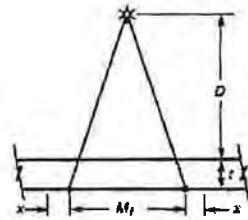
Curved components with radiation source to film distance less than radius of component
[See T-275.1(b)(2)]
(b)



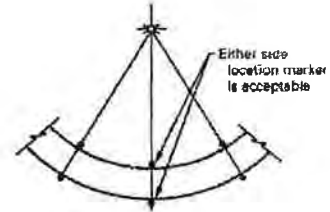
Curved components with convex surface towards radiation source
[See T-275.1(a)(3)]
(c)



Curved components with radiation source to film distance greater than radius of curvature
[See T-275.1(b)(1)]
(d)



Source side marker alternate
Flat component or longitudinal seam
 $x = (t / D) (M_f / 2)$
 x = additional required coverage beyond film side location marker
 t = component thickness
 M_f = film side location marker interval
 D = source to component distance
[See T-275.1(b)(2)]
(e)



Curved components with radiation source at center curvature
[See T-275.1(b)]
(f)

LEGEND: Radiation source — ☆
Location marker — ●
Component center — +



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VERIFICATION / CALIBRATION OF DENSITOMETER

Steps to be followed:

1. Procure a step wedge calibration film traceable to National Standard and having at least five steps with neutral densities from at least 1 through 4.0. The step wedge calibration film shall have been verified within last year by comparison with a national standard step tablet unless, prior to first use, it was maintained in the original light tight and waterproof sealed package as supplied by the manufacturer. Step wedge calibration films may be used without verification for one year upon opening, provided it is within the manufacturer's stated shelf life.
2. Measure density of each step closest to 1, 2, 3 and 4 on a step wedge calibration film and record in column 'C' as shown in the following table. At least four readings are required.

A	B	C	D	E
Step of Density Strip / Step Wedge Calibration Film	Reading of density of each step as per manufacturer	Measured density of each step	Difference in readings between Column B & C $D = B - C$	Sign. and Date of RT Level II

3. Values of differences in readings of density in useful range between column B and C shall not vary by more than ± 0.05 .
4. If the difference in density values between column B and C exceed ± 0.05 in the useful range then densitometer unit must be sent for re-calibration.
5. This calibration check shall be performed :
 - 5.1 Daily for four step readings.
 - 5.2 Within a period of 90 days.



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6. Periodic calibration verification check for densitometer shall be performed as explained in 1 to 4 above :

At the beginning at each shift.

After 8 Hrs. of continuous use.

After the change of apertures in densitometer, which ever occurs first the densitometer is acceptable if the density readings are within ± 0.05 of the calibration readings.

7. Densitometer calibration readings for four steps are to be recorded at least within 90 days as stated in Step 5.2 in the log book / register in the format shown in Step – (2) above.
8. Daily verification readings of each step of density shown by densitometer (Step-5.1) need not be recorded if the calibration readings are within acceptable limits but calibration must be documented by RT Level II with the time and date at which calibration was checked.
9. If the reading during any periodic verification are outside the acceptable limits, all radiographs reviewed after the last valid calibration check shall be re-examined and a fresh report shall be prepared.

For Patels Airtemp. India Ltd. :

Procedure Reviewed by,

D. P. Patel

Manager (QC)

19-12-2011

Procedure Prepared and Approved by,

Ashok J. Trivedi

NDE Level III

19-12-2011



NDE - RT

Radiography Technique Sheet

Page : 1

RT Technique Sheet No. :	Date :
RT Procedure No. :	Date :
Drawing No. :	Extent of RT :
Code of Construction :	Date of RT :

Identification

Manufacturer's Sr. No.	Weld Joint No.	Welder No.

Base Material Type :	Thickness :	T =
Reinforcement Thickness :	R =	Weld Thickness : t = T + R =
Type of Joint :	SOD (D) :	
	OFD (d) :	
Welding Process :		
Radiation Source Type :	Isotope - Ir 192	Source Strength Ci
	X-Ray Voltage _____ Kvp	Current mA
Source / Focal Spot Size :		
Film Make & Designation (Brand) :	Lead Screen :	
IQI Hole Type :	ASTM _____ Required Hole :	
IQI Wire Type :	ASTM _____ Required Wire :	
Exposure Technique :	Single Wall / Double Wall	Viewing : Single Wall / Double Wall
Film Viewing :	Single Film / Composite Film	
	No. of Film/s in Each Cassette	
No. of Exposures		
Location Markers :	As per Sketch on Page 2	
Letter 'B' :	Kept on back side of each film cassette	

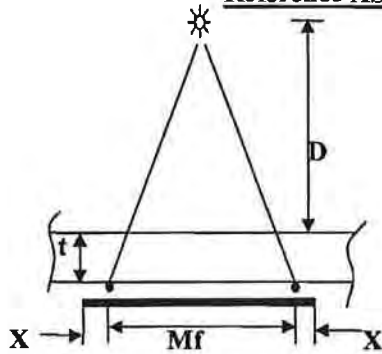
Weld Joint No.	Segment No.	Film Size



Radiography Technique Sheet
Technique Sheet No. :

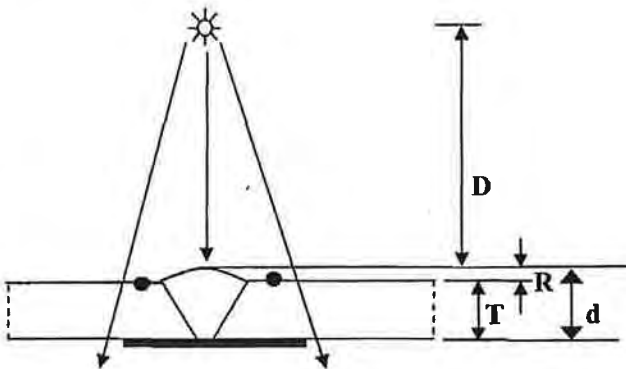
Page - 2
Date :

Reference ASME Sec V Article 2 Fig. T-275.1 (b)(2)



Flat components or Longitudinal Seam
 $X = (t / D) X (Mf / 2)$
 X = Additional Required Coverage beyond film side location marker
 t = Component Thickness
 Mf = Film side location marker interval
 D = Source to component distance

Placement of Film Side Location Marker for Longitudinal seam



T = Thickness of Base Material
 R = Reinforcement
 t = Component Thickness / Thickness of Weld
 D = Source to Top of Weld Distance
 d = Distance from source side of Object to Film / Distance from Top of Weld to Film (d=t+R).

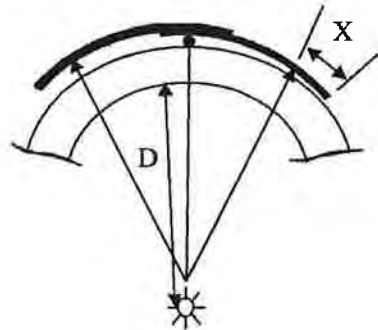
Exposure Set - up

LEGEND : Radiation Source - ☼ IQI Wire type -
 Location Marker - • Lead Letter 'B' - ■ For Back Scatter Check.
 Film - ———

PREPARED BY	RT CARRIED OUT BY	APPROVED BY
RT Level I / Level II Name, Sign. & Date	RT Level I / Level II Name, Sign. & Date	RT Level II Name, Sign. & Date

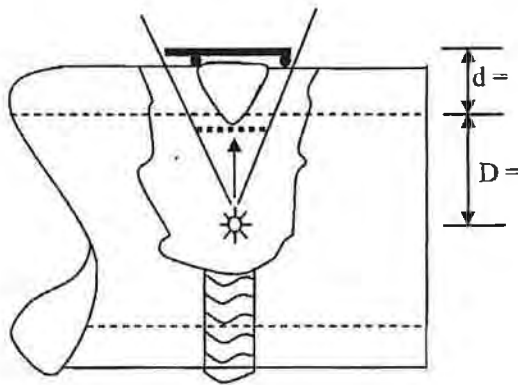


NDE - RT



X = Overlapping = 12 To 25 mm

Placement of Film Side Location Marker for Circumferential Seam



D = Source to Object distance
= Inside Radius
d = Object to Film Distance (thickness)
Exposure Technique : Single Wall
Wall Viewing Single : Single Wall

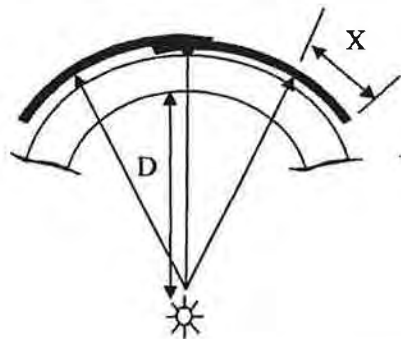
Exposure Set-up

LEGEND : Radiation Source - ☀ IQI Wire type -
Location Marker - • 'B' - ■ for Back Scatter Check.
Film - ———

PREPARED BY	RT CARRIED OUT BY	APPROVED BY
RT Level I / Level II Name, Sign. & Date	RT Level I / Level II Name, Sign. & Date	RT Level II Name, Sign. & Date

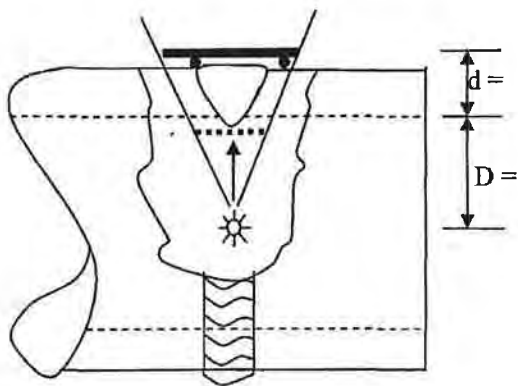


NDE - RT



X = Overlapping = 12 To 25 mm

Placement of Film Side Location Marker for Circumferential Seam



D = Source to Object distance
 = Inside Radius
 d = Object to Film Distance (thickness)
 Exposure Technique : Single Wall
 Wall Viewing Single : Single Wall

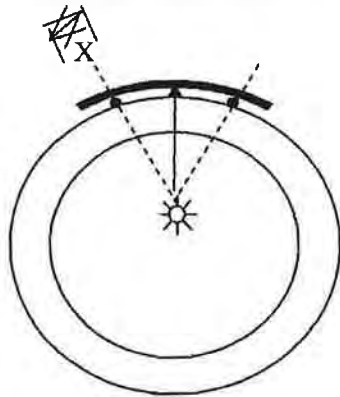
Exposure Set-up

LEGEND : Radiation Source - ☀ IQI Wire type -
 Location Marker - ● 'B' - ■ for Back Scatter Check.
 Film - ———

PREPARED BY	RT CARRIED OUT BY	APPROVED BY
RT Level I / Level II Name, Sign. & Date	RT Level I / Level II Name, Sign. & Date	RT Level II Name, Sign. & Date

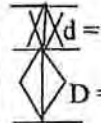
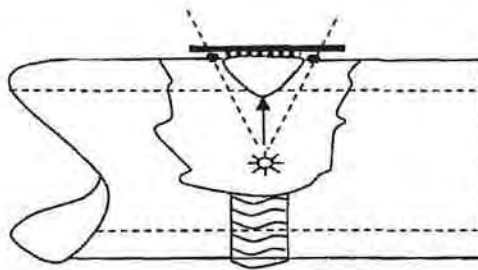


NDE - RT



Spot Radiography for selected spot
X = Overlapping = 12 To 25 mm

Placement of Film Side Location Marker for Circumferential Seam



D = Source to Object distance
= Inside Radius
d = Object to Film Distance (thickness)
Exposure Technique : Single Wall
Wall Viewing Single : Single Wall

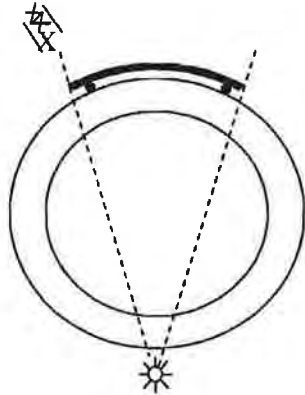
Exposure Set-up (Spot Radiography for selected spot)

LEGEND : Radiation Source - ☼ IQI Wire type -
Location Marker - ● 'B' - ■ for Back Scatter Check.
Film - ———

PREPARED BY	RT CARRIED OUT BY	APPROVED BY
RT Level I / Level II Name, Sign. & Date	RT Level I / Level II Name, Sign. & Date	RT Level II Name, Sign. & Date

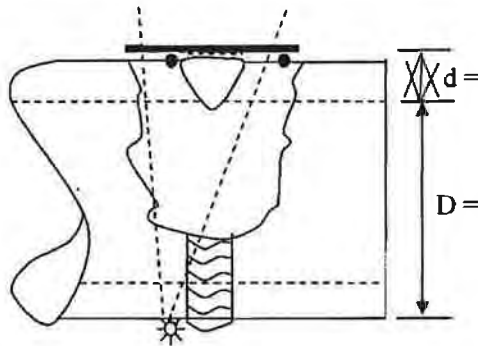


NDE - RT



Minimum three exposure are required for complete Coverage of Circumferential weld.
X = Overlapping = 12 To 25 mm

Placement of Film Side Location Marker for Circumferential Seam



D = D = Source to Object distance
= Inside Radius
d = d = Object to Film Distance (thickness)
Exposure Technique : Single Wall
Wall Viewing Single : Single Wall

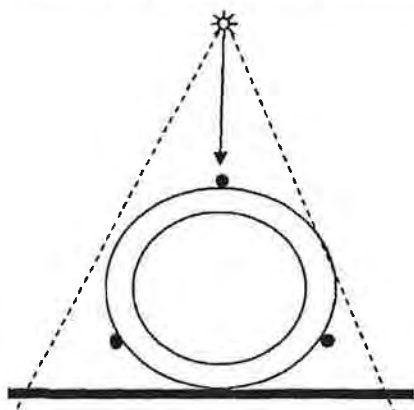
Exposure Set-up

LEGEND : Radiation Source - ☀ IQI Wire type -
Location Marker - • 'B' - ■ for Back Scatter Check.
Film - —

PREPARED BY	RT CARRIED OUT BY	APPROVED BY
RT Level I / Level II Name, Sign. & Date	RT Level I / Level II Name, Sign. & Date	RT Level II Name, Sign. & Date

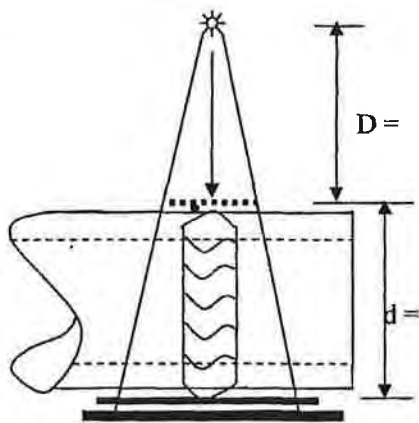


NDE - RT



For each location maker the source and film Position shall be kept as shown in fig.

Location marker on source side at 120° to each other for complete coverage



D = Source to Object distance
= Inside Radius
d = Object to Film Distance (thickness)
Exposure Technique : Single Wall
Wall Viewing Single : Single Wall

Exposure Set-up

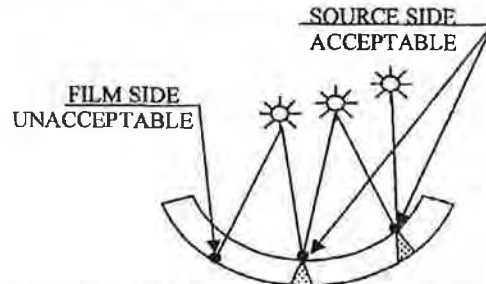
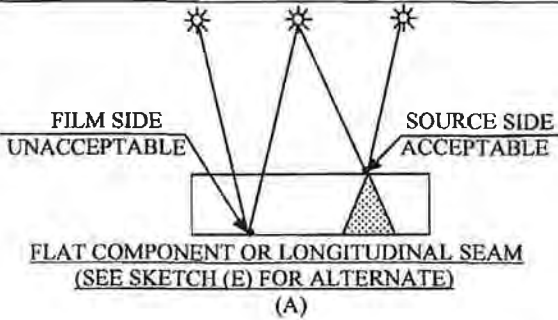
LEGEND : Radiation Source - ☼ IQI Wire type -
Location Marker - • 'B' - for Back Scatter Check.
Film - —

PREPARED BY	RT CARRIED OUT BY	APPROVED BY
RT Level I / Level II Name, Sign. & Date	RT Level I / Level II Name, Sign. & Date	RT Level II Name, Sign. & Date

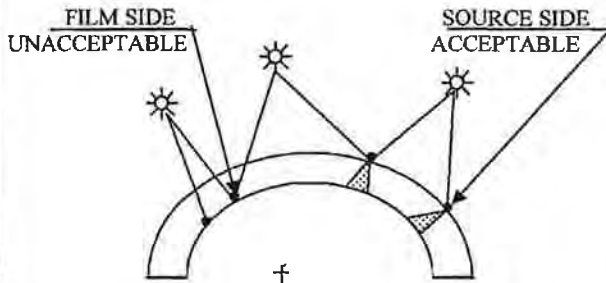


NDE - RT

Procedure No. : PAT/AT/RT/01 (Rev.)
Date : Page



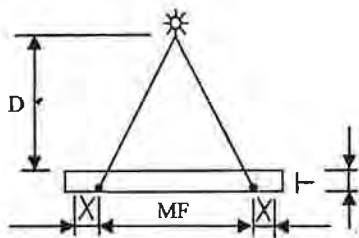
CURVED COMPONENTS WITH RADIATION SOURCE TO FILM DISTANCE LESS THAN RADIUS OF COMPONENT'S



CURVED COMPONENTS WITH CONVEX SURFACE TOWARDS RADIATION SOURCE



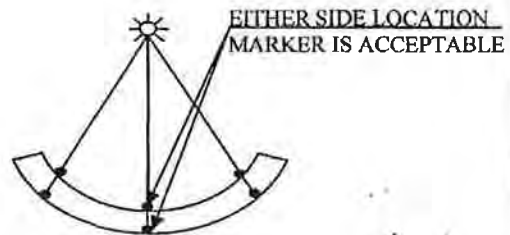
CURVED COMPONENTS WITH RADIATION SOURCE TO FILM DISTANCE GREATER THAN RADIUS OF CURVATURE.



SOURCE SIDE MARKER ALTERNATE
FLAT COMPONENT OR LONGITUDINAL SEAM

$X = (T/D) (MF/2)$
X=ADDITIONAL REQUIRED COVERAGE
BEYOND FILM SIDE LOCATION MARKER
T= COMPONENT THICKNESS
MF = FILM SIDE LOCATION MARKER INTERVAL
D = SOURCE TO COMPONENT DISTANCE

(E)



CURVED COMPONENTS WITH RADIATION SOURCE AT CENTRE CURVATURE

(F)

LEGEND

Radiation Source - ☼

Location Marker - •

Component Centre - +



NDE – RT

Radiograph Review Form / RT Report

Ref. Technique Sheet No. & Date

Report No.: Date : Shop Code : OE / TMPE / PPE

O.A. No. : RT Procedure No.: PAT/AT/RT/01 (Rev.) Dt.

Sr. No. P.O.No.: Extent of RT : Full / Spot

Client : Inspection Agency : Stage : Before / After - Hydro Test

Acceptance Standard : ASME Section VIII, Div. 1 Heat Treatment Condition :

Table with columns: Weld Joint No., Segment, Density Obtained (IQI, Min., Max), IQI Sensitivity Achieved (Wire Identity), Evaluation Shot I (Obs., Result), Evaluation Shot II (Obs., Result), Evaluation Shot III (Obs., Result)

Evaluation Guide

Table mapping Linear Indications (L1-L4) and Rounded Indications (P1-P4) to evaluation terms: Acc - Acceptable, NSD - No Significant Defect, R - Repair, U/C - Under cut, RS - Re-shot, DRS - Dress & Reshoot

Table for recording results: Columns for Shot No., RT Level-II Remarks (R/RS/DRS, Name, Sign & Date), and AI / TPI / Customer Remark (R/RS/DRS, Name, Sign & Date) for Shot I, II, and III.



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments		
101-E-110;101-E-111;101-E-112;101-E-113;101-E-114;101-E-115;101-E-120;101-E-121;101-E-210;101-E-225;101-E-226;101-E-240;101-E-241;101-E-450;101-E-451;102-E-610;102-E-613;102-E-655;103-E-080;103-E-190;103-E-290;103-E-390;103-E-490;103-E-590;103-E-705;103-E-707;104-E-135;104-E-136;107-E-305	JPI REV 1 - COORDIANTION		
Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1	
<p><input checked="" type="checkbox"/> 1 - Work May Proceed</p> <p><input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated</p> <p><input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture</p> <p><input type="checkbox"/> 4 - STOP WORK per attached written instructions</p> <p><input type="checkbox"/> 5 - Review Not Required: Work may proceed</p> <p><small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small></p>	Supplier	Exchanger Industries	
	Doc. Description	EXCHANGER - NDE HARDNESS TEST PROCEDURES	
	Vendor Document No.	EI NDE HARDNESS TESTING PROCEDURE	
	Client Document No.	VP088996-M609-00001	
	Purchase Order No.	Doc Cat.	Issue
CE416040-CC088996-00	M609	1	
BY : <u>SYED SHAH</u>	Categories		
DATE : <u>JULY 17, 2013</u>	Date Received	07/08/2013	



**EXCHANGER
INDUSTRIES
LIMITED**

5505 52nd Street SE, Calgary, Alberta T2C 2W8
Telephone (403) 236-0166 Fax (403) 279-8242 Website: www.exchangerindustries.com

NON-DESTRUCTIVE EXAMINATION PROCEDURES MANUAL

DOCUMENT COPY NUMBER: C-001

DATE ISSUED: September 23, 2011

ASSIGNED TO: Quality Control Manager

COMPANY: Exchanger Industries Limited



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**NDE PROCEDURES MANUAL
REVISION 1.0.0
DOCUMENT COPY NUMBER: C-001
DATE OF REVISION – September 23, 2011**

Future revisions will be marked “Rev. X.X.X ” to indicate a revision has been performed.



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Document Approval

Function	Name	Certification	Signature	Date
Prepared by	James Stuckless	CGSB UT II, MT II, PT II Reg. # 12036		September 23, 2011
Reviewed by	Scot Beavan	ASNT III 186344		September 23, 2011
Document owner (Approved by)	Peter Martens QC Manager	P Eng		September 23, 2011

Revision Records

Revision #	Date	Changes Since Last Revision	Author(s)	Reviewer(s)
1.0.0	September 23, 2011	Original Document	James Stuckless	Scott Beavan



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Distribution List

Document Copy Number	Name	Title / Position	Revision #	Date Assigned
C-001	Peter Martens	QC Manager	1.0.0	September 23, 2011



5505 52nd Street SE, Calgary, Alberta T2C 2W8
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September 16, 2011

Exchanger Industries Limited
5505-52nd Street SE
Calgary, Alberta T2C-2W8

Attention: Peter Martens, QA Manager

DEMONSTRATION OF VISIBLE LIGHT INTENSITY

This is a demonstration of visible light intensity as per ASME Section V, Article 6, T676.3 and Article 7, T777.1 check for light sources with a minimum light intensity requirement of 100fc (1000 Lux) at examination sites when performing examinations in accordance with Exchanger Industries Limited NDE procedures:

1. MT-1, MT-1 Magnetic Particle Examination – Dry Powder,
2. MT-1, MT-1 Magnetic Particle Examination – Dry Powder with contrast background,
3. MT-1, MT-2 Magnetic Particle Examination – Wet Visible,
4. PT-1, PT-1A Liquid Penetrant Examination – Wet Visible - Water Washable, and
5. PT-1, PT-2A Liquid Penetrant Examination – Wet Visible - Solvent Removable.

Light Source	Distance (inches)	Measured Intensity (foot candles)
Halogen Work lamp – 100 Watt	24"	113 foot candles
Flashlight – 2 AA batteries	8"	102 foot candles
Flashlight – 2 D batteries -- LED bulb	24"	123 foot candles

Minimum requirements are: 100 Foot Candles at surface to be examined.

The above light sources have been demonstrated to meet minimum ASME requirements.

Exchanger Industries Limited

James Stuckless
Non-Destructive Examination Technician

Date: September 16, 2011

Demonstrations Witnessed by:

Blair Ionel
(ABSA Representative)

Date: September 16, 2011



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Telephone (403) 236-0166 Fax (403) 279-8242 Website: www.exchangerindustries.com

September 16, 2011

Exchanger Industries Limited
5505-52nd Street SE
Calgary, Alberta T2C-2W8

Attention: Peter Martens, QA Manager

DEMONSTRATION OF NON-DESTRUCTIVE EXAMINATION PROCEDURES

The following procedures were demonstrated in accordance with ASME Section V, 2010 Edition:

1. Article 1 General Requirements, Section T-150,
2. Article 6 Liquid Penetrant Examination, Section T-621,
3. Article 7 Magnetic Particle Examination, Section T-721.

EXCHANGER INDUSTRIES LIMITED demonstrated the following Non-Destructive Examination Procedures on September 16, 2011.

Procedure #	Rev.	Description	Method	Specimen	Report #	Comments
MT-1, MT-1	1.0.0	Dry powder – Bright Red	Mag. Part. A/C	UT-2245	MT-11-0012	Circle Systems #63
MT-1, MT-2	1.0.0	Wet visible – (black particles)	Mag. Part. A/C	UT-2245	MT-11-0013	Magnaflux Family
MT-1, MT-3	1.0.0	Wet Fluorescent	Mag. Part. A/C	UT-2245	MT-11-0014	Magnaflux Family
MT-1, MT-1	1.0.0	Dry powder – Bright Red w/ Contrast background	Mag. Part. A/C	UT-2245	MT-11-0015	Circle Systems #63
PT-1, PT-1A	1.0.0	Visible Water Washable	Liquid Penetrant	UT-2242	PT-11-0001	Magnaflux Family
PT-1, PT-2A	1.0.0	Visible Solvent Removable	Liquid Penetrant	UT-2242	PT-11-0003	Magnaflux Family
PT-1, PT-2B	1.0.0	Fluorescent Solvent Removable	Liquid Penetrant	UT-2242	PT-11-0004	Magnaflux Family

Exchanger Industries Limited

James Stuckless
Non-Destructive Examination Technician
CGSB UT 2, MT 2, PT 2
CGSB # 12036

Date: September 16, 2011

Responsible NDE Level III



Scot Beavan
ASNT level 3
ASNT # 186344

Date: September 16, 2011

Demonstrations Witnessed by:



Blair Ionel
(ABSA Representative)

Date: September 16, 2011



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September 21, 2011

Exchanger Industries Limited
5505-52nd Street SE
Calgary, Alberta T2C-2W8

Attention: Peter Martens, QA Manager

DEMONSTRATION OF NON-DESTRUCTIVE EXAMINATION PROCEDURES

The following procedures were demonstrated in accordance with ASME Section V, 2010 Edition:

1. Article 1 General Requirements, Section T-150,
2. Article 4 Ultrasonic Examination of Welds, Section T-421,
3. Article 5 Ultrasonic Examination of Materials, Section T-522, and

EXCHANGER INDUSTRIES LIMITED demonstrated the following Non-Destructive Examination Procedures on September 21, 2011.

Procedure	Rev.	Description	Method	Specimen	Report #(s)	Comments
UT-1	1.0.0	Shearwave flaw detection, Longitudinal flaw detection, and Thickness measurement.	Ultrasonic	UT-2241	UTSW-11-0001, UT-11-0001, and UT-11-0002.	Sonotech UTX

Exchanger Industries Limited

James Stuckless
Non-Destructive Examination Technician
CGSB UT 2, MT 2, PT 2 CGSB # 12036

Date: September 21, 2011

Responsible NDE Level III

Scot Beavan
ASNT level 3 ASNT # 186344

Date: September 21, 2011

Demonstrations Witnessed by:

Blair Ionel
(ABSA Representative)

Date: September 21, 2011



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Telephone (403) 236-0166 Fax (403) 279-8242 Website: www.exchangerindustries.com

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1.0 SCOPE

- 1.1 It is the intention of this Manual to describe in detail the procedures and techniques employed by Exchanger Industries Limited by which NDT personnel are trained, examined and certified in methods of non-destructive examination. In this program, we have adhered to the guidelines recommended by the American Society for Non-destructive Testing SNT-TC-1A-2006. This written practice has been prepared to demonstrate Exchanger Industries Limited can meet the requirements, (to the latest acceptable edition and addenda) of Sections I, V, and VIII, Divisions 1 & 2 of the ASME Boiler and Pressure Vessel code and ASME B31.1 & B31.3 Piping codes, for the qualification of non-destructive examination personnel and written procedures.
- 1.2 This manual has been prepared in accordance with the recommendations of SNT-TC-1A-2006 of the American Society of Non-destructive Testing. This manual also meets the requirements of the ASME Boiler and Pressure Vessel Code, Section V, Article 1 in respect of Paragraph T-150: "Procedures" for non-destructive examinations and Paragraph T-170: "Examinations and Inspections".
- 1.3 Where inspections are made on vessels controlled by the ASME Boiler and Pressure Vessel code, it is to be understood that the term inspection used in this manual is synonymous with the term examination as defined in Section V, Paragraph T170 (b) of the ASME Pressure Vessel code. The use of the term inspection in this manual does not describe duties of the Authorized Code Inspector, but rather describes practices that would be performed by the manufacturer's examination personnel.

2.0 DEFINITIONS

- 2.1 ASNT - American Society for Non-destructive Testing Recommended Practice SNT-TC-1A-2006 edition
- 2.2 ASME Code Section I – Power Boilers
- 2.3 ASME Code Section V – Non-destructive Examination
- 2.4 ASME Code Section VIII – Pressure Vessels
- 2.5 ASME Code B31.1 – Power Piping
- 2.6 ASME Code B31.3 - Pressure Piping
- 2.7 Qualification - demonstrated skill, training, experience, and knowledge required for personnel to properly perform the duties of specific job.
- 2.8 CGSB – Canadian General Standards Board
- 2.9 Certification - written testimony of qualification meeting a standard.



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- 2.10 Certifying Agency – Nationally recognized regulatory body responsible for issuing individual certifications.
- 2.11 Closed book examination – Administered without reference material except that which is supplied with, or in, the examination.
- 2.12 Training - A program developed to impart the knowledge and skills necessary for qualification.
- 2.13 Other definitions may be obtained from SNT-TC-1A-2006.

3.0 NON-DESTRUCTIVE EXAMINATION METHODS

3.1 ULTRASONIC EXAMINATION - Procedure UT-1

3.1.1 Scope

The following procedure is designed for those persons performing NDE by ultrasonic examination. It should be understood that an NDE program is limited in its effectiveness by nature of the persons performing NDE, the equipment utilized and the capabilities of the procedure used. This procedure is to be used when no other specific code or standard has been referenced and where no specific examination criteria have been established.

This procedure is to be used for ultrasonic examination, using a hand scan method, for the determination of cracking, voids and non-metallic discontinuities, and other linear and non-linear discontinuities in welds and other materials. This procedure will also be used to determine the thickness of a given material.

This procedure is not designed for use with automated, computerized and/or digital imaging or acquisition systems.

3.1.2 Safety Requirements

All Exchanger Industries Limited personnel will adhere to company safe work policies at all times while performing NDE. Additionally all employees will adhere to all client safe work policies while performing NDE at client work sites.

3.1.3 Qualifications for Persons Performing NDE

Ultrasonic examinations may be performed by persons certified to a minimum of level 1 or Level 2 ASNT and/or Level 1 or Level 2 CAN/CGSB-48.9712. Where a level 1 certified person performs an



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Hardness Testing Procedure HT-01

1.0 Scope

When specified by the client, the hardness testing technique described in this document shall be used. This document is in conformance with ASTM, ASME, NACE, standard guides for hardness testing.

This document establishes requirements for hardness testing. This document shall be used to compare the hardness values of materials.

2.0 STANDARDS AND SPECIFICATIONS

2.1 This procedure is in conjunction with the following codes:

- a) ASTM
- b) ASME
- c) NACE

3.0 QUALIFICATIONS OF PERSONNEL

3.1 All hardness testing personal shall be properly trained to and qualified to operate hardness testing equipment.

3.2 Training may be completed in house and followed by an exam. A passing mark of 80% shall be obtained.

4.0 SAFETY

4.1 All personnel must follow all safety policies outlined in company Health and Environmental Manual.

4.2 All personnel utilizing this procedure must have WHMIS training.

4.3 Disposal or cleanup of waste examination materials shall conform to Federal, Provincial, and Municipal Environmental Regulations and Company policy.

4.4 Follow all manufacturer instructions and precautionary statements.

5.0 DEFINITIONS & TERMINOLOGY

1. Creep; A time-dependent deformation of a material while under an applied load that is below its yield strength.
2. Ductility; a measure of how much something deforms plastically before fracture.



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3. Etching; subjecting the surface of a metal to preferential chemical or electrolytic attack in order to reveal structural details.
4. Fracture toughness; an indication of the amount of stress required to propagate a preexisting flaw
5. Hardness testing; testing the property of a material that enables it to resist plastic deformation, usually by penetration.
6. Notch effect; the distribution of multiaxial stress state is produced due to the presence of a notch.
7. Notch toughness; the ability that a material possesses to absorb energy in the presence of a flaw.
8. Toughness; The ability of a metal to deform plastically and to absorb energy in the process before fracture.

6.0. Equipment

Calibrated hardness testing unit.
Calibration blocks.
Grinder with proper grinding and sanding discs.
Face shield.
Safety glasses.
Hearing protection.
Dust mask/respirator.
Etchants (If required by client)

7.0 Set Up.

Connect the probe to the probe cable. The red marking points on the probe socket and cable connector must be on top of each other.

Note: Never twist the connector.

Connect the probe cable to the MIC 10 socket.

Place the probe grip onto the probe.

Plug the cable into the top of the mic 10.

Leave the cable connected to the probe during storage. Connecting and disconnecting probe loosens connections and increases chances of dislodging pins.

7.1 Set Up.

Connect the probe cable to the Proceq Equotip Base Unit. The red marking points on the probe socket and cable connector must be on top of each other.

Note: Never twist the connector.

Connect the probe cable 3-Pole to the Coil with Holder.

Place the Impact Body into the Coil with Holder.

Leave the cable 3-Pole connected to the Coil with Holder during storage.

Connecting and disconnecting the cable 3-Pole loosens connections and increases chances of dislodging pins.



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8.0 Surface Preparation

The examination surface for hardness testing shall be ground to allow access to the heat affected zones.

Grinding shall be accomplished using a grinder and sanding disc to achieve a surface that is smooth and even to allow proper contact of the probe to work. All scale must be removed.

Weld caps may need to be ground flush to allow accurate readings of the heat affected zones in the parent material.

Grind shall be done as to not change the hardness values by overheating the examination surface.

Examination surface shall be clean and free from oils, grease, dust and rust. Etchant may be used as specified by customer.

9.0 Calibrations

9.1 Equipment shall be calibrated to ASTM one per year.

9.2 Pre inspection calibrations shall be carried out on the same material of known hardness to be tested.

Note: It is critical to calibrate to the same material under test.

9.3 Calibration shall be conducted prior to a series of tests, periodically during testing and at the conclusion of testing. If at any point the calibration has changed, retesting of all points shall be done up to the last point of calibration.

9.4 Position the probe perpendicular to the calibration test block surface. Using steady even pressure, press the probe into the material for about 1 second. (Until the acoustical alarm sounds). The measurement will be displayed. Repeat for 5 measurements on the calibration block. Adjust calibration to match the known hardness of the calibration block.

9.5 Position the probe perpendicular to the calibration test block surface. Press the probe carefully and evenly against the examination surface, then press the Release Button. Repeat for 5 measurements on the calibration block. Adjust calibration to match the known hardness on the calibration block.

10.0 Testing

Position the probe perpendicular to the testing surface.

Using steady even pressure, press the probe into the material for about 1 second (Until the acoustical alarm sounds).

The measurement will be displayed.

At a minimum, an average of 3 readings per location shall be recorded.



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When testing a weld, five points shall be taken traversing across the weld should be conducted, consisting of base material, Heat affected zone, weld, Heat affected zone and base material, unless otherwise stated by client.

Record the average for each location.

Note: the distance between two neighboring indents in relation to the mean length of the indent diagonal, must be at least 3 times the amount of the largest indent. (In steel)

10.1 Testing

Position the probe perpendicular to the testing surface.

Press the probe carefully and evenly against the examination surface, the probe is now charged.

At a minimum, an average of 3 readings per location shall be recorded.

When testing a weld, five points shall be taken traversing across the weld should be conducted, consisting of base material, Heat affected zone, weld, Heat affected zone and base material, unless otherwise stated by client.

Record the average for each location.

Note: the distance between two neighboring indents in relation to the mean length of the indent diagonal, must be at least 3 times the amount of the largest indent. (In steel)

11.0 Probe Handling

Ensure the conical probe attachment is screwed on for short time measurements.

Press the probe carefully and evenly against examination surfaces.

Avoid banging and shifting of probe against examination surface or dropping probe.

Always use both hands to guide probe and avoid damaging diamond tip.

Using two both hands will give the best possible control of the probe.

Press the probe vertically with one hand from the top.

Guide the probe with the other hand to the required measurement position.

11.1 Probe Handling

Avoid banging and shifting of probe against examination surface or dropping probe.

Press the probe carefully and evenly against the examination surface, the probe is now charged.

Press Release Button .

12.0 Conversion of Hardness Values

Hardness values cannot be generally converted due to the penetration behaviors of different materials.



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Note: conversion of values either into other hardness units or tensile strength may be inaccurate or inadmissible, depending on material, material preparation and surface preparation.

13.0 Reporting

The results of all hardness testing results shall be recorded. These records shall provide for traceability to the specific part or lot inspected. As a minimum, those records shall include:

- a) Client / Job or contract number.
- b) Date and time examinations were carried out.
- c) Current Procedure / technique number (revision#).
- d) Material.
- e) Equipment type make and serial numbers, probe load and calibration date
- f) Identification of parts, components, assemblies and welds examined.
- g) Record required hardness values.
- h) Areas of restricted access or inaccessible welds.
- i) Examination personnel identity and certification level.
- j) Applicable code and/or specifications.



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13. Written Instruction

Microdur 10 Technique	Procedure HT-01 rev. 0 Technique 1
Technique Description	Mic. 10
Material	Ferrous, nonferrous, welds, forgings, casting, plate, bar. But not limited to.
Temperature Range (operating)	Between (-15°C to 55°C)
Thickness Range	1 millimeter to unlimited
Weld Types	Any
Examination Surface(s)	Determined by client (where accessible)
Special Equipment	Special equipment may be used, documentation may be required.
Equipment Required: Instrument	Microdur 10 or equivalent.
Probes	UCI Probe (Ultrasonic Contact Impedance) 10
Reference Blocks	Representative of material under examination.
Surface preparation	Grinding shall be accomplished using a grinder and sanding disc to achieve a surface that is smooth and even to allow proper contact of the probe to work. All scale must be removed. Weld caps may need to be ground flush to allow accurate readings of the heat affected zones in the parent material. Grind shall be done as to not change the hardness values by overheating the examination surface. Examination surface shall be clean and free from oils, grease, dust and rust. Etchant may be used as specified by customer.



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Calibration	<p>Using a calibration block representative of the material being tested.</p> <p>And using proper probe handling techniques. Position the probe vertically to the calibration block.</p> <p>Using steady even pressure, press the probe into the calibration test piece for about 1 second. (Until acoustical alarm sounds). The measurement will be displayed.</p> <p>Take an average of 5 reading.</p> <p>Calibrate by adjusting the calibration readings. Verify the reading to the test piece.</p> <p>Repeat until the calibration readings match the calibration block.</p>
Examination	<p>Position the probe vertically to the testing surface.</p> <p>And using proper probe handling techniques Using steady even pressure, press the probe into the material for about 1 second. (Until acoustical alarm sounds).</p> <p>The measurement will be displayed.</p> <p>At a minimum, an average of 3 readings per spot shall be recorded.</p> <p>Repeat at each location traversing the weld. (Or areas as in the case of plate, forgings, castings Etc.)</p>
Recording	<p>Data to be recorded on Report Form(s)</p> <p>Complete with all test equipment used, results of examination, relevant information, and all data as required by procedure HT-01 paragraph 13.</p>



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14. Written Instruction

Proceq Equotip	Procedure HT-01 rev. 0 Technique 2
Technique Description	Equotip
Material	Ferrous, nonferrous, welds, forgings, casting, plate, bar. But not limited to.
Temperature Range (operating)	Between (0°C to 50°C)
Thickness Range	3 millimeter to unlimited
Weld Types	Any
Examination Surface(s)	Determined by client (where accessible)
Special Equipment	Special equipment may be used, documentation may be required.
Equipment Required: Instrument	Proceq Equotip
Probes	Leeb Rebound DL
Reference Blocks	Representative of material under examination.
Surface preparation	Grinding shall be accomplished using a grinder and sanding disc to achieve a surface that is smooth and even to allow proper contact of the probe to work. All scale must be removed. Weld caps may need to be ground flush to allow accurate readings of the heat affected zones in the parent material. Grind shall be done as to not change the hardness values by overheating the examination surface. Examination surface shall be clean and free from oils, grease, dust and rust. Etchant may be used as specified by customer.



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Calibration	<p>Using a calibration block representative of the material being tested.</p> <p>And using proper probe handling techniques. Position the probe vertically to the calibration block.</p> <p>Using steady even pressure, press the probe into the calibration test piece for about 1 second. (Until acoustical alarm sounds). The measurement will be displayed.</p> <p>Take an average of 5 reading.</p> <p>Calibrate by adjusting the calibration readings. Verify the reading to the test piece.</p> <p>Repeat until the calibration readings match the calibration block.</p>
Examination	<p>Position the probe vertically to the testing surface.</p> <p>And using proper probe handling techniques Using steady even pressure, press the probe into the material for about 1 second. (Until acoustical alarm sounds).</p> <p>The measurement will be displayed.</p> <p>At a minimum, an average of 3 readings per spot shall be recorded.</p> <p>Repeat at each location traversing the weld. (Or areas as in the case of plate, forgings, castings Etc.)</p>
Recording	<p>Data to be recorded on Report Form(s) Complete with all test equipment used, results of examination, relevant information, and all data as required by procedure HT-01 paragraph 13.</p>



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments			
101-E-110;101-E-111;101-E-112;101-E-113;101-E-114;101-E-115;101-E-120;101-E-121;101-E-210;101-E-225;101-E-226;101-E-240;101-E-241;101-E-450;101-E-451;102-E-610;102-E-613;102-E-655;103-E-080;103-E-190;103-E-290;103-E-390;103-E-490;103-E-590;103-E-705;103-E-707;104-E-135;104-E-136;107-E-305	JPI REV 1 - COORDINATION			
Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1		
<input checked="" type="checkbox"/> 1 - Work May Proceed <input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated <input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture <input type="checkbox"/> 4 - STOP WORK per attached written instructions <input type="checkbox"/> 5 - Review Not Required: Work may proceed <small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small>	Supplier	Exchanger Industries		
	Doc. Description	EXCHANGER - VISUAL EXAMINATION PROCEDURE		
	Vendor Document No.	QC-PR-009-VISUAL EXAM		
	Client Document No.	VP088996-M606-00012		
	Purchase Order No.	Doc Cat.	Issue	
	CE416040-CC088996-00	M606	3	
BY : <u>SYED SHAH</u>	Categories			
DATE : <u>JULY 17, 2013</u>	Date Received	07/08/2013		



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VISUAL EXAMINATION PROCEDURE

SCOPE

This procedure outlines the necessary visual examination required to ensure that the surface of welded joints, used in the construction of pressurized equipment, meet the requirements of the ASME Boiler and Pressure Vessel Code.

PURPOSE

- To provide the examiner clear direction to follow in the performance of Visual Examinations.
- To ensure that fabrication meets tolerances outlined in the governing construction Code.
- To ensure that fabrication meets tolerances outlined in customer specifications.

RESPONSIBILITY

Visual examinations shall be carried out during and after welding fabrication of pressure components.

PROCEDURE

Direct visual examination may be made when access is sufficient to place the eye within 24 inches of the surface to be examined and at an angle of not less than 30 degrees. Mirrors may be used to improve the angle of vision, and aids such as a magnifying lens may be used to assist examinations.

Illumination (natural or supplemental white light) for the specific part, component, vessel, or section thereof being examined is required. The minimum light intensity at the examination surface shall be 100 foot-candles (1000 lux). Remote examination aids may be employed if access to welds is limited. These aids shall include: mirrors, cameras, and borescopes with a resolution capability at least equivalent to that obtainable by direct visual examination. (Minimum display resolution: 160 x 234)

This procedure shall apply to all configurations and base material product forms, i.e.:

- Configurations including all circumferential seams, longitudinal seams, and attachment welds. Welded in the approved butt, corner, tee, edge, or lap joint configurations; either as groove or fillet welds.
- Product forms including pipe, plate, forgings, etc.

Instruments or tools such as wire brushes, or buffing wheels may be used to prepare the surface to be examined. Special care shall be taken to prevent contamination of corrosion resistant materials with carbon, or low-alloy, steel tools.

Personnel shall have an annual vision test to assure natural or corrected near distance acuity such that they are capable of reading standard J-1 letters on standard Jaeger test type charts for near vision. Equivalent near vision tests are acceptable.

EXAMINATION PROCEDURE

Visual examination shall be evaluated based on criteria in accordance with the most stringent governing code, material standard or applicable Buyer's engineering and project documents.

The surface to be inspected shall be free of weld spatter, slag, etc.

Adequate lighting is required, as described in the Procedural Requirements above.

The inspector shall have the following tools and instruments available for direct visual examination:

- Flashlight, which produces at least the minimum light intensity referenced above.
- Measuring tape.

Revision Number	Revision Date (mmddyy)	Author	Reason for Revision	Approved by	Date Approved	Approval Initial
3	07/11/2012		Company Name Change	Bhavin Patel	13/Jul/2012	<i>Bhavin Patel</i>



- c. Bridge-Cam Gauge.
- d. Fillet Size Gauges.
- e. Micrometer/Vernier Gauge(s).
- f. Level/Square.

All welds and material shall be inspected on the outside and inside (where accessible).

The following indications are unacceptable:

- a. Cracks.
- b. Pin holes.
- c. Undercut on the surface.
- d. Lack of fusion on the surface.
- e. Incomplete penetration (applies only when the inside surface is readily accessible).
- f. Surface porosity of any size.
- g. Arc strikes.
- h. Overlaps.
- i. Surface slag/scale.

As per ASME Section VIII, UW-35(a) - Butt welded joints shall be inspected to confirm they have full penetration and fusion. As-welded surfaces are permitted; however the surface of welds shall be free from coarse ripples, grooves, overlaps, and abrupt ridges and valleys.

As per ASME Section VIII, UW-35(b) - A reduction in thickness due to the welding process is acceptable provided all of the following conditions are met:

- a. The reduction in thickness shall not reduce the material of the adjoining surfaces below the minimum required thickness at any point.
- b. The reduction in thickness shall not exceed 1/32 in. (1 mm) or 10% of the nominal thickness of the adjoining surface, whichever is less.

As per ASME Section VIII, UW-35(d) - The thickness of the weld reinforcement on each face (of the weld) shall not exceed the following:

<i>Customary Units</i>		
Material Nominal Thickness, in.	Maximum Reinforcement	
	Category B & C Butt Welds	Other Welds
Less than 3/32	3/32	1/32
3/32 to 3/16, incl.	1/8	1/16
Over 3/16 to 1/2, incl.	5/32	3/32
Over 1/2 to 1, incl.	3/16	3/32
Over 1 to 2, incl.	1/4	1/8
Over 2 to 3, incl.	1/4	5/32
Over 3 to 4, incl.	1/4	7/32
Over 4 to 5, incl.	1/4	1/4
Over 5	5/16	5/16
<i>SI Units</i>		
Material Nominal Thickness, in.	Maximum Reinforcement	
	Category B & C Butt Welds	Other Welds
Less than 2.4	2.4	0.8
2.4 to 4.8, incl.	3.2	1.6
Over 4.8 to 13, incl.	4.0	2.4
Over 13 to 25, incl.	4.8	2.4
Over 25 to 51, incl.	5	3.2
Over 51 to 76, incl.	6	4
Over 76 to 102, incl.	6	6
Over 102 to 127, incl.	6	6
Over 127	8	8



Concavity due to the welding process on the root side of a single welded circumferential butt weld is permitted when the resulting thickness of the weld is at least equal to the thickness of the thinner member of the two sections being joined and the contour of the concavity is smooth.

Alignment shall be inspected to ensure it is within the tolerances listed in ASME Section VIII, Table UW-33, as shown below:

Table UW-33

<i>Customary Units</i>		
Section Thickness, In.	<i>Joint Categories</i>	
	A	B, C, & D
Up to 1/2, incl.	1/4t	1/4t
Over 1/2 to 3/4, incl.	1/8 in.	1/4t
Over 3/4 to 1 1/2, incl.	1/8 in.	3/16 in.
Over 1 1/2 to 2, incl.	1/8 in.	1/8t
Over 2	Lesser of 1/16t or 3/8 in.	Lesser of 1/8t or 3/4 in.
<i>SI Units</i>		
Section Thickness, mm	<i>Joint Categories</i>	
	A	B, C, & D
Up to 13, incl.	1/4t	1/4t
Over 13 to 19, incl.	3.2 mm	1/4t
Over 19 to 38, incl.	3.2mm	4.8mm
Over 38 to 51, incl.	3.2mm	1/8t
Over 51	Lesser of 1/16t or 10 mm	Lesser of 1/8t or 19mm

Fillet weld sizes shall be inspected to verify they meet the minimum sizes specified on the construction drawing.

Upon completion of the above inspections, the area on the Inspection and Test Plan (ITP) for final internal and/or external shall be signed and dated.

If applicable, a Visual Examination Report (Figure 1) shall be completed, signed, and dated within 24 hours of the inspection being completed.



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Visual Examination Report

Procedure No.: _____ Rev.: _____

Technique: Direct: _____ Remote: _____

If Remote, equipment used: _____

Examination By (Name): _____

Qualification Level: _____
(If Required)

E.I. Job No.: _____

Component(s) Inspected: _____

REMARKS

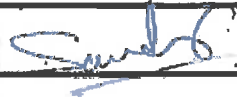
Signed: _____ Date: _____

Revision Number	Revision Date (mm/dd/yy)	Author	Reason for Revision	Approved by	Date Approved	Approval Initial
1	07/11/2012		Company Name Change	D. Korclanski	07/11/2012	


Figure 1: Visual Examination Report

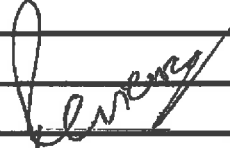

PATELS AIRTEMP (INDIA) LTD.

Tube Rolling Log Sheet

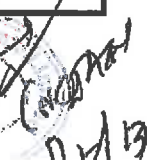
PAT Job Number: PEX-71413, EXE-1352 **Reading By:** SANDIP PATEL 
EI JOB No 13-3353 A
Customer Item Number: 104-E-135 **Recorded By:** KAUSHIK THAKAR

Sign Off and Acceptance

PAT Quality Controller:  **Client:** _____
Date: 12-13 **Date:** _____

Tube #	A	B	C	D	WR = (D-C+B-A) / (B - A)	Comment
	Tube I.D.	Average Tube O.D.	Tube Hole I.D.	Actual Final I.D.	% Wall Reduction	
1	14.83	19.05	19.25	15.3	6.4%	
2	14.84	19.05	19.25	15.32	6.7%	
3	14.83	19.05	19.25	15.3	6.4%	
4	14.85	19.05	19.25	15.35	7.1%	
5	14.83	19.05	19.25	15.34	7.3%	
6	14.84	19.05	19.25	15.36	7.6%	
7	14.83	19.05	19.25	15.35	7.6%	
8	14.85	19.05	19.25	15.34	6.9%	
9	14.83	19.05	19.25	15.34	7.3%	
10	14.84	19.05	19.25	15.33	6.9%	
11	14.83	19.05	19.25	15.32	6.9%	
12	14.83	19.05	19.25	15.31	6.6%	
13	14.83	19.05	19.25	15.3	6.4%	
14	14.83	19.05	19.25	15.34	7.3%	
15	14.85	19.05	19.25	15.32	6.4%	
16	14.83	19.05	19.25	15.35	7.6%	
17	14.84	19.05	19.25	15.32	6.7%	
18	14.83	19.05	19.25	15.3	6.4%	
19	14.84	19.05	19.25	15.32	6.7%	
20	14.83	19.05	19.25	15.32	6.9%	

Witnessed
 Reviewed
A. FONSO



21	14.83	19.05	19.25	15.35	7.6%	
22	14.85	19.05	19.25	15.33	6.7%	
23	14.83	19.05	19.25	15.31	6.6%	
24	14.83	19.05	19.25	15.32	6.9%	
25	14.83	19.05	19.25	15.33	7.1%	

[Handwritten signature]



PATELS AIRTEMP (INDIA) LTD.

Tube Rolling Log Sheet

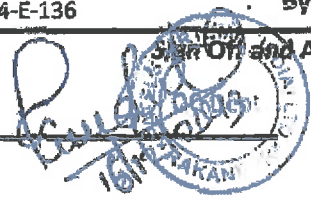
PAT Job Number: PEX-71413, EXE-1353 Reading By: SANDIP PATEL

Sandip Patel
16/12/2013

EI JOB No 13-3353 B

Customer Item Number: 104-E-136 Recorded By: KAUSHIK THAKAR

PAT Quality Controller:



Client:

Date:

Date:

Tube #	A	B	C	D	WR = (D-C+B-A) / (B - A)	Comment
	Tube I.D.	Average Tube O.D.	Tube Hole I.D.	Actual Final I.D.	% Wall Reduction	
1	14.85	19.05	19.25	15.32	6.4%	
2	14.84	19.05	19.25	15.32	6.7%	
3	14.83	19.05	19.25	15.32	6.9%	
4	14.85	19.05	19.25	15.35	7.1%	
5	14.85	19.05	19.25	15.32	6.4%	
6	14.84	19.05	19.25	15.36	7.6%	
7	14.83	19.05	19.25	15.35	7.6%	
8	14.85	19.05	19.25	15.34	6.9%	
9	14.83	19.05	19.25	15.34	7.3%	
10	14.84	19.05	19.25	15.33	6.9%	
11	14.84	19.05	19.25	15.34	7.1%	
12	14.83	19.05	19.25	15.31	6.6%	
13	14.83	19.05	19.25	15.3	6.4%	
14	14.83	19.05	19.25	15.34	7.3%	
15	14.84	19.05	19.25	15.34	7.1%	
16	14.83	19.05	19.25	15.35	7.6%	
17	14.84	19.05	19.25	15.32	6.7%	
18	14.83	19.05	19.25	15.3	6.4%	
19	14.84	19.05	19.25	15.32	6.7%	
20	14.83	19.05	19.25	15.32	6.9%	

Witnessed
 Reviewed

A FONSO

DEC 16 2013

21	14.83	19.05	19.25	15.35	7.6%	
22	14.85	19.05	19.25	15.33	6.7%	
23	14.83	19.05	19.25	15.31	6.6%	
24	14.83	19.05	19.25	15.32	6.9%	
25	14.83	19.05	19.25	15.33	7.1%	



Lawrence

[Signature]



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments		
101-E-110;101-E-111;101-E-112;101-E-113;101-E-114;101-E-115;101-E-120;101-E-121;101-E-210;101-E-225;101-E-226;101-E-240;101-E-241;101-E-450;101-E-451;102-E-610;102-E-613;102-E-655;103-E-080;103-E-190;103-E-290;103-E-390;103-E-490;103-E-590;103-E-705;103-E-707;104-E-135;104-E-136;107-E-305	JPI REV 1 - COORDINATION		
Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1	
<input checked="" type="checkbox"/> 1 - Work May Proceed <input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated <input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture <input type="checkbox"/> 4 - STOP WORK per attached written instructions <input type="checkbox"/> 5 - Review Not Required: Work may proceed <small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small>	Supplier	Exchanger Industries	
	Doc. Description	EXCHANGER - TUBE EXPANSION PROCEDURE	
	Vendor Document No.	TUBE EXPANSION PROCEDURE	
	Client Document No.	VP088996-M608-00001	
	Purchase Order No.	Doc Cat.	Issue
CE416040-CC088996-00	M608	0	
BY : <u>SYED SHAH</u>	Categories		
DATE : <u>JULY 17/2013</u>	Date Received	07/08/2013	



Exchanger Industries

E.I Fabrication: Rev 0 June 3, 2005

TUBE EXPANSION PROCEDURE

Page 1 of 1

- 1) Tubesheets, baffles and tubes (if required) shall be steam cleaned etc. prior to installation of tubes.
- 2) Visually examine the tubes and tubesheets for dirt, etc. prior to installation of tubes.
- 3) MIC. 5 tube holes per tubesheet.
- 4) MIC. 5 tubes on the O.D. to determine average.
- 5) Subtract (4) from (3) to get average tube hole clearance.
- 6) MIC. 5 tubes on the I.D. to determine average.
- 7) Subtract (6) from (4) to get average tube wall thickness.
- 8) Calculate metal reduction required – average tube wall thickness multiplied by 4%. (This is the minimum expansion required.)
- 9) Sum the tube hole clearance, the tube I.D. and the metal reduction required to obtain the average I.D. after rolling dimension.
- 10) To achieve the required I.D. use an Air Tool Model ATR 1550-900 machine with torque control or equivalent machine and start with a light roll then increase the expansion until the required I.D. is reached. Lube-A-Tube LAT 4000 is normally used as a lubricant with a small quantity being placed inside each tube where expanding will take place. The expander is cooled by using water.
- 11) Re-check one or two more tube holes and tubes to confirm the setting.
- 12) Roll the balance of the tubes by starting to roll on the bottom row of tubes. Roll complete row before moving to the next row of tubes.
- 13) The rolling shall be done as shown on fabrication drawing but shall not be closer than 3mm (1/8") of the shell side surface. To achieve this, a recessed thrust collar shall be placed on the rolling tool at the required position.
- 14) During the hydrostatic test, if there are leaks between the tube and tubesheets, the tube joints in question shall be marked and then re-expanded by increasing the tube I.D. approximately 1% or more if required to stop the leak.



VP088996-1608-00001



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments		
101-E-110;101-E-111;101-E-112;101-E-113;101-E-114;101-E-115;101-E-120;101-E-121;101-E-210;101-E-225;101-E-226;101-E-240;101-E-241;101-E-450;101-E-451;102-E-610;102-E-613;102-E-655;103-E-080;103-E-190;103-E-290;103-E-390;103-E-490;103-E-590;103-E-705;103-E-707;104-E-136;107-E-305	JPI REV 1 - COORDINATION		
Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1	
<div style="font-size: small;"> <p>hmm</p> <p><input checked="" type="checkbox"/> 1 - Work May Proceed</p> <p><input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated</p> <p><input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture</p> <p><input type="checkbox"/> 4 - STOP WORK per attached written instructions</p> <p><input type="checkbox"/> 5 - Review Not Required: Work may proceed</p> <p>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</p> </div>	Supplier	Exchanger Industries	
	Doc. Description	EXCHANGER - LONG TERM PRESERVATION AND STORAGE GUIDELINES – 13-3343 THROUGH 13-3355	
	Vendor Document No.	13-3343 TO 13-3355 CS LONG TERM PRESERVATION AND STORAGE GUIDELINES	
	Client Document No.	VP088996-M615-00001	
	Purchase Order No.	Doc Cat.	Issue
CE416040-CC088996-00	M615	2	
BY : <u>SYED SHAH</u>	Categories	M627	
DATE : <u>DEC 17, 2013</u>	Date Received	11/28/2013	



<p align="center">Exchanger Industries Limited 5505 - 52 Street SE, Calgary, Alberta, T2C 2W8</p>	<p align="center">Document Description or Title:</p> <p align="center">Long Term Preservation and Storage Guidelines</p>
<p>Customer: Jacobs Engineering Canada Project: CNRL - Kirby North Phase-1</p>	<p align="center">Rev: 2 Date: Nov. 28, 2013</p>
<p>Project No. CE4160</p>	<p align="center">EI Doc. No:</p>
<p>Item No:</p> <ul style="list-style-type: none"> 101-E-110 to 115 101-E-120 + 121 101-E-210 101-E-225 + 226 101-E-240 + 241 102-E-610 + 613 102-E-655 103-080 103-E-190 to 590 103-E-705 + 707 104-E-135 + 136 107-E-305 101-E-450 + 451 <p>Equipment Title:</p> <ul style="list-style-type: none"> Degassed Emulsion / BFW Helixchanger Degassed Emulsion / Glycol Helixchanger Fresh Diluent / Diluent Vapor Exchanger Glycol / Produced gas Condensate Exchanger Glycol / Produced gas Exchanger Glycol / Evaporator Blowdown Exchanger Glycol / Excess Produced Water Exchanger Glycol / BFW Exchanger BFW / Blowdown Exchanger Glycol / Blowdown Exchanger Sales Oil / Glycol Exchanger TEG / Natural Gas Exchanger Cool Glycol / VRU Inlet Exchanger 	<p align="center">EI Job: 13-3343 to 55</p> <p align="center">SDRL Doc. Code:</p>
<p>P.O. No: CE416040-CC088996</p>	<p align="center">SDRL Doc. Code:</p>
<p align="center">Notes Specific For This Job</p>	
<p align="right">Submission No.: 1</p> <p>1 Refer to drawings 13-3343 to 55</p>	



Exchanger Industries

A Division of Premetalco Inc.

ISSUED BY:	REVISION/DATE	LONG TERM PRESERVATION and STORAGE GUIDELINES
N.ZOUDINA	Rev 2	

These guidelines provide requirements for air cooler and shell & tube exchangers when there is an extended period (more than one month) of time lag between arrival at site and commissioning.

This document was written such that full conformance will validate the extended warrantee. At the time of writing, several assumptions have been made such as location of storage, facility, availability, etc. Persons using these guidelines are expected to exercise independent judgment in circumstances different from the presumption. Deviations require Exchanger Industries' prior acknowledgement and authorization.

1.0 Receiving Inspection

- 1.1 All goods shall be inspected in arrival at receiving warehouse / yard.
- 1.2 Inspection shall be directed to quantity check against shipping list (attached with shipment).
- 1.3 Inspect for damage during shipping shall be noted and reported immediately to Customer's Traffic Personnel and Exchanger Industries' shipping department.

2.0 Preservation Requirements

- 2.1 All damaged painted or coated surfaces shall be cleaned-up and touched up immediately with compatible or similar coating material to avoid further deterioration.
- 2.2 All unpainted surface (including but not limited to, drive shafts, sheaves, fan bearings) shall be sprayed with rust preventative FILM GUARD 3600 as recommended by CEDA (any other type of relevant rust preventative to meet or exceed specification of FILM GUARD 3600 is acceptable) See Appendix A.
- 2.3 Air cooler tube bundles and shell & tube exchangers (both sides) shall be purged and charged with nitrogen with positive pressure up to 5 psig. At least one connection shall be fitted with valve and pressure gauge. All nozzles will require blind flanges, full sets of bolts and neoprene gaskets. A period monitoring of all pressurized units is required to ensure no leakage throughout the entire storage period.

3.0 Storage Requirements

- 3.1 All structural members, fans, sheaves and belts may be stored outdoor.
- 3.2 Tube bundles, air cooler, and shell & tube exchangers may be stored outdoor with proper nitrogen pressurization and monitoring.
- 3.3 Motors storage if installed on the structure could be stored outdoor with proper preparation as per EI's Long Term Preservation Guideline for Installed Motor. (See Appendix B) If motor is supplied loose it shall be stored in door with requirements as outlined in manufacturer's literature.
- 3.4 Installed instruments including vibration switches and RTDs (if applicable) can be stored outdoor with proper plastic wrapping.
- 3.5 Actuators are normally shipped loose and shall be stored in doors.

CEDA FILM GUARD 3600

CEDA FILM GUARD 3600 is a highly polar organic-inorganic complex, which forms adherent coating with ferrous and non-ferrous.

Uses

CEDA FILM GUARD 3600 can be used to coat internal and external surfaces of equipment and pipe. It is ideal for use on materials, which are going into short-term storage or being transported in harsh environments.

Features and Advantages

Ease of Application:

Dries quickly to a waxy film.

Inhibits Corrosion:

Provides freedom from oxidation in indoor and outdoor storage for extended periods of time.

Excludes Water:

CEDA FILM GUARD 3600 has the quality of excluding water from the metal surface, improving application and preventing corrosion. This makes CEDA FILM GUARD 3600 very useful in marine environments.

Neutralizes Acids:

Prevents corrosion in the harshest of industrial environments.

Self Healing:

CEDA FILM GUARD 3600 coating provides a self-healing surface, which covers over scratches and small ruptures.

Methods of Application

CEDA FILM GUARD 3600 can be applied as a spray, by brush or in a dip tank to give the recommended film thickness. When the part is required to return to service CEDA FILM GUARD 3600 can be removed by wiping off with an organic solvent or power-wash using soap and/or a solvent emulsion.

Packing and Storage

CEDA Film Guard 3600 is available in 20L pails, 208L drums or in bulk.

The shelf life of CEDA FILM GUARD 3600 is 18 months.

FILM GUARD PROPERTIES**CC3600**

AVERAGE INDOOR STORAGE LIFE	1 year
AVERAGE OUTDOOR STORAGE	8 months
AVERAGE COVERAGE/GAL AT 0.2 mil	350 ft ² *
DIPPED WAXY FILM THICKNESS (mils)	0.5
SPECIFIC GRAVITY	0.83
VISCOSITY (@ 100°F SVS)	-
POUR POINT	-
FLASH POINT	55° C

*Coverage at 0.5 mils film thickness

MATERIAL SAFETY DATA SHEET**CC 3600****MATERIAL IDENTIFICATION AND USE**

MANUFACTURER'S NAME..... CEDA-REACTOR LTD.
 MANUFACTURER'S ADDRESS..... 2130 - 121 AVENUE N.E.
 EDMONTON, ALBERTA
 P. O. BOX 3009 (mailing address)
 SHERWOOD PARK, ALBERTA
 T8A 2A6

EMERGENCY PHONE NUMBER..... (780) 472-6766

SUPPLIER IDENTIFIER..... CEDA-REACTOR LTD.
 SUPPLIER'S ADDRESS..... 2130 - 121 AVENUE N.E.
 EDMONTON, ALBERTA
 P. O. BOX 3009 (mailing address)
 SHERWOOD PARK, ALBERTA
 T8A 2A6

SUPPLIER EMERGENCY PHONE NUMBER..... (780) 472-6766

PRODUCT IDENTIFIER..... CC 3600

PRODUCT USE..... Coating against Atmospheric Corrosion

HAZARDOUS INGREDIENTS OF MATERIALS

Chemical Identity	Concentration	CAS # / NA # / UN #	LD (50)	LC (50)
MIXTURE OF PETROLEUM HYDROCARBONS	60 - 100	64742-47-8	NO DATA	NO DATA
DIPROPYLENE GLYCOL METHYL ETHER	0.5 - 1.5	34590-84-8	RAT, ORAL: 5.4 ml/kg	No adverse effects
CALCIUM SALT OF A FATTY ACID	15 - 40	NOT ASSIGNED	NO DATA	NO DATA

PHYSICAL DATA FOR PRODUCT

PHYSICAL STATE..... LIQUID
 ODOUR AND APPEARANCE..... Yellow to brown coloured emulsion; hydrocarbon odour

ODOUR THRESHOLD..... NO DATA
 SPECIFIC GRAVITY..... 0.912
 VAPOUR PRESSURE..... NO DATA
 VAPOUR DENSITY (air = 1)..... NO DATA

July 21, 2000

Page 1

E:\PUBLIC\REFM\SDS\CC3600.DOC

MATERIAL SAFETY DATA SHEET

CC 3600

EVAPORATION RATE..... NO DATA
BOILING POINT..... NO DATA
FREEZING POINT - 25 to - 30°C
PH..... NOT APPLICABLE
DENSITY (g/ml)..... 0.912
COEFFICIENT OF WATER/OIL DISTRIBUTION NO DATA

FIRE AND EXPLOSION HAZARD OF PRODUCT

CONDITIONS OF FLAMMABILITY Can be ignited under almost all normal temperature conditions.
MEANS OF EXTINCTION..... To extinguish fire use carbon dioxide, dry chemical or foam. Water is not generally suitable but can be used to reduce the rate of burning. Wear self-contained breathing apparatus and complete personal protective equipment.
FLASH POINT & METHOD OF DETERMINATION .. 51° to 56°C (TCC)
UPPER EXPLOSION LIMIT (% BY VOL) NO DATA
LOWER EXPLOSION LIMIT (% BY VOL)..... NO DATA
AUTO-IGNITION TEMPERATURE NO DATA
FLAMMABILITY CLASSIFICATION..... Flammable liquid.
HAZARDOUS COMBUSTION PRODUCTS Carbon monoxide, carbon dioxide.
EXPLOSION DATA..... NO DATA
SENSITIVITY TO STATIC DISCHARGE NO DATA

REACTIVITY DATA

CHEMICAL STABILITY..... Normally stable to heat, light, air, acids and bases.
INCOMPATIBLE MATERIALS Strong oxidizing agents.
CONDITIONS OF REACTIVITY..... No data.
HAZARDOUS DECOMPOSITION PRODUCTS Stable and none are expected.

TOXICOLOGICAL PROPERTIES OF PRODUCT

ROUTES OF ENTRY:
SKIN CONTACT..... Burning sensation on skin; drying and cracking.
SKIN ABSORPTION..... Not expected.
EYE Vapour can irritate eyes. Liquid can cause severe irritation, reddening, swelling, and corneal burns. Effects are normally reversible.
INHALATION Irritation of nose and throat, headache, nausea, vomiting, dizziness, fatigue, light headedness, irritable behaviour, loss of appetite, reduced co-ordination and unconsciousness.

MATERIAL SAFETY DATA SHEET

CC 3600

INGESTION.....	Burning sensation in the stomach; damage to the lining of the stomach and intestines. Severe lung damage if aspirated into the lungs.
ACUTE OVER EXPOSURE EFFECTS.....	SEE ROUTES OF ENTRY.
CHRONIC OVER EXPOSURE EFFECTS	Major health problems from long-term exposure are not expected.
SKIN:	Irritation and dermatitis from prolonged or repeated contact.
EXPOSURE LIMITS.....	NO DATA
IRRITANCY OF PRODUCT	NO DATA
SENSITIZATION TO MATERIAL	NO DATA
CARCINOGENICITY, REPRODUCTIVE EFFECTS	No data available, but unlikely to be carcinogenic. May be toxic to embryo or fetus, and may reduce fertility.
TERATOGENICITY, MUTAGENICITY.....	Not mutagenic; not teratogenic.
TOXICOLOGICALLY SYNERGISTIC PRODUCTS ..	NO DATA

PREVENTIVE MEASURES

PERSONAL PROTECTIVE EQUIPMENT.....	Chemical cartridge respirator with organic vapour cartridge for up to 1,000 ppm. For emergency or planned entry into unknown concentrations use a self-contained breathing apparatus.
EYE/FACE PROTECTION	Chemical goggles or a face mask.
SKIN PROTECTION.....	Gloves, coveralls and boots, etc., as needed to prevent skin exposure.
SPECIFIC ENGINEERING CONTROLS.....	General ventilation is normally adequate for small-scale use at room temperature or below. Local exhaust ventilation is normally needed with large-scale use or at elevated temperatures.
LEAK AND SPILL PROCEDURES	Provide adequate ventilation, protective clothing and respirators. Remove sources of heat and flame. Absorb liquid on dry clay, sand, sawdust or other absorbent material.
WASTE DISPOSAL.....	Combustible wastes may be burned in an approved incineration facility. Consult local environmental authorities before disposal.
HANDLING PROCEDURES AND EQUIPMENT.....	Use minimal quantities in designated areas with adequate ventilation. Containers should be covered when not in use.
STORAGE REQUIREMENTS.....	Store in tightly closed containers in a cool area separate from work areas.

MATERIAL SAFETY DATA SHEET

CC 3600

SPECIAL SHIPPING INFORMATION.....

TRANSPORTATION OF DANGEROUS GOODS CLASSIFICATION:

FLAMMABLE LIQUIDS N.O.S. (petroleum distillates) UN1993, 3.0, III

WHMIS CLASSIFICATION:

CLASS B, DIVISION 3: COMBUSTIBLE LIQUIDS

CLASS D, DIVISION 2, SUBDIVISION B: TOXIC MATERIAL

FIRST AID MEASURES

SPECIFIC FIRST AID PROCEDURES

INHALATION:.....

Remove from contaminated area or remove source of contamination. If breathing has stopped, begin artificial respiration immediately. Obtain medical attention immediately.

EYE CONTACT:.....

Immediately flush the contaminated eye(s) with warm water for at least 15 minutes. Obtain medical attention if irritation persists.

SKIN CONTACT:.....

Flush contaminated area with warm water for at least 15 minutes. Under running water, remove contaminated clothing, shoes and leather goods. If irritation persists, obtain medical attention.

INGESTION:.....

DO NOT INDUCE VOMITING. Never give anything by mouth if victim is unconscious or convulsing. Rinse mouth thoroughly with water. If victim can swallow, have him drink 300 ml of water to dilute the material. Obtain medical attention immediately.

FIRST AID COMMENTS:

Provide general supportive measures (comfort, warmth, rest). Consult a doctor for all exposures except minor instances of inhalation or skin contact.

MATERIAL SAFETY DATA SHEET

CC 3600

PREPARATION DATE OF MATERIAL SAFETY DATA SHEET

PREPARED BY..... CEDA-REACTOR LTD., EDMONTON
TELEPHONE NUMBER OF PREPARER..... (780) 472-6766
DATE PREPARED..... January 1999

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Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments		
104-E-135;104-E-136	JPI REV 1 - COORDINATION		
Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1	
<i>Rev</i> <input checked="" type="checkbox"/> 1 - Work May Proceed <input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated <input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture <input type="checkbox"/> 4 - STOP WORK per attached written instructions <input type="checkbox"/> 5 - Review Not Required: Work may proceed <small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small>	Supplier	Exchanger Industries	
	Doc. Description	EXCHANGER - MECHANICAL DESIGN CALCULATIONS SUPPLEMENTAL 13-3353	
	Vendor Document No.	13-3353 MDC SUPPLEMENTAL	
	Client Document No.	VP088996-M500-00026	
	Purchase Order No.	Doc Cat.	Issue
CE416040-CC088996-00	M500	0	
BY : <u>SYED SHAH</u>	Categories	S077	
DATE : <u>May 26, 2013</u>	Date Received	05/01/2013	

EXCHANGER INDUSTRIES

Page 1
Sheet Count 16

SUPPLEMENTAL MECHANICAL DESIGN CALCULATION

V1.0

Date April 5, 2013

Customer Jacobs Canada Inc.

Owner Canadian Natural Resources Limited

Location Kirby North Phase 1 Project

Customer Reference CE416040-CC088996-00

E.I. Job No. 13-3353

Item 104-E-135/136

Prepared by HW

Checked by KW

Description 15-240 BEU; Sales Oil Tank Heater

Notes Process design pressures;

Shell Side = 507.6 psi (3500 kPa); Tube Side = 507.6 psi (3500 kPa)

Calculation Set	Description and	Page Number
Revision Number	Initial Issue----	All Pages
0		

Date
5-Apr-13

Approved
KW




VPO88996-M506-00026.

v1.0

EXCHANGER INDUSTRIES

Customer Jacobs Canada Inc.
Job 13-3353
Item 104-E-135/136

Date April 5, 2013
Dsgn HW
Chkd 

Supplemental Calculations

Table of Contents

Document	# Pages		Rev	Date
1	1	Cover Sheet	0	5-Apr-13
2	1	Table of Contents	0	5-Apr-13
3	1	Wind & Seismic Loads on Saddle	0	4-Apr-13
4	2	Zick Analysis	0	4-Apr-13
5	1	Anchor Bolts Calculations	0	4-Apr-13
6	1	Lifting Lug Calculations	0	5-Apr-13
7	1	Lifting Ear Calculations	0	5-Apr-13
8	4	Nozzle (S1/S2) External Loads Calculations	0	4-Apr-13
9	4	Nozzle (T1/T2) External Loads Calculations	0	4-Apr-13

Horizontal Vessel Wind & Earthquake
per National Building Code of Canada 2005 - Division B Part 4

88-V1.01

For Jacobs Canada Inc. c/o CNRL
Job 13-3363
Item 104-E-135/136

Date April 4, 2013
Design HW
Chkd 
File 0
Rev 0

Weight Full of Water(1shell) 7,165 lb
Distance between Saddles 13.12 ft
Front saddle to C of G 4.72 ft
Number of stacked Shells 1

Increment Factor 1.1
Diameter 1.75 ft (each shell)
Vessel Length 22.83 ft
Vessel Elevation 1.34 ft (centroid of assembly)
At Grade 0 ft above Grade
Saddle Width 1.312 ft

Wind Load q 0.40 kPa
Exposure Ce 0.90
Gust Cg 2.00
Lateral ext pressure Cp 1.20
Vertical ext pressure Cp 1.20
Importance Iw 1

Reaction due to Transverse Wind Force	1215	lbs
Reaction due to Longitudinal Wind Force	5	lbs

Seismic Load Factors for
Cold Lake AB Sa(0.2) 0.120
Per NBC 2005 Sa(0.5) 0.056
Appendix C Table C-2 Sa(1.0) 0.023
Sa(2.0) 0.006
PGA 0.059

Site class D - Stiff Soil
Moderately Ductile Braced Steel Frame
Concentrically braced in tension
Rd = 3.5 Ro = 1.5

Mode Factor Mw = 1
Importance Ie = 1

Acceleration Coefficient Fa = 1.3
Velocity Coefficient Fv = 1.4
Period Ta 0.07 sec
Design Spectral Acceleration S(Ta) 0.156

Saddle reaction at base	22	lbs	due to Longitudinal Seismic Force
Saddle reaction at base	326	lbs	due to Transverse Seismic Force

TOTAL LOADS ON EACH SADDLE

Maximum Transverse Force = 397 lbs
Maximum Longitudinal Load = 22 lbs
Maximum Wind or Seismic Force = 397 lbs
Total Load due to Wind & Seismic = 2430 lbs

FRONT SADDLE

	Vertical (Qv)	Transverse (QT)*	Longitudinal (QL)*
WEIGHT	4587		
WIND		1215	5
SEISMIC		326	22
TOTAL	4587	1215	22

*maximum of Wind & Seismic is considered

Load due to Vertical and Transverse Reactions (Q1=Qv+QT) 5802 lbs

Load due to Vertical and Longitudinal Reactions (Q2=Qv+QL) 4609 lbs

Loads Applied (maximum of Q1 and Q2) 5802 lbs

REAR SADDLE

	Vertical (Qv)	Transverse (QT)*	Longitudinal (QL)*
WEIGHT	2578		
WIND		1215	5
SEISMIC		326	22
TOTAL	2578	1215	22

*maximum of Wind & Seismic is considered

Load due to Vertical and Transverse Reactions (Q1=Qv+QT) 3793 lbs

Load due to Vertical and Longitudinal Reactions (Q2=Qv+QL) 2599 lbs

Loads Applied (maximum of Q1 and Q2) 3793 lbs

For Jacobs Canada Inc. c/o Canadian Natural Resources Limited

Date Apr 04, 2013

Job 13-3353
Item 104-E-135/136

Dsgn HW
Chkd KS
Rev 0

Heat Exchanger Mechanical Design Shell&TubeMech V8.0 (ASME 2012)

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Horizontal Vessels on Saddles

Saddle material: SA-516 K02700 Grd 70 Plate
Wear plate mtl: SA-516 K02700 Grd 70 Plate

Shell mean radius	R = 7.8385 in	Total force Q = W + WS = 9595 lbf
Weight used	W = 7165 lbf	From wind WS = 2430 lbf
Shell length	L = 239.4375 in	Angle alpha Alpha = 1.6913 rad
Angle beta	Beta = 102 deg	Angle delta Delta = 1.658 rad
Vessel thickness	TS = 0.551 in	Wear plate tks. w = 0.3937 in
Vessel corr.allowance	CA = 0.126 in	Vessel thk TS+w-CA tsw = 0.8187 in
Saddle depth	b = 4.0 in	Effective depth b1 = 6.8474 in
Wear plate width	bw = 6.0 in	Angle theta Theta = 156 deg
Pressure	P = 520 psi	Inside diameter ID = 15.252 in
Joint efficiency	JE = 1	Head joint eff. JEH = 1
Front head thickness	TH = 0.551 in	Rear head thickness TH = 0.551 in
Head diameter	D = 15.252 in	Head corr.allowance CAH = 0.126 in

b1 = b+1.56*(R*(TS-CA))**0.5)

	Saddle A	Saddle B	
Loads on saddles	Q = 5802	3793	lbf
Distance from ref. point	A = 40.094	41.906	in
Head length	H = 0	6.3125	in
Ratio A/R	A/R = 5.115	5.3462	
Bending moment factor	K7 = 0.0283	0.0283	
Shell pressure stress	PS = P*R/(2*tsw) = 4795 psi		
Fr. head press. stress	= P*D+0.2*P*(TH-CAH)/(2*(TH-CAH)) = ---		
Re. head press. stress	= P*D+0.2*P*(TH-CAH)/(2*(TH-CAH)) = ---		
Alpha = Pi-(Pi/180)*(Theta/2+Beta/20)	Delta = (Pi/180)*(5*Theta/12+30)		
S11 = (3*Q*L/(Pi*(TS-CA)*R**2))	S12 = 1-(1-A/L+(R**2-H**2)/(2*A*L))/(1+4*H/3*L)		
S13 = Pi*(Sin(Delta)/Delta-Cos(Delta))	S13/S14=1 if shell is stiffened		
S14 = Delta+Sin(Delta)*Cos(Delta)-2*Sin(Delta)**2/Delta			
Stresses in psi	*** Saddles ***		
Bending stress at saddle + pressure	A	B	Allowable
S1 = S11*(4*A/L)*S12*S13/S14 + PS	7486	7056	20000
Bending stress at midspan + pressure			
S21 = (1+2*(R**2-H**2)/L**2)/(1+4*H/(3*L))			
S2 = S11*(S21-4*A/L) + PS	6202	5533	20000
Tangential shear in shell (unstiffened)			
S41 = Sin(Alpha)/(Pi-Alpha+Sin(Alpha)*Cos(Alpha))			
S42 = L-H-2*A/(L+H)			
S4 = (Q/R*(TS-CA))*S42*S41	864	516	16000

For Jacobs Canada Inc. c/o Canadian Natural Resources Limited
Job 13-3353
Item 104-E-135/136

Date Apr 04, 2013
Dsgn HW
Chkd KJ
Rev 0

Heat Exchanger Mechanical Design Shell&TubeMech V8.0 (ASME 2012)

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Tangential shear in shell (stiffened)

$$S61 = \text{Sin}(\text{Alpha}) * \text{Cos}(\text{Alpha})$$

$$S62 = (\text{Sin}(\text{Alpha})/\text{Pi}) * (\text{Alpha}-S61) / (\text{Pi}-\text{Alpha}+S61)$$

$$S6 = (Q / (R * (\text{TS}-\text{CA}))) * S62$$

Circumferential stress at horn, psi

$$S71 = 3 * Q * K7 / (2 * \text{tsw} ** 2)$$

$$S72 = 4 * \text{tsw} * b1$$

$$S7 = -Q/S72 - S71$$

-627 -410 -25000

Ring compression in shell over saddle, psi

$$S91 = 1 + \text{Cos}(\text{Alpha}) / (\text{Pi}-\text{Alpha} + \text{Sin}(\text{Alpha}) * \text{Cos}(\text{Alpha}))$$

$$S92 = (\text{TS}-\text{CA}) * (B + 1.56 * (R * (\text{TS}-\text{CA})) ** 0.5)$$

$$S9 = (Q/S92) * S91$$

684 447 16789

Tangential shear stresses in head, psi

$$S51 = \text{Sin}(\text{Alpha}) * \text{Cos}(\text{Alpha})$$

$$S52 = (\text{Sin}(\text{Alpha})/\text{Pi}) * (\text{Alpha}-S51) / (\text{Pi}-\text{Alpha}+S51)$$

$$S5 = (Q / (12 * R * (\text{TH}-\text{CAH}))) * S52$$

Head stresses, psi

$$S81 = 3 * Q / (8 * 12 * R * (\text{TH}-\text{CAH}))$$

$$S82 = (\text{Sin}(\text{Alpha})) ** 2$$

$$S83 = \text{Pi}-\text{Alpha} + \text{Sin}(\text{Alpha}) * \text{Cos}(\text{Alpha})$$

$$S8 = S81 * (S82/S83)$$

Head stresses + pressure, psi

$$S8 + \text{PH}$$

**Horizontal Vessel Anchor Bolt Load Calculation
due to Bundle Pulling , Wind , Selsmic, Transportation**

83-V1.06

For **Jacobs Canada Inc. c/o CNRL**
Job **13-3353**
Item **104-E-135/136**

Date **April 4, 2013**
Design **HW**
Chkd **UG**
File **0**
Rev **0**

Shipping weight	5512	lbs	Saddle Span	157.5	in
Operation weight	7165	lbs	Coefficient of Expansion	6.9	$\times 10^{-6}$ in/in / F
Bundle weight	1808	lbs	Slot length in saddle	2.125	in
			Friction Coefficient	0.4	steel to steel
Operation Temperature	302	F	Bundle Pulling Factor	2	X bundle weight

Anchor Bolt Nominal Diameter	0.75	in	<u>Transportation Load factors</u>	
# of anchor bolts per saddle	2		Transverse Coefficient	0.45
Cross Sectional Area	0.302	in ² per bolt	Vertical Coefficient	0.25
Anchor Bolt Material	SA-325		Longitudinal Coefficient	0.6
Bolt material Shear stress	15000	psi (allowable) *		
Bolt material tension stress	40000	psi (allowable) *		

Operating Loads (lbs)

Front Saddle

	Transverse	Longitudinal	Vertical
Wind	1215	5	0
Siesmic	326	22	0
Shell Thermal Expansion	0	1031	0
Total Directional Load	1541	1058	0
Total Anchor bolt shear load (Operational)	1869		0 lbs
Actual Bolt Stress	3095	0	psi

(Shear) (Tension)

Bolts Acceptable

Rear Saddle

	Transverse	Longitudinal *	Vertical
Wind	1215	5	0
Siesmic	326	22	0
Shell Thermal Expansion	0	0	0
Total Directional Load	1541	27	0
Total Anchor bolt shear load (Operational)	1541		0 lbs
Actual Bolt Shear Stress	2552	0	psi

(Shear) (Tension)

Bolts Acceptable

Non Operating Loads (lbs) i.e. Bundle Pulling (if applicable), Transportation Loads

Front Saddle

	Transverse	Longitudinal	Vertical
Bundle Pulling	0	3616	0
Transportation	1588	3307	882
Total Directional Load	1588	3307	882
Total Anchor bolt shear load (highest value)	3669		882 lbs
Actual Bolt Shear Stress	6074	1461	psi

(Shear) (Tension)

Bolts Acceptable

Rear Saddle

	Transverse	Longitudinal *	Vertical
Bundle Pulling	0	0	0
Transportation	892	0	496
Total Directional Load	892	0	496
Total Anchor bolt shear load (Operational)	892		496 lbs
Actual Bolt Shear Stress	1477	821	psi

(Shear) (Tension)

Bolts Acceptable

Rear (Sliding) Saddle Minimum Slot Length Calculation

Thermal Expansion of Shell	0.2521	in
API 660 clearance (per para 7.3.5)	0.3125	in
Anchor Bolt diameter	0.75	in
Minimum slot length	1.567	in

Slot Length Acceptable

* Allowable stress per "Statics and Strength of Materials " Jensen & Chenoweth 2 nd Ed (re printed values from AISC 7th ED)

EXCHANGER INDUSTRIES

V85- V2.03

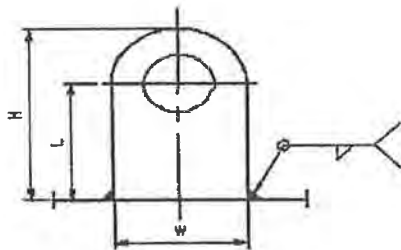
Lift Lug for Channel Covers , Flanges and Floating Heads

For CNRL
 Job Number 13-3353
 Item 104-E-135/136
 Channel Cylinder Lift Lugs

Date April 5, 2013 page 6
 Dsgn HW
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Material	SA-516-70N
Ultimate Tensile Stress Sut	70000 psi
Yield Stress Sy	38000 psi
Sut/5	14000 psi
Sy/2	19000 psi
Allowable Stress Sa	14000 psi
Allowable Shear Stress = Sa/2	7000 psi
Allowable Bending Stress Sb = (1.5*Sa)	21000 psi

Pin dia, d	1.375 in
Pin Hole Dia, D	1.5 in
Lug Height, H	6 in
Lug Width, W	3 in
Lug thickness, t	0.3937 in
Weld Leg outside	0.25 in
Weld Length	6.7874 in
Effective Throat	0.177 in
Distance L	4.5 in



Max yield @ pin hole of lug

Area	0.271 sqin
Allowable Force	10285 lbs

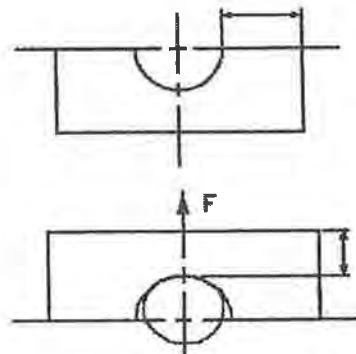
Shear In Weld

Area	1.20 sqin
Allowable Force (Shear stress * Area)	8398 lbs



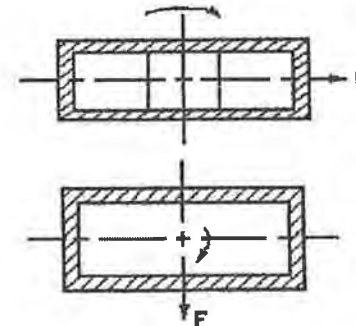
Tension @ Pin Hole of Lug

Area	0.59 sqin
Allowable Force (Allowable Stress * Area)	8268 lbs



Rip Thru @Pin Hole Of Lug

Area	0.30 sqin	0.75 Check Height
Allowable Force (Allowable stress * Area)	4134 lbs	



Bending At the Base Of Lug

(a) Side Load

Moment of Inertia I	0.89 in4
Allowable side Force (Sb/(L*C/I))	2756 lbs

(b) Cross Load

Moment of Inertia I	0.02 in4
Allowable cross force (Sb/(L*C/I))	362 lbs

Max Vertical Lift	2 Ton / Lug
Max Side Load	1 Ton / Lug
Max Cross Load	362 Lbs / Lug

Saddle Ear Lifting Lug Calculation

For **Jacobs Canada Inc.**
 Job **13-3353**
 Item **104-E-135/136**

Date **April 5, 2013**
 Dsgn **HW**
 Chkd **[Signature]**
 File **0**
 Rev **0**

Lift Ear Material **SA-516-70 N**

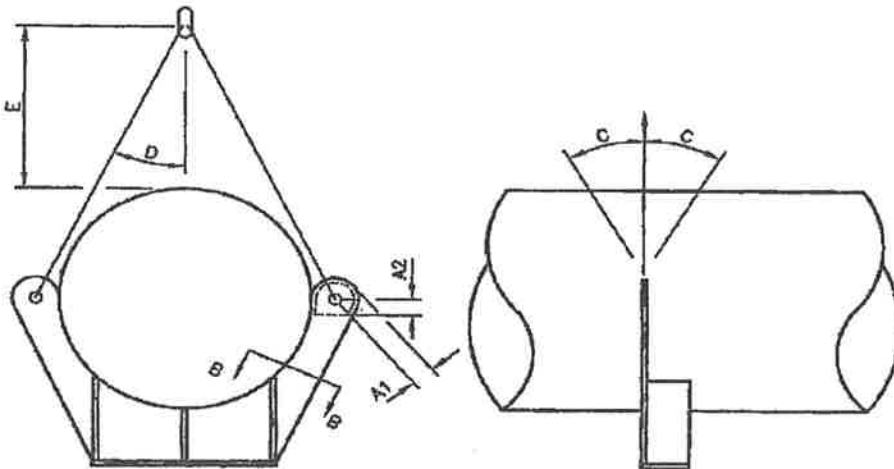
Allowable Stress Cold	20,000	psi	Allowable Based on Code Stress
Yield Stress	38,000	psi	Stresses include 2.0 shock factor
Design Load	3,529	lb	Maximum vertical load per ear.
Shackle Pin Diameter	1 3/8	inch	(4 total) Load based on larger saddle reaction
Pin Hole Diameter	1 1/2	inch	No Repad
Ear Outside Radius	2.25	inch	
Shell OD	16.102	inch	Minimum Web Width below pin 3/4 inch
Distance Between Pin	27.625	inch (C-C)	
Ear Thickness	0.551	inch	
Insulation Thickness	2.5	inch	
Overall Saddle Width	32.125	inch (Outside of ear)	

Local Stress over half the pin diameter at Pin Hole = **10,828 psi (28% of yield)**

Min / max outside radius of ear from center of pin **A1 = 1.88 / 2.97 inch**
 Minimum cross section of web **B = 0.3529 Sq in**

Maximum off vertical for spreader bar (longitudinal view) **C = 6.1 degree (1.28"/ft) (50% yield at pin)**
 Maximum sling half angle (circumferential view) **D = 30.6 degree**
 Minimum distance from sling link to outside of insulation **E = 1.0 ft (to clear by 1/2 pin dia.)**

Minimum shackle and rope strength = **4.8 Ton**



Vertical load = **7058 lb** off vertical = **30.6 degree**
 Longitudinal load = **4181 lb**
 Max. cross load = **759 lb** off vertical = **6.1 degree**
 Total sling load = **8239 lb** **5 Ton**

MINIMUM PIN SEPARATION = **25.6020 in**
 Minimum clearance pin to shell = **2.2188 in**
 Minimum ear thickness = **0.2567 in (local pin stress)**
 Repad or Insulation thickness = **2.5000 in**

For Jacobs Canada Inc. c/o Canadian Natural Resources Limited

Date Apr 04, 2013

Job 13-3353
Item 104-E-135/136

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Rev 0

Heat Exchanger Mechanical Design Shell&TubeMech V8.0 (ASME 2012)

File: 133353(mawp).EDR Printed: 4/4/2013 at 3:32:13 PM

Component: Nozzle S1/S2

Local Stresses in Cylindrical Shell Due to External Loadings at the Shell-to-Attachment Junction

Method: Welding Research Council Bulletin 107 (WRC 107) 1972 (79 Add.)

Design conditions	Geometry
Design pressure Pr = 520 psi	Shell ID = 15.0 in
Design temperature = 302 F	Shell OD = 16.102 in
Material allow. Str. = 20000 psi	Shell thickness = 0.551 in
Code stress multiplier = 3	Joint efficiency E = 1
Shell allowable Str. = 60000 psi	Attachment OD = 5.75 in
Shell corrosion = 0.126 in	Attachment C2 = 0.0 in
	Attachment tks. = 0.875 in
	Pad reinf. tks. Prtk = 0.0 in

Materials of construction

Shell material = SA-516 K02700 Grd 70 Plate

Applied loads Geometric parameters (corroded cond.)

Radial load P = 674 lbf	Vessel mean radius Rm = 7.8385 in
Circ. moment Mc = 10621 lbf*in	Vessel + pad tks. T = 0.425 in
Long. moment Ml = 13719 lbf*in	Attachment radius ro = 2.875 in
Tors. moment Mt = 17259 lbf*in	Gamma = Rm/T = 18.44
Shear load Vc = 843 lbf	Beta = 0.875*ro/Rm = 0.32
Shear load Vl = 843 lbf	Beta1 = C1/Rm = 0
	Beta2 = C2/Rm = 0

Stress concentration Due To:

Membrane load Kn = 1.51	Sign convention:
Bending load Kb = 1.24	+ = tensile stress
Min. fillet radius = 0.43 in	- = compressive stress

For Jacobs Canada Inc. c/o Canadian Natural Resources Limited

Date Apr 04, 2013

Job 13-3353
Item 104-E-135/136

Dsgn HW
Chkd 
Rev 0

Heat Exchanger Mechanical Design Shell&TubeMech V8.0 (ASME 2012)

File: 133353(mawp).EDR

Printed: 4/4/2013 at 3:32:13 PM

Circumferential Stresses			Units: psi						
	Coefficient	Au	Al	Bu	B1	Cu	Cl	Du	D1
Membrane	P	2.4291	-743	-743	-743	-473	-473	-473	-473
		1.5478 *	-743	-743	-743	-473	-473	-473	-473
Bending	P	0.0284	-788	-788	-788	-1477	-1477	-1477	-1477
		0.0532 *	788	788	788	1477	1477	1477	1477
Membrane	Mc	0.7798	0	0	0	-1492	-1492	1492	1492
Bending	Mc	0.0785	0	0	0	-13646	-13646	13646	13646
			0	0	0	13646	13646	-13646	-13646
Membrane	Ml	1.8069	-4466	4466	4466	0	0	0	0
Bending	Ml	0.0225	-5046	5046	5046	0	0	0	0
		0.0235 *	5046	-5046	-5046	0	0	0	0
Stress due to pressure			9642	9642	9642	9642	9642	9642	9642
			9642	9642	9642	9642	9642	9642	9642

* = This coefficient is used for locations Cu, Cl, Du, & D1.

Circumferential Stresses		Units: psi							
		Au	Al	Bu	B1	Cu	Cl	Du	D1
Sub-total									
Membrane stresses		-5209		3724		-1965		1019	
			-5209		3724		-1965		1019
Bending stresses		-5834		4258		-15122		12169	
			5834		-4258		15122		-12169
Stress due to pressure		9642		9642		9642		9642	
			9642		9642		9642		9642
Total Circumferential Stresses									
		-1400		17623		-7445		22830	
			10268		9108		22799		-1507

For **Jacobs Canada Inc. c/o Canadian Natural Resources Limited**
Job **13-3353**
Item **104-E-135/136**

Dsgn **HW**
Chkd 
Rev **0**

Heat Exchanger Mechanical Design Shell&TubeMech V8.0 (ASME 2012)
File: 133353(mawp).EDR Printed: 4/4/2013 at 3:32:13 PM

Longitudinal Stresses			Units: psi						
	Coefficient	Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Membrane	P	1.5478	-473	-473	-473	-743	-743	-743	-743
		2.4291 *	-473	-473	-473	-743	-743	-743	-743
Bending	P	0.0529	-1468	-1468	-1468	-778	-778	-778	-778
		0.028 *	1468	1468	1468	778	778	778	778
Membrane	Mc	1.6037	0	0	0	-3069	-3069	3069	3069
			0	0	0	-6435	-6435	6435	6435
Bending	Mc	0.037	0	0	0	-6435	-6435	6435	6435
			0	0	0	6435	6435	-6435	-6435
Membrane	Ml	0.7544	-1865	1865	1865	0	0	0	0
			-1865	1865	1865	0	0	0	0
Bending	Ml	0.038	-8527	8527	8527	0	0	0	0
		0.0409 *	8527	-8527	-8527	0	0	0	0
Stress due to pressure			4561	4561	4561	4561	4561	4561	4561
			4561	4561	4561	4561	4561	4561	4561

* = This coefficient is used for locations Cu, Cl, Du, & Dl.

Longitudinal Stresses			Units: psi						
		Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Sub-total									
Membrane stresses		-2338		1392		-3811		2326	
			-2338		1392		-3811		2326
Bending stresses		-9995		7058		-7213		5657	
			9995		-7058		7213		-5657
Stress due to pressure		4561		4561		4561		4561	
			4561		4561		4561		4561
Total Longitudinal Stresses		-7772		13011		-6463		12544	
			12210		-1106		7963		1230

For Jacobs Canada Inc. c/o Canadian Natural Resources Limited

Job 13-3353
Item 104-E-135/136

Dsgn HW
Chkd *KS*
Rev 0

Heat Exchanger Mechanical Design Shell&TubeMech V8.0 (ASME 2012)

File: 133353(mawp).EDR Printed: 4/4/2013 at 3:32:13 PM

		Shear stresses, psi						
		Au	Bu	Cu	Du			
		A1	B1	C1	D1			
Torsion	Mt	782	782	782	782			
Shear	Vc	220	-220	0	0			
Shear	Vl	0	0	-220	220			
Total shear stresses								
		1002	562	562	1002			
			1002	562	562		1002	
		Total stresses, psi						
Combined stress intensity, psi		7926	17691	7701	22927			
			12641	10276	22821		3392	

For Jacobs Canada Inc. c/o Canadian Natural Resources Limited
Job 13-3353
Item 104-E-135/136

Date Apr 04, 2013

Dsgn HW
Chkd 
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Heat Exchanger Mechanical Design Shell&TubeMech V8.0 (ASME 2012)

File: 133353(mawp).EDR Printed: 4/4/2013 at 3:32:13 PM

Component: Nozzle T1/T2

Local Stresses in Cylindrical Shell Due to External Loadings at the Shell-to-Attachment Junction

Method: Welding Research Council Bulletin 107 (WRC 107) 1972 (79 Add.)

Design conditions	Geometry
Design pressure Pr = 520 psi	Shell ID = 15.0 in
Design temperature = 302 F	Shell OD = 16.102 in
Material allow. Str. = 20000 psi	Shell thickness = 0.551 in
Code stress multiplier= 3	Joint efficiency E = 1
Shell allowable Str. = 60000 psi	Attachment OD = 5.75 in
Shell corrosion = 0.126 in	Attachment C2 = 0.0 in
	Attachment tks. = 0.875 in
	Pad reinf. tks. Prtk = 0.0 in

Materials of construction

Shell material = SA-516 K02700 Grd 70 Plate

Applied loads Geometric parameters (corroded cond.)

Radial load P = 674 lbf	Vessel mean radius Rm = 7.8385 in
Circ. moment Mc = 10621 lbf*in	Vessel + pad tks. T = 0.425 in
Long. moment Ml = 13719 lbf*in	Attachment radius ro = 2.875 in
Tors. moment Mt = 17259 lbf*in	Gamma = Rm/T = 18.44
Shear load Vc = 843 lbf	Beta = 0.875*ro/Rm = 0.32
Shear load Vl = 843 lbf	Beta1 = C1/Rm = 0
	Beta2 = C2/Rm = 0

Stress concentration Due To:

Membrane load Kn = 1.51	Sign convention:
Bending load Kb = 1.24	+ = tensile stress
Min. fillet radius = 0.43 in	- = compressive stress

For Jacobs Canada Inc. c/o Canadian Natural Resources Limited
Job 13-3353
Item 104-E-135/136

Dsgn HW
Chkd
Rev 0

Heat Exchanger Mechanical Design Shell&TubeMech V8.0 (ASME 2012)

File: 133353(mawp).EDR Printed: 4/4/2013 at 3:32:13 PM

Circumferential Stresses

Units: psi

		Coefficient	Au	Al	Bu	B1	Cu	Cl	Du	D1
Membrane	P	2.4291	-743		-743		-473		-473	
		1.5478 *		-743		-743		-473		-473
Bending	P	0.0284	-788		-788		-1477		-1477	
		0.0532 *		788		788		1477		1477
Membrane	Mc	0.7798	0		0		-1492		1492	
			0		0			-1492		1492
Bending	Mc	0.0785	0		0		-13646		13646	
			0		0			13646		-13646
Membrane	Ml	1.8069	-4466		4466		0		0	
				-4466		4466		0		0
Bending	Ml	0.0225	-5046		5046		0		0	
		0.0235 *		5046		-5046		0		0
Stress due to pressure			9642		9642		9642		9642	
				9642		9642		9642		9642

* = This coefficient is used for locations Cu, Cl, Du, & D1.

Circumferential Stresses

Units: psi

		Au	Al	Bu	B1	Cu	Cl	Du	D1
Sub-total									
Membrane stresses		-5209		3724		-1965		1019	
			-5209		3724		-1965		1019
Bending stresses		-5834		4258		-15122		12169	
			5834		-4258		15122		-12169
Stress due to pressure		9642		9642		9642		9642	
			9642		9642		9642		9642
Total Circumferential Stresses		-1400		17623		-7445		22830	
			10268		9108		22799		-1507

For **Jacobs Canada Inc. c/o Canadian Natural Resources Limited**
 Job **13-3353**
 Item **104-E-135/136**

Dsgn **HW**
 Chkd *KJ*
 Rev **0**

Heat Exchanger Mechanical Design Shell&TubeMech V8.0 (ASME 2012)

File: 133353(mawp).EDR Printed: 4/4/2013 at 3:32:13 PM

Longitudinal Stresses			Units: psi						
	Coefficient	Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Membrane	P	1.5478	-473	-473	-473	-743	-743	-743	-743
		2.4291 *	-473	-473	-473	-743	-743	-743	-743
Bending	P	0.0529	-1468	-1468	-1468	-778	-778	-778	-778
		0.028 *	1468	1468	1468	778	778	778	778
Membrane	Mc	1.6037	0	0	0	-3069	-3069	3069	3069
			0	0	0	-6435	-6435	6435	6435
Bending	Mc	0.037	0	0	0	-6435	-6435	6435	6435
			0	0	0	6435	6435	-6435	-6435
Membrane	Ml	0.7544	-1865	1865	1865	0	0	0	0
			-1865	1865	1865	0	0	0	0
Bending	Ml	0.038	-8527	8527	8527	0	0	0	0
		0.0409 *	8527	-8527	-8527	0	0	0	0
Stress due to pressure			4561	4561	4561	4561	4561	4561	4561
			4561	4561	4561	4561	4561	4561	4561

* = This coefficient is used for locations Cu, Cl, Du, & Dl.

Longitudinal Stresses		Units: psi							
		Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Sub-total									
Membrane stresses		-2338		1392		-3811		2326	
			-2338		1392		-3811		2326
Bending stresses		-9995		7058		-7213		5657	
			9995		-7058		7213		-5657
Stress due to pressure		4561		4561		4561		4561	
			4561		4561		4561		4561
Total Longitudinal Stresses									
		-7772		13011		-6463		12544	
			12218		-1106		7963		1230

For Jacobs Canada Inc. c/o Canadian Natural Resources Limited
Job 13-3353
Item 104-E-135/136

Date Apr 04, 2013

Dsgn HW
Chkd VJ
Rev 0

Heat Exchanger Mechanical Design Shell&TubeMech V8.0 (ASME 2012)

File: 133353(mawp).EDR Printed: 4/4/2013 at 3:32:13 PM

		Shear stresses, psi						
		Au	Bu	Cu	Du			
			Al	B1	C1	D1		
Torsion	Mt	782	782	782	782	782		
Shear	Vc	220	-220	0	0	0	782	
Shear	Vl	0	220	-220	0	0	0	
Total shear stresses			0	0	-220	220	220	
		1002	562	562	1002			
			1002	562	562	1002		
		Total stresses, psi						
Combined stress intensity, psi		7926	17691	7701	22927			
			12641	10276	22821	3392		



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments			
104-E-135;104-E-136	JPI REV 1 - COORDINATION			
Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1		
<i>Em</i> <input checked="" type="checkbox"/> 1 - Work May Proceed <input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated <input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture <input type="checkbox"/> 4 - STOP WORK per attached written instructions <input type="checkbox"/> 5 - Review Not Required: Work may proceed SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.	Supplier	Exchanger Industries		
	Doc. Description	EXCHANGER - MECHANICAL DESIGN CALCULATIONS 13-3353		
	Vendor Document No.	13-3353 MDC		
	Client Document No.	VP088996-M500-00025		
	Purchase Order No.	Doc Cat.	Issue	
	CE416040-CC088996-00	M500	0	
BY : <u>SYED SHAH</u>	Categories			
DATE : <u>May 26, 2013</u>	Date Received	05/01/2013		

EXCHANGER INDUSTRIES

Page 1
Sheet Count 27

MECHANICAL DESIGN CALCULATION COVER SHEET

205 V2.08

Design Code: ASME Section VIII Div 1
2010 Edition and 2011a Addenda

Date April 5, 2013

Customer Jacobs Canada Inc.
 Owner Canadian Natural Resources Limited
 Location Kirby North Phase 1 Project
 Customer Reference CE416040-CC088996-00
 E.I. Job No. 13-3353
 Item 104-E-135/136
 Prepared by HW Checked by KJ
 Description 15-240 BEU; Sales Oil Tank Heater
 Notes Process design pressures;
 Shell Side = 507.6 psi (3500 kPa); Tube Side = 507.6 psi (3500 kPa)

Design Conditions	Shellside	Tube	
Pressure	520 (3585)	520 (3585)	psi
Temperature	302 (150)	302 (150)	°F
Vacuum	F.V @ 299°F (148°C)	F.V @ 299°F (148°C)	
MDMT	-20 (-29)	-20 (-29)	°F(°C)
Corrosion	0.126 (3.2)	0.126 (3.2)	inch (mm)
PWHT	No	U-Bends & Channel	
UT / Radiography	Full (RT1)	Full (RT1)	

Calculation Set
Revision Number 0

Description and Page Number
Initial Issue -- All Pages

UG-22 Checked?
Yes

DWG Changed?
Yes

Date
5-Apr-13

Approved
KJ



VP088996-M500-00025

EXCHANGER INDUSTRIES

61 V2.03

Customer Jacobs Canada Inc.
Job 13-3353
Item 104-E-135/136

Date April 5, 2013
Dsgn HW
Chkd *KJ*

Document	# Pages	Table of Contents	Rev	Date
1	1	Cover Sheet	0	5-Apr-13
2	1	Table of Contents	0	5-Apr-13
3	1	UG-22 Check list	0	5-Apr-13
4	1	Shell Cylinder	0	4-Apr-13
5	1	Front Head Cylinder	0	4-Apr-13
6	1	Shell Cover	0	4-Apr-13
7	1	Front Head Cover	0	4-Apr-13
8	1	Tubes	0	4-Apr-13
9	1	Front Pass Partition	0	4-Apr-13
10	3	Front Head Flange at TS	0	4-Apr-13
11	3	Front Shell Flange	0	4-Apr-13
12	4	Front TubeSheet	0	4-Apr-13
13	3	Nozzle S1/S2	0	4-Apr-13
14	3	Nozzle T1/T2	0	4-Apr-13
15	1	MAWP Calculations	0	4-Apr-13
16	1	HydroTest Pressure Calculations	0	4-Apr-13

EXCHANGER INDUSTRIES

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ASME Section VIII Div 1 2010 Edition and 2011a Addenda Calculation Checklist

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		Shellside	Tubeside
UG-22	Are the Primary Membrane Stress Calculations Included ?	Yes	Yes
	Are the Support Calculations Included ?	Yes	N/A
	Are the Nozzle Loadings Included ?	Yes	Yes
	Are the Attachment / Lifting Loadings Included ?	Yes	Yes
	Are the Thermal Loadings Included ?	Yes	Yes
	Are the Dynamic, Cyclic, or Shock Loadings Included ?	No	No
	Are the Weather and Seismic Loadings Included ?	Yes	Yes

Supplemental		No	No
	Is the Unit In Lethal Service ?	No	No
	Is the Unit In Sour or Hydrogen Service ?	No	No
	Is the Unit Generating Steam Over 50 psi ?	No	No
	Is the Material P-No 1, Gr-1 or 2 ?	Yes	Yes

	Shellside		Tubeside		Tubesheet		Flat Cover
	Exempt	Per UG	Exempt	Per UG	Exempt	Per UG	
	20f		20f		20f		
Impact Testing							<i>N/A</i>

		Shellside	Tubeside
UG-20 f 1	Is the Material listed on UCS-66 Curve A and ½ inch thick or less ?	No	No
	Is the Material listed on UCS-66 Curve B, C or D and 1 inch thick or less ?	Yes	Yes
	Vessel is exempt per this Paragraph	Yes	Yes

		Shellside	Tubeside
UG-20 f 2	Will the Vessel be hydro tested per UG-99b, UG-99c or 27-3 ?	Yes	Yes
	Vessel is exempt per this Paragraph	Yes	Yes

		Shellside	Tubeside
UG-20 f 3	Is the Design Temperature above 650°F (343°C) or Below -20°F (-29°C)	No	No
	Vessel is exempt per this Paragraph	Yes	Yes

		Shellside	Tubeside
UG-20 f 4	Are Thermal or Mechanical Shock Loads Controlling ?	No	No
	Vessel is exempt per this Paragraph	Yes	Yes

		Shellside	Tubeside
UG-20 f 5	Are Cyclic Loads Controlling ?	No	No
	Vessel is exempt per this Paragraph	Yes	Yes

	Flat Cover	Tubesheet
Tubesheet / Flat Cover Listed on UCS-66 Curve A and below 2 inch thick ?	No	No
Tubesheet / Flat Cover Listed on UCS-66 Curve B, C or D and 4 inch thick or less ?	No	Yes

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Component: Shell Cylinder

ASME Section VIII-1 2011a UG-27 Thickness of Shells under Int. Pressure

--- Calculations --- Cylinder Internal Pressure

Material: SA-516 K02700 Grd 70 Plate

Design pressure	P = 520 psi	Design temperature	T = 302 F
Radiography	= Full	Joint eff.circ str.	E = 1
Design stress	S = 20000 psi	Joint eff.long str.	E = 1
Design stress, long	S = 20000 psi	Min thk. UG-16(b) tmin	= 0.1885 in
Inside corr.allow.	CAI = 0.126 in	Outside corr. all. CAO	= 0.0 in
Material tolerance	Tol = 0.0 in	TEMA min. thickness tm	= 0.375 in
Outside diameter	OD = 16.102 in	Corroded radius	IR = 7.626 in

Required wall thickness of the cylinder , greater of:

Circumferential stress

$$t = (P \cdot IR / (S \cdot E - 0.6 \cdot P)) + cai + cao + tol = 0.3274 \text{ in} \quad \text{UG-27(c) (1)}$$

Longitudinal stress

$$t = (P \cdot IR / (2 \cdot S \cdot E + 0.4 \cdot P)) + cai + cao + tol = 0.2246 \text{ in} \quad \text{UG-27(c) (2)}$$

Actual wall thickness of cylinder: tnom = 0.551 in

(Required wall tks. for nozzle attachments, E=1 , tri = 0.2014 in)

ASME Section VIII-1 2011a UG-28 Thickness of Shells under Ext. Pressure

--- Calculations --- Cylinder External Pressure

Material: SA-516 K02700 Grd 70 Plate

Design pressure	PE = 15 psi	Design temperature	T = 299 F
Inside corr. allow.	CAI = 0.126 in	Corrosion allow.	CAO = 0 in
Radiography	= Full	Material tol.	Tol = 0 in
Cyl. outside dia.	Do = 16.102 in	Cylinder length EP	L = 245.9361 in

Nominal thickness	tnom = 0.551 in	(tnom-CAI-CAO-Tol)	t = 0.425 in
L/Do ratio	Ldo = 15.2736	Do/t	Dot = 37.8857

(2*S) or (0.9*yield) SE	= -	Mod. of elasticity ME	= 28105000 psi
A factor SII-D-FigG	A = 0.000809	B factor CS-2	B = 11436

Max allowed external pressure: Pa	= 4*B / (3*Dot)	= 402.49 psi
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Actual external design pressure: PE = 15 psi

(Required cyl. tks. for nozzle attachments at PE, tre = 0.144 in)

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Component: Front Head Cylinder

ASME Section VIII-1 2011a UG-27 Thickness of Shells under Int. Pressure
 --- Calculations --- Cylinder Internal Pressure

Material: SA-516 K02700 Grd 70 Plate

Design pressure	P = 520 psi	Design temperature	T = 302 F
Radiography	= Full	Joint eff.circ str.	E = 1
Design stress	S = 20000 psi	Joint eff.long str.	E = 1
Design stress, long	S = 20000 psi	Min thk. UG-16(b) tmin	= 0.1885 in
Inside corr.allow.	CAI = 0.126 in	Outside corr. all. CAO	= 0.0 in
Material tolerance	Tol = 0.0 in	TEMA min. thickness tm	= 0.375 in
Outside diameter	OD = 16.102 in	Corroded radius	IR = 7.626 in

Required wall thickness of the cylinder , greater of:

Circumferential stress

$$t = (P \cdot IR / (S \cdot E - 0.6 \cdot P)) + cai + cao + tol = 0.3274 \text{ in} \quad \text{UG-27(c) (1)}$$

Longitudinal stress

$$t = (P \cdot IR / (2 \cdot S \cdot E + 0.4 \cdot P)) + cai + cao + tol = 0.2246 \text{ in} \quad \text{UG-27(c) (2)}$$

Actual wall thickness of cylinder: tnom = 0.551 in

(Required wall tks. for nozzle attachments, E=1 , tri = 0.2014 in)

ASME Section VIII-1 2011a UG-28 Thickness of Shells under Ext. Pressure
 --- Calculations --- Cylinder External Pressure

Material: SA-516 K02700 Grd 70 Plate

Design pressure	PE = 15 psi	Design temperature	T = 299 F
Inside corr. allow.	CAI = 0.126 in	Corrosion allow.	CAO = 0 in
Radiography	= Full	Material tol.	Tol = 0 in
Cyl. outside dia.	Do = 16.102 in	Cylinder length EP	L = 16.0625 in
		Max length EP	Lmax = 830.0 in
Nominal thickness	tnom = 0.551 in	(tnom-CAI-CAO-Tol)	t = 0.425 in
L/Do ratio	Ldo = 0.9975	Do/t	Dot = 37.8857
(2*S) or (0.9*yield)	SE = -	Mod. of elasticity	ME = 28105000 psi
A factor SII-D-FigG	A = 0.006039	B factor CS-2	B = 17246
Max allowed external pressure:	Pa = 4*B / (3*Dot)		= 606.96 psi

Actual external design pressure: PE = 15 psi

(Required cyl. tks. for nozzle attachments at PE, tre = 0.054 in)

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Component: Shell Cover

ASME Section VIII-1 2011a UG-32 Formed Heads, and Sections,
 Pressure on Concave Side

--- Calculations --- Ellipsoidal Cover Internal Pressure with t/L >= 0.002

Material: SA-516 K02700 Grd 70 Plate

Design pressure	P = 520 psi	Design temperature	T = 302 F
Radiography	= Full	Joint efficiency	E = 1
Design stress	S = 20000 psi	TEMA min. thk	tm = 0.375 in
		Min thk UG-16(b)	tmin = 0.251 in
Inside corr.all.	CAI = 0.126 in	Outside corr.all.	CAO = 0.0 in
Major/minor rat.	D/2h = 2.0	Forming tolerance	Tol = 0.0625 in
Corroded min. thk	t = 0.2045 in	Equiv.dish radius	L = 13.7268 in
Minimum thickness	ts = 0.3625 in	Ratio ts/L	ts/L = 0.02641
K = 0.1667*(2+(D/2h)**2)	= 1.0	Material tol.	Tol = 0.0 in
Outside diameter	OD = 16.102 in	Corroded diameter	OD = 16.102 in

Required wall thickness of the cover:

$$t = (P*OD*K / (2*S*E+2*P*(K-0.1))) + cai + cao + tol = 0.393 \text{ in} \quad \text{App. 1-4(c)}$$

Actual wall thickness of cover: tnom = 0.551 in

(Required wall tks. for nozzle attachments, E=1, tri = 0.2045 in)
 (If opening & reinf. are within 80% of head diameter, tri = 0.1865 in)

ASME Section VIII-1 2011a UG-33 Formed Heads, Pressure on Convex Side

--- Calculations --- Ellipsoidal Cover External Pressure

Material: SA-516 K02700 Grd 70 Plate

Design pressure	PE = 15 psi	Design temperature	T = 299 F
Inside corr. allow.	CAI = 0.126 in	Outside corr. all.	CAO = 0 in
Radiography	= Full	Forming tolerance	Tol = 0.0625 in
		Material tolerance	Tol = 0 in
Cover outside dia.	Do = 16.102 in	Outside sph.radius	Ro = 14.4918 in
Nominal thickness	tnom = 0.551 in	tnom-CAI-CAO-Tol	t = 0.3625 in
Ko factor (UG-33.1)	Ko = 0.9	Ro/t ratio	Rot = 39.9756
UG-33(a)	938.58/1.67 = 562.03 psi	Mod. of elasticity	ME = 28105000 psi
A factor = 0.125/Rot	= 0.003127	B factor CS-2	B = 16285
Maximum allowed external pressure:	Pa = B / Rot		= 407.37 psi
Actual external design pressure:			PE = 15 psi

(Required cov. tks. for nozzle attachments at PE, tre = 0.0465 in)

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Component: Front Head Cover

ASME Section VIII-1 2011a UG-32 Formed Heads, and Sections,
Pressure on Concave Side

--- Calculations --- Ellipsoidal Cover Internal Pressure with t/L >= 0.002

Material: SA-516 K02700 Grd 70 Plate

Design pressure	P = 520 psi	Design temperature	T = 302 F
Radiography	= Full	Joint efficiency	E = 1
Design stress	S = 20000 psi	TEMA min. thk	tm = 0.375 in
		Min thk UG-16(b)	tmin = 0.251 in
Inside corr.all.	CAI = 0.126 in	Outside corr.all.	CAO = 0.0 in
Major/minor rat.	D/2h = 2.0	Forming tolerance	Tol = 0.0625 in
Corroded min. thk	t = 0.2045 in	Equiv.dish radius	L = 13.7268 in
Minimum thickness	ts = 0.3625 in	Ratio ts/L	ts/L = 0.02641
K = 0.1667*(2+(D/2h)**2)	= 1.0	Material tol.	Tol = 0.0 in
Outside diameter	OD = 16.102 in	Corroded diameter	OD = 16.102 in

Required wall thickness of the cover:

$$t = (P*OD*K / (2*S*E+2*P*(K-0.1))) + cai + cao + tol = 0.393 \text{ in} \quad \text{App. 1-4(c)}$$

Actual wall thickness of cover: tnom = 0.551 in

(Required wall tks. for nozzle attachments, E=1, tri = 0.2045 in)

(If opening & reinf. are within 80% of head diameter, tri = 0.1865 in)

ASME Section VIII-1 2011a UG-33 Formed Heads, Pressure on Convex Side

--- Calculations --- Ellipsoidal Cover External Pressure

Material: SA-516 K02700 Grd 70 Plate

Design pressure	PE = 15 psi	Design temperature	T = 299 F
Inside corr. allow.	CAI = 0.126 in	Outside corr. all.	CAO = 0 in
Radiography	= Full	Forming tolerance	Tol = 0.0625 in
		Material tolerance	Tol = 0 in
Cover outside dia.	Do = 16.102 in	Outside sph.radius	RO = 14.4918 in
Nominal thickness	tnom = 0.551 in	tnom-CAI-CAO-Tol	t = 0.3625 in
Ko factor (UG-33.1)	Ko = 0.9	Ro/t ratio	Rot = 39.9756
UG-33(a)	938.58/1.67 = 562.03 psi	Mod. of elasticity	ME = 28105000 psi
A factor = 0.125/Rot	= 0.003127	B factor CS-2	B = 16285
Maximum allowed external pressure:	Pa = B / Rot		= 407.37 psi
Actual external design pressure:			PE = 15 psi

(Required cov. tks. for nozzle attachments at PE, tre = 0.0465 in)

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Component: Tubes

ASME Section VIII-1 2011a UG-27 Thickness of Shells under Int. Pressure
--- Calculations --- Cylinder Internal Pressure

Material: SA-179 K01200 Smls. tube

Design pressure	P = 535 psi	Design temperature	T = 302 F
Radiography	= -	Joint eff.circ str.	E = 1
Design stress	S = 13400 psi	Joint eff.long str.	E = -
Design stress, long	S = -	Min thk. UG-16(b) tmin	= -
Inside corr.allow.	CAI = 0.0 in	Outside corr. all. CAO	= 0.0 in
Material tolerance	Tol = 0.0 in	TEMA min. thickness tm	= 0.0 in
Outside diameter	OD = 0.75 in	Corroded radius	OR = 0.375 in

Required wall thickness of the cylinder , greater of:

Circumferential stress

$$t = (P \cdot OR / (S \cdot E + 0.4 \cdot P)) + cai + cao + tol = 0.0147 \text{ in} \quad \text{APP.1-1(A)}$$

Longitudinal stress

$$t = (P \cdot IR / (2 \cdot S \cdot E + 0.4 \cdot P)) + cai + cao + tol = - \quad \text{UG-27(c) (2)}$$

Actual wall thickness of cylinder: tnom = 0.083 in

(Required wall tks. for nozzle attachments, E=- , tri = -)

TEMA RCB-2.31 U-Bend Requirements - Minimum tube wall thk in the bent portion

to = t1 * (1 + do / (4*R)) + c	to = 0.0303 in
Min. Code wall thk t1 = 0.026 in	Outside diameter do = 0.75 in
Min. Code wall thickness:	Corrosion allowance c = 0 in
Internal press t1i = 0.0147 in	External pressure t1e = 0.026 in
Min. mean bend radius R = 1.125 in	

ASME Section VIII-1 2011a UG-28 Thickness of Shells under Ext. Pressure

--- Calculations --- Cylinder External Pressure

Material: SA-179 K01200 Smls. tube

Design pressure	PE = 535 psi	Design temperature	T = 302 F
Inside corr. allow.	CAI = 0 in	Corrosion allow.	CAO = 0 in
Radiography	= -	Material tol.	Tol = 0 in
Cyl. outside dia.	Do = 0.75 in	Cylinder length EP	L = 240 in
		Max length EP	Lmax = 720.0 in

Nominal thickness tnom = 0.083 in (tnom-CAI-CAO-Tol) t = 0.083 in

L/Do ratio Ldo = 320.0 Do/t Dot = 9.0361

(2*S) or (0.9*yield) SE = 24827 psi Mod. of elasticity ME = 28292000 psi

A factor SII-D-FigG A = 0.014136 B factor CS-1 B = 13787

Max allowed external pressure: Pa = B*((2.167/Dot)-0.0833) = 2157.94 psi

Actual external design pressure: PE = 535 psi

(Required cyl. tks. for nozzle attachments at PE, tre = 0.026 in)

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Component: Front Pass Partition

Pass Partition Plate Max. Allowed Pressure Differential (TEMA 2007 RCB-9.132)

Pass plate material: SA-516 K02700 Grd 70 Plate

Thickness $t = 0.3937$ in Pressure drop $q_a = 10.2$ psi

TEMA min thk $t_{min} = 0.375$ in

Corrosion allowance $c = 0.126$ in Minimum thickness, t_m

Design stress $S = 20000$ psi $t_m = b \cdot \text{SQRT}((q_a \cdot B) / (1.5 \cdot S)) + c$

Max. allowable pressure drop: $q = (1.5 \cdot S \cdot ((t-c)/b)^2) / B = \text{see table below}$

Sides fixed	Dim a in	Dim b in	a/b	B factor	q psi	t_m in	Selected
a & b	15.0	21.824	0.687	0.15	30.1	0.2815	*
a	21.824	15.0	1.455	0.489	19.5	0.319	
b	21.824	15.0	1.455	0.614	15.6	0.3422	

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Component: Front Head Flng At TS

ASME Section VIII-1 2011a App. 2 Bolted Flange With Ring Type Gaskets

Flange type: Integral tapered hub - ASME fig.2-4(6)

Flange material: SA-105 K03504 Forgings

Int. design pressure	PI = 520 psi	Design temperature	T = 302 F
Ext. design pressure	PE = 15 psi	B1 = B+g1 or B+g0	B1 = -
Inside corr. allow	CAI = 0.126 in	Outside corr. all.	CAO = 0.0 in
Stress (operating)	SFO = 20000 psi	Stress (atmos.)	SFA = 20000 psi
Outside diameter	A = 20.625 in	Inside spherical rad.	L = -
Inside diameter	B = 15.252 in	Hub thickness	g1 = 0.55 in
Bolt circle diameter	C = 19.0 in	Hub tks. at attach.	g0 = 0.425 in
Mean gasket diameter	G = 17.125 in	Weld leg/hub length	h = 1.0 in
Hub to bolt circle	R = 1.324 in	Bolt circle to OD	E = 0.8125 in
Flange thickness	t = 2.0625 in		
Overlay thickness	OL = -		

Gasket material: KammProfile

Gasket outside dia.	ODG = 17.5 in	Gasket width	N = 0.375 in
Gasket thickness	tkg = 0.125 in	Gasket factor	m = 3.75
Gasket seating stress	y = 7600 psi	Gasket eff. width	b = 0.1875 in
Gasket unit stress	Sg = 11975 psi	factor f	f = 0.0 in
Gasket rib length	Rib = 25.125 in	Seating width	bo = 0.1875 in
Gasket rib eff width	Br = 0.25 in	(Table 2-5.2 facing 1a/1b Col. II)	

Bolt material: SA-193 G41400 Grd B7 Bolt(<= 2 1/2)

Bolt diameter	db = 0.75 in	No. of bolts	No. = 32
Bolt root area	Area = 0.302 in2	Sg = Ab*Sa/((Pi/4)*((do-f)**2-di**2))	
Bsmax = 2*db+6*t/(m+0.5)		Actual bolt spacing	Bs = 1.8653 in
Max bolt spacing	BsMax = 4.4118 in	Min bolt spacing	BsMin = 1.75 in
Cf = SQRT(Bs/Bsmax)	Cf = 0.65	Cf used	Cf = 1
Stress (operating)	SB = 25000 psi	Stress (atmos.)	SA = 25000 psi

Joint-contact compr. load	HP = 6.2832*b*G*PI*m+2*Br*m*PI*RIB	=	63838 lbf
Hydrostatic end force	H = 0.7854*G*G*PI	=	119772 lbf
Hydrostatic end force	H = 0.7854*G*G*PE	=	3455 lbf

Operating conditions:

Min. calc. bolt load	WM1 = HP+H	=	183610 lbf
Min. used bolt load	WM1 = max of 2 mating flanges	=	183610 lbf

Bolting up conditions:

Minimum bolt load	WM2 = b*3.1416*G*Y+Br*Y*RIB	=	124402 lbf
Min. used bolt load	WM2 = max of 2 mating flanges	=	124402 lbf
Required bolt area	AM = WM2/SA or WM1/SB	=	7.34 in2
Available bolt area	AB = No.Bolt*Area	=	9.66 in2
Ratio of bolt areas	AB/AM = 1.316		
Design bolt load	W = 0.5*(AM+AB)*SA	=	212605 lbf
Minimum gasket width	NMIN = AB*SA/(6.283*y*G)	=	0.2955 in
Gasket compression stress	Gcst = AB*SA/((Pi*G*N)+(Br*RIB))	=	9132 psi

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Loads:

Integral Flange Calculations

Operating conditions:

Hydrostatic end load HD = 0.785*B*B*PI = 95005 lbf
 Hydrostatic end load HDe= 0.785*B*B*PE = 2741 lbf
 Gasket load HG = WM1-H = 63838 lbf
 Result. hydrostatic force HT = H-HD = 24767 lbf
 Result. hydrostatic force HTe= He-HDe = 714 lbf

Bolting up conditions:

Gasket load HG = W = 212605 lbf

Operating conditions:

Hydrostatic lever arm hd = R+0.5*g1 = 1.599 in
 Gasket load lever arm hg = (C-G)/2.0 = 0.9375 in
 Result. hydro. lever arm ht = (R+g1+hg)/2.0 = 1.4058 in

Bolting up conditions:

Gasket load lever arm hg = (C-G)/2.0 = 0.9375 in

Operating conditions:

Hydrostatic moment MD = HD*hd = 151914 lbf*in
 Gasket moment MG = HG*hg = 59848 lbf*in
 Result. hydro. moment MT = HT*ht = 34817 lbf*in
 Total operating moment MOP = MD+MG+MT = 246578 lbf*in
 Total operating mom. MOPe= HDe(hd-hg)+HTe(ht-hg) = 2147 lbf*in

Bolting up conditions:

Bolt up moment MATM = W*hg = 199317 lbf*in
 Effective bolt moment MB = MATM*SFO/SFA = 199317 lbf*in
 Total moment MO = MOP or MB = 246578 lbf*in
 Bolt spacing correction M = MO*Cf = 246578 lbf*in

(TEMA 2007 RCB-11.23) Cf= 1

Flange shape constants:

K = A/B = 1.3523 ho = SQ(B*G0) = 2.546
 T = Fig.2-7.1 = 1.7749 h/ho = h/ho = 0.3928
 Z = Fig.2-7.1 = 3.4135 F = Fig.2-7.2 = 0.8774
 Y = Fig.2-7.1 = 6.5912 V = Fig.2-7.3 = 0.3985
 U = Fig.2-7.1 = 7.243 f = Fig.2-7.6 = 1.0
 G1/G0 = G1/Go = 1.2941 e = F/ho = 0.3446
 t = 2.0625 in
 d = U*ho*g0*g0/V = 8.3588 Alpha = t*e+1.0 = 1.7108
 Beta = 1.333*t*e+1.0 = 1.9475 Gamma = Alpha/TF = 0.9639
 Delta = t*t*t/D = 1.0496 Lambda = Gamma+Delta = 2.0135

Stress calculations:

Allowable stress:

Long. hub SH = (f*M)/(Lambda*g1**2*B) = 26542 psi 1.5*SFO = 30000 psi
 Radial SR = Beta*M/(Lambda*t**2*B) = 3676 psi SFO = 20000 psi
 Tangential ST1 = M*Y/(t**2*B) - (Z*SR) = 12502 psi SFO = 20000 psi
 (greater) ST2 = (SH+SR)/2 or (SH+ST1)/2 = 19522 psi SFO = 20000 psi

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Component: Front Head Flng At TS

ASME Section VIII Div.1 2011a, Appendix 2, 2-14 Flange Rigidity

--- Calculations ---

Operating moment, Mo = 246578 lbf*in Gasket seat. moment Ma = 199317 lbf*in
 Factor VI VI = 0.3985 Factor L L = 2.0135
 Mod. elast.design T Ed = 28092000 psi Mod.elast.atm. temp Ea = 29200000 psi
 Thickness g0 g0 = 0.425 in Factor h0 h0 = 2.546 in
 Factor KI KI = 0.3 Factor KL KL = 0.2
 Corrosion allowance ca = 0.126 in Factor K K = 1.3523
 Thickness, T T = 2.0625 in

Flange Rigidity

Loose type flanges without hubs and optional flanges designed as loose type

Gasket seating $J = 109.4 * Ma / (E * T ** 3 * Ln(K) * KL) = -$

Operating $J = 109.4 * Mo / (E * T ** 3 * Ln(K) * KL) = -$

Integral type flanges and optional type flanges designed as integral and

Loose type flanges with hubs

Gasket seating $J = 52.14 * Ma * VI / (L * E * G0 ** 2 * ho * KI) = 0.5105$

Operating $J = 52.14 * Mo * VI / (L * E * G0 ** 2 * ho * KI) = 0.6565$

ASME appendix 2 calculation of hub thickness 'go' as a cylinder

Design pressure P = 520 psi Allowable stress S = 20000 psi

Outside radius OR = 0.0 in Inside radius IR = 7.626 in

Joint efficiency E = 1 Corr.Allow or OL c = 0.126 in

Material tolerance tol = 0.0 in


Min hub thk / small end = $P * IR / (S * E - 0.6 * P) + c + Tol$ UG-27(c) (1)
 = 0.3274 in

Hub thk / small end = 0.551 in

New thickness 'go' = 0.551 in New thickness 'g1' = 0.676 in

Corroded thickness 'go' = 0.425 in Corroded thk 'g1' = 0.55 in

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Component: Front Shell Flng

ASME Section VIII-1 2011a App. 2 Bolted Flange With Ring Type Gaskets

Flange type: Integral tapered hub - ASME fig.2-4(6)

Flange material: SA-105 K03504 Forgings

Int. design pressure	PI = 520 psi	Design temperature	T = 302 F
Ext. design pressure	PE = 15 psi	B1 = B+g1 or B+go	B1 = -
Inside corr. allow	CAI = 0.126 in	Outside corr. all.	CAO = 0.0 in
Stress (operating)	SFO = 20000 psi	Stress (atmos.)	SFA = 20000 psi
Outside diameter	A = 20.625 in	Inside spherical rad.	L = -
Inside diameter	B = 15.252 in	Hub thickness	g1 = 0.55 in
Bolt circle diameter	C = 19.0 in	Hub tks. at attach.	go = 0.425 in
Mean gasket diameter	G = 17.125 in	Weld leg/hub length	h = 1.0 in
Hub to bolt circle	R = 1.324 in	Bolt circle to OD	E = 0.8125 in
Flange thickness	t = 2.0625 in		
Overlay thickness	OL = -		

Gasket material: KammProfile

Gasket outside dia.	ODG = 17.5 in	Gasket width	N = 0.375 in
Gasket thickness	tk = 0.125 in	Gasket factor	m = 3.75
Gasket seating stress	y = 7600 psi	Gasket eff. width	b = 0.1875 in
Gasket unit stress	Sg = 11975 psi	factor f	f = 0.0 in
Gasket rib length	Rib = 0.0 in	Seating width	bo = 0.1875 in
Gasket rib eff width	Br = 0.0 in	(Table 2-5.2 facing 1a/1b Col. II)	

Bolt material: SA-193 G41400 Grd B7 Bolt(<= 2 1/2)

Bolt diameter	db = 0.75 in	No. of bolts	No. = 32
Bolt root area	Area = 0.302 in ²	Sg = Ab*Sa/((Pi/4)*((do-f)**2-di**2))	
Bsmax = 2*db+6*t/(m+0.5)		Actual bolt spacing	Bs = 1.8653 in
Max bolt spacing	BsMax = 4.4118 in	Min bolt spacing	BsMin = 1.75 in
Cf = SQRT(Bs/Bsmax)	Cf = 0.65	Cf used	Cf = 1
Stress (operating)	SB = 25000 psi	Stress (atmos.)	SA = 25000 psi

Joint-contact compr. load	HP = 6.2832*b*G*PI*m+2*Br*m*PI*RIB	=	39341 lbf
Hydrostatic end force	H = 0.7854*G*G*PI	=	119772 lbf
Hydrostatic end force	H = 0.7854*G*G*PE	=	3455 lbf

Operating conditions:

Min. calc. bolt load	WM1 = HP+H	=	159113 lbf
Min. used bolt load	WM1 = max of 2 mating flanges	=	183610 lbf

Bolting up conditions:

Minimum bolt load	WM2 = b*3.1416*G*Y+Br*Y*RIB	=	76665 lbf
Min. used bolt load	WM2 = max of 2 mating flanges	=	124402 lbf
Required bolt area	AM = WM2/SA or WM1/SB	=	7.34 in ²
Available bolt area	AB = No.Bolt*Area	=	9.66 in ²
Ratio of bolt areas	AB/AM = 1.316		
Design bolt load	W = 0.5*(AM+AB)*SA	=	212605 lbf
Minimum gasket width	NMIN = AB*SA/(6.283*y*G)	=	0.2955 in
Gasket compression stress	Gcst = AB*SA/((Pi*G*N)+(Br*RIB))	=	11975 psi

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Loads:

Operating conditions:
 Hydrostatic end load
 Hydrostatic end load
 Gasket load
 Result. hydrostatic force
 Result. hydrostatic force
 Bolting up conditions:
 Gasket load
 Operating conditions:
 Hydrostatic lever arm
 Gasket load lever arm
 Result. hydro. lever arm
 Bolting up conditions:
 Gasket load lever arm
 Operating conditions:
 Hydrostatic moment
 Gasket moment
 Result. hydro. moment
 Total operating moment
 Total operating mom. MOPE=
 Bolting up conditions:
 Bolt up moment
 Effective bolt moment
 Total moment
 Bolt spacing correction
 (TEMA 2007 RCB-11.23) Cf= 1

Integral Flange Calculations

HD = 0.785*B*B*PI = 95005 lbf
 HDe= 0.785*B*B*PE = 2741 lbf
 HG = WMI-H = 63838 lbf
 HT = H-HD = 24767 lbf
 HTe= He-HDe = 714 lbf
 HG = W = 212605 lbf
 hd = R+0.5*g1 = 1.599 in
 hg = (C-G)/2.0 = 0.9375 in
 ht = (R+g1+hg)/2.0 = 1.4058 in
 hg = (C-G)/2.0 = 0.9375 in
 MD = HD*hd = 151914 lbf*in
 MG = HG*hg = 59848 lbf*in
 MT = HT*ht = 34817 lbf*in
 MOP = MD+MG+MT = 246578 lbf*in
 HDe(hd-hg)+HTe(ht-hg) = 2147 lbf*in
 MATM = W*hg = 199317 lbf*in
 MB = MATM*SFO/SFA = 199317 lbf*in
 MO = MOP or MB = 246578 lbf*in
 M = MO*Cf = 246578 lbf*in

Flange shape constants:

K = A/B = 1.3523 ho = SQ(B*G0) = 2.546
 T = Fig.2-7.1 = 1.7749 h/ho = h/ho = 0.3928
 Z = Fig.2-7.1 = 3.4135 F = Fig.2-7.2 = 0.8774
 Y = Fig.2-7.1 = 6.5912 V = Fig.2-7.3 = 0.3985
 U = Fig.2-7.1 = 7.243 f = Fig.2-7.6 = 1.0
 G1/G0 = G1/Go = 1.2941 e = F/ho = 0.3446
 t = 2.0625 in
 d = U*ho*g0*g0/V = 8.3588 Alpha = t*e+1.0 = 1.7108
 Beta = 1.333*t*e+1.0 = 1.9475 Gamma = Alpha/TF = 0.9639
 Delta = t*t*t/D = 1.0496 Lambda = Gamma+Delta = 2.0135

Stress calculations:

Long. hub SH = (f*M)/(Lambda*g1**2*B) = 26542 psi 1.5*SFO = 30000 psi
 Radial SR = Beta*M/(Lambda*t**2*B) = 3676 psi SFO = 20000 psi
 Tangential ST1 = M*Y/(t**2*B) - (Z*SR) = 12502 psi SFO = 20000 psi
 (greater) ST2 = (SH+SR)/2 or (SH+ST1)/2 = 19522 psi SFO = 20000 psi

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Component: Front Shell Flng

ASME Section VIII Div.1 2011a, Appendix 2, 2-14 Flange Rigidity

--- Calculations ---

Operating moment,	Mo = 246578 lbf*in	Gasket seat. moment	Ma = 199317 lbf*in
Factor VI	VI = 0.3985	Factor L	L = 2.0135
Mod. elast.design T	Ed = 28092000 psi	Mod.elast.atm. temp	Ea = 29200000 psi
Thickness g0	g0 = 0.425 in	Factor h0	h0 = 2.546 in
Factor KI	KI = 0.3	Factor KL	KL = 0.2
Corrosion allowance	ca = 0.126 in	Factor K	K = 1.3523
Thickness, T	T = 2.0625 in		

Flange Rigidity

Loose type flanges without hubs and optional flanges designed as loose type

Gasket seating $J = 109.4 * Ma / (E * T ** 3 * Ln(K) * KL) = -$

Operating $J = 109.4 * Mo / (E * T ** 3 * Ln(K) * KL) = -$

Integral type flanges and optional type flanges designed as integral and

Loose type flanges with hubs


Gasket seating $J = 52.14 * Ma * VI / (L * E * G0 ** 2 * ho * KI) = 0.5105$

Operating $J = 52.14 * Mo * VI / (L * E * G0 ** 2 * ho * KI) = 0.6565$

ASME appendix 2 calculation of hub thickness 'go' as a cylinder

Design pressure	P = 520 psi	Allowable stress	S = 20000 psi
Outside radius	OR = 0.0 in	Inside radius	IR = 7.626 in
Joint efficiency	E = 1	Corr.Allow or OL	c = 0.126 in
		Material tolerance tol	= 0.0 in
Min hub thk / small end	= $P * IR / (S * E - 0.6 * P) + c + Tol$		UG-27(c) (1)
	= 0.3274 in		
Hub thk / small end	= 0.551 in		
New thickness 'go'	= 0.551 in	New thickness 'g1'	= 0.676 in
Corroded thickness 'go'	= 0.425 in	Corroded thk 'g1'	= 0.55 in

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Component: Front Tubesheet

Tubesheet Details - ASME VIII-1 2011a - UHX - U-tube Construction
 Materials of construction Fig UHX-12.1 U-Tube Tubesheet configuration (d)
 Tubesheet: SA-516 K02700 Grd 70 Plate
 Tubes: SA-179 K01200 Smls. tube
 Shell: SA-516 K02700 Grd 70 Plate
 Channel: SA-516 K02700 Grd 70 Plate

Design conditions	Shell side	Tube side	Tubes	Tubesheet
Design pressure	psi * 520	520	(* = controlling)	
Vacuum	psi -15	* -15		
Design temperature	F 302	302	302	302
All.stress tubesheet	S = 20000 psi	All.stress tubes	St = 13400 psi	
All.stress shell	Ss = 20000 psi	All.stress channel	Sc = 20000 psi	
Yield stress shell	Sys = 33578 psi	Yield stress chann.	Syc = 33578 psi	
Mod.of elas.tubesheet	E = 28092000 psi	Mod.of elas. tubes	Et = 28292000 psi	
All.str.tubes at T	Stt = 13400 psi	Mod.of E.tubes at T	Ett = 28292000 psi	
Mod.of elas.shell	Es = 28092000 psi	Mod.of elas. channel	Ec = 28092000 psi	
Poisson Ratio shell	vs = 0.3	Poisson ratio chan.	vc = 0.3	
Shell diameter	Ds = 15.252 in	Channel diameter	Dc = 15.252 in	
Shell thickness	ts = 0.425 in	Channel thickness	tc = 0.425 in	
Tube OD	dt = 0.75 in	Tube thickness	tt = 0.083 in	
Number of tube holes	Nt = 102	Tube pitch	p = 1.0 in	
Outer tube limit	Do = 14.5 in	Outer tube radius	ro = 6.875 in	
Tube expan. ratio	rho = 0.927	Tube expanded len.	ltx = 1.5915 in	
Gasket Gs diameter	Gs = 17.125 in	Gasket Gc diameter	Gc = 17.125 in	
Center distance	UL = 1.4142 in	Gasket G diameter	G = 17.125 in	
Tubesheet cor.all.	ct = 0.126 in	Pass groove depth	hgt = 0.1875 in	
Tubesheet cor.all.	cs = 0.126 in	Pass groove depth	hgs = 0.0 in	
Tubes cor.all.	c = -	Effective groove depth:	h'g = 0.0615 in	
h'g = MAX[(hgt-ct), (0)]		Bolt load	W* = 183610 lbf	
Bolt circle diameter	C = 19.0 in	Channel bolt load	Wm1c = 183610 lbf	
Shell bolt load	Wm1s = 159113 lbf	DL = (4*Ap/Cp)	DL = 9.3488 in	
Tubesheet diameter	A = 20.625 in	Actual tubesheet thk	ha = 1.9685 in	
Tubesheet thickness	h = 1.7165 in	UHX-12.5.1 Step 1. Determine Do, Mu, Mu* and h'g from UHX-11.5.1		
Basic ligamente efficiency, mu = (p - dt) / p mu = 0.25				
Effective tube hole diameter d* = dt-2*tt*(Et/E)*(St/S)*rho = 0.6461 in				
(maximum of) d* = dt-2*tt = 0.584 in				
d* = 0.6461 in				
Pass lane area limit 4*Do*p = 58 in2				
Actual pass lane area, AL = 48.9 in2				
Effective tube pitch = p/SQRT(1-(4*MIN[AL,4*Do*p]/Pi*Do**2)) p* = 1.1919 in				
Effective ligament efficiency, mu* = (p*-d*)/p* mu* = 0.4579				
UHX-12.5.2 Step 2. Calculate diameter ratios rhos and rhoc. For each loading case, calculate moment Mts due to pressures Ps and Pt acting on the unperforated tubesheet rim.				

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 Rhos = Gs / Do Rhos = 1.181 Rhoc = Gc / Do Rhoc = 1.181
 $MTS = (Do^{**2}/16) * ((rhos-1) * (rhos^{**2}+1) * Ps - (rhoc-1) * (rhoc^{**2}+1) * Pt)$
 Load case 1 2 3
 Shell Pressure, psi 0 520 520
 Tubes Pressure, psi -15 0 -15
 Moment MTS, lbf*in/in 85.46 2962.5 3047.95

UHX-12.5.3 Step 3. Calculate h/p. If rho changes, recalculate d* and mu* from figure UHX-11.5.1. Determin E*/E and v* relative to h/p from UHX-11.5.2.
 Determine E*/E and v* from Fig UHX-11.4 h/p = 1.7165
 Ratio E*/E = 0.5387 Factor v* = 0.3067

UHX-12.5.5 Step 5. Calculate diameter ratio K and coefficient F
 $K = A/Do$ K = 1.4224
 $F = ((1-v^*)/E^*) * E * \ln(K)$ F = 0.4534

UHX-12.5.6 Step 6. For each loading case, calculate moment M* acting on the unperforated tubesheet rim.

$M^* = Mts + ((Gc-Gs) / (2*Pi*Do)) * W^*$
 Load case 1 2 3
 Effective W, lbf 183610 159113 183610
 Moment M*, lbf*in/in 85.46 2962.5 3047.95

UHX-12.5.7 Step 7. For each loading case, calculate the maximum bending moments acting on the tubesheet at the periphery Mp and at the center Mo
 At the periphery:

$Mp = (M^* - (Do^{**2}/32) * F * (Ps - Pt)) / (1 + F)$

At the center:

$Mo = Mp + (Do^{**2}/64) * (3+v^*) * (Ps-pt)$

$M = \text{MAX}[|Mp|, |Mo|]$

Load case 1 2 3
 Mp, lbf*in/in 28.05 972.37 1000.42
 Mo, lbf*in/in 191 6621.18 6812.18
 M , lbf*in/in 191 6621.18 6812.18

UHX-12.5.8 Step 8. For each loading case, calculate the tubesheet bending stress sigma.

$\sigma = 6 * M / (\mu^* * (h - h'g)^{**2})$

Load case 1 2 3
 sigma, psi 914 31675 32588
 Allowable stress, psi 40000 40000 40000
 Min tubesheet thk, in 0.3116 1.5343 1.5554

UHX-12.5.9 Step 9. For each loading case, calculate the average shear stress in the tubesheet at the outer edge of the perforated region.

$\tau = 1/(4*\mu) * (Diam/h) * |Ps-Pt|$

Load case 1 2 3
 |Ps-Pt|, psi 15 520 535
 $3.2*S*\mu*h/Do$ 1894.1 1894.1 1894.1

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Diam = DL or Do, in	14.5	14.5	14.5
Tau, psi	127	4393	4519
Allowable stress, psi	16000	16000	16000
Min tubesheet thickness, in	0.0136	0.4713	0.4848

UHX-9 Tubesheet Flanged Extension

G = diameter of gasket load reaction	G = 17.125 in
hG = gasket moment arm	hG = 0.9375 in
Sa = allowable stress for tubesheet extension at ambient temperature	Sa = 20000 psi
Sd = allowable stress for tubesheet extension at design temperature	Sd = 20000 psi
Ta = ambient temperature	Ta = 70 F
Td = design temperature	Td = 302 F
Wo = flange design bolt load, operating conditions	Wo = 183610 lbf
Wg = flange design bolt load, gasket seating	Wg = 212605 lbf
Minimum required thickness of the tubesheet flanged extension	
hro = $\text{SQRT}((1.9 * Wo * hG) / (Sd * G))$	hro = 0.9772 in
hrg = $\text{SQRT}((1.9 * Wg * hG) / (Sa * G))$	hrg = 1.0515 in
hr = MAX[hro, hrg]	hr = 1.0515 in

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Pressure case	Ps psi	Pt psi	MTS	M*	Mp	Mo	M	F
-----lbf*in/in-----								
- 1 -	0	520	-2962	-2962	-972	-6621	6621	0.4534
- 2 -	520	0	2962	2962	972	6621	6621	0.4534
- 3 -	520	520	0	0	0	0	0	0.4534
- 4 -	0	-15	85	85	28	191	191	0.4534
- 5 -	520	0	2962	2962	972	6621	6621	0.4534
- 6 -	520	-15	3048	3048	1000	6812	6812	0.4534
- 7 -	0	520	-2962	-2962	-972	-6621	6621	0.4534
- 8 -	-15	0	-85	-85	-28	-191	191	0.4534
- 9 -	-15	520	-3048	-3048	-1000	-6812	6812	0.4534
- 10 -	0	-15	85	85	28	191	191	0.4534
- 11 -	-15	0	-85	-85	-28	-191	191	0.4534
- 12 -	-15	-15	0	0	0	0	0	0.4534

Pressure case	sigma psi	Smax psi	hmin in	tau psi	Smax psi	hmin in
- 1 -	31675	40000	1.5343	4393	16000	0.4713
- 2 -	31675	40000	1.5343	4393	16000	0.4713
- 3 -	0	40000	0.0615	0	16000	0.0
- 4 -	914	40000	0.3116	127	16000	0.0136
- 5 -	31675	40000	1.5343	4393	16000	0.4713
- 6 -	32588	40000	1.5554	4519	16000	0.4848
- 7 -	31675	40000	1.5343	4393	16000	0.4713
- 8 -	914	40000	0.3116	127	16000	0.0136
- 9 -	32588	40000	1.5554	4519	16000	0.4848
- 10 -	914	40000	0.3116	127	16000	0.0136
- 11 -	914	40000	0.3116	127	16000	0.0136
- 12 -	0	40000	0.0615	0	16000	0.0

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Component: Nozzle S1/S2

ASME VIII-1 2011a UG-27 Thickness of Cylinders under Internal Pressure
 --- Calculations --- Cylinder Internal Pressure

Material: SA-105 K03504 Forgings
 Design pressure P = 520 psi Design temperature T = 302 F
 Radiography = Full Joint efficiency E = 1
 Design stress S = 20000 psi
 Inside corr.allow. cai = 0.126 in Outside corr. all. cao = 0.0 in
 Material tolerance tol = 0.0 in Minimum thickness tmin = 0.3274 in
 Outside diameter OD = 5.75 in Corroded radius OR = 2.875 in
 - Min. thk. not less than UG-45, UG-16(b):
 - UG-45 ta Internal pressure:
 $t = (P \cdot OR / (S \cdot E + 0.4 \cdot P)) + cai + cao + tol = 0.2 \text{ in}$ APP.1-1(A)
 - UG-45 tb external pressure+cai+cao+tol t = 0.145 in
 Smaller of: t = 0.3274 in
 - UG-45 tb3 from Table UG-45+cai+cao+tol = 0.3334 in
 Greater of: t = 0.3274 in
 - UG-45 tb1 +cai+cao+tol = 0.3274 in
 - UG-16(b) +cai+cao+tol = 0.1885 in
 - UG-45 tb2 +cai+cao+tol = 0.1317 in
 Minimum thickness: tmin = 0.3274 in
 Nominal thickness: tnom = 0.875 in

ASME Section VIII-1 2011a UG-28 Thickness of Shells under Ext. Pressure
 --- Calculations --- Cylinder External Pressure

Material: SA-105 K03504 Forgings
 Design pressure PE = 15 psi Design temperature T = 299 F
 Inside corr. allow. CAI = 0.126 in Corrosion allow. CAO = 0 in
 Radiography = Full Material tol. Tol = 0 in
 Cyl. outside dia. Do = 5.75 in Cylinder length EP L = 6 in
 Max length EP Lmax = 300.0 in
 Nominal thickness tnom = 0.875 in (tnom-CAI-CAO-Tol) t = 0.749 in
 L/Do ratio Ldo = 1.0435 Do/t Dot = 7.6767
 (2*S) or (0.9*yield) SE = 31680 psi Mod. of elasticity ME = 28105000 psi
 A factor SII-D-FigG A = 0.068646 B factor CS-2 B = 17600
 Max allowed external pressure: Pa = B*((2.167/Dot)-0.0833) = 3502.07 psi
 Actual external design pressure: PE = 15 psi
 (Required cyl. tks. for nozzle attachments at PE, tre = 0.019 in)

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Component: Reinforcement Nozzle S1/S2

ASME Section VIII-1 2011a UG-37 Reinforcement Required for Openings in Shells and Formed Heads

--- Design Conditions:

Int. design pressure PI = 520 psi	Ext. design press. PE = 15 psi
Design temperature T = 302 F	Fig.UW-16.1 Sketch (c)
Vessel material: SA-516 K02700 Grd 70 Plate	
Inside corr. allow. CAI = 0.126 in	Outside corr.allow.CAO = 0.0 in
Vessel design stress Sv = 20000 psi	Joint efficiency E = 1
Vessel outside dia Do = 16.102 in	Corroded radius IR = 7.626 in
Nominal thickness tnom = 0.551 in	Reinforcement limit lp = 4.252 in
Req. tks. int.pres. tr = 0.2014 in	Req. tks.ext.pres. tre = 0.144 in
Corroded thickness t = 0.425 in	Reinf. efficiency E1 = 1.0

Attachment Material: SA-105 K03504 Forgings

Inside corr. allow. CAI = 0.126 in	Outside corr.allow.CAO = 0.0 in
Nozzle design stress Sn = 20000 psi	Joint efficiency E = 1
Nozzle outside dia. Don = 5.75 in	Corroded radius OR = 2.875 in
Nominal thickness tnom = 0.875 in	Reinforcement limit ln = 1.0625 in
Req.tks. int.pres. trn = 0.074 in	Req.tks.ext.pres. trne = 0.019 in
Corroded thickness tn = 0.749 in	Nozzle Projection ha = 0.0 in
	Nozzle Proj. used h = 0.0 in

Reinforcement element material:

Limit of reinf. Dp = 0.0 in	Nominal thickness te = 0.0 in
Outside diameter = 0.0 in	Design stress Se = 0 psi
Minimum weld size tmin = 0.425 in	Weld leg (1/2*tmin) = 0.0 in
Weld throat (1/2*tmin) = 0.2125 in	Weld throat (1/2*tmin) = 0.0 in
Weld throat tw (min) = 0.0 in	Weld throat tw = 0.0 in
weld throat tc (min) = 0.25 in	Weld throat tc = 0.2625 in
smaller |0.25 in |	Weld leg tw = 0.0 in
tc of |0.7 * tmin|	Weld leg tc = 0.375 in
Outward nozzle weld L1 = 0.375 in	fr1 = Sn/Sv = 1.0
Outer element weld L2 = 0.0 in	fr2 = Sn/Sv = 1.0
Inward nozzle weld L3 = 0.0 in	fr3 = Sn/Sv or Se/Sv = 1.0
Inward nozzle weld new = 0.0 in	fr4 = Se/Sv = 1.0
Corroded int.proj.thk ti = 0.0 in	

For Jacobs Canada Inc. c/o Canadian Natural Resources Limited
Job 13-3353
Item 104-E-135/136

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Heat Exchanger Mechanical Design Shell&TubeMech V8.0 (ASME 2012)

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Corroded inside diameter $d = 4.252$ in
Vessel wall length available for reinforcement $2*Lp-d = 4.252$ in
Plane correction factor (Fig.UG-37) $F = 1.0$
Offset distance from centerline $doff = 0.0$ in
Reinforcement areas (internal pressure condition) ASME 2011a UG-37
A1 = Vessel wall. Larger of:
| $(2*Lp-d)*(E1*t-F*tr) - 2*tn*(E1*t-F*tr)*(1-fr1)$ | = 0.9507 in2
| $2*(t+tn)*(E1*t-F*tr) - 2*tn*(E1*t-F*tr)*(1-fr1)$ | = 0.525 in2
A1 = 0.9507 in2
A2 = Nozzle wall outward | $5*(tn-trn)*fr2*t$ | = 1.4345 in2
Smaller of: | $5*(tn-trn)*fr2*tn$ | = 2.5281 in2
A2 = 1.4345 in2
A3 = Nozzle wall inward | $5*t*ti*fr2$ | = 0.0 in2
Smallest of: | $5*ti*ti*fr2$ | = 0.0 in2
| $2*h*ti*fr2$ | = 0.0 in2
A3 = 0.0 in2
A41 = Outward nozzle weld = $(L1**2)*fr3 = 0.1406$ in2
A42 = Outer element weld = $(L2**2)*fr4 = 0.0$ in2
A43 = Inward nozzle weld = $(L3**2)*fr2 = 0.0$ in2
A4 = 0.1406 in2
JE = pad joint efficiency = 1
A5 = Reinforcement pad Area = $(Dp-d-2*tn)*te*fr4*JE$ A5 = 0.0 in2
Aa = Area Available = $A1+A2+A3+A4+A5$ Aa = 2.5259 in2
A = Area required = $(d*tr*F)+2*tn*tr*F*(1-fr1)$ A = 0.8564 in2

ASME VIII-1 2011a Reinforcement areas (external pressure) UG-37(d)

A1 = Vessel wall. Larger of:
| $(2*Lp-d)*(E1*t-F*tre) - 2*tn*(E1*t-F*tre)*(1-fr1)$ | = 1.1948 in2
| $2*(t+tn)*(E1*t-F*tre) - 2*tn*(E1*t-F*tre)*(1-fr1)$ | = 0.6598 in2
A1 = 1.1948 in2
A2 = Nozzle wall outward | $5*(tn-trne)*fr2*t$ | = 1.5513 in2
Smaller of: | $5*(tn-trne)*fr2*tn$ | = 2.7339 in2
A2 = 1.5513 in2
A3 = Nozzle wall inward | $5*t*ti*fr2$ | = 0.0 in2
Smallest of: | $5*ti*ti*fr2$ | = 0.0 in2
| $2*h*ti*fr2$ | = 0.0 in2
A3 = 0.0 in2
A41 = Outward nozzle weld = $(L1**2)*fr3 = 0.1406$ in2
A42 = Outer element weld = $(L2**2)*fr4 = 0.0$ in2
A43 = Inward nozzle weld = $(L3**2)*fr2 = 0.0$ in2
A4 = 0.1406 in2
A5 = Reinforcement pad Area = $(Dp-d-2*tn)*te*fr4*JE$ A5 = 0.0 in2
Aa = Area Available = $A1+A2+A3+A4+A5$ Aa = 2.8867 in2
A = Area required = $0.5*(d*tre*F+2*tn*tre*F*(1-fr1))$ A = 0.3062 in2
Nozzle attachment weld loads per UG-41 not required per UW-15(b).

For **Jacobs Canada Inc. c/o Canadian Natural Resources Limited**

Date **Apr 04, 2013**

Job **13-3353**
Item **104-E-135/136**

Dsgn **HW**
Chkd **VG**
Rev **0**

Heat Exchanger Mechanical Design Shell&TubeMech V8.0 (ASME 2012)

File: 133353(mawp).EDR

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Component: Nozzle T1/T2

ASME VIII-1 2011a UG-27 Thickness of Cylinders under Internal Pressure
--- Calculations --- Cylinder Internal Pressure

Material: SA-105 K03504 Forgings

Design pressure P = 520 psi Design temperature T = 302 F

Radiography = Full Joint efficiency E = 1

Design stress S = 20000 psi

Inside corr.allow. cai = 0.126 in Outside corr. all. cao = 0.0 in

Material tolerance tol = 0.0 in Minimum thickness tmin = 0.3274 in

Outside diameter OD = 5.75 in Corroded radius OR = 2.875 in

- Min. thk. not less than UG-45, UG-16(b):

- UG-45 ta Internal pressure:

$$t = (P \cdot OR / (S \cdot E + 0.4 \cdot P)) + cai + cao + tol = 0.2 \text{ in} \quad \text{APP.1-1(A)}$$

- UG-45 tb external pressure+cai+cao+tol t = 0.145 in

Smaller of: t = 0.3274 in

- UG-45 tb3 from Table UG-45+cai+cao+tol = 0.3334 in

Greater of: t = 0.3274 in

- UG-45 tb1 +cai+cao+tol = 0.3274 in

- UG-16(b) +cai+cao+tol = 0.1885 in

- UG-45 tb2 +cai+cao+tol = 0.1317 in

Minimum thickness: tmin = 0.3274 in

Nominal thickness: tnom = 0.875 in

ASME Section VIII-1 2011a UG-28 Thickness of Shells under Ext. Pressure
--- Calculations --- Cylinder External Pressure

Material: SA-105 K03504 Forgings

Design pressure PE = 15 psi Design temperature T = 299 F

Inside corr. allow. CAI = 0.126 in Corrosion allow. CAO = 0 in

Radiography = Full Material tol. Tol = 0 in

Cyl. outside dia. Do = 5.75 in Cylinder length EP L = 6 in

Max length EP Lmax = 300.0 in

Nominal thickness tnom = 0.875 in (tnom-CAI-CAO-Tol) t = 0.749 in

L/Do ratio Ldo = 1.0435 Do/t Dot = 7.6767

(2*S) or (0.9*yield) SE = 31680 psi Mod. of elasticity ME = 28105000 psi

A factor SII-D-FigG A = 0.068646 B factor CS-2 B = 17600

Max allowed external pressure: Pa = B*((2.167/Dot)-0.0833) = 3502.07 psi

Actual external design pressure: PE = 15 psi

(Required cyl. thks. for nozzle attachments at PE, tre = 0.019 in)

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Component: Reinforcement Nozzle T1/T2

ASME Section VIII-1 2011a UG-37 Reinforcement Required for Openings in Shells and Formed Heads

--- Design Conditions:

Int. design pressure PI = 520 psi	Ext. design press. PE = 15 psi
Design temperature T = 302 F	Fig.UW-16.1 Sketch (c)
Vessel material: SA-516 K02700 Grd 70 Plate	
Inside corr. allow. CAI = 0.126 in	Outside corr.allow.CAO = 0.0 in
Vessel design stress Sv = 20000 psi	Joint efficiency E = 1
Vessel outside dia Do = 16.102 in	Corroded radius IR = 7.626 in
Nominal thickness tnom = 0.551 in	Reinforcement limit lp = 4.252 in
Req. tks. int.pres. tr = 0.2014 in	Req. tks.ext.pres. tre = 0.054 in
Corroded thickness t = 0.425 in	Reinf. efficiency E1 = 1.0
Attachment Material: SA-105 K03504 Forgings	
Inside corr. allow. CAI = 0.126 in	Outside corr.allow.CAO = 0.0 in
Nozzle design stress Sn = 20000 psi	Joint efficiency E = 1
Nozzle outside dia. Don = 5.75 in	Corroded radius OR = 2.875 in
Nominal thickness tnom = 0.875 in	Reinforcement limit ln = 1.0625 in
Req.tks. int.pres. trn = 0.074 in	Req.tks.ext.pres. trne = 0.019 in
Corroded thickness tn = 0.749 in	Nozzle Projection ha = 0.0 in
	Nozzle Proj. used h = 0.0 in
Reinforcement element material:	
Limit of reinf. Dp = 0.0 in	Nominal thickness te = 0.0 in
Outside diameter = 0.0 in	Design stress Se = 0 psi
Minimum weld size tmin = 0.425 in	Weld leg (1/2*tmin) = 0.0 in
Weld throat (1/2*tmin) = 0.2125 in	Weld throat (1/2*tmin) = 0.0 in
Weld throat tw (min) = 0.0 in	Weld throat tw = 0.0 in
Weld throat tc (min) = 0.25 in	Weld throat tc = 0.2625 in
smaller |0.25 in |	Weld leg tw = 0.0 in
tc of |0.7 * tmin|	Weld leg tc = 0.375 in
Outward nozzle weld L1 = 0.375 in	fr1 = Sn/Sv = 1.0
Outer element weld L2 = 0.0 in	fr2 = Sn/Sv = 1.0
Inward nozzle weld L3 = 0.0 in	fr3 = Sn/Sv or Se/Sv = 1.0
Inward nozzle weld new = 0.0 in	fr4 = Se/Sv = 1.0
Corroded int.proj.thk ti = 0.0 in	



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Corroded inside diameter

$$d = 4.252 \text{ in}$$

Vessel wall length available for reinforcement $2*Lp-d = 4.252 \text{ in}$

Plane correction factor (Fig.UG-37) $F = 1.0$

Offset distance from centerline $doff = 0.0 \text{ in}$

Reinforcement areas (internal pressure condition) ASME 2011a UG-37

A1 = Vessel wall. Larger of:

$$|(2*Lp-d)*(E1*t-F*tr)-2*tn*(E1*t-F*tr)*(1-fr1)| = 0.9507 \text{ in}^2$$

$$|2*(t+tn)*(E1*t-F*tr)-2*tn*(E1*t-F*tr)*(1-fr1)| = 0.525 \text{ in}^2$$

$$A1 = 0.9507 \text{ in}^2$$

A2 = Nozzle wall outward $|5*(tn-trn)*fr2*t| = 1.4345 \text{ in}^2$

Smaller of: $|5*(tn-trn)*fr2*tn| = 2.5281 \text{ in}^2$

$$A2 = 1.4345 \text{ in}^2$$

A3 = Nozzle wall inward $|5*t*ti*fr2| = 0.0 \text{ in}^2$

Smallest of: $|5*ti*ti*fr2| = 0.0 \text{ in}^2$

$$|2*h*ti*fr2| = 0.0 \text{ in}^2$$

$$A3 = 0.0 \text{ in}^2$$

A41 = Outward nozzle weld = $(L1**2)*fr3 = 0.1406 \text{ in}^2$

A42 = Outer element weld = $(L2**2)*fr4 = 0.0 \text{ in}^2$

A43 = Inward nozzle weld = $(L3**2)*fr2 = 0.0 \text{ in}^2$

$$A4 = 0.1406 \text{ in}^2$$

JE = pad joint efficiency = 1

A5 = Reinforcement pad Area = $(Dp-d-2*tn)*te*fr4*JE$ $A5 = 0.0 \text{ in}^2$

Aa = Area Available = $A1+A2+A3+A4+A5$ $Aa = 2.5259 \text{ in}^2$

A = Area required = $(d*tr*F)+2*tn*tr*F*(1-fr1)$ $A = 0.8564 \text{ in}^2$

ASME VIII-1 2011a Reinforcement areas (external pressure) UG-37 (d)

A1 = Vessel wall. Larger of:

$$|(2*Lp-d)*(E1*t-F*tre)-2*tn*(E1*t-F*tre)*(1-fr1)| = 1.5775 \text{ in}^2$$

$$|2*(t+tn)*(E1*t-F*tre)-2*tn*(E1*t-F*tre)*(1-fr1)| = 0.8711 \text{ in}^2$$

$$A1 = 1.5775 \text{ in}^2$$

A2 = Nozzle wall outward $|5*(tn-trne)*fr2*t| = 1.5513 \text{ in}^2$

Smaller of: $|5*(tn-trne)*fr2*tn| = 2.7339 \text{ in}^2$

$$A2 = 1.5513 \text{ in}^2$$

A3 = Nozzle wall inward $|5*t*ti*fr2| = 0.0 \text{ in}^2$

Smallest of: $|5*ti*ti*fr2| = 0.0 \text{ in}^2$

$$|2*h*ti*fr2| = 0.0 \text{ in}^2$$

$$A3 = 0.0 \text{ in}^2$$

A41 = Outward nozzle weld = $(L1**2)*fr3 = 0.1406 \text{ in}^2$

A42 = Outer element weld = $(L2**2)*fr4 = 0.0 \text{ in}^2$

A43 = Inward nozzle weld = $(L3**2)*fr2 = 0.0 \text{ in}^2$

$$A4 = 0.1406 \text{ in}^2$$


A5 = Reinforcement pad Area = $(Dp-d-2*tn)*te*fr4*JE$ $A5 = 0.0 \text{ in}^2$

Aa = Area Available = $A1+A2+A3+A4+A5$ $Aa = 3.2694 \text{ in}^2$

A = Area required = $0.5*(d*tre*F+2*tn*tre*F*(1-fr1))$ $A = 0.1148 \text{ in}^2$

Nozzle attachment weld loads per UG-41 not required per UW-15(b).

For Jacobs Canada Inc. c/o Canadian Natural Resources Limited
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Heat Exchanger Mechanical Design Shell&TubeMech V8.0 (ASME 2012)

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Maximum Allowable Working Pressures

* = Shell Side MAWP + = Tube Side MAWP

Component	Side	--Design conditions--			---- New and cold ----		
		Temp F	Stress psi	MAWP psi	Temp F	Stress psi	MAWP psi
Shell Cylinder	S	302	20000	1078.6	70	20000	1407.3
Front Head Cylinder	T	302	20000	1078.6	70	20000	1407.3
Front Head Cover	T	302	20000	938.6	70	20000	1283.6
Shell Cover	S	302	20000	938.6	70	20000	1283.6
Front Tubesheet	S	302	20000	683.9	70	20000	899.4
Front Tubesheet	T	302	20000	683.9	70	20000	899.4
Front Head Flng At TS	T	302	20000	520.7+	70	20000	624.6+
Front Shell Flng	S	302	20000	520.4*	70	20000	686.8*
Tubes	T	302	13400	3253.9	70	13400	3253.9
Nozzle S1	S	302	20000	1932.6	70	20000	2272.4
Nozzle S2	S	302	20000	1932.6	70	20000	2272.4
Nozzle T1	T	302	20000	1932.6	70	20000	2272.4
Nozzle T2	T	302	20000	1932.6	70	20000	2272.4
Nozzle Flng S1	S	302	20000	654.6	70	20000	740
Nozzle Flng S2	S	302	20000	654.6	70	20000	740
Nozzle Flng T1	T	302	20000	654.6	70	20000	740
Nozzle Flng T2	T	302	20000	654.6	70	20000	740
Nozzle Reinforcement S1	S	302	-	961	70	-	1179
Nozzle Reinforcement S2	S	302	-	961	70	-	1179
Nozzle Reinforcement T1	T	302	-	961	70	-	1179
Nozzle Reinforcement T2	T	302	-	961	70	-	1179
Front Hd Bolting At TS	T	302	25000	684.2	70	25000	684.2
Front Hd Bolting At TS	S	302	25000	789.6	70	25000	789.6
Nozzle Flng Bolting S1	S	302	25000	654.6	70	25000	740
Nozzle Flng Bolting S2	S	302	25000	654.6	70	25000	740
Nozzle Flng Bolting T1	T	302	25000	654.6	70	25000	740
Nozzle Flng Bolting T2	T	302	25000	654.6	70	25000	740

SHELL SIDE

TUBE SIDE

MAWP(hot&corr)
 Limited by;

520 psi
 Front Shell Flange

520 psi
 Front Head Flange at TS

MAP(new&cold)
 Limited by;

686 psi
 Front Shell Flange

624 psi
 Front Head Flange at TS

For Jacobs Canada Inc. c/o Canadian Natural Resources Limited
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Heat Exchanger Mechanical Design Shell&TubeMech V8.0 (ASME 2012)

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Hydrostatic Test Pressure - ASME VIII-1 2011a UG-99 Factor: 1.3

Component	Material	Side	Temp F	Design	Test	Stress	Ratio
				Stress psi	Stress psi		
Shell Cylinder	SA-516 K02700	Grd 70 Plate	S 302	20000	20000		1
Front Head Cylinder	SA-516 K02700	Grd 70 Plate	T 302	20000	20000		1
Front Head Cover	SA-516 K02700	Grd 70 Plate	T 302	20000	20000		1
Shell Cover	SA-516 K02700	Grd 70 Plate	S 302	20000	20000		1
Front Tubesheet	SA-516 K02700	Grd 70 Plate	S 302	20000	20000		1
Front Head Flng At TS	SA-105 K03504	Forgings	T 302	20000	20000		1
Front Shell Flng	SA-105 K03504	Forgings	S 302	20000	20000		1
Tubes	SA-179 K01200	Smls. tube	T 302	13400	13400		1
Nozzle S1	SA-105 K03504	Forgings	S 302	20000	20000		1
Nozzle S2	SA-105 K03504	Forgings	S 302	20000	20000		1
Nozzle T1	SA-105 K03504	Forgings	T 302	20000	20000		1
Nozzle T2	SA-105 K03504	Forgings	T 302	20000	20000		1
Nozzle Flng S1	SA-105 K03504	Forgings	S 302	20000	20000		1
Nozzle Flng S2	SA-105 K03504	Forgings	S 302	20000	20000		1
Nozzle Flng T1	SA-105 K03504	Forgings	T 302	20000	20000		1
Nozzle Flng T2	SA-105 K03504	Forgings	T 302	20000	20000		1
Front Hd Bolting At TS	SA-193 G41400	Grd B7 Bolt(	T 302	25000	25000		-
Nozzle Flng Bolting S1	SA-193 G41400	Grd B7 Bolt(	S 302	25000	25000		-
Nozzle Flng Bolting S2	SA-193 G41400	Grd B7 Bolt(	S 302	25000	25000		-
Nozzle Flng Bolting T1	SA-193 G41400	Grd B7 Bolt(	T 302	25000	25000		-
Nozzle Flng Bolting T2	SA-193 G41400	Grd B7 Bolt(	T 302	25000	25000		-
Hydrostatic Test Pressure - UG-99 - Bolting exception							
Component	Material			1.3*LSR*All.Stress psi		90% Yield psi	
Front Hd Bolting At TS	SA-193 G41400	Grd B7 Bolt(		32499		105000	
Nozzle Flng Bolting S1	SA-193 G41400	Grd B7 Bolt(		32499		105000	

SHELL SIDE

TUBE SIDE

Shop HydroTest
1.3*MAP (new&cold)

892 psi

812 psi

Field HydroTest
1.3*LSR*MAWP (hot&corr.)

676 psi

676 psi

October 19, 2013

Attention: Document Control
EXCHANGER INDUSTRIES LIMITED
5811 46 STREET SE SUITE 200
CALGARY, AB

The design submission, tracking number 2013-06546, originally received on August 28, 2013 was surveyed and accepted for registration as follows:

CRN : W3077.2

Accepted on: October 19, 2013

Reg Type: New Design

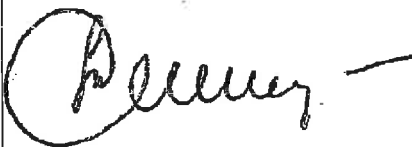
Drawing No. : 13-3353 A/B Rev 3

Description	MAWP	Design Temperature	MDMT
SS Internal Pressure	3585kPa	150 °C	-29 °C
SS External Pressure	103kPa	148 °C	-29 °C
TS Internal Pressure	3585kPa	150 °C	-29 °C
TS External Pressure	103kPa	148 °C	-29 °C

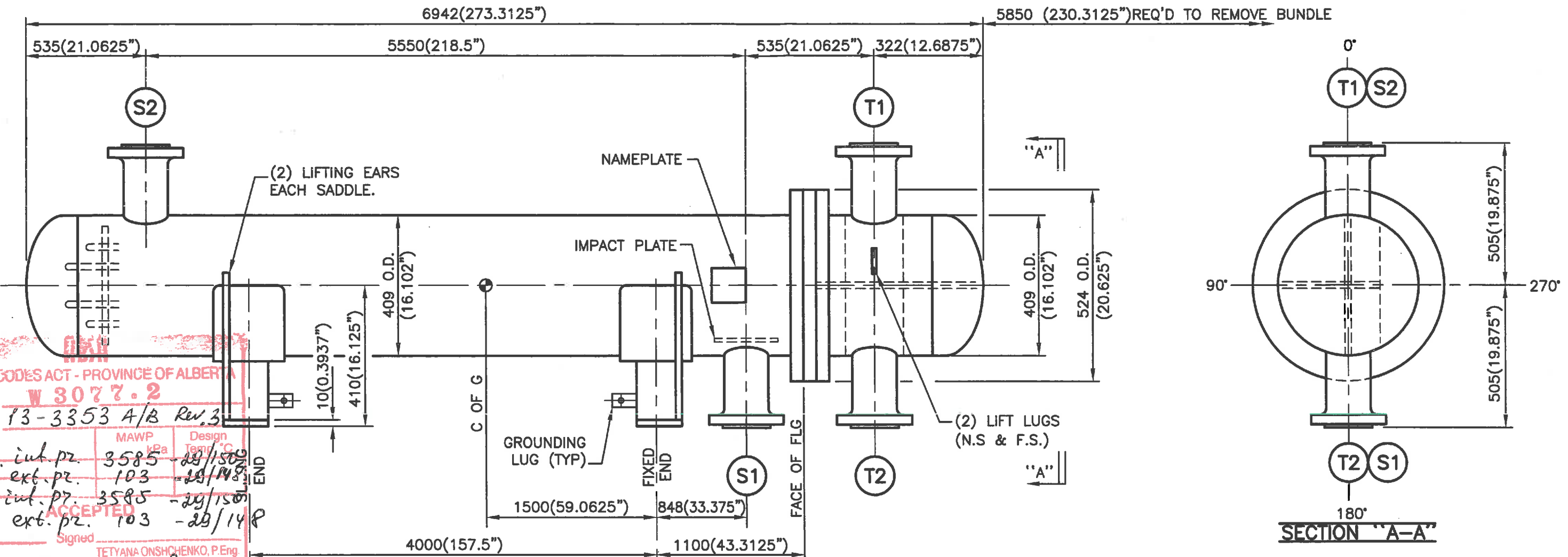
An invoice covering survey and registration fees will be forwarded from our Revenue Accounts.

Enclosed are stamped prints for your reference.

Sincerely,



ONSHCHENKO, TETYANA, P. Eng.



SAFETY CODES ACT - PROVINCE OF ALBERTA
 REG. No. **W 3077.2**
 DWG. No. **13-3353 A/B Rev. 3**

S.S. int. pz.	3585	28/1509
S.S. ext. pz.	103	28/1488
T.S. int. pz.	3585	29/1509
T.S. ext. pz.	103	29/1488

ACCEPTED

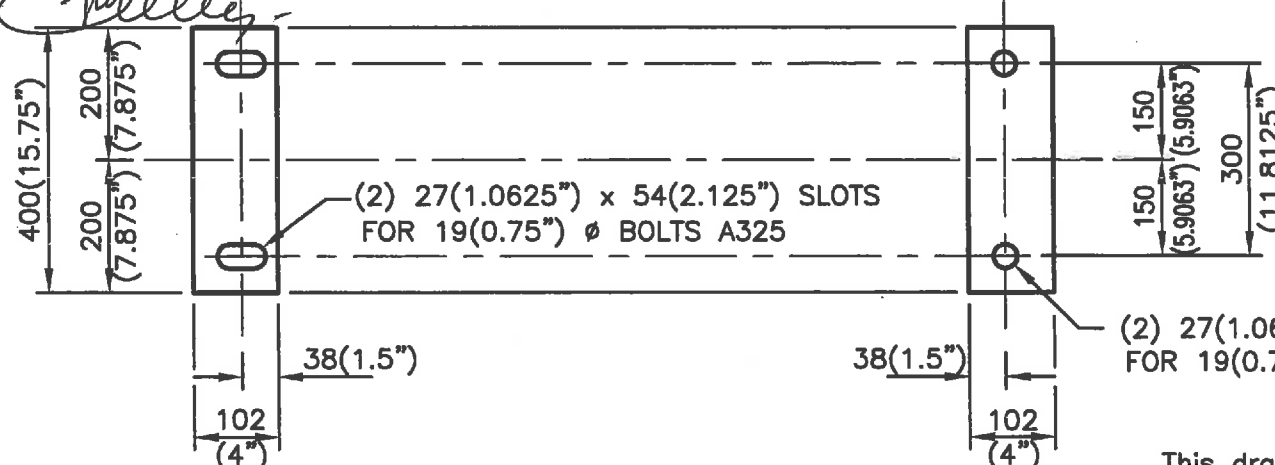
Signed: *Tetyana Onshchenko*
 TETYANA ONSHCENKO, P.Eng.
 DESIGN SURVEILLANCE ENGINEER

Date: **OCT 19 2013**

APPROVED FOR CONSTRUCTION

[Signature]

COPY OF EI JOB:-11-3014A/B
 DWN SP CKD KW



This drawing is the property of Exchanger Industries and shall not be used in any way detrimental to Exchanger Industries nor shall be copied, lent or used for any purpose other than that intended.

NOZZLE SCHEDULE					
MARK	SIZE	RATING	TYPE	SCH.	SERVICE
T1	4"	CL.300	RFLWN	-	CHANNEL INLET
T2	4"	CL.300	RFLWN	-	CHANNEL OUTLET
S1	4"	CL.300	RFLWN	-	SHELL INLET
S2	4"	CL.300	RFLWN	-	SHELL OUTLET

REVISION CONTROL BOX © Denotes DCR & Rev.# Added to This Sheet Only

1 PER CUST. MARK-UPS & E.I. MAY 16/2013 (FZ)

2 PER E.I. JULY 17/2013 (AG) © DCR-IFP-016523

3 PER E.I. AUG 2/2013 (AG) © DCR-NI-016545

CUSTOMER: CANADIAN NATURAL RESOURCES LTD.
 FOR: KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB
 P.O. NO.: CE416040-CC088996-00
 TEMA TYPE: BEU
 SIZE: 381-6096(15"-240")
 SERVICE: SALES OIL TANK HEATER

SHELL & TUBE EXCHANGER OUTLINE DRAWING

NO. OF EXCHANGERS REQ'D: TWO

DWN FX CKD KW ITEM 104-E-135/136

EXCHANGER INDUSTRIES LIMITED
 CALGARY, ALBERTA

DWG NO. 13-3353A/B

SHEET 1 OF 13

MATERIAL LIST

CONSTRUCTION NOTES

LINE	PART	MATERIAL
CHANNEL		
1	COVER/HEAD	SA-516-70N
2	TEMA FLANGE	SA-105N
3	CYLINDER	SA-516-70N
4	NOZZLE FLANGE	SA-105N
5	NOZZLE NECK	-
6	NOZZLE REINFORCEMENT PAD	-
7	COUPLING/THREDOLET/PLUG	-
8	PASS PLATE	SA-516-70N/SA-106-B
9	STUDBOLTS	SA-193-B7
10	NUTS	SA-194-2H
11		
12		
SHELL		
13	TEMA FLANGE	SA-105N
14	CYLINDER	SA-516-70N
15	COVER/HEAD	SA-516-70N
16	CONE	-
17	NOZZLE FLANGE	SA-105N
18	NOZZLE NECK	-
19	NOZZLE REINFORCEMENT PAD	-
20	COUPLING/THREDOLET/PLUG	-
21	SUPPORT WRAPPER PLATE	SA-516-70N&I.T.
22	SUPPORT	SA-516-70N&I.T.
23	STUDBOLTS	SA-193-B7
24	NUTS	SA-194-2H
25		
26		
27		
FLOATING HEAD		
28	BACKING RING	-
29	COVER FLANGE	-
30	DISH	-
31	PASS PLATE	-
32	STUDBOLTS	-
33	NUTS	-
34		
35		
36		

LINE	PART	MATERIAL
TUBE BUNDLE		
37	TUBESHEET	SA-516-70N
38	TUBES	SA-179 ANNEALED
39	BAFFLE/SUPPORT PLATES	SA-36 OR EQ.
40	IMPINGEMENT PLATE	SA-36 OR EQ.
41	TIE-ROD/NUT/SPACER	CARBON STEEL
42		
43		
GASKETS		
44	CHANNEL	KAMMPROFILE*
45	SHELL	KAMMPROFILE*
46	FLOATING HEAD	-
47	CHANNEL NOZZLE	-
48	SHELL NOZZLE	-
49		
50		

MATERIAL NOTES

*316 S.S. CORE, FLEX, GRAPHITE

(1) E.I. TO SUPPLY ONE SET OF SPARE TEMA FLANGE GASKETS AND 10% (MIN 2 SETS) OF SPARE TEMA FLANGE BOLTING

(2) FLG FACES TO HAVE A SURFACE FINISH 125-150 Ra.

(3) MDMT FOR LIFTING LUGS & SUPPORTS TO BE -45°C(-49°F).

CONSTRUCTION NOTES

(12) PAINT:

(a) SANDBLAST TO SSPC-SP6

(b) PRIME WITH ONE COAT OF INTERNATIONAL INTERTHERM 228 4-5 MILS DFT

(c) PROTRUSIONS ONLY - FINISH WITH (1) ONE COAT OF INTERNATIONAL INTERFINE 629-HS 2-3 MILS DFT (GRAY 80326)

(13) DESICCANT FOR TUBESIDE & SHELLSIDE.

REVISIONS

⚠ PER CUST. MARK-UPS & E.I. MAY 16/2013 (FZ)

⚠ PER E.I. JULY 17/2013 (AG)

⚠ PER E.I. AUG 2/2013 (AG)

(1) CONSTRUCTION TO BE PER ASME CODE SECTION VIII DIVISION 1 2010 EDITION, 2011a ADDENDA, TEMA CLASS "R" 9th EDITION, API 660 AND CUSTOMER SPECIFICATIONS.

(2) ALL BOLT HOLES TO STRADDLE CENTER LINES UNLESS NOTED OTHERWISE.

(3) CODE STAMP REQ'D: YES (PROVINCE OF ALBERTA).

(4) IMPACT TESTING: EXEMPT PER UG-20 (f) 1-5

(5) STRESS RELIEVE: (CHARTED) U-BENDS & 152mm(6") OF STRAIGHT LENGTH @ 635°C ±15°C FOR 1 HOUR (ELECTRIC RESISTANCE METHOD). (1175°F ±27°F)

(6) RADIOGRAPHY: RT1 SHELL & CHANNEL. ⚠ ⚠ ⚠ repairs requir

(7) WELD PROCEDURES: WPS 210, WPS-SAW 4/210, C2 & C17(REPART) requir

(8) INSULATION: 64mm(2.5") THK. MINERAL WOOL C/W ALUMINUM ON SHELL & ⚠ 51mm(2") THK. ON CHANNEL. INSULATION BLANKETS ON TEMA FLGS (BY E.I.)

(9) 100% MT LIFT LUG WELDS.

(10) SUPPLIED BUNDLES ARE INTERCHANGEABLE.

(11) TOLERANCE PER "STANDARD FABRICATION TOLERANCE" REV.0 (LOCATED IN WELDING PROCEDURE LOG BOOK)

W 3077.2

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* REGISTER AT MAWP # CHARTED

DESIGN CONDITIONS	SHELL SIDE	CHANNEL SIDE
PROCESS DESIGN PRESSURE*	3500 kPaG(507 PSIG)	3500 kPaG(507 PSIG)
EXTERNAL PRESSURE	FV @ 148°C(299°F)	FV @ 148°C(299°F)
DESIGN TEMPERATURE.	150°C(302°F)	150°C(302°F)
MDMT	-29°C(-20°F)	-29°C(-20°F)
C&H MAWP	3585 kPaG(520 PSIG)	3585 kPaG(520 PSIG)
C&H MAWP LIMITED BY	TEMA FLANGE	TEMA FLANGE
FIELD HYDRO TEST PRESSURE	4661 kPaG(676 PSIG)	4661 kPaG(676 PSIG)
CORROSION ALLOWANCE	3.2 mm(0.126")	3.2 mm(0.126")
N&C MAX. PRESS.	4729 kPaG(686 PSIG)	4302 kPaG(624 PSIG)
N&C M.P. LIMITED BY	TEMA FLANGE	TEMA FLG BOLTING
SHOP HYDRO TEST PRESS.#	6151 kPaG(892 PSIG)	5599 kPaG(812 PSIG)
NUMBER OF PASSES	E-SHELL	FOUR
SURFACE AREA	36.6 SQ. M(393.9 SQ.Ft)	(EACH)
SHIPPING WEIGHT	2500 kgs(5511 Lbs)	(EACH)
WEIGHT FULL OF WATER	3250 kgs(7165 Lbs)	(EACH)
BUNDLE WEIGHT	820 kgs(1808 Lbs)	(EACH)
CHANNEL WEIGHT	210 kgs(463 Lbs)	(EACH)
CAPACITY	0.75 CU. M(26.49 CU.Ft)	(EACH)


MATERIALS & DESIGN CONDITIONS

NO. OF EXCHANGERS REQ'D: TWO

PO #: CE416040-CC088996-00

⚠ CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB

DWN FX | CKD KW | ITEM 104-E-135/136


EXCHANGER INDUSTRIES LIMITED
CALGARY, ALBERTA

DWG NO. 13-3353A/B

SHEET 1A OF 13

1. NOTE: Any material welding to a pressure component must have a MTR and traceability or be qualified under Section VIII, Div. 1 ASME code for welding to a pressure part.

2. For removable-bundle heat exchangers, the permissible out-of-roundness of a completed shell, after all welding and heat treatment, shall allow a metal template to pass through the entire shell length without binding. The template shall consist of two rigid disks (each with a diameter equal to the diameter of the transverse baffle or support plate), rigidly mounted perpendicularly on a shaft and spaced not less than 300 mm (12") apart.

3. Welds attaching non-pressure attachments (such as lugs or structural steel supports, except for insulation support rings) shall be continuous.

4. All exposed flange gasket surfaces shall be coated with an easily removable rust preventative and shall be protected by a wood, plastic, or steel cover complete with rubber gasket and (4) four bolts minimum.

5. All welded attachments provided with tell tale holes shall be pneumatically tested with 350 kPag (50.76 psig) air prior to PWHT and/or hydrotest.

6. The item number, shipping weight, center of gravity and purchase order number shall be painted on the exchanger.

7. All boxes, crates, or packages shall be identified with the purchaser's order and equipment number.

8. RT - Radiography Examination & acceptance criteria in accordance with ASME Section VIII, Div.1, UW-51, ASME Section V Article 2 T220, standards as defined in ASME Section V Article 22.

9. a). The interior of all exchangers shall be free of oil, grease, weld slag, scale, dirt, grit, weld splatter, rust, rags, wood, and other foreign matter.

b) Exchangers containing or coated with insulating fluids, corrosion inhibitors, antifreeze solutions, desiccants, or other chemicals shall be prominently tagged or labeled at openings or other appropriate locations to indicate the nature of the contents and precautions for shipping, storage, and handling.

c) Material Safety Data Sheets (MSDS) for these chemicals shall comply with all relevant regulations where the equipment will be located. If any chemical is exempt from such laws, a statement to that effect shall be included on the MSDS.

d) Material Safety Data Sheets (MSDS) for the exchanger shall be provided to the shipper at the time of shipping.

10. MPI - Magnetic particle examination and criteria for acceptance shall comply with ASME Section V Article 7 (T720), Appendix 6 of Sec.VIII Div.1 and standards as defined in ASME Section V Article 25.

11. LPI - Liquid penetrant examination and criteria for acceptance shall comply with appendix 8 of section VIII, Div 1, ASME code.

12. UT- Ultrasonic examination in accordance with ASME Section V Art. 4 T420 (for welds) and ASME section V Art.5 T520 (for materials), and standards as defined in ASME Section V Art.23.

13. Weld Hardness Testing:

a) The weld metal and heat-affected zone of pressure retaining welds in components made from a material that has a P number of 1 shall be tested.

b) Examination shall be made after any postweld heat treatment.

c) Hardness shall not exceed 237 Brinell for materials with P numbers of 1 (for sweet service).

d) Hardness shall be determined using a 10 millimeter diameter ball unless otherwise specified.

e) One longitudinal weld, one circumferential weld, and each connection-to-component weld where the connection is NPS 2 or larger shall be tested.

f) If more than one welding procedure is used to fabricate longitudinal or circumferential welds, hardness readings shall be made of welds deposited by each procedure.

14. The hydrotest pressure shall be maintained for at least 1 hour, using potable water & charted.

15. Gasket used for hydrotest shall be of the same material and design as the gasket to be furnished with the exchanger.

16. Flanged joints that have been taken apart after hydrostatic test shall be reassembled with unused gaskets and re-hydrotest.

17. Paint or other external coatings shall not be applied over welds before the final hydrostatic test.

18. The following parts shall be stamped with the manufacturer's serial number: channel & shell girth flanges, tubsheet.

19. No welding after hydrotest.

20. Permanent backing rings shall not be used.

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REVISIONS
△ PER CUST. MARK-UPS MAY 16/2013 (FZ)

API 660 8th EDITION
NOTES & CUST. SPEC'S

PO #: CE416040-CC088996-00

△ CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB

DWN FX | CKD KW | ITEM 104-E-135/136


EXCHANGER INDUSTRIES
LIMITED
CALGARY, ALBERTA

DWG NO. 13-3353A/B

SHEET 1B OF 13

0.8(0.03125") THK X 152(6") X 159(6.25")
 MAT'L: STAINLESS STEEL



CERTIFIED BY
EXCHANGER INDUSTRIES LIMITED
 CALGARY, ALBERTA, CANADA

U	MAWP: SHELL	3585 kPaG	AT	150 °C
W	MAWP: SHELL	103 kPaG	AT	148 °C
RT1	MAWP: TUBE	3585 kPaG	AT	150 °C
PHT-T	MAWP: TUBE	103 kPaG	AT	148 °C
-	MDMT: SHELL	-29 °C	AT	3585 kPaG
-	MDMT: TUBE	-29 °C	AT	3585 kPaG

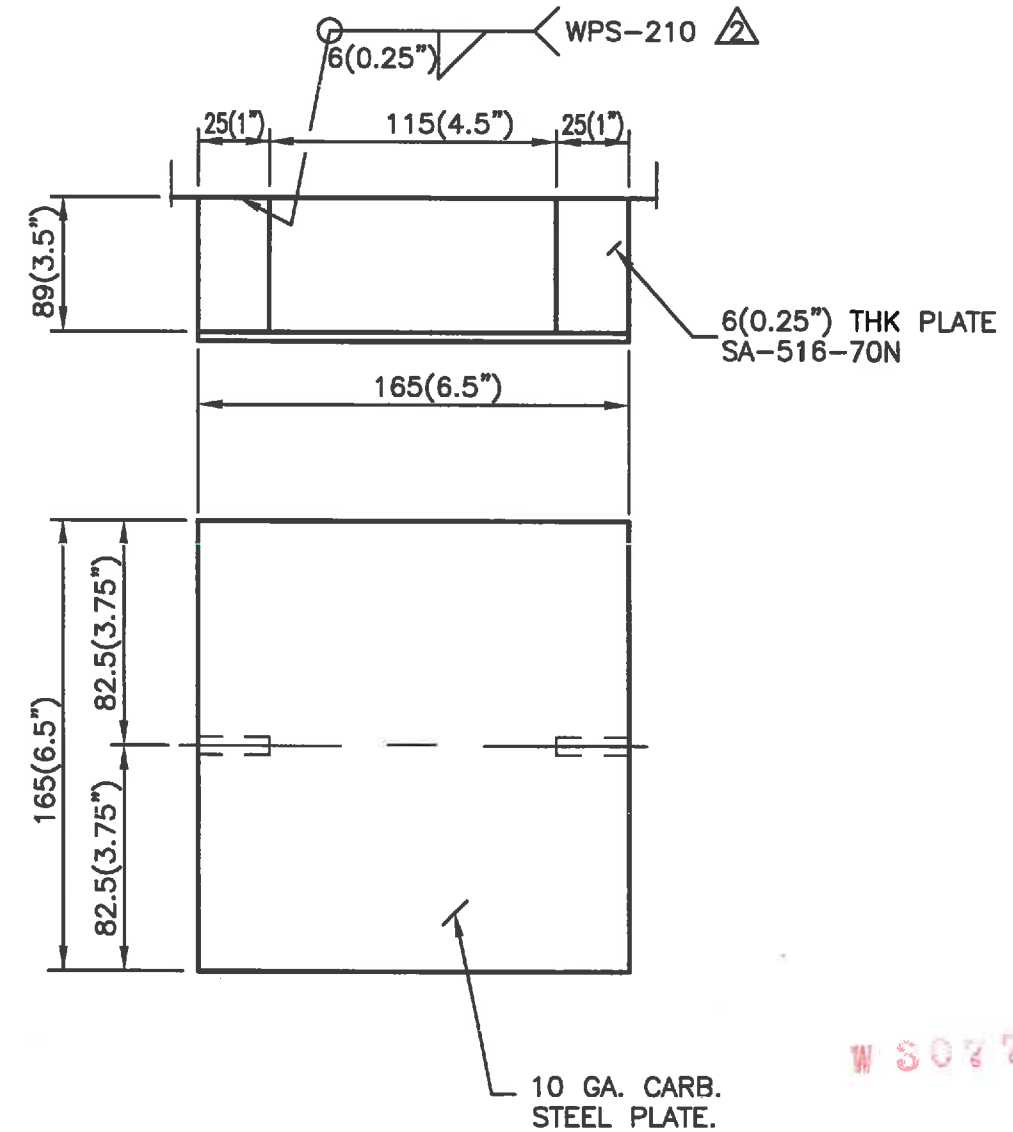
SERIAL NO. **13-3353*** YEAR MFD. **2014**

SALES OIL TANK HEATER
 PO NO.: CE416040-CC088996-00 ITEM #: 104-E-** CNRL KNP-1
 SIZE: 381-6096 TYPE: BEU TEMA CLASS: "R"
 TEST PRESS: SHELL: 4661 kPaG TUBE SIDE: 4661 kPaG
 SHELL MAT'L SA-516-70N THK 14 MIN. C.A. 3.2
 CHAN. MAT'L SA-516-70N THK 14 MIN. C.A. 3.2
 TUBE MAT'L: SA-179 ANNEALED 14 BWG M/W

PROV. REG. CRN

NO. REQ'D EACH EXCHANGER: ONE

* **
 A 135
 B 136

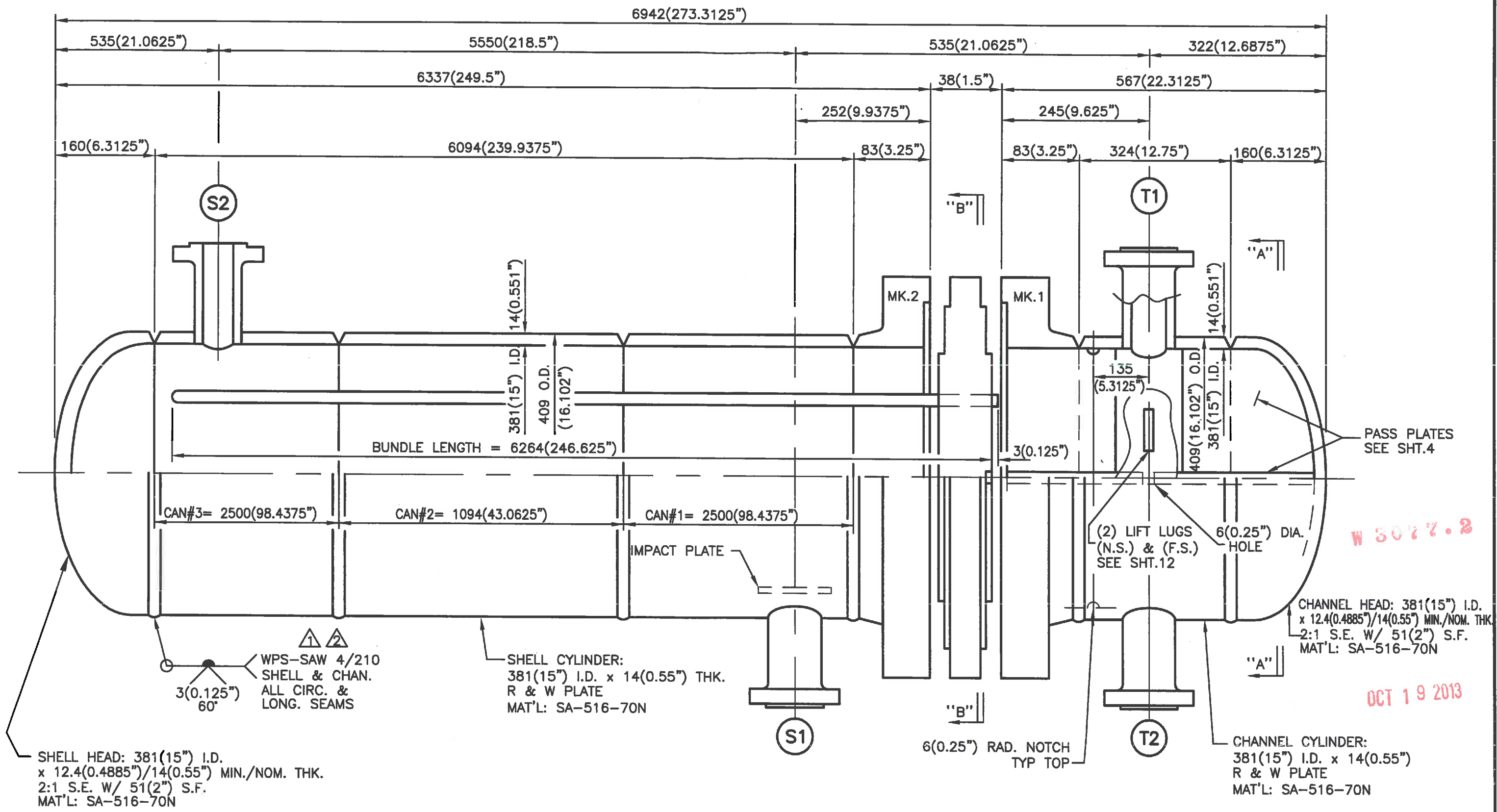


NAMEPLATE BKT DETAIL

W 3077.2

OCT 19 2013

REVISIONS PER CUST. MARK-UPS & E.I. MAY 16/2013 (FZ) PER E.I. JULY 17/2013 (AG)	NAME PLATE DETAIL NO. REQ'D EACH EXCHANGER: ONE NO. OF EXCHANGERS REQ'D: TWO		 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA
	PO #: CE416040-CC088996-00			DWG NO. 13-3353A/B
CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB		DWN FX CKD KW ITEM 104-E-135/136	SHEET 2 OF 13



REVISIONS

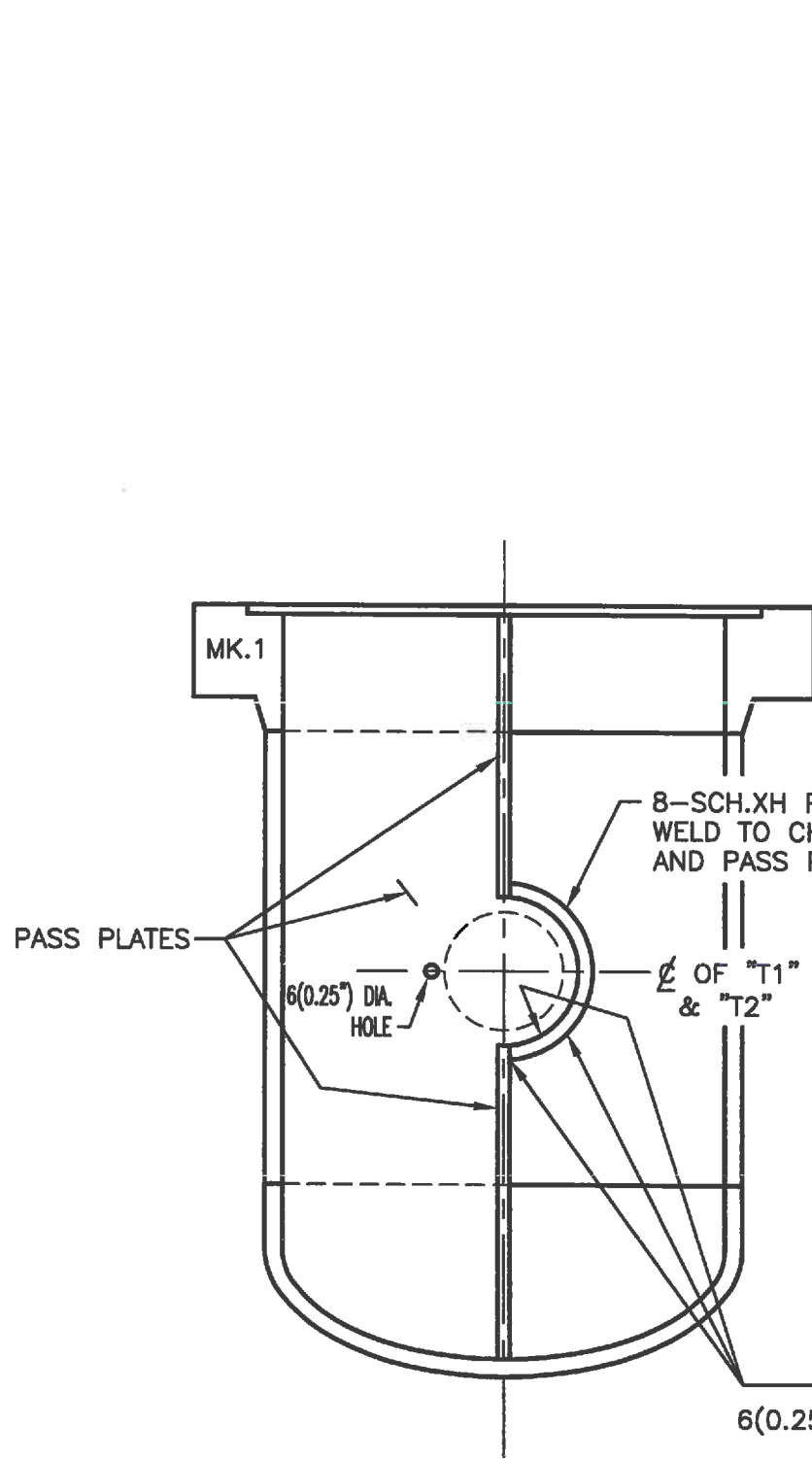
1	PER CUST. MARK-UPS MAY 16/2013 (FZ)
2	PER E.I. JULY 17/2013 (AG)

SHELL & CHANNEL DETAIL	
NO. OF EXCHANGERS REQ'D: TWO	
PO #: CE416040-CC088996-00	
CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB	
DWN FX	CKD KW
ITEM104-E-135/136	

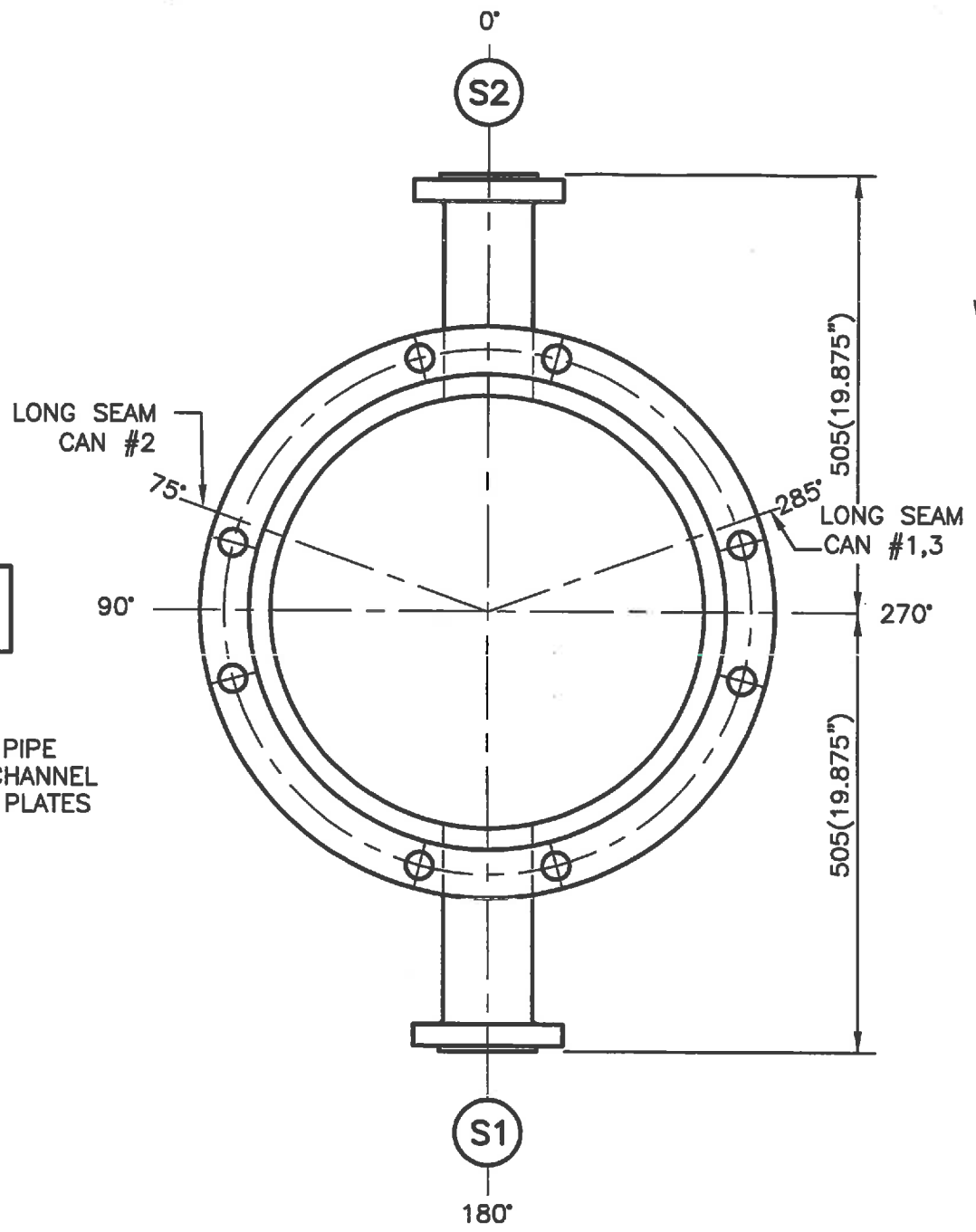

**EXCHANGER INDUSTRIES
LIMITED**
 CALGARY, ALBERTA

DWG NO. 13-3353A/B

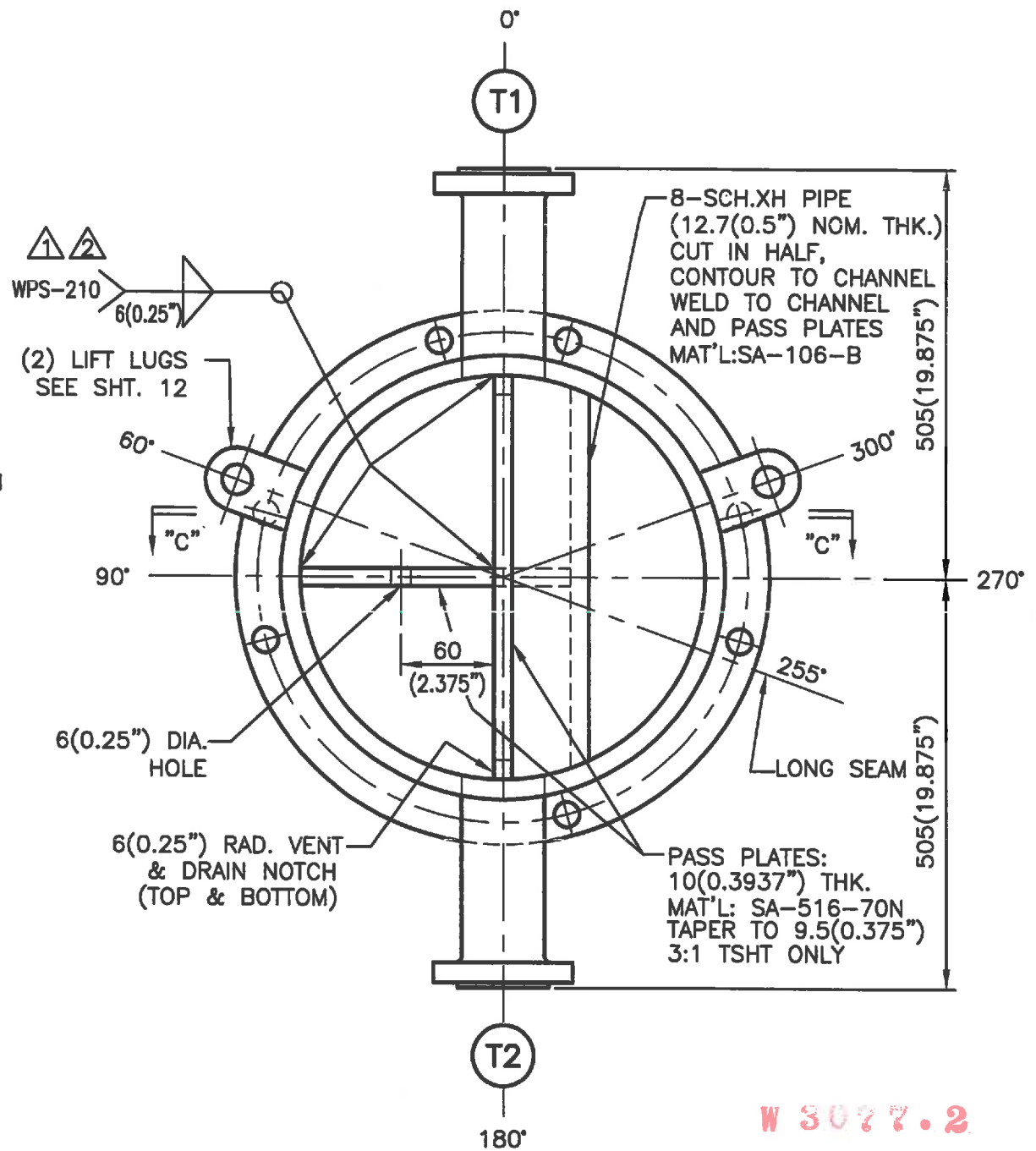
SHEET 3 OF 13



VIEW "C-C"



SECTION "B-B"
 PREHEAT WELDS: 10°C(50°F)
 RADIOGRAPHY: RT1
 POST HEAT TREAT: NO



SECTION "A-A"
 PREHEAT WELDS: 10°C(50°F)
 RADIOGRAPHY: RT1
 POST HEAT TREAT: NO

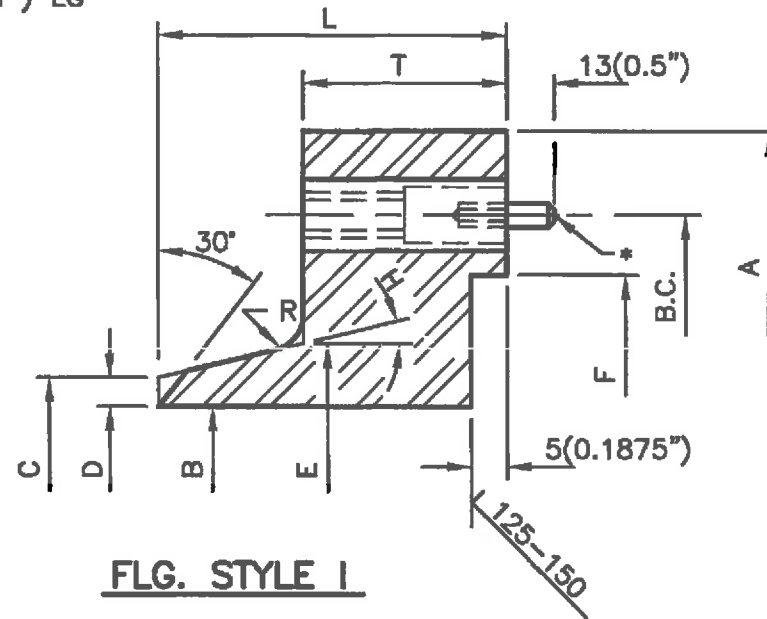
W 3027.2
 OCT 19 2013

REVISIONS ⚠ PER CUST. MARK-UPS MAY 16/2013 (FZ) ⚠ PER E.I. JULY 17/2013 (AG)	
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SHELL & CHANNEL SECTIONS NO. OF EXCHANGERS REQ'D: TWO		
PO #: CE416040-CC088996-00		
⚠ CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB		
DWN FX	CKD KW	ITEM 104-E-135/136

 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA
DWG NO. 13-3353A/B
SHEET 4 OF 13

* (1) 10(0.3937") DIA. X 25(1") LG
 CARB. STL DOWEL PIN.
 DRILL & TAP 13(0.5") DEEP
 ON B.C. @ 0' IN MK.1 & 2.



FLG. STYLE I

W 3077.2

OCT 19 2013

MATERIAL: SA-105N

250 OVERALL FINISH EXCEPT AS NOTED.

LOCATE (2) 12.7(0.5") DIA. JACKSCREWS ON 495(19.5") DIA. @ 90° & 270°. DRILL & TAP(BACK FLG. SIDE) 19.05(0.75") DEEP & COUNTERBORE REMAINDER TO 15.9(0.625") DIA. ON MK.1 & 2

LINE NO.	MK. NO.	NO. REQ'D	FLG. STYLE	A	B	C	D	E	F	G	H	R	T	L	B.C.	BOLT HOLES	
																NO.	DIA.
1	1	ONE	I	524 (20.625")	381 (15")	409 (16.102")	14 (0.551")	416 (16.352")	448 (17.625")	-	7.12"	11.1 (0.4375")	57 (2.25")	83 (3.25")	483 (19")	32	22.2 (0.875")
2	2	ONE	I														

REVISIONS

△ PER CUST. MARK-UPS MAY 16/2013 (FZ)

FLANGE DETAIL

MK.1 381(15") - 4661 kPaG(676 PSIG)
 MK.2 381(15") - 4661 kPaG(676 PSIG)
 DESIGN TEMA "R"
 NO. OF EXCHANGERS REQ'D: TWO

PO #: CE416040-CC088996-00

△ CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB

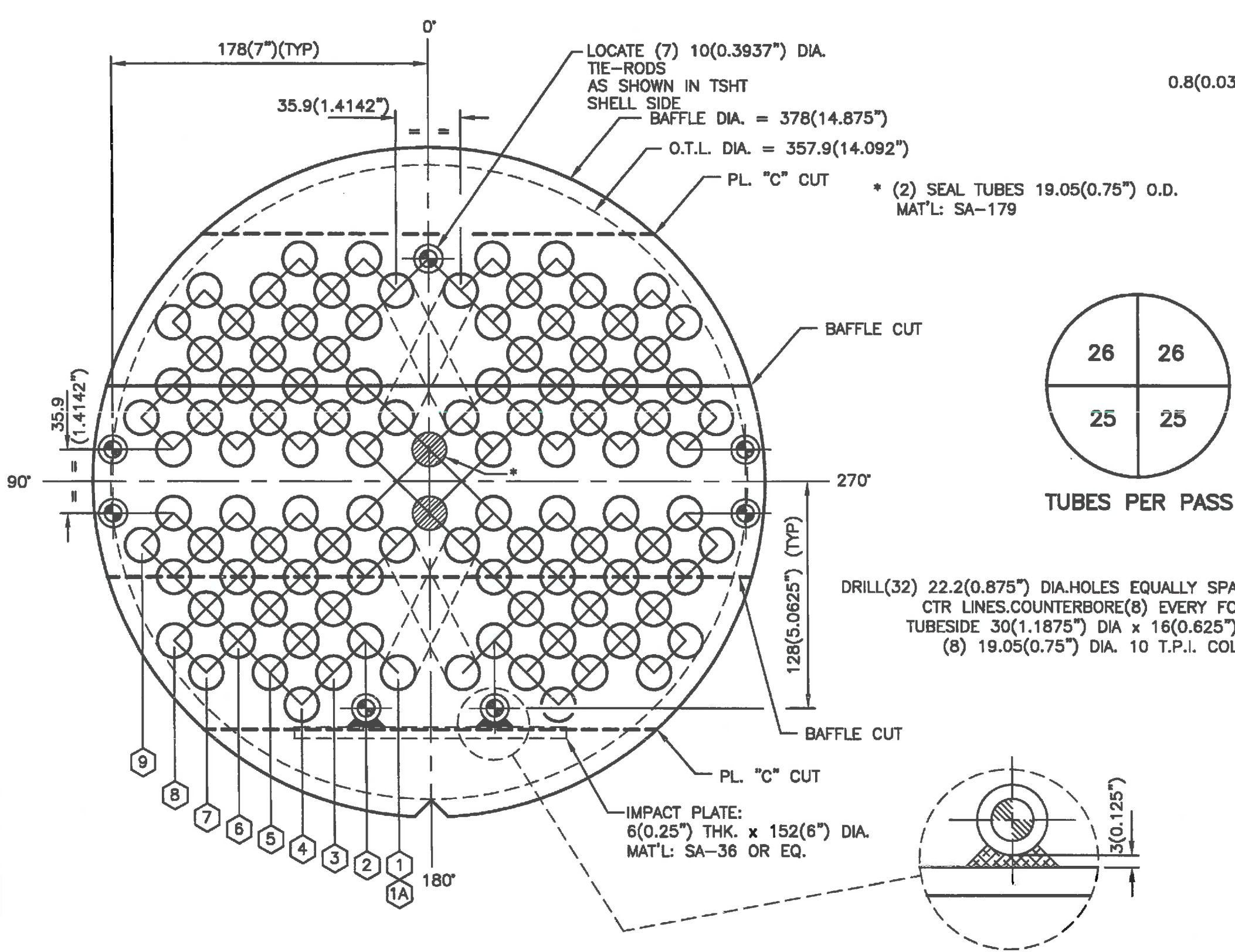
DWN FX CKD KW ITEM 104-E-135/136



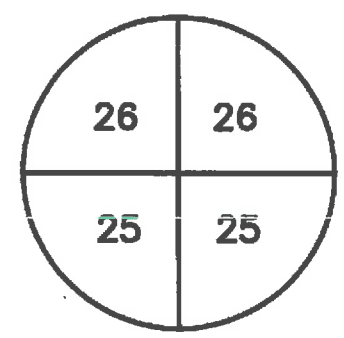
EXCHANGER INDUSTRIES LIMITED
 CALGARY, ALBERTA

DWG NO. 13-3353A/B

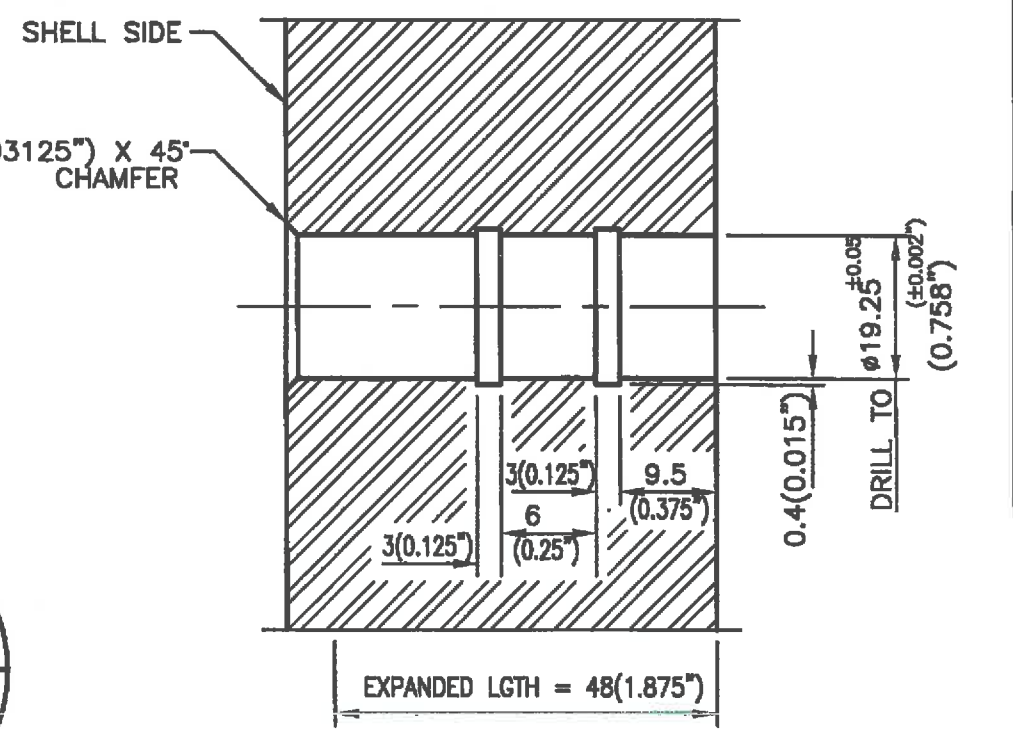
SHEET 5 OF 13



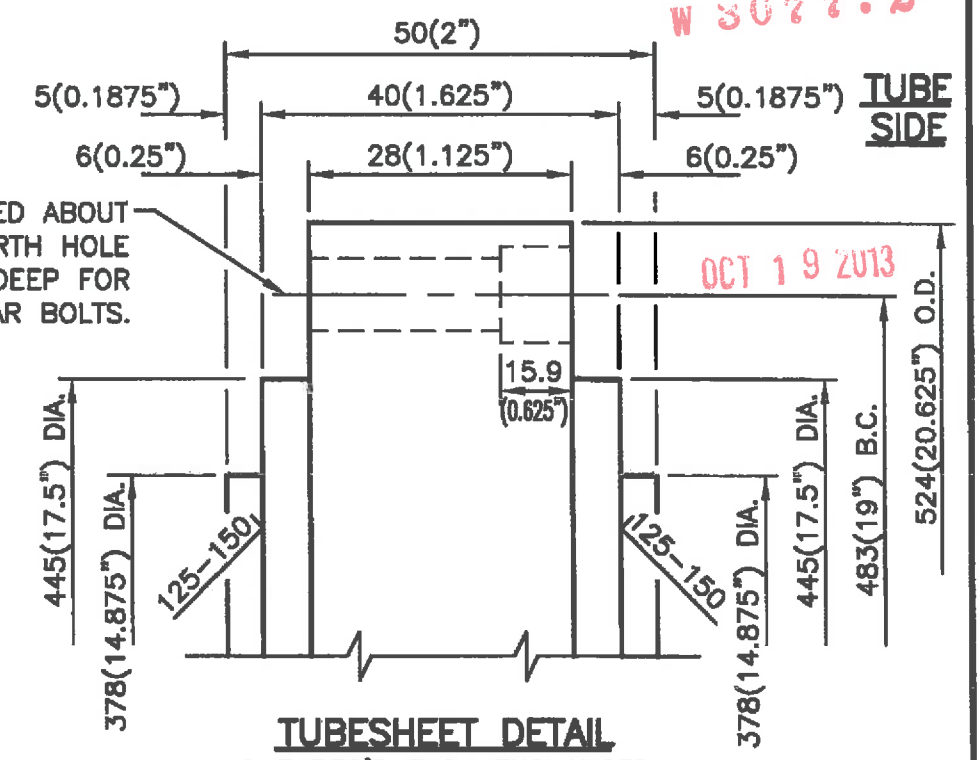
* (2) SEAL TUBES 19.05(0.75") O.D. MAT'L: SA-179



DRILL (32) 22.2(0.875") DIA. HOLES EQUALLY SPACED ABOUT CTR LINES. COUNTERBORE (8) EVERY FOURTH HOLE TUBESIDE 30(1.1875") DIA x 16(0.625") DEEP FOR (8) 19.05(0.75") DIA. 10 T.P.I. COLLAR BOLTS.



TUBE HOLE GROOVING DETAIL



TUBESHEET DETAIL
ONE REQ'D EACH EXCHANGER
MAT'L: SA-516-70N

TUBE O.D. = 19.05(0.75")

TUBE PITCH = 25.4(1") 45° ◇

NO. OF TUBES = (51) "U"

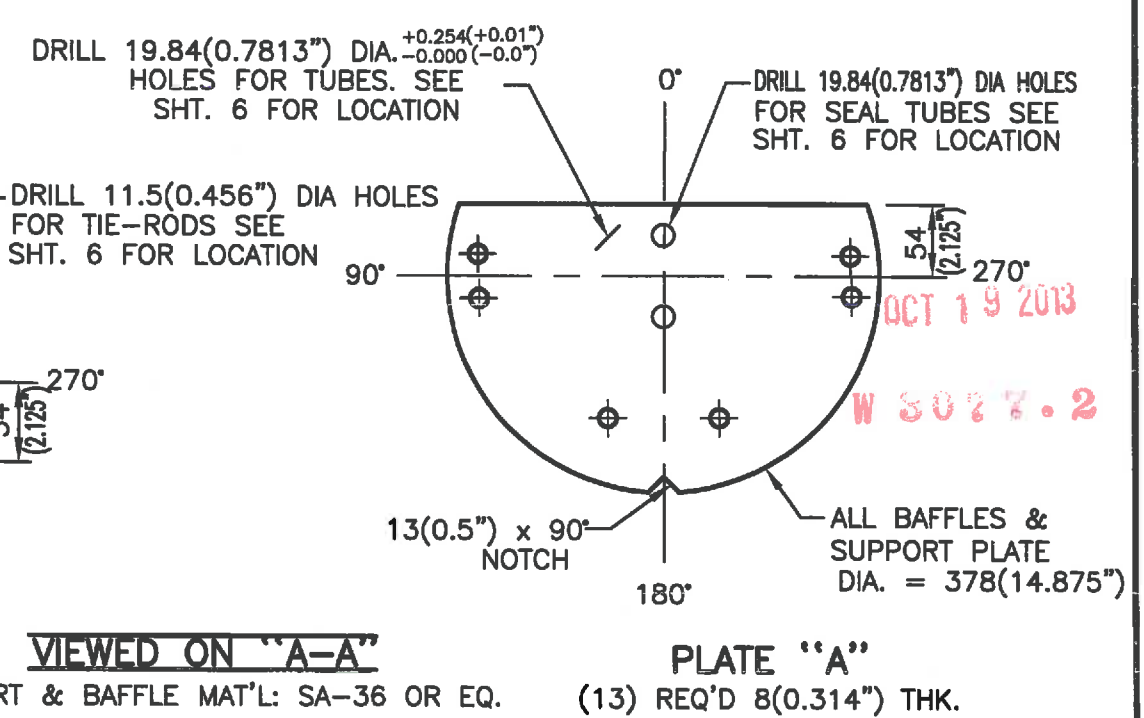
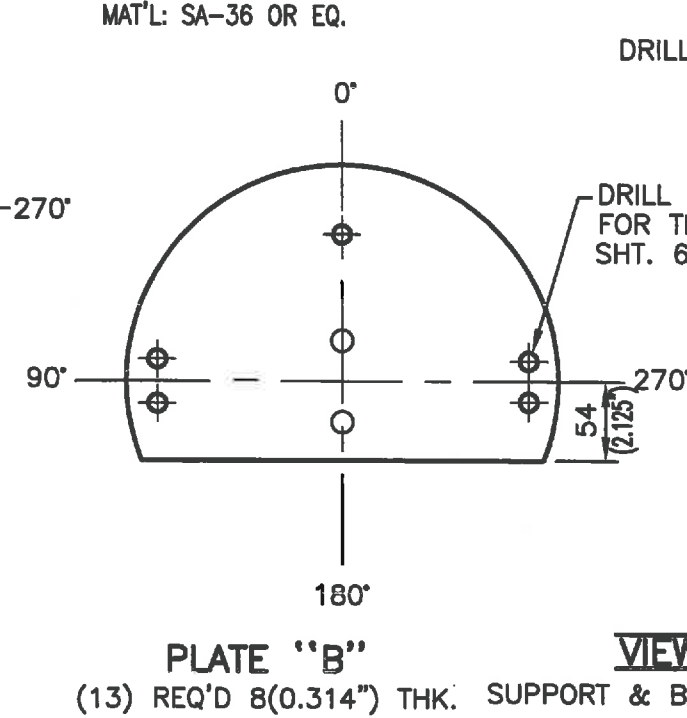
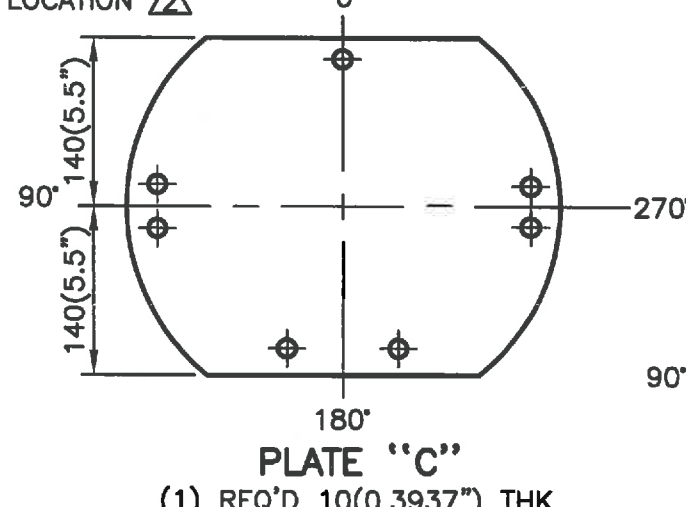
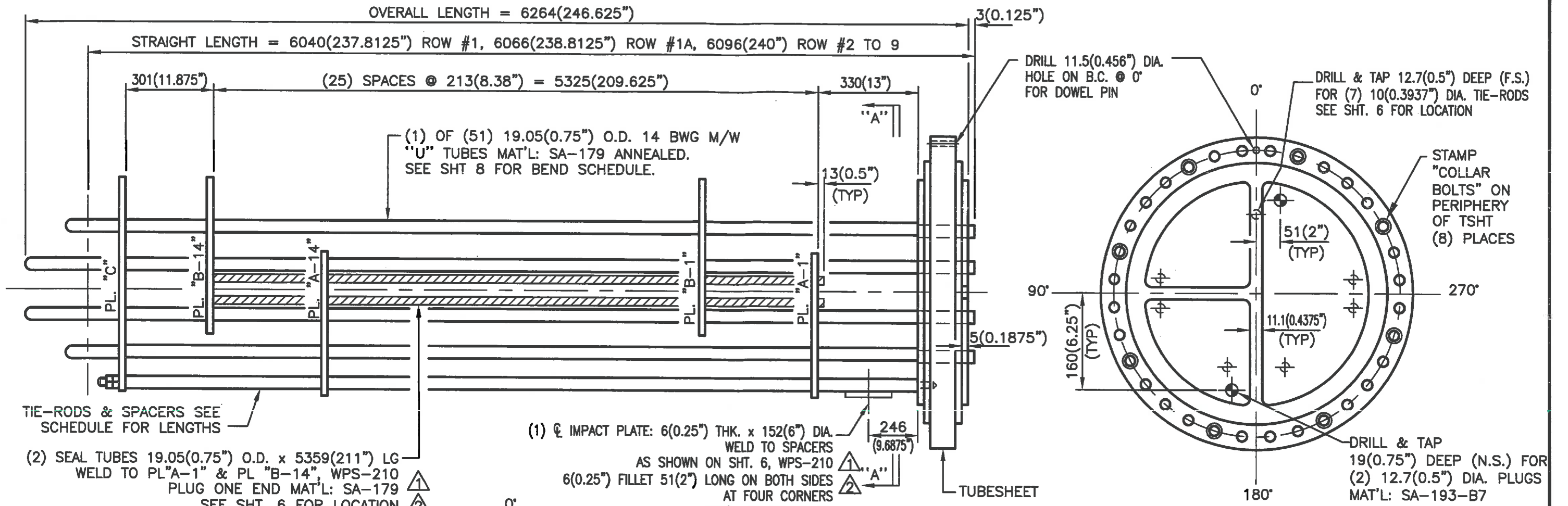
NO. OF PASSES = FOUR

REVISIONS
⚠ PER CUST. MARK-UPS MAY 16/2013 (FZ)

TUBE HOLE LAYOUT

NO. OF EXCHANGERS REQ'D: TWO
PO #: CE416040-CC088996-00

EXCHANGER INDUSTRIES LIMITED
CALGARY, ALBERTA



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TIE-ROD SCHEDULE						
TIE-ROD DIA.: 10(0.3937")			TIE-ROD MAT'L: SA-36 OR EQ			
TOTAL NO. REQ'D EACH BUNDLE: (7) C/W (2) CARB. STL NUTS EACH						
NO.:	(7)					
LGTH:	6013 (236.75")					

SPACER SCHEDULE						
SPACER O.D.: 15.9(0.625")			SPACER MAT'L: SA-179			
TOTAL NO. REQ'D EACH BUNDLE: (150)						
NO.:	(6)	(1)	(100)	(36)	(2)	(5)
LGTH:	530 (21")	543 (21.38")	205 (8.066")	418 (16.44")	506 (19.94")	293 (11.56")

REVISIONS

△ PER CUST. MARK-UPS MAY 16/2013 (FZ)

△ PER E.I. JULY 17/2013 (AG)

BUNDLE DETAIL			
NO. OF EXCHANGERS REQ'D: TWO			
PO #: CE416040-CC088996-00			
CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB			
DWN	FX	CKD KW	ITEM 104-E-135/136

EXCHANGER INDUSTRIES LIMITED
CALGARY, ALBERTA

DWG NO. 13-3353A/B

SHEET 7 OF 13

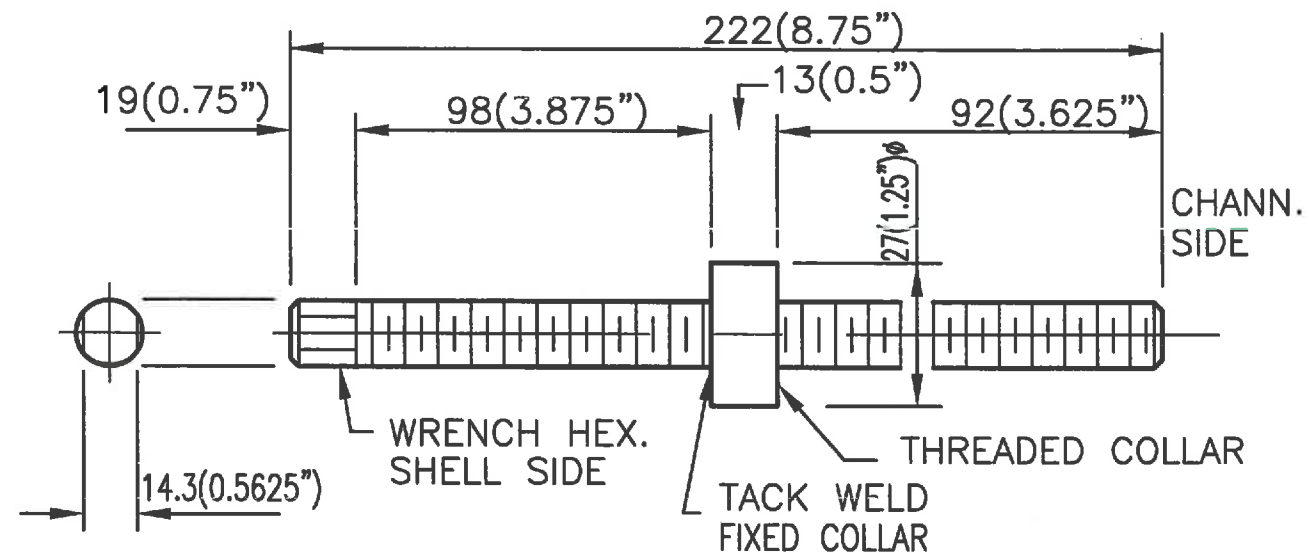
ROW NO.	NO. OF TUBES	BEND DIA.	STRAIGHT LENGTH	U TUBE LENGTH	OVERALL TUBE LENGTH	
1	2	80(3.125")	6040(237.8125")	6090(239.75")	12206(480.5625")	
1A	2	80(3.125")	6066(238.8125")	6116(240.8125")	12258(482.625")	
2	7	72(2.8125")	6096(240")	6141(241.8125")	12305(484.4375")	
3	6	108(4.25")		6159(242.5")	12362(486.6875")	
4	8	143(5.625")		6177(243.1875")	12417(488.875")	
5	6	180(7.0625")		6196(243.9375")	12475(491.125")	
6	6	216(8.5")		6213(244.625")	12531(493.375")	
7	6	251(9.875")		6231(245.3125")	12586(495.5")	
8	6	287(11.3125")		6249(246")	12643(497.75")	
9	2	324(12.75")		6267(246.75")	12700(500")	
TOTAL (51) "U" TUBES						<p>NOTES:</p> <p>(1) MAX. OUT OF ROUNDNESS OF "U" BENDS TO BE 10% OF TUBE O.D.</p> <p>(2) U BENDS PLUS 152(6") OF STRAIGHT LENGTH TO BE STRESS RELIEVE @ 635°C ±15°C FOR (1) HOUR (1175°F ±27°F)</p> <p>(3) OVERALL TUBE LENGTH SHOWN IS EXACT LENGTH WITH NO ADDITION FOR TRIMMING.</p> <p>TUBE DETAILS: TUBE O.D. = 19.05(0.75") TUBE GAGE = 14 BWG M/W TUBE MAT'L = SA-179 FULLY ANNEALED</p> <p style="color: red; text-align: right;">W 3077.2 OCT 19 2013</p>

REVISIONS △ PER CUST. MARK-UPS MAY 16/2013 (FZ)	<h3>U BEND SCHEDULE</h3>		 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA		
	NO. OF EXCHANGERS REQ'D: TWO				
	PO #: CE416040-CC088996-00		DWG NO. 13-3353A/B		
	CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB				
	DWN	FX	CKD KW	ITEM 104-E-135/136	SHEET 8 OF 13

LOCATION	NO. REQ'D	SIZE	LENGTH	T.P.I.
CHANNEL TO SHELL	27*	19.05(0.75") DIA.	203(8")	10
CHANNEL TO SHELL COLLAR BOLTS	9*	19.05(0.75") DIA.	222(8.75")	10
JACKSCREWS	4	12.7(0.5") DIA.	89(3.5")	13

* INCLUDES 10% SPARE STUDS & NUTS

SIZE	SHOP TORQUE VALUES	
	(Nm)	(FT.LBS)
19.05(0.75") DIA.	260	192



COLLAR BOLT DETAIL

OCT 19 2013

W 3027.8

NOTES:

- (1) NUMBER SHOWN IS NUMBER OF STUDBOLTS REQ'D FOR EACH EXCHANGER.
- (2) TWO AMERICAN STANDARD HEAVY HEX. NUTS REQ'D FOR EACH STUDBOLT UNLESS NOTED OTHERWISE. ①②
- (3) COAT ENTIRE LENGTH OF STUDBOLTS WITH JET LUBE 550 COAT LUBRICATION.

MATERIAL:

STUDBOLTS: SA-193-B7
 NUTS: SA-194-2H
 JACKSCREWS: SA-193-B7

REVISIONS

- ① PER CUST. MARK-UPS & E.I. MAY 16/2013 (FZ)
- ② PER E.I. JULY 17/2013 (AG)

BOLT SCHEDULE
 NO. OF EXCHANGERS REQ'D: TWO

PO #: CE416040-CC088996-00

① CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB

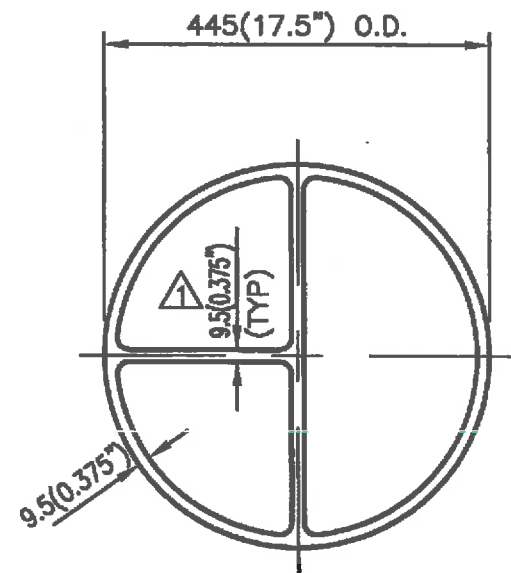
DWN FX CKD KW ITEM 104-E-135/136



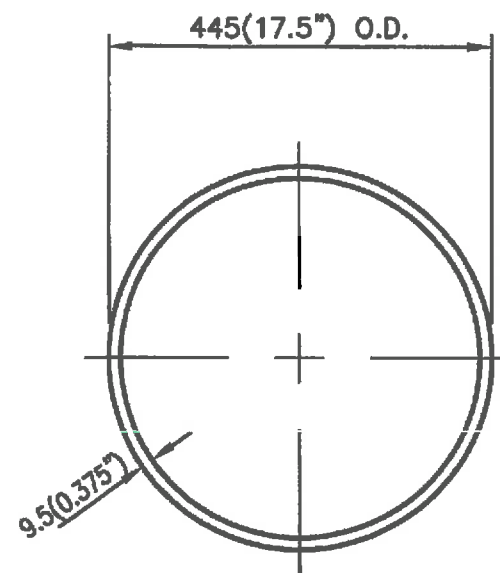
EXCHANGER INDUSTRIES LIMITED
 CALGARY, ALBERTA

DWG NO. 13-3353A/B

SHEET 9 OF 13



MK.1 TO TUBESHEET




MK.2 TO TUBESHEET

NOTES:

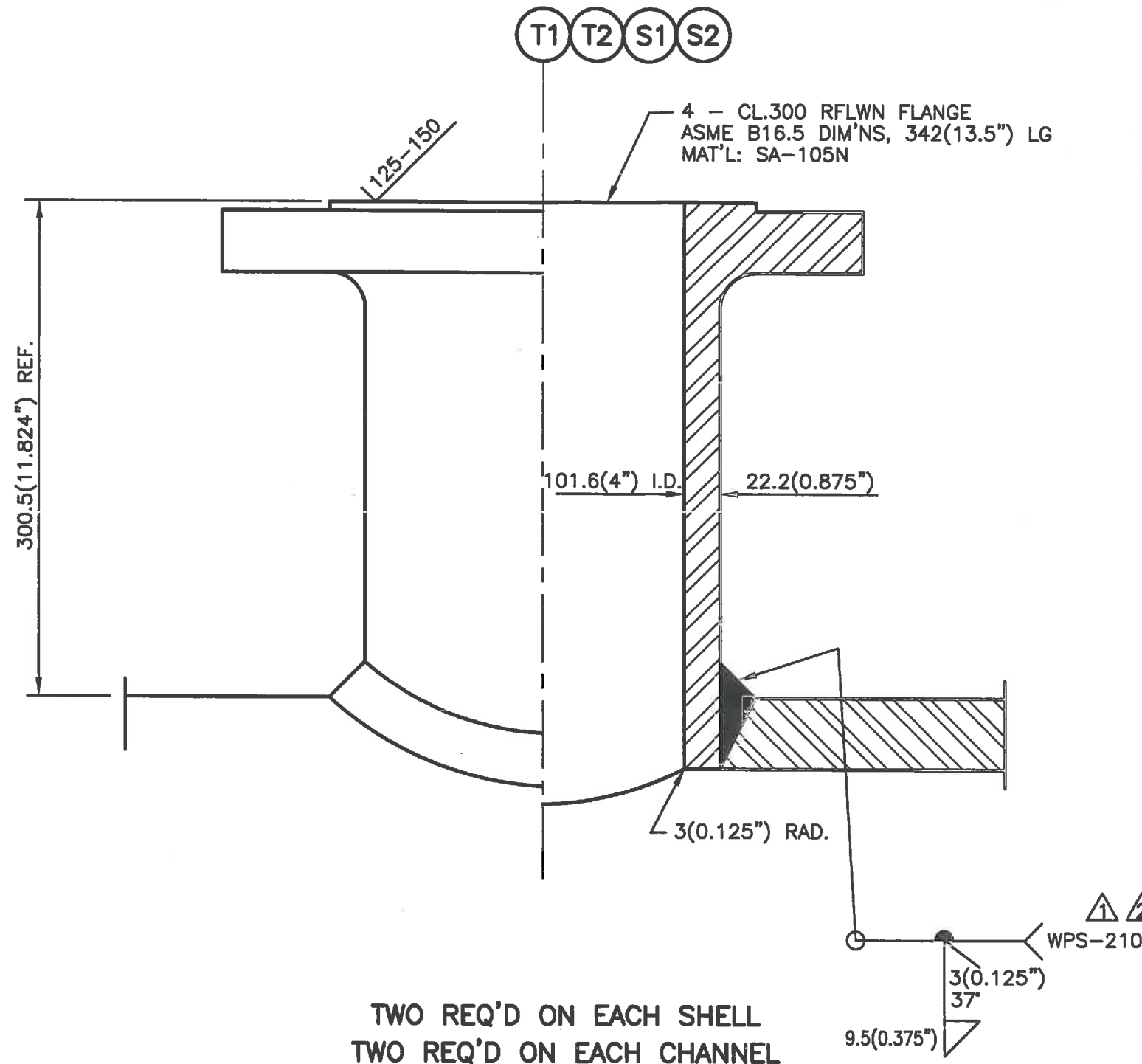
- (1) UNLESS OTHERWISE NOTED ALL GASKETS ARE TO BE: 3.2(0.125") THK. KAMMPROFILE - 316 S.S. CORE, FLEX, GRAPHITE.
- (2) THICKNESS CALLED FOR IS THE TOTAL THICKNESS REQUIRED
- (3) ALL GASKETS ARE TO BE ONE PIECE CONSTRUCTION

* INCLUDES ONE SPARE SET

REVISIONS ⚠ PER CUST. MARK-UPS MAY 16/2013 (FZ)	GASKET DETAIL NO. OF SETS REQ'D EACH EXCHANGER: TWO* NO. OF EXCHANGERS REQ'D: TWO		 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA
	PO #: CE416040-CC088996-00		
	⚠ CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB		
	DWN FX	CKD KW		ITEM 104-E-135/136
		DWG NO. 13-3353A/B	SHEET 10 OF 13

OCT 19 2013

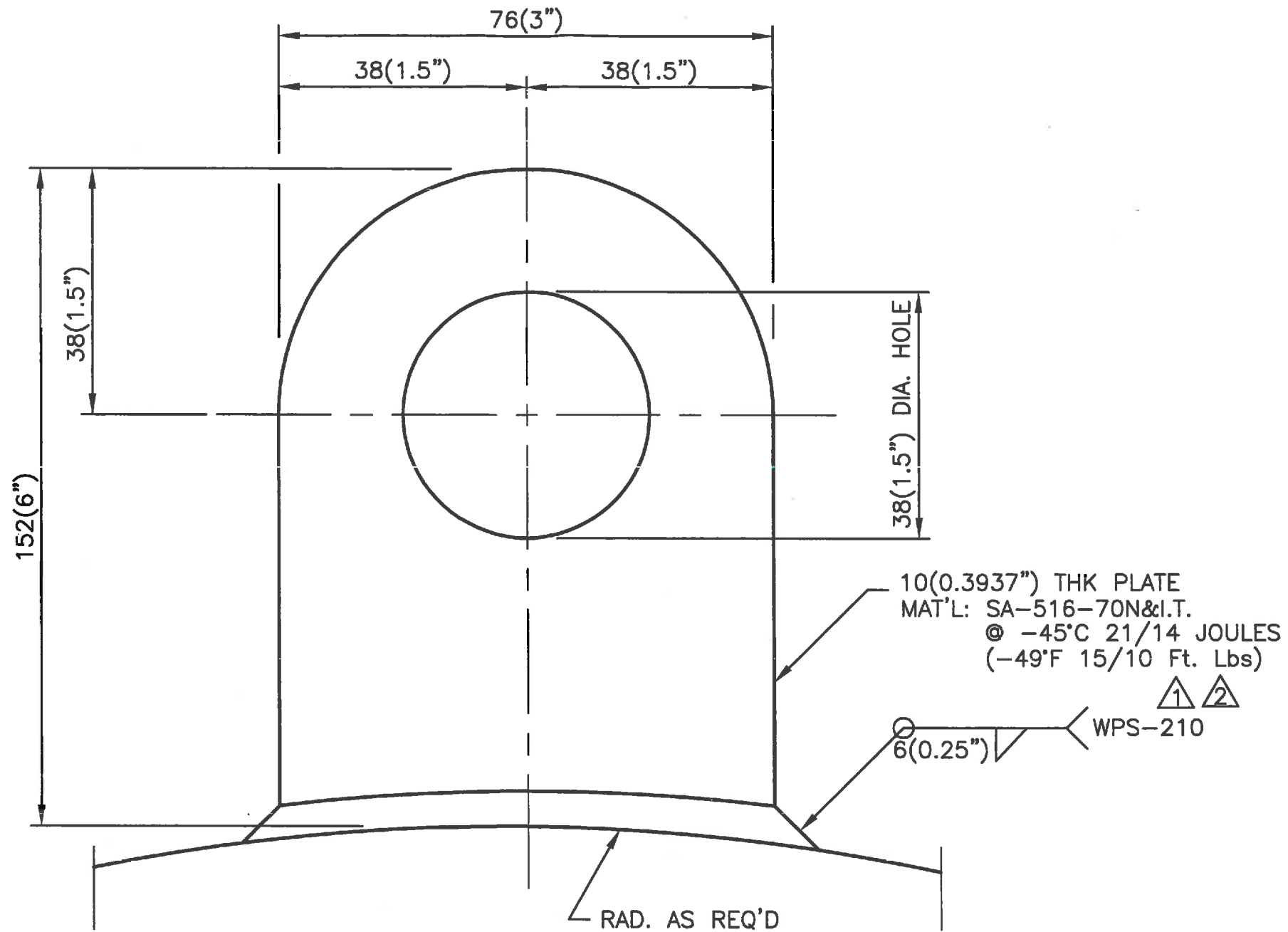
W 3072.2



OCT 19 2013
W 3077.2


NOZZLE ORIENTATION SEE SHT.1

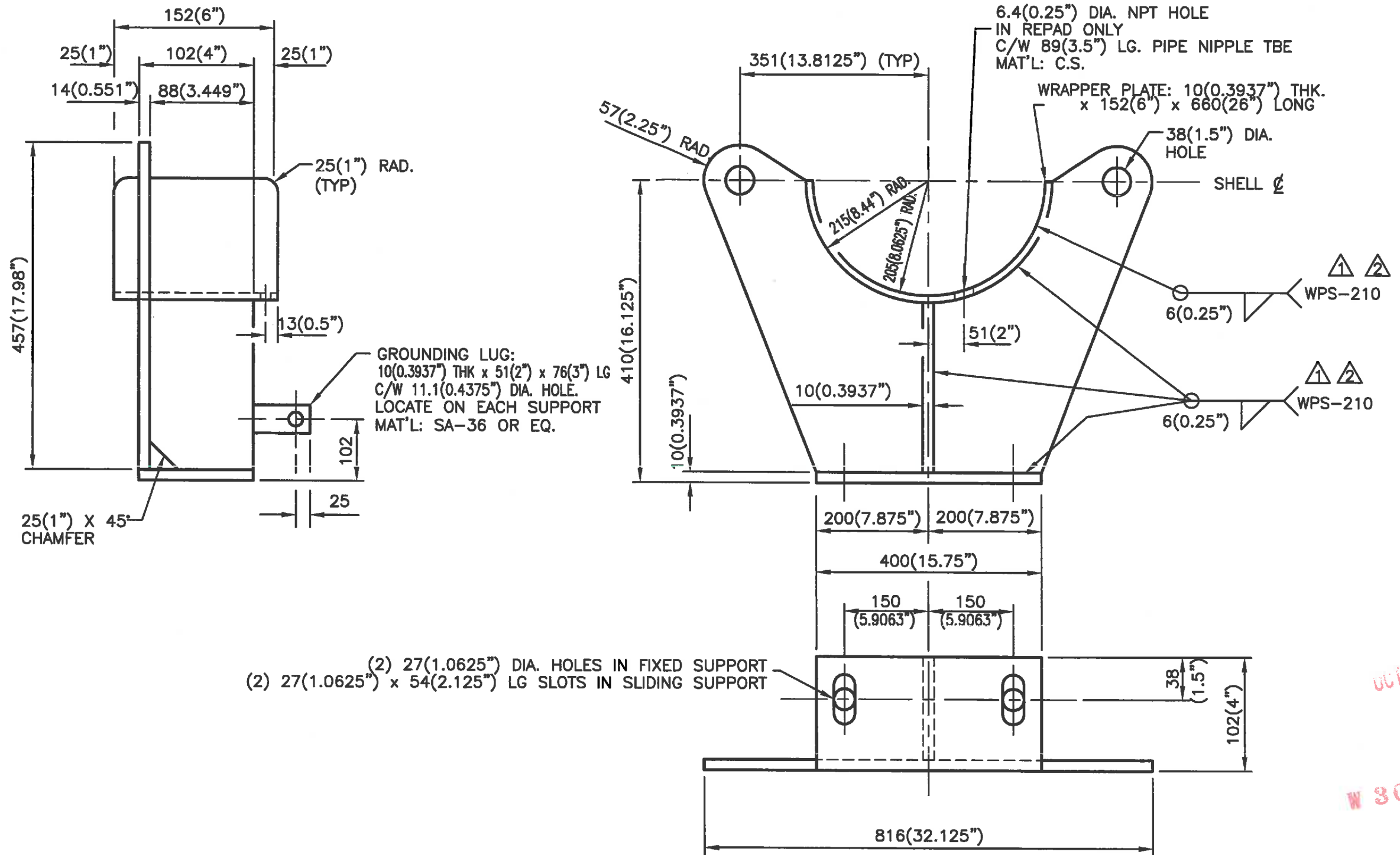
REVISIONS ▲ PER CUST. MARK-UPS MAY 16/2013 (FZ) ▲ PER E.I. JULY 17/2013 (AG)	NOZZLE DETAILS		 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA
	NO. OF EXCHANGERS REQ'D: TWO		
	PO #: CE416040-CC088996-00		DWG NO. 13-3353A/B SHEET 11 OF 13
	▲ CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB		
	DWN FX CKD KW	ITEM 104-E-135/136	



OCT 19 2013
W 3077.2

TWO REQ'D ON EACH CHANNEL CYLINDER

REVISIONS 1 PER CUST. MARK-UPS MAY 16/2013 (FZ) 2 PER E.I. JULY 17/2013 (AG)	LIFT LUG DETAIL NO. OF EXCHANGERS REQ'D: TWO		 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA
	PO #: CE416040-CC088996-00		
	1 CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB		DWG NO. 13-3353A/B
	DWN FX CKD KW	ITEM 104-E-135/136	SHEET 12 OF 13



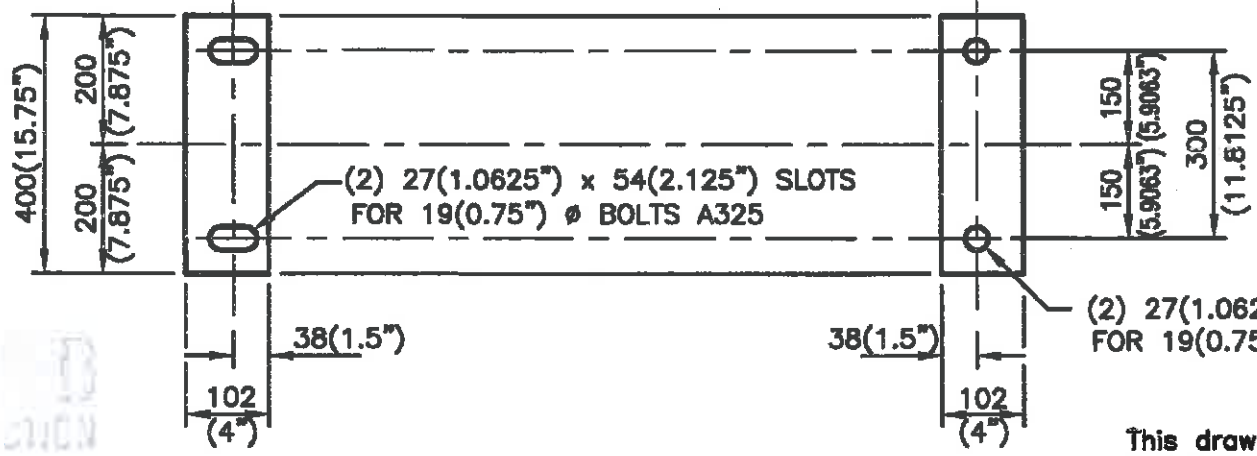
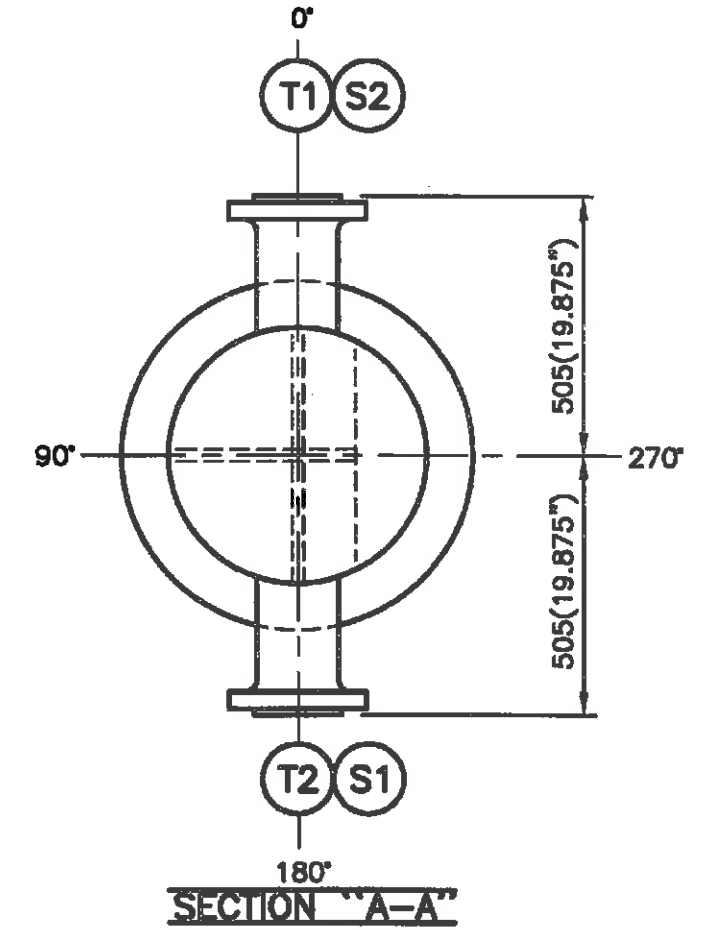
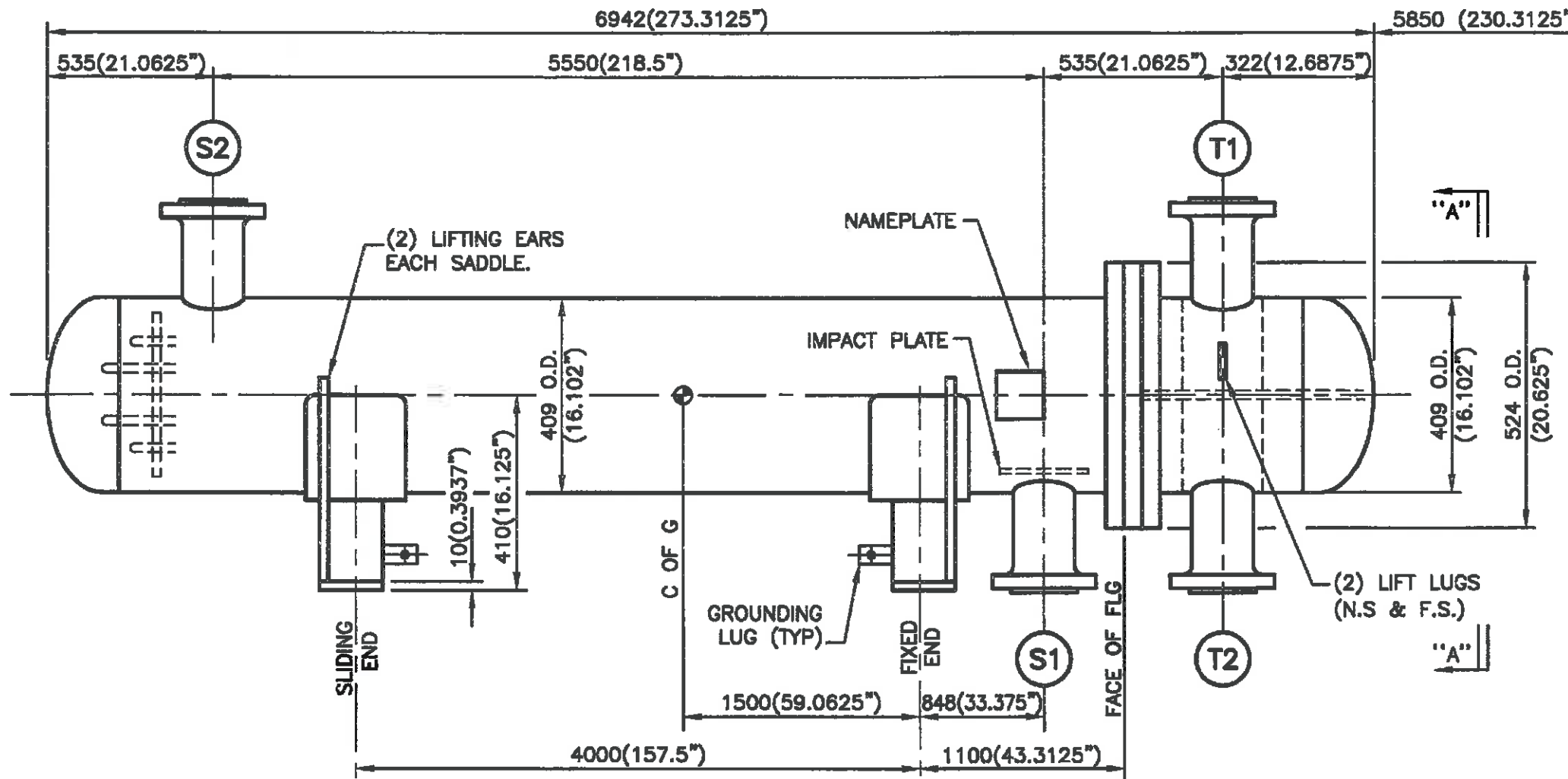
OCT 19 2013

W 3077.2

NOTES:

(1) ALL MATERIAL TO BE SA-516-70N&I.T. @ -45°C 21/14 JOULES (-49°F 15/10 Ft.Lbs) EXCEPT FOR GROUNDING LUG.

REVISIONS △ PER CUST. MARK-UPS MAY 16/2013 (FZ) △ PER E.I. JULY 17/2013 (AG)	SUPPORT DETAIL NO. OF EXCHANGERS REQ'D: TWO NO. OF SUPPORTS REQ'D: TWO		 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA
	PO #: CE416040-CC088996-00		
	△ CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB		DWG NO. 13-3353A/B
	DWN FX	CKD KW	ITEM104-E-135/136 SHEET 13 OF 13



**CERTIFIED
AS BUILT**

COPY OF EI JOB:-11-3014A/B
DWN SP CKD KW

NOZZLE SCHEDULE					
MARK	SIZE	RATING	TYPE	SCH.	SERVICE
T1	4"	CL.300	RFLWN	-	CHANNEL INLET
T2	4"	CL.300	RFLWN	-	CHANNEL OUTLET
S1	4"	CL.300	RFLWN	-	SHELL INLET
S2	4"	CL.300	RFLWN	-	SHELL OUTLET

This drawing is the property of Exchanger Industries and shall not be used in any way detrimental to Exchanger Industries nor shall be copied, lent or used for any purpose other than that intended.

REVISION CONTROL BOX Denotes DCR & Rev.# Added to This Sheet Only
 1 PER CUST. MARK-UPS & E.I. MAY 16/2013 (FZ)
 2 PER E.I. JULY 17/2013 (AG) DCR-IFP-016523
 3 PER E.I. AUG 2/2013 (AG) DCR-NI-016545
 4 PER E.I. Oct. 30/2013 (JL) DCR-A-016717
 5 PER EIL JAN 09/2014 (JL) DCR-B-016845

CUSTOMER: CANADIAN NATURAL RESOURCES LTD.
 FOR: KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB
 P.O. NO.: CE416040-CC088996-00
 TEMA TYPE: BEU
 SIZE: 381-6096(15"-240")
 SERVICE: SALES OIL TANK HEATER

**SHELL & TUBE EXCHANGER
OUTLINE DRAWING**
 NO. OF EXCHANGERS REQ'D: TWO
 DWN FX CKD KW ITEM 104-E-135/136

**EXCHANGER INDUSTRIES
LIMITED**
 CALGARY, ALBERTA
 DWG NO. 13-3353A/B
 SHEET 1 OF 13

MATERIAL LIST

LINE	PART	MATERIAL
CHANNEL		
1	COVER/HEAD	SA-516-70N
2	TEMA FLANGE	SA-105N
3	CYLINDER	SA-516-70N
4	NOZZLE FLANGE	SA-105N
5	NOZZLE NECK	--
6	NOZZLE REINFORCEMENT PAD	--
7	COUPLING/THREDOLET/PLUG	--
8	PASS PLATE	SA-516-70N/SA-106-B
9	STUDBOLTS	SA-193-B7
10	NUTS	SA-194-2H
11		
12		
SHELL		
13	TEMA FLANGE	SA-105N
14	CYLINDER	SA-516-70N
15	COVER/HEAD	SA-516-70N
16	CONE	--
17	NOZZLE FLANGE	SA-105N
18	NOZZLE NECK	--
19	NOZZLE REINFORCEMENT PAD	--
20	COUPLING/THREDOLET/PLUG	--
21	SUPPORT WRAPPER PLATE	SA-516-70N&i.T.
22	SUPPORT	SA-516-70N&i.T.
23	STUDBOLTS	SA-193-B7
24	NUTS	SA-194-2H
25		
26		
27		
FLOATING HEAD		
28	BACKING RING	--
29	COVER FLANGE	--
30	DISH	--
31	PASS PLATE	--
32	STUDBOLTS	--
33	NUTS	--
34		
35		
36		

LINE	PART	MATERIAL
TUBE BUNDLE		
37	TUBESHEET	SA-516-70N
38	TUBES	SA-179 ANNEALED
39	BAFFLE/SUPPORT PLATES	SA-36 OR EQ.
40	IMPINGEMENT PLATE	SA-36 OR EQ.
41	TIE-ROD/NUT/SPACER	CARBON STEEL
42		
43		
GASKETS		
44	CHANNEL	KAMMPROFILE*
45	SHELL	KAMMPROFILE*
46	FLOATING HEAD	--
47	CHANNEL NOZZLE	--
48	SHELL NOZZLE	--
49		
50		

MATERIAL NOTES

*316 S.S. CORE, FLEX, GRAPHITE

(1) E.I. TO SUPPLY ONE SET OF SPARE TEMA FLANGE GASKETS AND 10% (MIN 2 SETS) OF SPARE TEMA FLANGE BOLTING

(2) FLG FACES TO HAVE A SURFACE FINISH 125-150 Ra.

(3) MDMT FOR LIFTING LUGS & SUPPORTS TO BE -45°C(-49°F).

CONSTRUCTION NOTES

(12) PAINT:

(a) SANDBLAST TO SSPC-SP6

(b) PRIME WITH ONE COAT OF INTERNATIONAL INTERTHERM 228 4-5 MILS DFT

(c) PROTRUSIONS ONLY - FINISH WITH (1) ONE COAT OF INTERNATIONAL INTERFINE 629-HS 2-3 MILS DFT (GRAY 80326)

(13) 5USG INHIBITED PROPYLENE GLYCOL FOR TUBESIDE & SHELLSIDE.

CERTIFIED AS BUILT

- REVISIONS**
- ⚠ PER CUST. MARK-UPS & E.I. MAY 16/2013 (FZ)
 - ⚠ PER E.I. JULY 17/2013 (AG)
 - ⚠ PER E.I. AUG 2/2013 (AG)
 - ⚠ PER E.I. Oct. 30/2013 (JL)
 - ⚠ PER E.I. JAN 08/2014 (JL)


MATERIALS & DESIGN CONDITIONS

NO. OF EXCHANGERS REQ'D: TWO

PO #: CE416040-CC088996-00

⚠ CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB

DWN FX | CKD KW | ITEM 104-E-135/136


EXCHANGER INDUSTRIES LIMITED
CALGARY, ALBERTA

DWG NO. 13-3353A/B

SHEET 1A OF 13

CONSTRUCTION NOTES

- (1) CONSTRUCTION TO BE PER ASME CODE SECTION VIII DIVISION 1 2010 EDITION, 2011a ADDENDA, TEMA CLASS "R" 9th EDITION, API 660 AND CUSTOMER SPECIFICATIONS.
 - (2) ALL BOLT HOLES TO STRADDLE CENTER LINES UNLESS NOTED OTHERWISE.
 - (3) CODE STAMP REQ'D: YES (PROVINCE OF ALBERTA).
 - (4) IMPACT TESTING: EXEMPT PER UG-20 (f) 1-5
 - (5) STRESS RELIEVE: (CHARTED) U-BENDS & 152mm(6") OF STRAIGHT LENGTH
● 635°C ±15°C FOR 1 HOUR (ELECTRIC RESISTANCE METHOD).
 (1175°F ±27°F)
 - (6) RADIOGRAPHY: RT1 SHELL & CHANNEL. ⚠⚠⚠⚠
 - (7) WELD PROCEDURES: WPS 210, WPS-SAW 4/210, C2 & C17(REPAIRS IF REQUIRED)
 - (8) INSULATION: 64mm(2.5") THK. MINERAL WOOL C/W ALUMINUM ON SHELL &
⚠ 51mm(2") THK. ON CHANNEL. INSULATION BLANKETS ON TEMA FLGS (BY E.I.)
 - (9) 100% MT LIFT LUG WELDS.
 - (10) SUPPLIED BUNDLES ARE INTERCHANGEABLE.
 - (11) TOLERANCE PER "STANDARD FABRICATION TOLERANCE" REV.0 (LOCATED IN WELDING PROCEDURE LOG BOOK)
- * REGISTER AT MAWP # CHARTED

DESIGN CONDITIONS	SHELL SIDE	CHANNEL SIDE
PROCESS DESIGN PRESSURE*	3500 kPaG(507 PSIG)	3500 kPaG(507 PSIG)
EXTERNAL PRESSURE	FV ● 148°C(299°F)	FV ● 148°C(299°F)
DESIGN TEMPERATURE.	150°C(302°F)	150°C(302°F)
MDMT	-29°C(-20°F)	-29°C(-20°F)
C&H MAWP	3585 kPaG(520 PSIG)	3585 kPaG(520 PSIG)
C&H MAWP LIMITED BY	TEMA FLANGE	TEMA FLANGE
FIELD HYDRO TEST PRESSURE	4661 kPaG(676 PSIG)	4661 kPaG(676 PSIG)
CORROSION ALLOWANCE	3.2 mm(0.126")	3.2 mm(0.126")
N&C MAX. PRESS.	4729 kPaG(686 PSIG)	4302 kPaG(624 PSIG)
N&C M.P. LIMITED BY	TEMA FLANGE	TEMA FLG BOLTING
SHOP HYDRO TEST PRESS.#	6151 kPaG(892 PSIG)	5599 kPaG(812 PSIG)
NUMBER OF PASSES	E-SHELL	FOUR
SURFACE AREA	36.6 SQ. M(393.9 SQ.Ft)	(EACH)
SHIPPING WEIGHT	2500 kgs(5511 Lbs)	(EACH)
WEIGHT FULL OF WATER	3250 kgs(7165 Lbs)	(EACH)
BUNDLE WEIGHT	820 kgs(1808 Lbs)	(EACH)
CHANNEL WEIGHT	210 kgs(463 Lbs)	(EACH)
CAPACITY	0.75 CU. M(26.49 CU.Ft)	(EACH)

1. NOTE: Any material welding to a pressure component must have a MTR and traceability or be qualified under Section VIII, Div. 1 ASME code for welding to a pressure part.

2. For removable-bundle heat exchangers, the permissible out-of-roundness of a completed shell, after all welding and heat treatment, shall allow a metal template to pass through the entire shell length without binding. The template shall consist of two rigid disks (each with a diameter equal to the diameter of the transverse baffle or support plate), rigidly mounted perpendicularly on a shaft and spaced not less than 300 mm (12") apart.

3. Welds attaching non-pressure attachments (such as lugs or structural steel supports, except for insulation support rings) shall be continuous.

4. All exposed flange gasket surfaces shall be coated with an easily removable rust preventative and shall be protected by a wood, plastic, or steel cover complete with rubber gasket and (4) four bolts minimum.

5. All welded attachments provided with tell tale holes shall be pneumatically tested with 350 kPag (50.76 PSIG) air prior to PWHT and/or hydrotest.

6. The item number, shipping weight, center of gravity and purchase order number shall be painted on the exchanger.

7. All boxes, crates, or packages shall be identified with the purchaser's order and equipment number.

8. RT - Radiography Examination & acceptance criteria in accordance with ASME Section VIII, Div.1, UW-51, ASME Section V Article 2 T220, standards as defined in ASME Section V Article 22.

9. a). The interior of all exchangers shall be free of oil, grease, weld slag, scale, dirt, grit, weld splatter, rust, rags, wood, and other foreign matter.

b) Exchangers containing or coated with insulating fluids, corrosion inhibitors, antifreeze solutions, desiccants, or other chemicals shall be prominently tagged or labeled at openings or other appropriate locations to indicate the nature of the contents and precautions for shipping, storage, and handling.

c) Material Safety Data Sheets (MSDS) for these chemicals shall comply with all relevant regulations where the equipment will be located. If any chemical is exempt from such laws, a statement to that effect shall be included on the MSDS.

d) Material Safety Data Sheets (MSDS) for the exchanger shall be provided to the shipper at the time of shipping.

10. MPI - Magnetic particle examination and criteria for acceptance shall comply with ASME Section V Article 7 (T720), Appendix 6 of Sec.VIII Div.1 and standards as defined in ASME Section V Article 25.

11. LPI - Liquid penetrant examination and criteria for acceptance shall comply with appendix 8 of section VIII, Div 1, ASME code.

12. UT- Ultrasonic examination in accordance with ASME Section V Art. 4 T420 (for welds) and ASME section V Art.5 T520 (for materials), and standards as defined in ASME Section V Art.23.

13. Weld Hardness Testing:

a) The weld metal and heat-affected zone of pressure retaining welds in components made from a material that has a P number of 1 shall be tested.

b) Examination shall be made after any postweld heat treatment.

c) Hardness shall not exceed 237 Brinell for materials with P numbers of 1 (for sweet service).

d) Hardness shall be determined using a 10 millimeter diameter ball unless otherwise specified.

e) One longitudinal weld, one circumferential weld, and each connection-to-component weld where the connection is NPS 2 or larger shall be tested.

f) If more than one welding procedure is used to fabricate longitudinal or circumferential welds, hardness readings shall be made of welds deposited by each procedure.

14. The hydrotest pressure shall be maintained for at least 1 hour, using potable water & charted.

15. Gasket used for hydrotest shall be of the same material and design as the gasket to be furnished with the exchanger.

16. Flanged joints that have been taken apart after hydrostatic test shall be reassembled with unused gaskets and re-hydrotest.

17. Paint or other external coatings shall not be applied over welds before the final hydrostatic test.

18. The following parts shall be stamped with the manufacturer's serial number: channel & shell girth flanges, tubsheet.

19. No welding after hydrotest.

20. Permanent backing rings shall not be used.

**CERTIFIED
AS BUILT**

REVISIONS
1 PER CUST. MARK-UPS MAY 16/2013 (FZ)

API 660 8th EDITION
NOTES & CUST. SPEC'S

PO #: CE416040-CC088996-00

1 CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB

DWN FX CKD KW ITEM 104-E-135/136


EXCHANGER INDUSTRIES
LIMITED
CALGARY, ALBERTA

DWG NO. 13-3353A/B

SHEET 1B OF 13

0.8(0.03125") THK X 152(6") X 159(6.25")
 MAT'L: STAINLESS STEEL



CERTIFIED BY
EXCHANGER INDUSTRIES LIMITED
 CALGARY, ALBERTA, CANADA

U	MAWP: SHELL	3585 kPaG	AT	150 °C
W	MAWP: SHELL	103 kPaG	AT	148 °C
RT1	MAWP: TUBE	3585 kPaG	AT	150 °C
PHT-T	MAWP: TUBE	103 kPaG	AT	148 °C
-	MDMT: SHELL	-29 °C	AT	3585 kPaG
-	MDMT: TUBE	-29 °C	AT	3585 kPaG

SERIAL NO. **13-3353*** YEAR MFD. **2014**

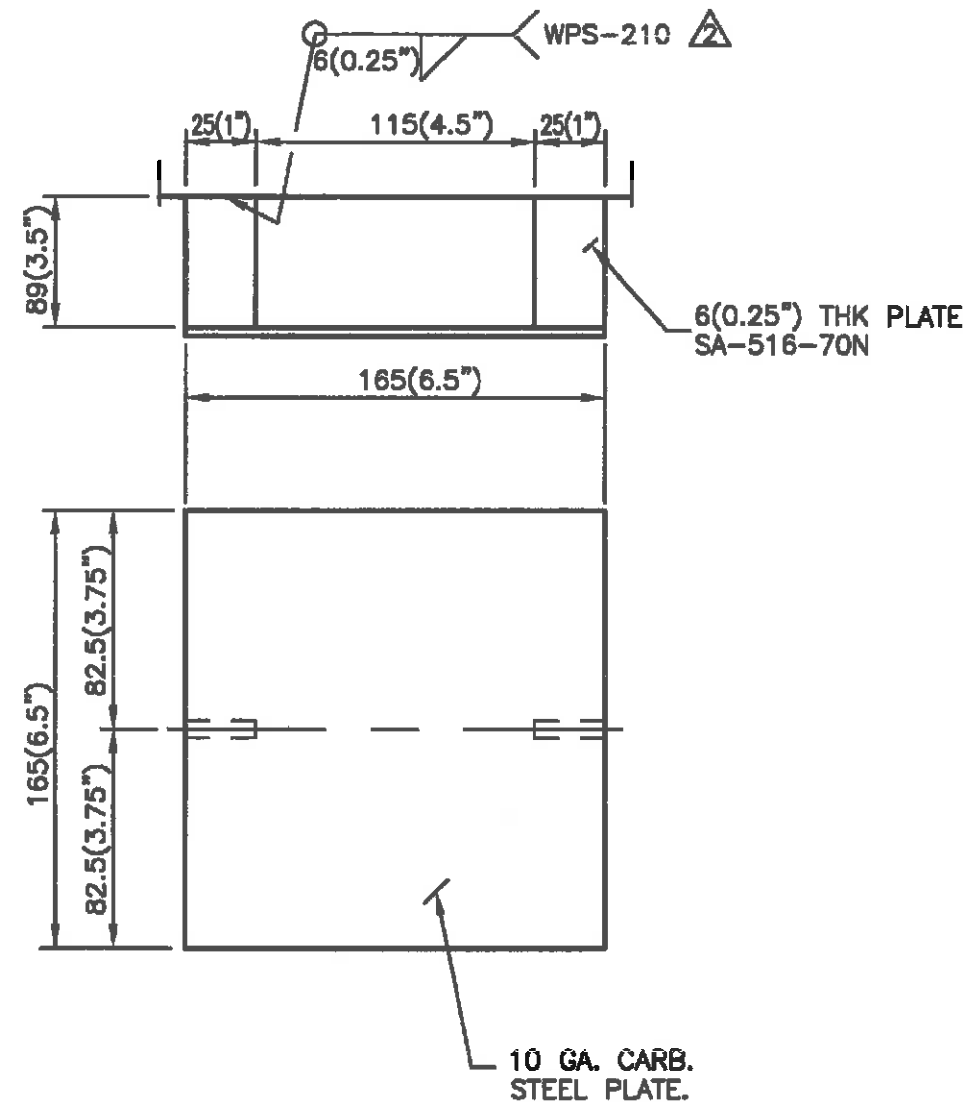
SALES OIL TANK HEATER
 PO NO.: CE416040-CC088996-00 ITEM #: 104-E-** CNRL KNP-1
 SIZE: 381-6096 TYPE: BEU TEMA CLASS: "R"
 TEST PRESS: SHELL: 4661 kPaG TUBE SIDE: 4661 kPaG
 SHELL MAT'L SA-516-70N THK 14 MIN. C.A. 3.2
 CHAN. MAT'L SA-516-70N THK 14 MIN. C.A. 3.2
 TUBE MAT'L: SA-179 ANNEALED 14 BWG M/W

PROV. REG. CRN

NO. REQ'D EACH EXCHANGER: ONE

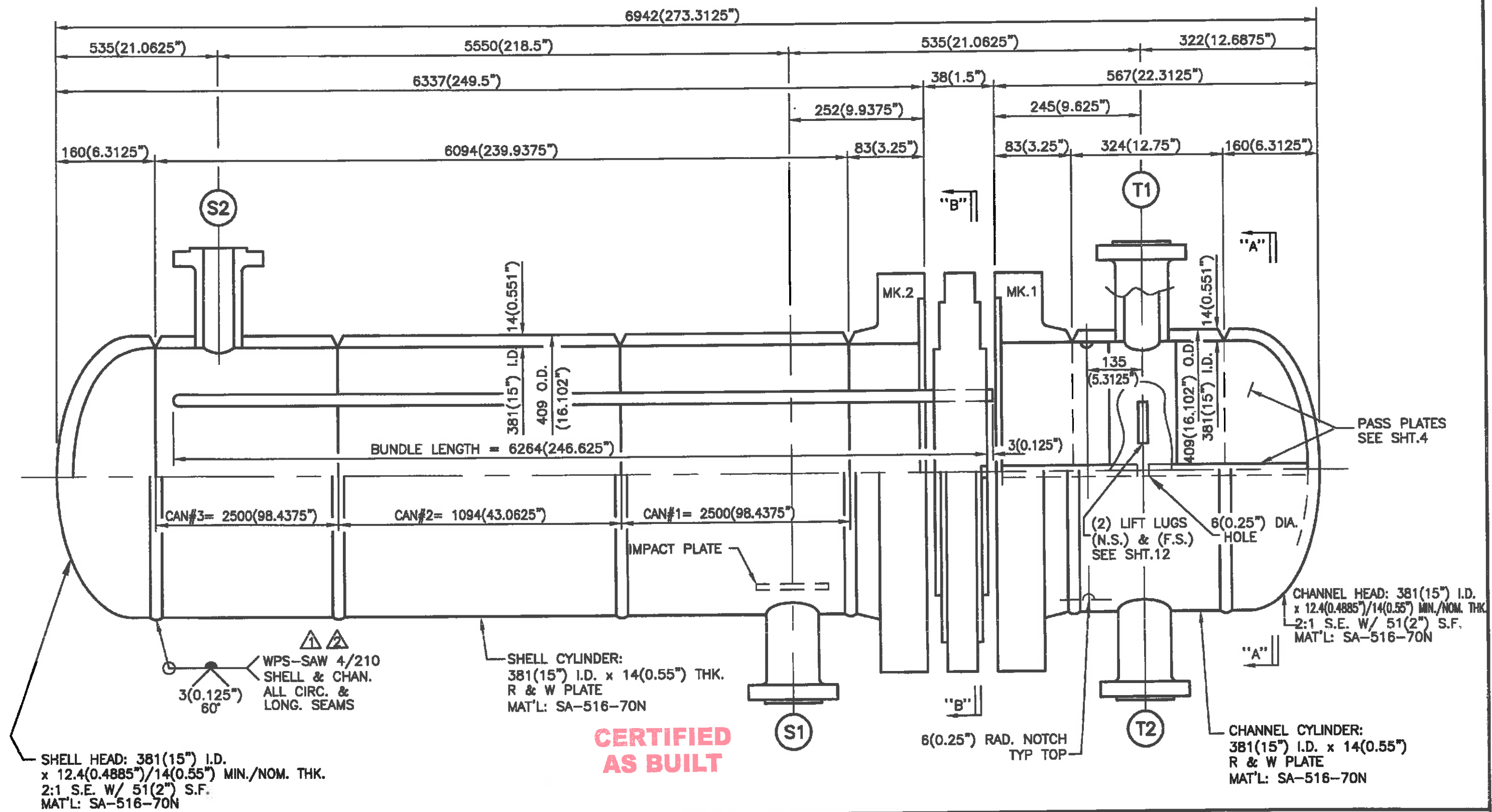
*	**
A	135
B	136

**CERTIFIED
 AS BUILT**



NAMEPLATE BKT DETAIL

REVISIONS PER CUST. MARK-UPS & E.I. MAY 16/2013 (FZ) PER E.I. JULY 17/2013 (AG)	NAME PLATE DETAIL NO. REQ'D EACH EXCHANGER: ONE NO. OF EXCHANGERS REQ'D: TWO	 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA
	PO #: CE416040-CC088996-00 CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB		DWG NO. 13-3353A/B
	DWN FX | CKD KW | ITEM 104-E-135/136	SHEET 2 OF 13



SHELL HEAD: 381(15") I.D.
 x 12.4(0.4885")/14(0.55") MIN./NOM. THK.
 2:1 S.E. W/ 51(2") S.F.
 MAT'L: SA-516-70N

WPS-SAW 4/210
 SHELL & CHAN.
 ALL CIRC. &
 LONG. SEAMS

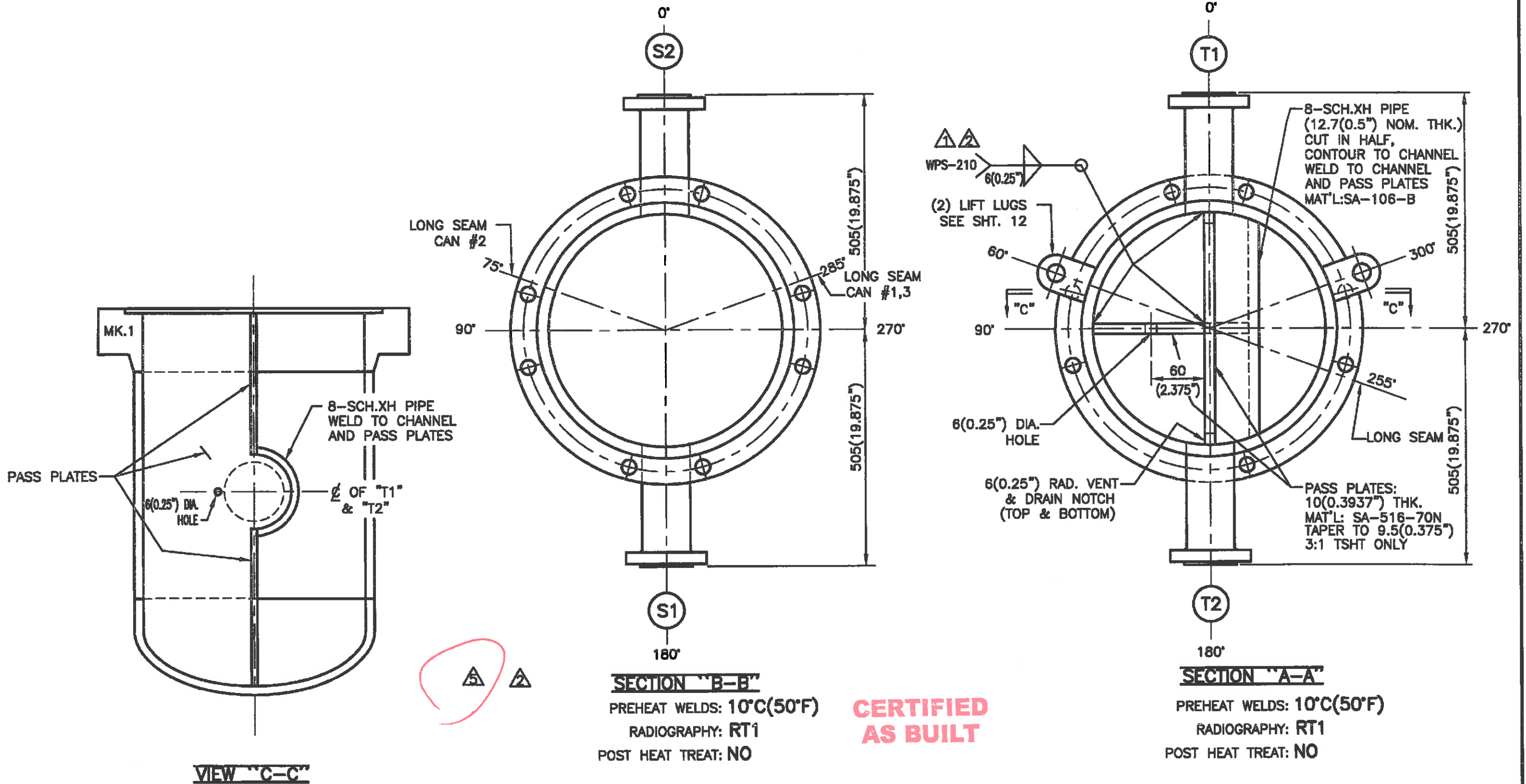
SHELL CYLINDER:
 381(15") I.D. x 14(0.55") THK.
 R & W PLATE
 MAT'L: SA-516-70N

**CERTIFIED
 AS BUILT**

CHANNEL HEAD: 381(15") I.D.
 x 12.4(0.4885")/14(0.55") MIN./NOM. THK.
 2:1 S.E. W/ 51(2") S.F.
 MAT'L: SA-516-70N

CHANNEL CYLINDER:
 381(15") I.D. x 14(0.55")
 R & W PLATE
 MAT'L: SA-516-70N

REVISIONS ⚠ PER CUST. MARK-UPS MAY 16/2013 (FZ) ⚠ PER E.I. JULY 17/2013 (AG)	SHELL & CHANNEL DETAIL		 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA
	NO. OF EXCHANGERS REQ'D: TWO PO #: CE416040-CC088996-00		
⚠ CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB		DWN FX CKD KW ITEM104-E-135/136	DWG NO. 13-3353A/B SHEET 3 OF 13



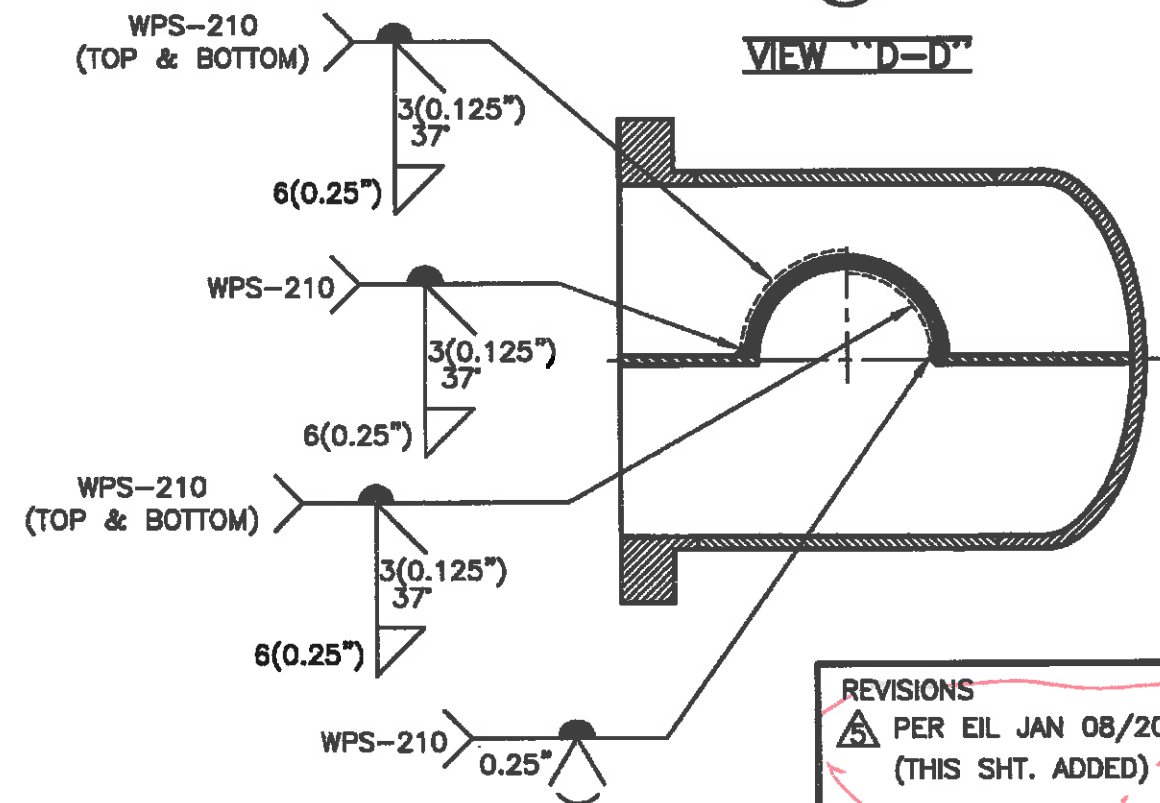
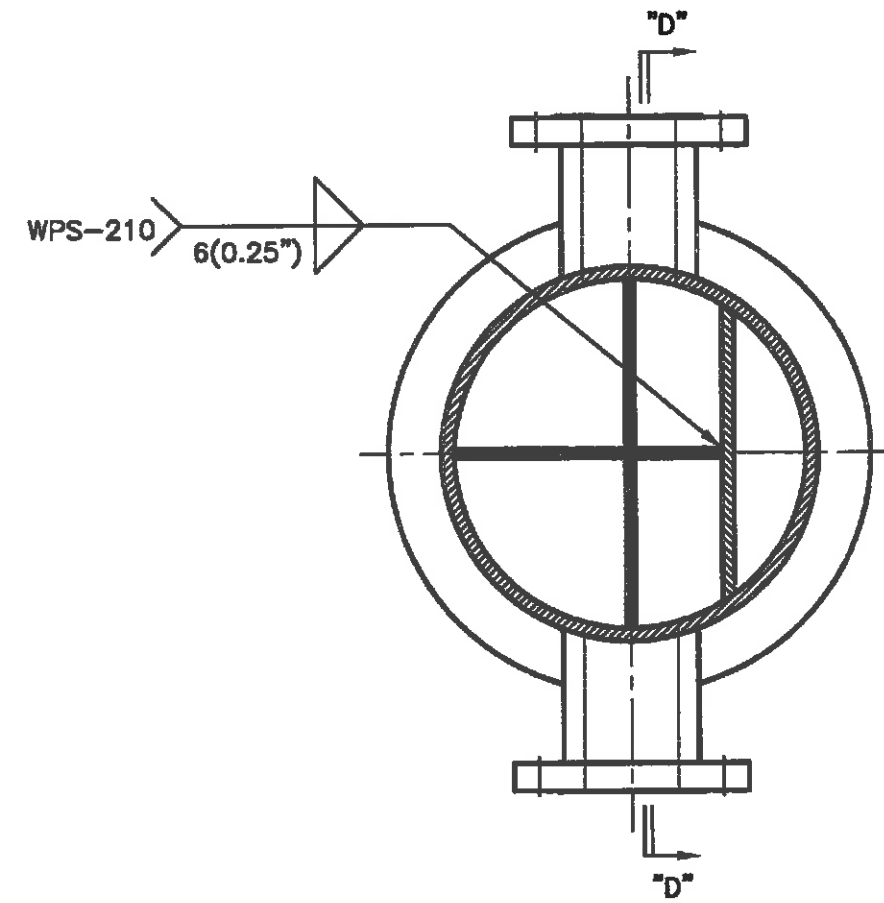
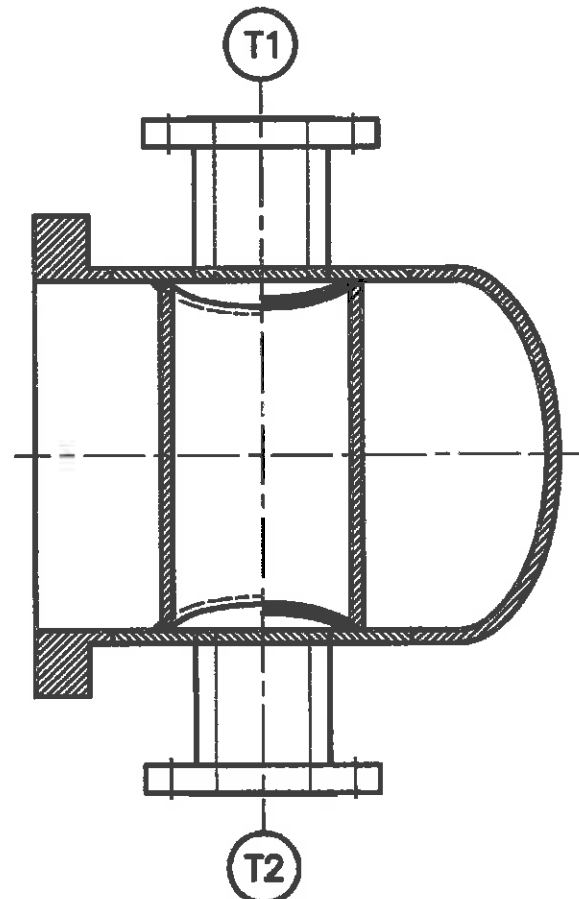
REVISIONS

⚠	PER CUST. MARK-UPS MAY 16/2013 (FZ)
⚠	PER E.I. JULY 17/2013 (AG)
⚠	PER EIL JAN 08/2014 (JL)

SHELL & CHANNEL SECTIONS

NO. OF EXCHANGERS REQ'D: TWO
 PO #: CE416040-CC088996-00

EXCHANGER INDUSTRIES LIMITED
 CALGARY, ALBERTA

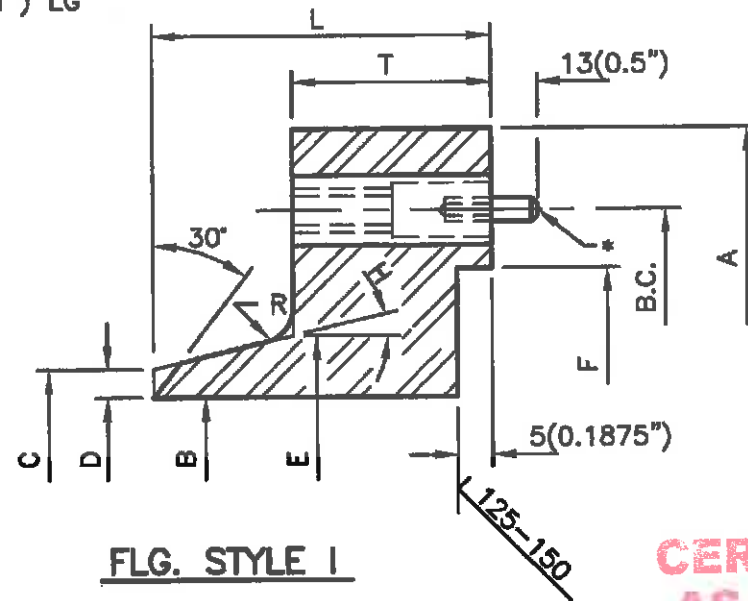


VIEW "D-D"

**CERTIFIED
AS BUILT**

REVISIONS 5 PER EIL JAN 08/2014 (JL) (THIS SHT. ADDED) <i>JL</i>	HALF PIPE WELDING DETAILS		 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA
	NO. OF EXCHANGERS REQ'D: TWO		
	PO #: CE416040-CC088996-00		DWG NO. 13-3353A/B
	DWN JL	CKD <i>JL</i>	ITEM 104-E-135/136 SHEET 4A OF 13

* (1) 10(0.3937") DIA. X 25(1") LG
 CARB. STL DOWEL PIN.
 DRILL & TAP 13(0.5") DEEP
 ON B.C. @ 0° IN MK.1 & 2.



**CERTIFIED
 AS BUILT**

MATERIAL: SA-105N

250 OVERALL FINISH EXCEPT AS NOTED.

LOCATE (2) 12.7(0.5") DIA. JACKSCREWS ON 495(19.5") DIA. @ 90° & 270°. DRILL & TAP(BACK FLG. SIDE)
 19.05(0.75") DEEP & COUNTERBORE REMAINDER TO 15.9(0.625") DIA. ON MK.1 & 2

LINE NO.	MK. NO.	NO. REQ'D	FLG. STYLE	A	B	C	D	E	F	G	H	R	T	L	B.C.	BOLT HOLES	
																NO.	DIA.
1	1	ONE	I	524 (20.625")	381 (15")	409 (16.102")	14 (0.551")	416 (16.352")	448 (17.625")	-	7.12"	11.1 (0.4375")	57 (2.25")	83 (3.25")	483 (19")	32	22.2 (0.875")
2	2	ONE	I	↓	↓	↓	↓	↓	↓	-	↓	↓	↓	↓	↓	↓	↓

REVISIONS

△ PER CUST. MARK-UPS MAY 16/2013 (FZ)

FLANGE DETAIL

MK.1 381(15") - 4661 kPaG(678 PSIG)
 MK.2 381(15") - 4661 kPaG(678 PSIG)
 DESIGN TEMA "R"
 NO. OF EXCHANGERS REQ'D:TWO

PO #: CE416040-CC088996-00

△ CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB

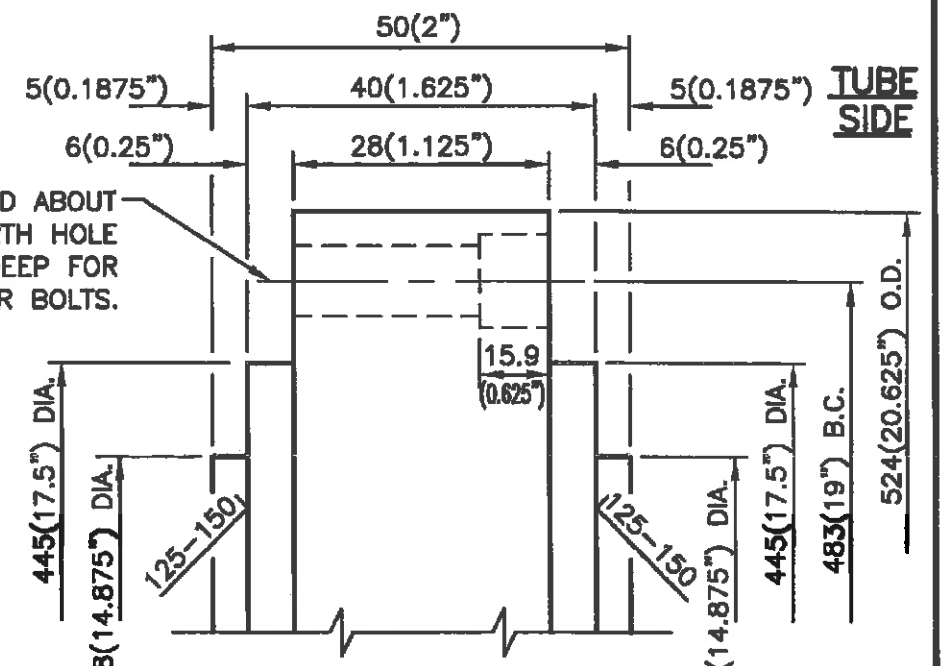
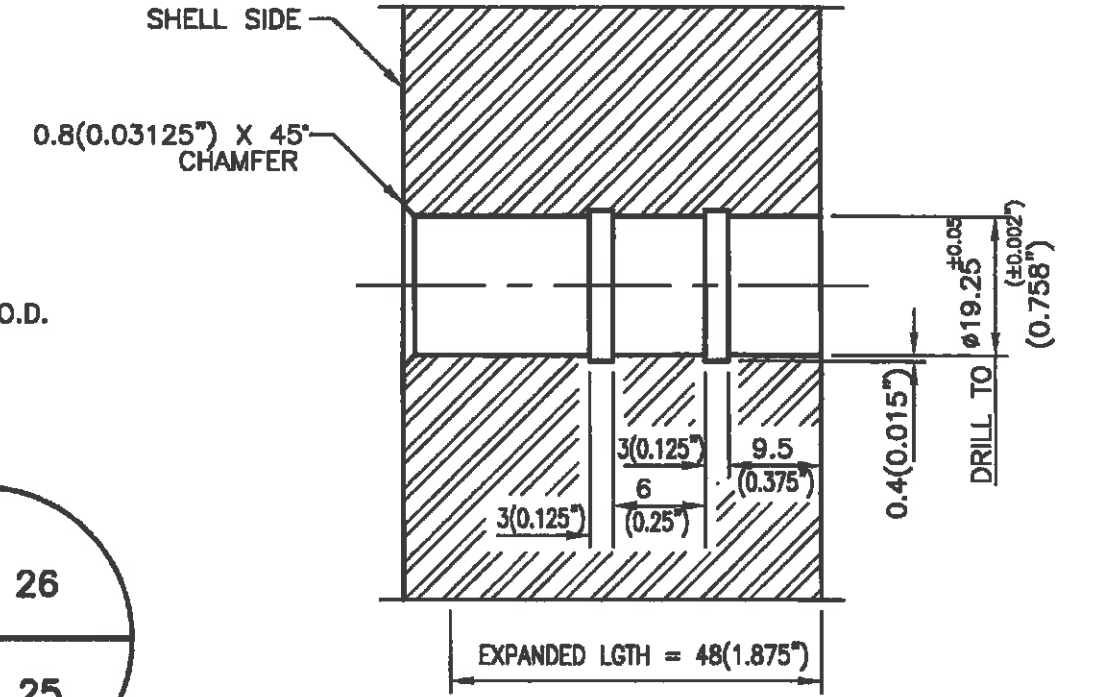
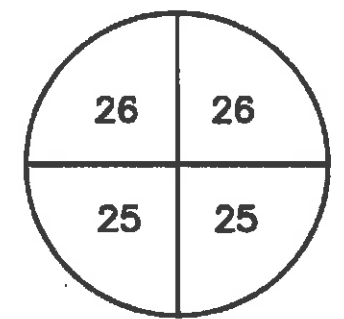
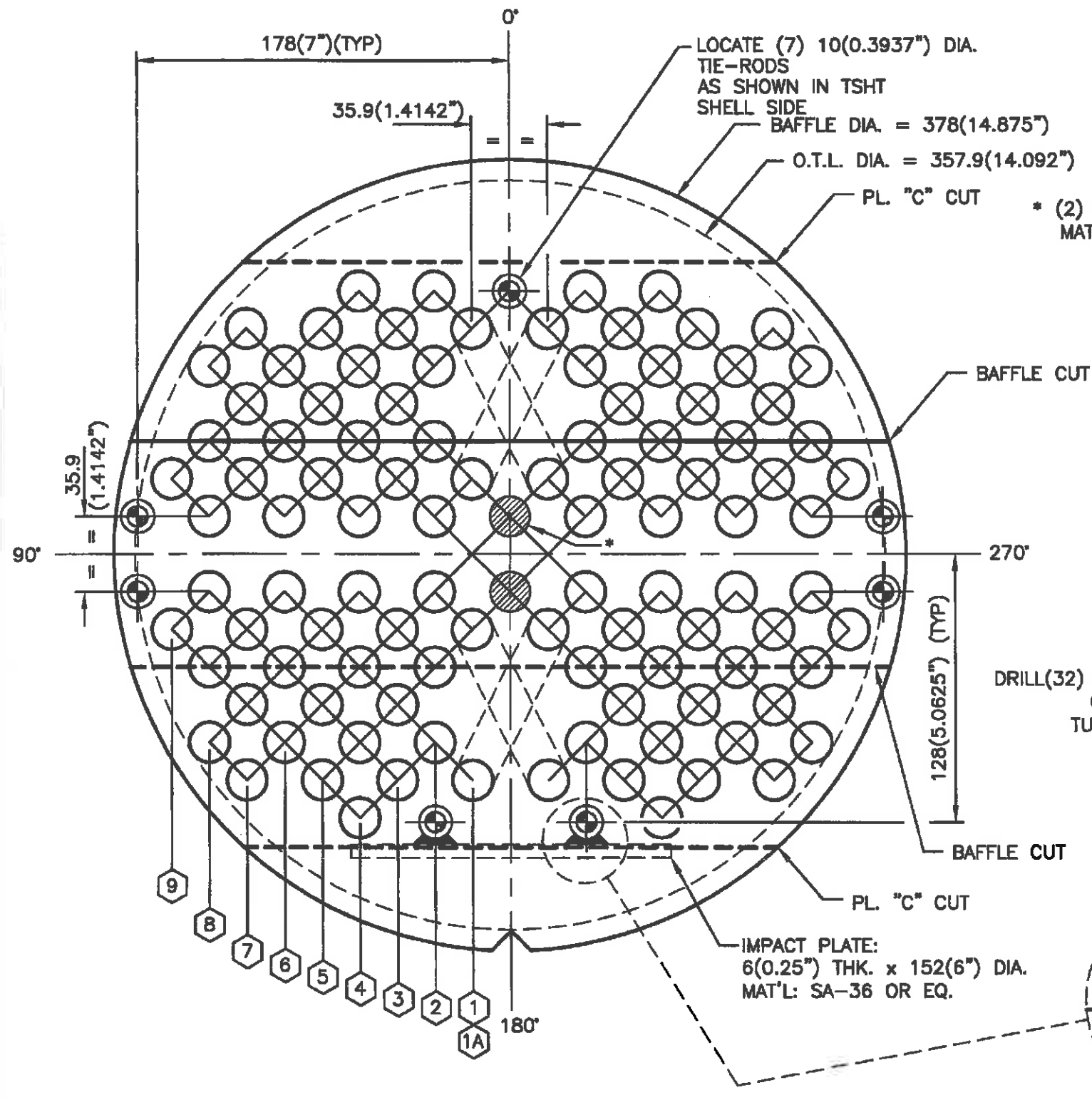
DWN FX CKD KW ITEM 104-E-135/136



**EXCHANGER INDUSTRIES
 LIMITED**
 CALGARY, ALBERTA

DWG NO. 13-3353A/B

SHEET 5 OF 13



DRILL(32) 22.2(0.875") DIA. HOLES EQUALLY SPACED ABOUT CTR LINES. COUNTERBORE(8) EVERY FOURTH HOLE TUBESIDE 30(1.1875") DIA. x 16(0.625") DEEP FOR (8) 19.05(0.75") DIA. 10 T.P.I. COLLAR BOLTS.

IMPACT PLATE:
6(0.25") THK. x 152(6") DIA.
MAT'L: SA-36 OR EQ.

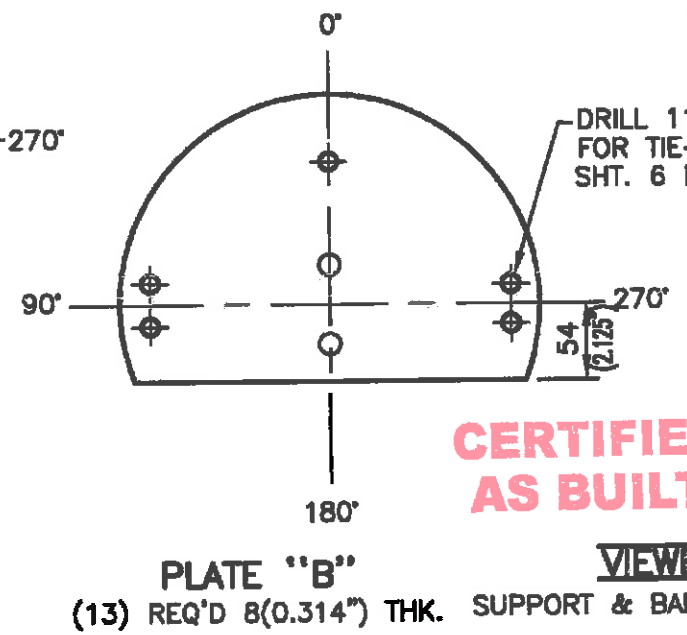
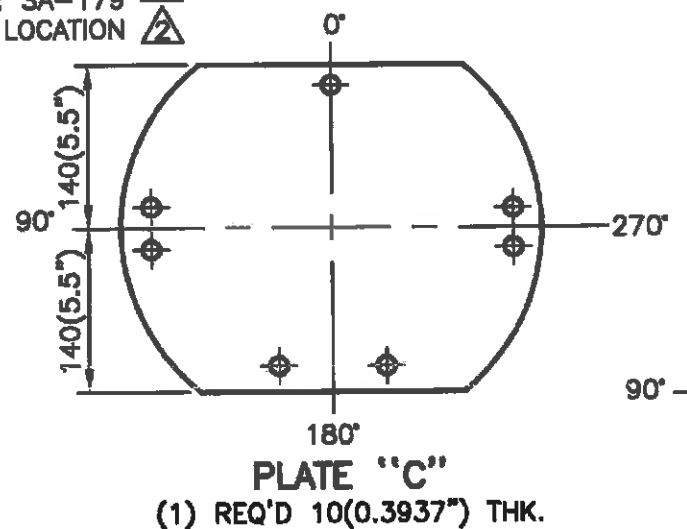
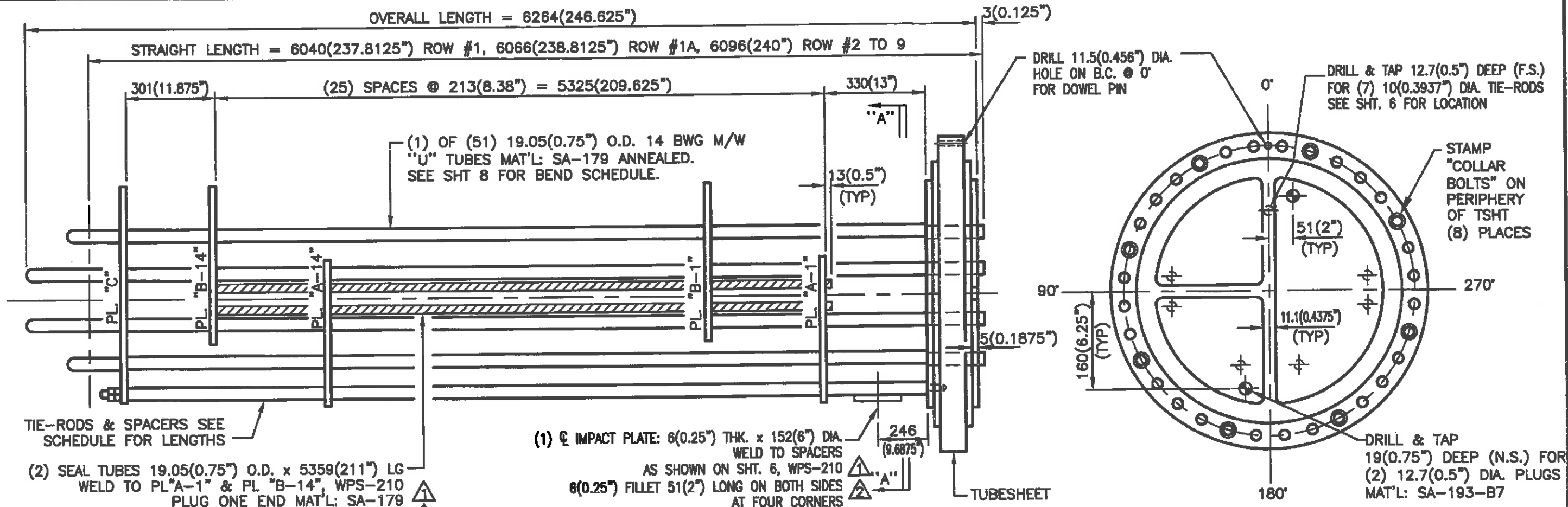
**CERTIFIED
AS BUILT**

TUBE O.D. = 19.05(0.75")
TUBE PITCH = 25.4(1") 45° ◇
NO. OF TUBES = (51) "U"
NO. OF PASSES = FOUR

REVISIONS
△ PER CUST. MARK-UPS MAY 16/2013 (FZ)

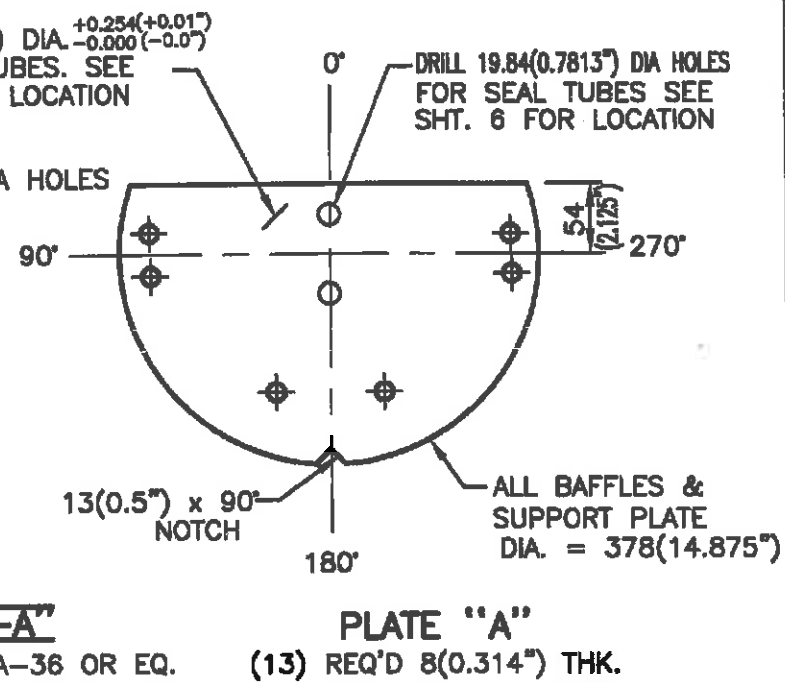
TUBE HOLE LAYOUT		
NO. OF EXCHANGERS REQ'D: TWO		
PO #: CE416040-CC088996-00		
CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB		
DWN FX	CKD KW	ITEM 104-E-135/136

 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA
DWG NO. 13-3353A/B
SHEET 6 OF 13



CERTIFIED AS BUILT

VIEWED ON "A-A"



TIE-ROD SCHEDULE						
TIE-ROD DIA.: 10(0.3937")			TIE-ROD MAT'L: SA-36 OR EQ			
TOTAL NO. REQ'D EACH BUNDLE: (7) C/W (2) CARB. STL NUTS EACH						
NO.:	(7)					
LGTH:	6013 (236.75")					
SPACER SCHEDULE						
SPACER O.D.: 15.9(0.625")			SPACER MAT'L: SA-179			
TOTAL NO. REQ'D EACH BUNDLE: (150)						
NO.:	(6)	(1)	(100)	(36)	(2)	(5)
LGTH:	330 (13")	543 (21.38")	205 (8.066")	418 (16.44")	506 (19.94")	293 (11.56")

REVISIONS

⚠ PER CUST. MARK-UPS MAY 16/2013 (FZ)

⚠ PER E.I. JULY 17/2013 (AG)

BUNDLE DETAIL			
NO. OF EXCHANGERS REQ'D: TWO			
PO #: CE416040-CC088996-00			
CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB			
DWN	FX	CKD	KW
ITEM		104-E-135/136	

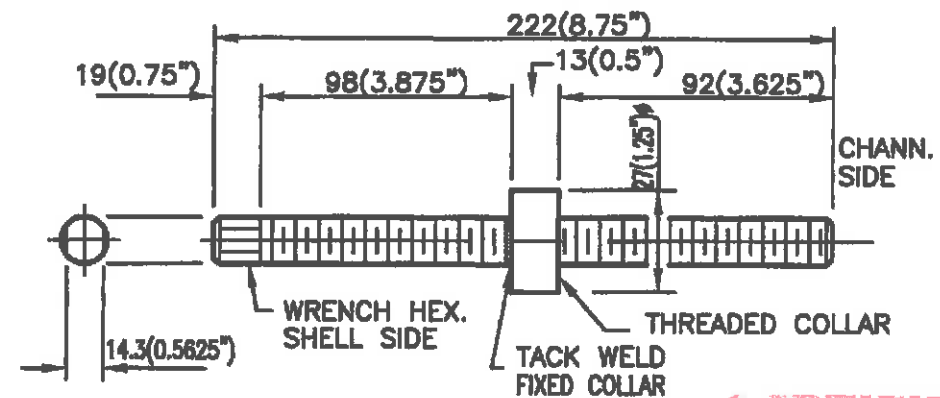
 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA
DWG NO. 13-3353A/B
SHEET 7 OF 13

ROW NO.	NO. OF TUBES	BEND DIA.	STRAIGHT LENGTH	U TUBE LENGTH	OVERALL TUBE LENGTH	
1	2	80(3.125")	6040(237.8125")	6090(239.75")	12206(480.5625")	
1A	2	80(3.125")	6066(238.8125")	6116(240.8125")	12258(482.625")	
2	7	72(2.8125")	6096(240")	6141(241.8125")	12305(484.4375")	
3	6	108(4.25")		6159(242.5")	12362(486.6875")	
4	8	143(5.625")		6177(243.1875")	12417(488.875")	
5	6	180(7.0625")		6196(243.9375")	12475(491.125")	
6	6	216(8.5")		6213(244.625")	12531(493.375")	
7	6	251(9.875")		6231(245.3125")	12586(495.5")	
8	6	287(11.3125")		6249(246")	12643(497.75")	
9	2	324(12.75")		6267(246.75")	12700(500")	
TOTAL (51) "U" TUBES						<p>NOTES:</p> <p>(1) MAX. OUT OF ROUNDNESS OF "U" BENDS TO BE 10% OF TUBE O.D.</p> <p>(2) U BENDS PLUS 152(6") OF STRAIGHT LENGTH TO BE STRESS RELIEVE @ 635°C ±15°C FOR (1) HOUR (1175°F ±27°F)</p> <p>(3) OVERALL TUBE LENGTH SHOWN IS EXACT LENGTH WITH NO ADDITION FOR TRIMMING.</p> <p>TUBE DETAILS: TUBE O.D. = 19.05(0.75") TUBE GAGE = 14 BWG M/W TUBE MAT'L = SA-179 FULLY ANNEALED</p>
CERTIFIED AS BUILT						
REVISIONS ▲ PER CUST. MARK-UPS MAY 16/2013 (FZ)			U BEND SCHEDULE NO. OF EXCHANGERS REQ'D: TWO PO #: CE416040-CC088996-00			 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA
			▲ CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB			
			DWN FX CKD KW ITEM 104-E-135/136			
						DWG NO. 13-3353A/B SHEET 8 OF 13

LOCATION	NO. REQ'D	SIZE	LENGTH	T.P.I.
CHANNEL TO SHELL	27*	19.05(0.75") DIA.	203(8")	10
CHANNEL TO SHELL COLLAR BOLTS	9*	19.05(0.75") DIA.	222(8.75")	10
JACKSCREWS	4	12.7(0.5") DIA.	89(3.5")	13

* INCLUDES 10% SPARE STUDS & NUTS

SIZE	SHOP TORQUE VALUES	
	(Nm)	(FT.LBS)
19.05(0.75") DIA.	260	192



COLLAR BOLT DETAIL

**CERTIFIED
AS BUILT**

NOTES:

- (1) NUMBER SHOWN IS NUMBER OF STUDBOLTS REQ'D FOR EACH EXCHANGER.
- (2) TWO AMERICAN STANDARD HEAVY HEX. NUTS REQ'D FOR EACH STUDBOLT UNLESS NOTED OTHERWISE.
- (3) COAT ENTIRE LENGTH OF STUDBOLTS WITH JET LUBE 550 OR OKS-250 LUBRICANT.

MATERIAL:

STUDBOLTS: SA-193-B7
NUTS: SA-194-2H
JACKSCREWS: SA-193-B7

REVISIONS

- ⚠ PER CUST. MARK-UPS & E.I. MAY 16/2013 (FZ)
- ⚠ PER E.I. JULY 17/2013 (AG)
- ⚠ PER E.I. Oct. 30/2013 (JL)

BOLT SCHEDULE

NO. OF EXCHANGERS REQ'D: TWO

PO #: CE416040-CC088996-00

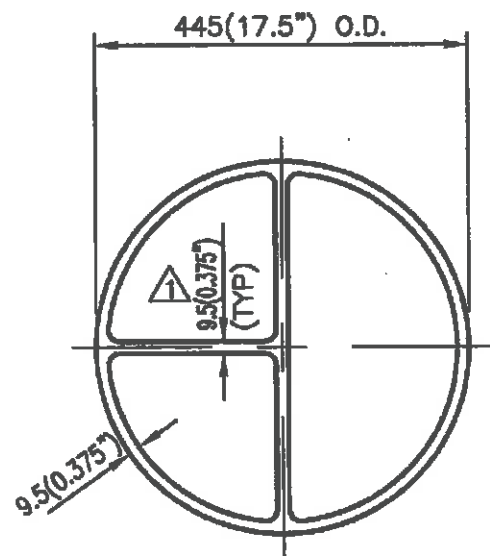
⚠ CANADIAN NATURAL RESOURCES LTD NIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB

DWN FX CKD KW ITEM 104-E-135/136

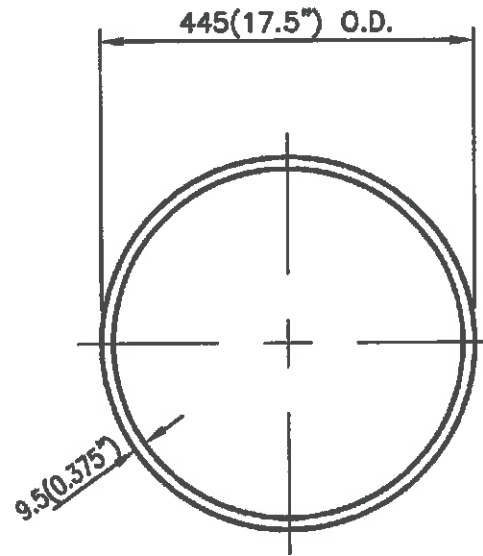
**EXCHANGER INDUSTRIES
LIMITED**
CALGARY, ALBERTA

DWG NO. 13-3353A/B

SHEET 9 OF 13



MK.1 TO TUBESHEET




MK.2 TO TUBESHEET

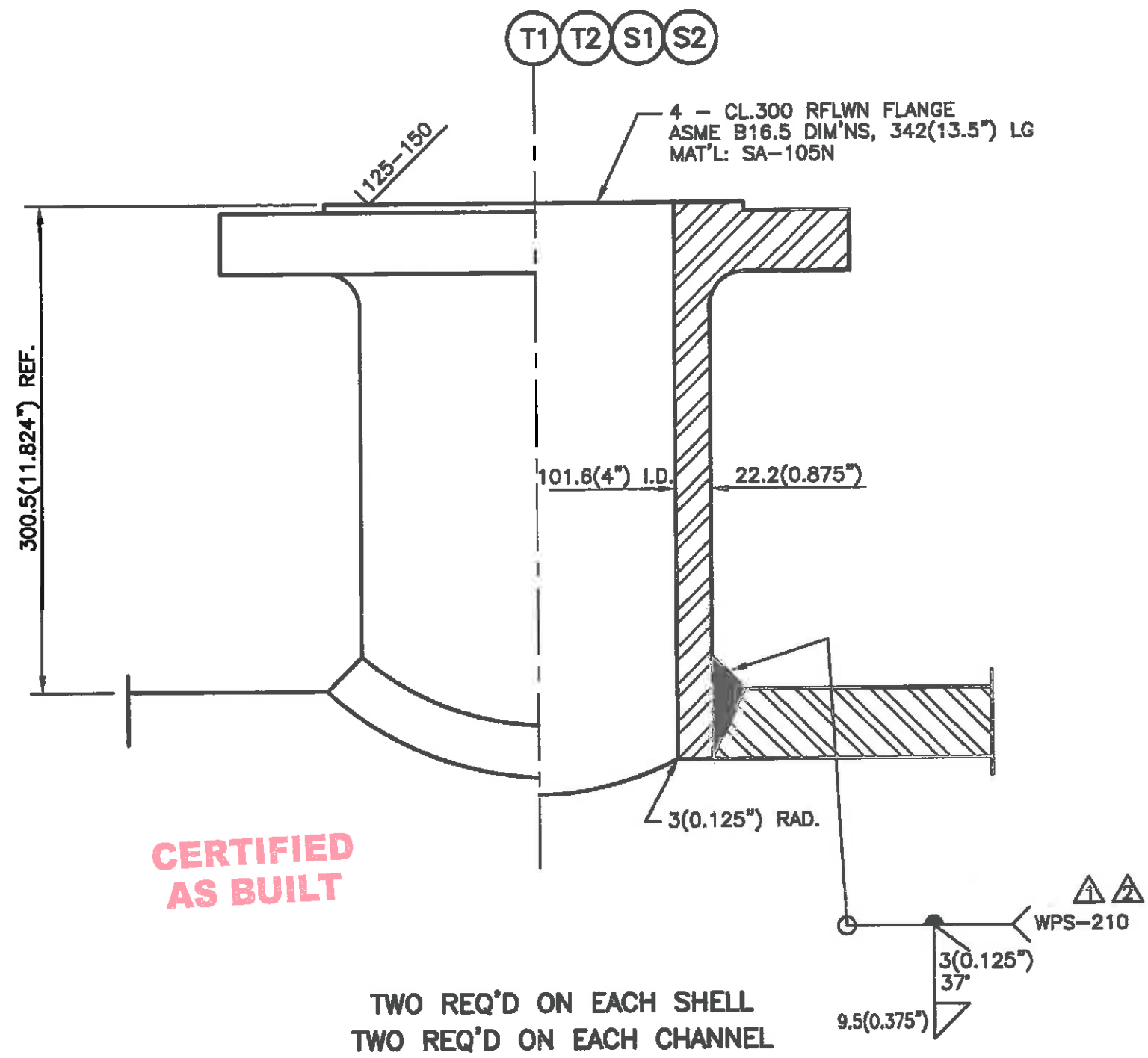
**CERTIFIED
AS BUILT**

NOTES:

- (1) UNLESS OTHERWISE NOTED ALL GASKETS ARE TO BE: 3.2(0.125") THK. KAMMPROFILE - 316 S.S. CORE, FLEX, GRAPHITE.
- (2) THICKNESS CALLED FOR IS THE TOTAL THICKNESS REQUIRED
- (3) ALL GASKETS ARE TO BE ONE PIECE CONSTRUCTION

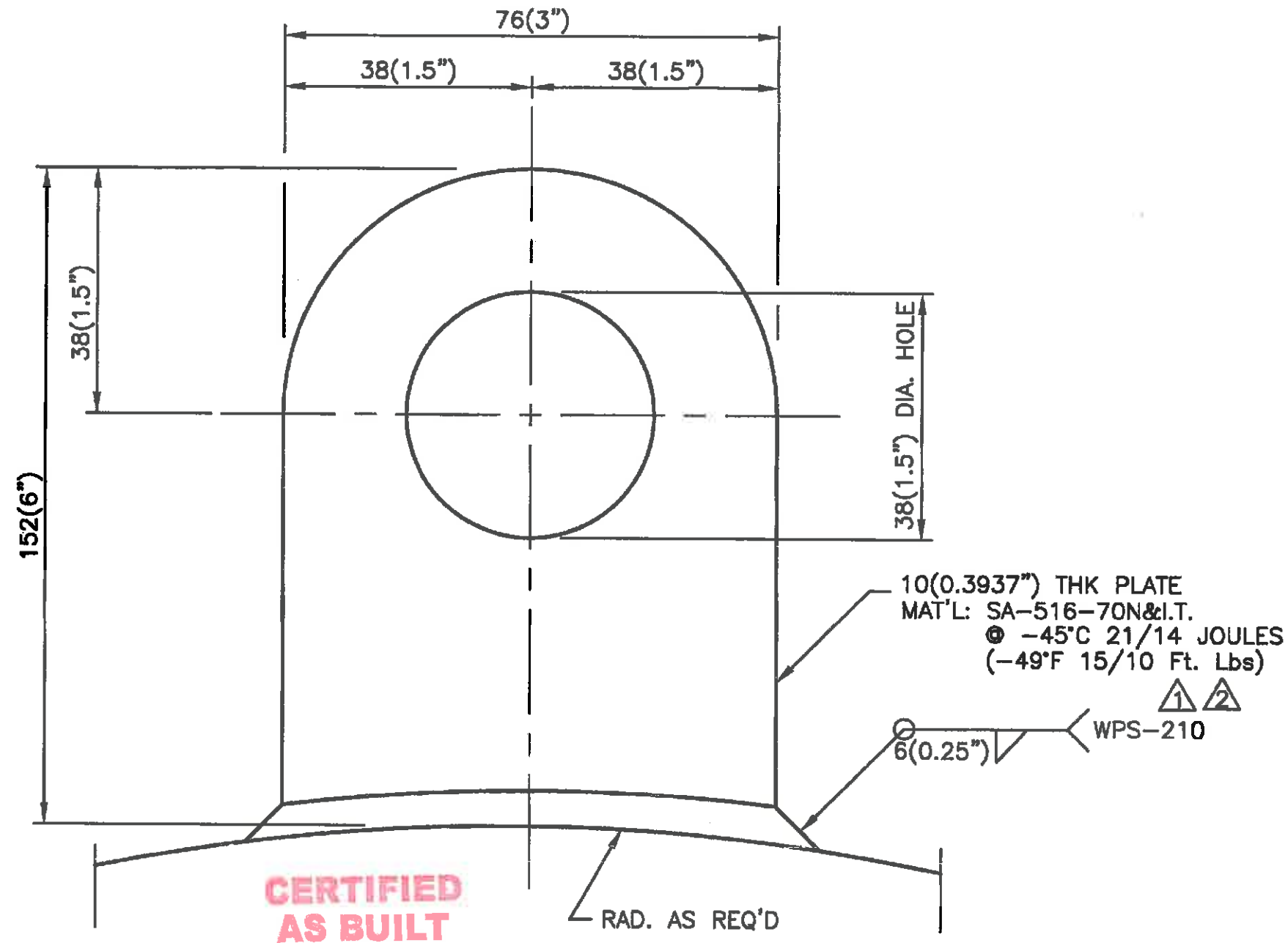
* INCLUDES ONE SPARE SET

REVISIONS △ PER CUST. MARK-UPS MAY 16/2013 (FZ)	GASKET DETAIL NO. OF SETS REQ'D EACH EXCHANGER: TWO* NO. OF EXCHANGERS REQ'D: TWO		 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA
	PO #: CE416040-CC088996-00		
	△ CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB		
	DWN FX | CKD KW | ITEM 104-E-135/136		
		DWG NO. 13-3353A/B SHEET 10 OF 13	




NOZZLE ORIENTATION SEE SHT.1

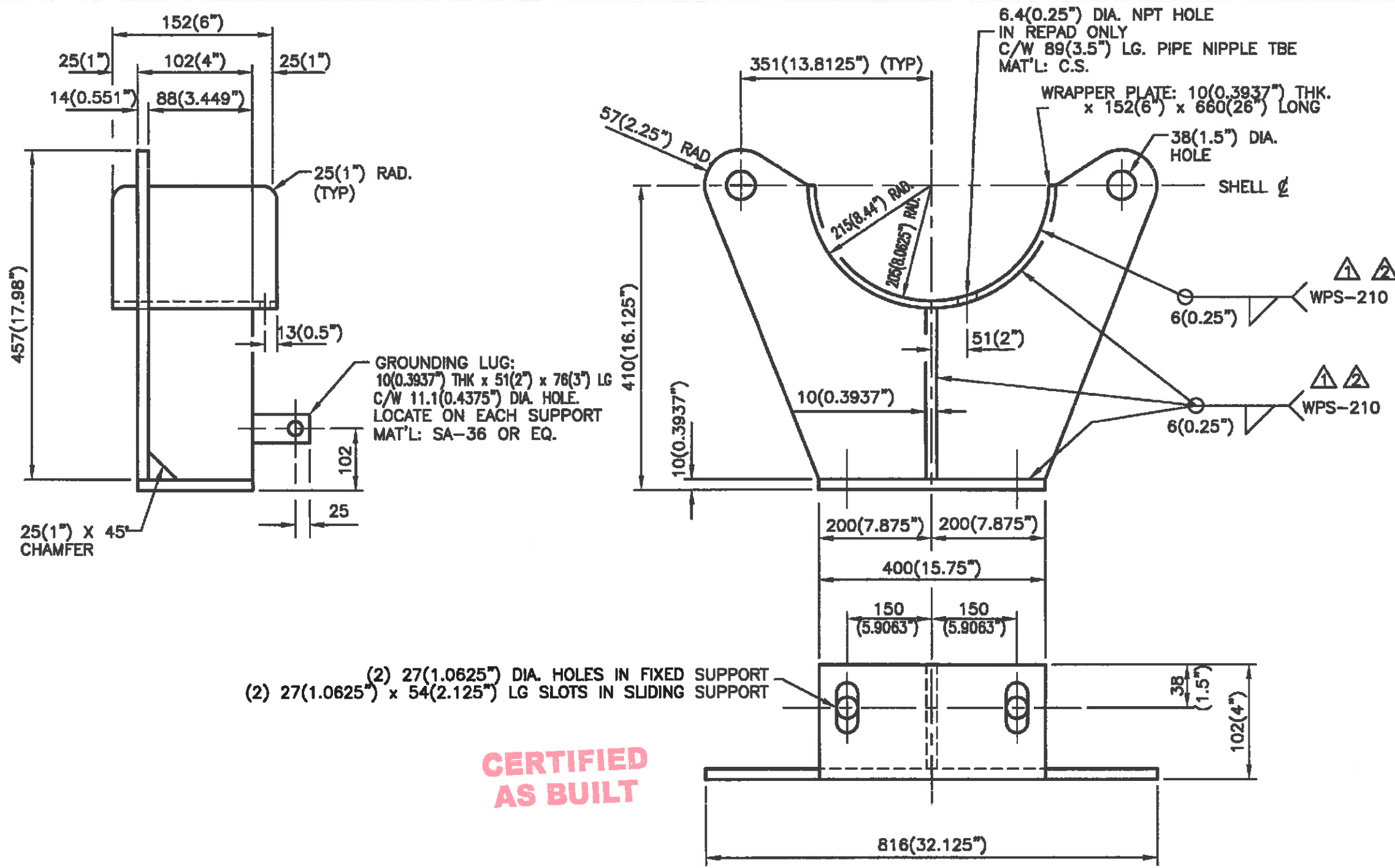
REVISIONS ⚠ PER CUST. MARK-UPS MAY 16/2013 (FZ) ⚠ PER E.I. JULY 17/2013 (AG)	NOZZLE DETAILS		 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA	
	NO. OF EXCHANGERS REQ'D: TWO			
	PO #: CE416040-CC088996-00			
	⚠ CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB			
DWN	FX	CKD KW	ITEM 104-E-135/136	DWG NO. 13-3353A/B
				SHEET 11 OF 13



**CERTIFIED
AS BUILT**

TWO REQ'D ON EACH CHANNEL CYLINDER

REVISIONS ① PER CUST. MARK-UPS MAY 16/2013 (FZ) ② PER E.I. JULY 17/2013 (AG)	LIFT LUG DETAIL NO. OF EXCHANGERS REQ'D: TWO		 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA
	PO #: CE416040-CC088996-00		
	① CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB		
	DWN FX | CKD KW | ITEM 104-E-135/136		
		DWG NO. 13-3353A/B	SHEET 12 OF 13



(2) 27(1.0625") DIA. HOLES IN FIXED SUPPORT
(2) 27(1.0625") x 54(2.125") LG SLOTS IN SLIDING SUPPORT

**CERTIFIED
AS BUILT**

NOTES:

(1) ALL MATERIAL TO BE SA-516-70N&I.T. @ -45°C 21/14 JOULES (-49°F 15/10 Ft.Lbs) EXCEPT FOR GROUNDING LUG.

REVISIONS ⚠ PER CUST. MARK-UPS MAY 16/2013 (FZ) ⚠ PER E.I. JULY 17/2013 (AG)	SUPPORT DETAIL NO. OF EXCHANGERS REQ'D: TWO NO. OF SUPPORTS REQ'D: TWO		 EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA
	PO #: CE416040-CC088996-00		
	⚠ CANADIAN NATURAL RESOURCES LTD KIRBY NORTH PHASE 1 PROJECT/CONKLIN, AB		DWG NO. 13-3353A/B
	DWN FX	CKD KW	ITEM104-E-135/136 SHEET 13 OF 13



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

Supplier's Document Review Sheet

Equipment Numbers	Comments		
101-E-110;101-E-111;101-E-112;101-E-113;101-E-114;101-E-115;101-E-120;101-E-121;101-E-210;101-E-225;101-E-226;101-E-240;101-E-241;101-E-450;101-E-451;102-E-610;102-E-613;102-E-655;103-E-080;103-E-190;103-E-290;103-E-390;103-E-490;103-E-590;103-E-705;103-E-707;104-E-135;104-E-136;107-E-305	JPI REV 5 - INFORMATION		
Review Status Codes	Project / Req Title	CNRL Kirby North Phase 1	
<input type="checkbox"/> 1 - Work May Proceed <input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated <input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture <input type="checkbox"/> 4 - STOP WORK per attached written instructions. <input type="checkbox"/> 5 - Review Not Required: Work may proceed <small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small>	Supplier	Exchanger Industries	
	Doc. Description	EXCHANGER - QUALITY ASSURANCE MANUAL 11 EDITION	
	Vendor Document No.	EI QUALITY ASSURANCE MANUAL - 11 EDITION	
	Client Document No.	VP088996-M001-00001	
	Purchase Order No.	Doc Cat.	Issue
CE416040-CC088996-00	M001	11	
BY : _____	Categories	Othercategories	
DATE : _____	Date Received	01/17/2014	



Revision Number 11.2	Revision Date: August 23, 2011	Section 1 Page 1 of 7
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SECTION 1 TITLE PAGE AND CERTIFICATIONS

QUALITY CONTROL MANUAL

**FOR THE FOLLOWING CONSTRUCTION ACTIVITIES
IN ACCORDANCE WITH THE ASME CODE:**

**SECTION VIII, DIVISION 1; PRESSURE VESSELS
AND**

**SECTION I; POWER BOILERS
AND**

**THE CONSTRUCTION OF PRESSURE PIPING IN ACCORDANCE WITH
ASME B31.1 AND B31.3 AND THE ALBERTA SAFETY CODES ACT AND REGULATIONS
AND**

**THE REPAIR AND ALTERATION OF EXISTING BOILERS & PRESSURE VESSELS
IN ACCORDANCE WITH (AS REQUIRED)**

**THE NATIONAL BOARD INSPECTION CODE, (ANSI / NB-23)
AND / OR ANY ADDITIONAL REQUIREMENTS IMPOSED BY
THE ALBERTA SAFETY CODES ACT AND REGULATIONS
AT**

Exchanger Industries Limited
5505 52nd Street SE, Calgary, Alberta T2C 2W8
Telephone (403) 236-0166 Fax (403) 279-8242 Website: www.exchangerindustries.com

(General Name Change on All Headers and Selected Exhibits)



AND AT

**FIELD SITES CONTROLLED FROM THE ABOVE LOCATION
AND**

**PERFORMANCE QUALIFICATION TESTING OF WELDERS AND
THE CONSTRUCTION OF 'A', 'B' AND 'H' PRESSURE FITTINGS
IN ACCORDANCE WITH THE ALBERTA SAFETY CODES ACT AND REGULATIONS
AT THE ABOVE ADDRESS ONLY**

Manual Number		11 th Edition	1 st Edition 1981	7 th Edition 1999
AQP Registration Number		AQP-1025(S)	2 nd Edition 1984	8 th Edition 2002
Issued to			3 rd Edition 1987	9 th Edition 2005
			4 th Edition 1990	10 th Edition 2008
			5 th Edition 1993	11 th Edition 2011
			6 th Edition 1996	

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VP088996-M001-00001

SECTION 1 TITLE PAGE AND CERTIFICATIONS

EXHIBIT 1.1 – ASME Certificate of Authorization – U



CERTIFICATE OF AUTHORIZATION

This certificate certifies the named company as authorized to use the indicated symbol of the American Society of Mechanical Engineers (ASME) for the scope of activity shown below in accordance with the applicable rules of the ASME Boiler and Pressure Vessel Code. The use of the Code symbol and the authority granted by this Certificate of Authorization are subject to the provisions of the agreement set forth in the application. Any construction stamped with this symbol shall have been built strictly in accordance with the provisions of the ASME Boiler and Pressure Vessel Code.

COMPANY:

**Exchanger Industries Limited
5505 52nd Street SE
Calgary, Alberta, T2C 2W8
Canada**

SCOPE:

Manufacture of pressure vessels at the above location and field sites controlled by the above location (This authorization does not cover impregnated graphite)

AUTHORIZED: **March 10, 2011**

REVISED: **September 15, 2011**

EXPIRES: **March 30, 2014**

CERTIFICATE NUMBER: **5,983**



Vice President
Conformity Assessment



Director, Accreditation and Certification

The American Society of Mechanical Engineers



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SECTION 1 TITLE PAGE AND CERTIFICATIONS

EXHIBIT 1.2 – ASME Certificate of Authorization – S



CERTIFICATE OF AUTHORIZATION

This certificate certifies the named company as authorized to use the indicated symbol of the American Society of Mechanical Engineers (ASME) for the scope of activity shown below in accordance with the applicable rules of the ASME Boiler and Pressure Vessel Code. The use of the Code symbol and the authority granted by this Certificate of Authorization are subject to the provisions of the agreement set forth in the application. Any construction stamped with this symbol shall have been built strictly in accordance with the provisions of the ASME Boiler and Pressure Vessel Code.

COMPANY:

Exchanger Industries Limited
5505 52nd Street SE
Calgary, Alberta, T2C 2W8
Canada

SCOPE:

Manufacture and assembly of power boilers at the above location and field sites controlled by the above location

AUTHORIZED: March 10, 2011

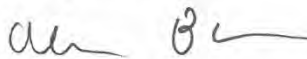
REVISED: September 15, 2011

EXPIRES: March 30, 2014

CERTIFICATE NUMBER: 8,719



Vice President
Conformity Assessment



Director, Accreditation and Certification

The American Society of Mechanical Engineers



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SECTION 1 TITLE PAGE AND CERTIFICATIONS

EXHIBIT 1.3 – National Board Certificate of Authorization – R



THE NATIONAL BOARD
OF
BOILER & PRESSURE VESSEL INSPECTORS
Certificate of Authorization



This is to certify that

EXCHANGER INDUSTRIES LIMITED
5505 52ND STREET SE
CALGARY, PROVINCE OF ALBERTA T2C 2W8
CANADA

is authorized to use the "R" SYMBOL in accordance with the provisions of the National Board.

The scope of Authorization is limited as follows:

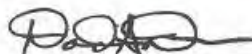
METALLIC REPAIRS AND/OR ALTERATIONS AT THE ABOVE LOCATION AND EXTENDED FOR FIELD REPAIRS AND/OR ALTERATIONS CONTROLLED BY THIS LOCATION

CERTIFICATE NUMBER: R-7031

ISSUE DATE: MARCH 11, 2011

EXPIRATION DATE: MARCH 30, 2014

Executive Director



SECTION 1 TITLE PAGE AND CERTIFICATIONS

EXHIBIT 1.4 – National Board – Certificate of Authorization - NB



THE NATIONAL BOARD
OF
BOILER & PRESSURE VESSEL INSPECTORS

Certificate of Authorization



This is to certify that

EXCHANGER INDUSTRIES LIMITED
5505 52ND STREET SE
CALGARY, AB T2C 2W8
CANADA

is authorized to apply the "NB" mark and register boilers, pressure vessels, or other pressure retaining items with the National Board in accordance with its provisions.

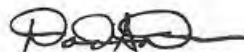
The scope of Authorization is limited to items manufactured in accordance with:

ASME Stamp(s): S U

ISSUE DATE: September 15, 2011

EXPIRATION DATE: March 30, 2014

Executive Director



SECTION 1 TITLE PAGE AND CERTIFICATIONS

EXHIBIT 1.5 – ABSA – Certificate of Authorization – APQ-1025(S) – Manufacturing



the pressure equipment safety authority

Certificate of Authorization Permit

Quality Management System

Expiry Date: **March 30, 2014**

Reg. No.: **AQP-1025(S)**

This is to certify that:

EXCHANGER INDUSTRIES LIMITED

5505 - 52 STREET S.E.
CALGARY, ALBERTA

having complied with the provisions of the SAFETY CODES ACT, is hereby authorized to:

Construct, Repair/Alter ASME Section I Power Boilers and ASME Section VIII-1 Pressure Vessels

Construct, Repair/Alter ASME B31.1 Power Piping, Boiler External Piping and ASME B31.3 Process Piping

Manufacture, Repair/Alter Category 'A', 'B' & 'H' Fittings in accordance with CSA B51 at the SHOP and FIELD sites controlled from the above address.



Form No. AB-121
Rev. (2010/05)

Dated at Edmonton, this 14th day of September, 2011



Chief Inspector and Administrator

Certificate No.: 8153

UNCONTROLLED COPY

SECTION 1 TITLE PAGE AND CERTIFICATIONS

EXHIBIT 1.6 – ABSA – Certificate of Authorization – AOQP-7015 – Welder Testing



the pressure equipment safety authority

Certificate of Authorization Permit

Quality Management System

Expiry Date: **May 5, 2013**

Reg. No.: **AOQP-7015**

This is to certify that:

EXCHANGER INDUSTRIES LIMITED

5505 - 52 STREET S.E.
CALGARY, ALBERTA

having complied with the provisions of the SAFETY CODES ACT, is hereby authorized to:

Conduct Performance Qualification Testing of Pressure Welders and Machine Welding Operators

at the above SHOP address.



Form No. AB-121
Rev. (2010/05)

Dated at Edmonton, this 14th day of September, 2011



Chief Inspector and Administrator

Certificate No.: 1297

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Revision Number 11.2	Revision Date: August 23, 2011	Section 2 Page 1 of 4
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EXHIBIT 1.4 Certificate of Authorization 'NB'	5 of 7	11.2	Aug 23, 2011
EXHIBIT 1.5 Certificate of Authorization 'APQ-1025(S)'	6 of 7	11.2	Aug 23, 2011
EXHIBIT 1.6 Certificate of Authorization 'AOPQ-7015'	7 of 7	11.2	Aug 23, 2011
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EXHIBIT 8.2 Drawing and, 20or Change Release (S&T Revision)	10 of 17	11.2	Aug 23, 2011
EXHIBIT 8.3 Drawing and, 20or Change Release (AC Issue)	11.2 of 17	11.2	Aug 23, 2011
EXHIBIT 8.4 Drawing and, 20or Change Release (AC Revision)	12 of 17	11.2	Aug 23, 2011
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Revision Number 11.2	Revision Date: August 23, 2011	Section 2 Page 2 of 4
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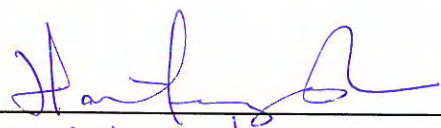


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Approval by Quality Control Manager
and
Acceptance by Authorized Inspector
of
Revision 11.2 of the Quality Control Manual as shown in the table of contents above.

Quality Control Manager Signature  Date: SEP 02 2011
Name PETER MARTENS

Authorized Inspector Signature  Date: SEP 06 2011
Name H. Shi

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SECTION 3 SCOPE OF WORK

3.0 Exchanger Industries Limited is a Company primarily engaged in the design and manufacture of heat exchanger equipment, power boilers and unfired pressure vessels. This equipment is designed to the customer's specifications and in conformance with

the Alberta Safety Codes Act and Regulations,
the A.S.M.E. Code Section VIII, Division 1, pressure vessels,
the A.S.M.E. Code Section I, boilers, and
T.E.M.A. and/or API

at the location below and at field sites controlled from this location.

LOCATION AND FUNCTIONS:

Head Office and Plant – 5505 - 52 Street S.E.,
Calgary, Alberta , Canada
T2A 2W8

Office Functions – Design, Engineering,
Drafting and Purchasing

Plant Functions – Receiving, Fabrication,
Inspection and Testing

3.1 Repairs and alterations to boilers and pressure vessels are limited to shop repairs or alterations of existing ASME Section VIII Division 1 pressure vessels and Section I Boilers in accordance with the Alberta Safety Codes Act and Regulations, or if National Board registration is required, in accordance with the National Board Inspection Code and any additional requirements imposed by the Alberta Safety Codes Act and Regulations, at the location above and at field sites controlled from this location.

3.2 Pressure Welders performance qualification testing scope includes issuance of performance qualification cards pursuant to the Alberta Safety Codes Act and the Pressure Welders Regulations at the location above.

SECTION 3 SCOPE OF WORK

- 3.3 New pressure piping constructed under this Quality Control System shall conform to the scope and all requirements of ASME B31.1 and ASME B31.3 Code Sections, and the Alberta Safety Codes Act and Regulations. Within these limitations pressure piping of any size, thickness and material allowed by the Codes shall be constructed, provided the requisite welding procedures are qualified and registered with the ABSA. Threaded piping which is constructed, repaired or altered under this Quality Control System shall be limited to the sizes, thicknesses, materials, fluid services and design pressures and temperatures specified by ASME B31.1 and B31.3 Codes. (Code Stamping Shall Not Be Applied except to Boiler External Piping which meets all of the requirements of ASME B31.1 and Section I).
- 3.4 Work under this system may also include repairs, alteration and replacement of piping systems that are under the jurisdiction of the Alberta Safety Codes Act and Regulations. (Code Stamping Shall Not Be Applied)
- 3.5 Pressure piping work, within the scope of this quality system, may be undertaken at the above location and field sites controlled from this location.
- 3.6 Category “A”, “B”, and “H” pressure fittings under this quality system shall be constructed in accordance with the requirements of the Alberta Safety Codes Act and Regulations and the CSA B51 Boiler, Pressure Vessel and Pressure Piping Code. (Code Stamping Shall Not Be Applied)

SECTION 4 STATEMENT OF AUTHORITY

- 4.0 This Quality Control Manual accurately describes the quality control system that will be employed by EXCHANGER INDUSTRIES LIMITED to ensure that:
- a) Pressure vessels are constructed in accordance with ASME Section VIII, Division 1 and the Alberta Safety Codes Act.
 - b) Power boilers are constructed in accordance with ASME Section I and the Alberta Safety Codes Act.
 - c) Repairs and/or alterations to existing pressure vessels and power boilers are performed in accordance with the Alberta Safety Codes Act and Regulations or, if National Board registration is required, in accordance with the National Board Inspection Code and any additional requirements imposed by the Alberta Safety Codes Act and Regulations, and, insofar as possible, with ASME Section VIII, Division 1 or ASME Section I.
 - d) Welders/Welding Operator performance qualification tests are conducted in accordance with the Alberta Pressure Welders Regulations, and ASME Section IX.
 - e) Power and process piping systems are constructed, repaired, altered or replaced in compliance with ASME Pressure Piping Code B31.1 or B31.3 as applicable, Customer Specifications, and the Alberta Safety Codes Act. (Code Stamping Shall Not Be Applied except to Boiler External Piping which meets all of the requirements of ASME B31.1 and Section I).
 - f) Category "A", "B", and "H" pressure fittings not requiring Authorized Inspection are constructed in accordance with CSA B51 Boiler and Pressure Piping Code and the Alberta Safety Codes Act. (Code Stamping Shall Not Be Applied)
- 4.1 No uncontrolled Quality Control Manuals will be used for Code work.



Revision Number 11.2	Revision Date: August 23, 2011	Section 4 Page 2 of 2
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SECTION 4 STATEMENT OF AUTHORITY

- 4.2 The Quality Control Manager is hereby appointed to administer and implement the system described in this Quality Control Manual. He has sufficient and well-defined responsibility along with the authority and organizational freedom to identify quality control problems and to preclude the use, installation or further processing of nonconforming items until their correction is verified and Code compliance is assured.
- 4.3 This quality system has the full support of management, who will ensure that adequate resources, including trained personnel, are provided to effectively implement this system.
- 4.4 Any conflicts of interpretation or requirements of this Quality Control Manual between the Quality Control Manager and other departments, which cannot be resolved by the Quality Control Manager, shall be brought to my attention for resolution without compromising the Code and this Quality Control Manual.
- 4.5 Any individual assigned a responsibility in this Quality Control Manual may delegate the performance of this activity to a qualified individual within the department; however, the responsibility remains with the individual assigned. When responsibilities are assigned to a department within this Quality Control Manual the responsibility ultimately shall be with the department manager.

Signature *B.M. Wetmore*

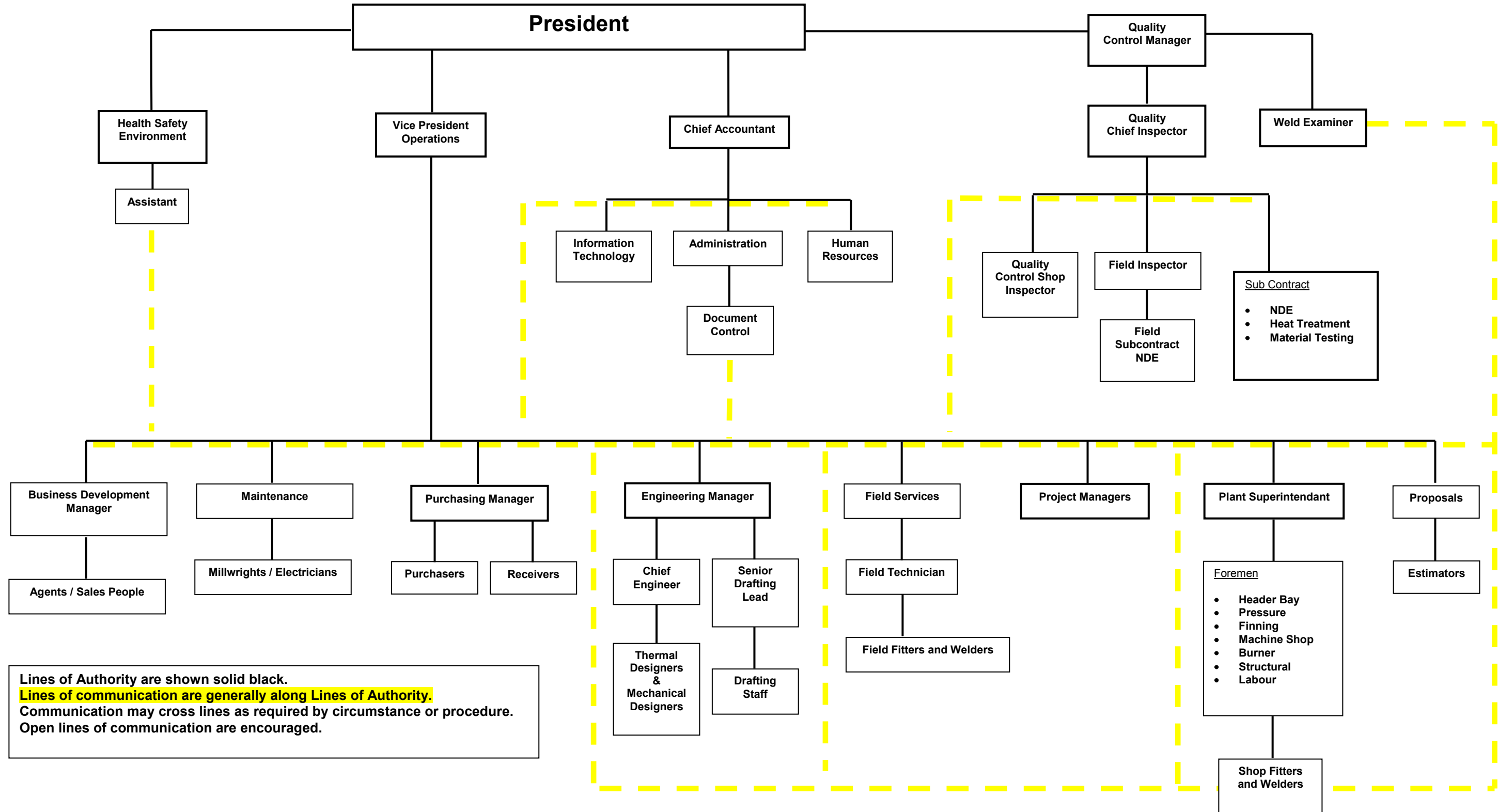
Name B.M. Wetmore

Title President

Date August 22, 2011

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SECTION 5 ORGANIZATIONAL CHART



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SECTION 6 DEFINITIONS

6.1 ABSA

ABSA is the regulatory organization delegated by the Province of Alberta to provide pressure equipment safety services under the Alberta Safety Codes Act, and act as the sole Jurisdiction/Regulatory Authority as defined in the CSA B51 Code and as accredited by ASME.

6.2 **A.I.A.** Authorized Inspection Agency

6.3 ALBERTA SAFETY CODES ACT

The Alberta Safety Codes Act; Statutes of Alberta, Chapter S-1 as it applies for pressure equipment and the following adopted regulations under the Alberta Safety Codes Act:

- Pressure Equipment Safety Regulation
- Administrative Items Regulation
- Pressure Equipment Exemption Order
- Pressure Welders Regulation

6.4 ALTERATION

A change in any item described on the original Manufacturer's Data Report, which affects the pressure containing capacity of a pressure retaining item. Non-physical changes such as an increase in the maximum allowable working pressure (internal or external), increase in design temperature, or a reduction in the minimum temperature of a pressure retaining item shall be considered an alteration.

6.5 APPLICABLE CODE EDITION AND ADDENDA

The latest ASME Edition and Addenda or that which is mandatory on the contract date.

6.6 APPROVAL (Acceptance)

Approval (Acceptance) shall be indicated by signature or initial or stamp, and the date unless specifically indicated otherwise within this Quality Control Manual.

SECTION 6 DEFINITIONS

6.7 **ASNT** American Society for Nondestructive Testing

6.8 **ANSI** American National Standards Institute (for flanges and connections)

6.9 **ASME** American Society of Mechanical Engineers

6.10 **AUTHORIZED INSPECTOR (AI)**

An inspector, regularly employed by the ASME accredited Authorized Inspection Agency, who is qualified by written examination in accordance with the ASME QAI-1 Standard. The ABSA Authorized Inspector is also a Safety Codes Officer (Boilers and Pressure Vessels) appointed to administer the Alberta Safety Codes Act

6.11 **BOILER EXTERNAL PIPING**

Piping as defined in ASME Code B31.1, paragraph 100.1.2, which is subject to mandatory inspection by the Authorized Inspector, as defined in ASME Code Section I.

6.12 **BURNER**

An employee of Exchanger Industries Limited, operating out of the machine shop, who cuts material for use per 10.4.1.

6.13 **CRN**

Canadian Registration Number; registration number allotted by the regulatory authority to designs and specifications when accepted and registered.

6.14 **CSA B51**

Canadian Standards Association, latest Edition and Addenda of B51 Boiler, Pressure Vessel and Pressure Piping Code.

SECTION 6 DEFINITIONS

6.15 CODE

American Society of Mechanical Engineers (ASME), latest mandatory Edition and Addenda (at time of contract acceptance) of the ASME Boiler and Pressure Vessel Code:

- a) Section VIII Division 1, Rules for Construction of Pressure Vessels.
- b) Section I, Power Boilers
- c) B31.1, Power Piping.
- d) B31.3, Process Piping.
- e) Sections referenced by the construction Section.

and, if required, The National Board Inspection Code.

6.16 CUSTOMER INSPECTOR

A person or representative who has been designated to carry out inspections on behalf of the customer or owner.

6.17 CONSTRUCTION DRAWING

A drawing that has been created from a new or existing design drawing that is or is in the process of being registered and accepted with the applicable Canadian Jurisdiction. This drawing will be used for the purposes of fabrication.

6.18 DESIGN DRAWING

A drawing that is or in the process of being registered with the applicable Canadian Jurisdiction and has been stamped by the applicable Jurisdiction. This drawing is used to facilitate the creation of a construction drawing.

6.19 DRAWINGS

The term drawings, when not defined as design or construction in this Quality Control Manual will be considered both types, design and construction drawings.

6.20 DCR – Drawing and/or Change Release

6.21 ENGINEERING MANAGER (Manager of Engineering)

An employee of Exchanger Industries Limited responsible for the Engineering department.

SECTION 6 DEFINITIONS

6.22 EXCHANGER INDUSTRIES LIMITED

Exchanger Industries Limited 

The full name must appear on the Manufacturers Data Reports and Nameplates.

6.23 EXPANSIBLE FLUID

Expansible fluid means;

- a) any vapour or gaseous fluid, or
- b) a liquid under pressure and at a temperature at which the liquid changes to a gas or vapor when the pressure is reduced to atmospheric pressure or when the temperature is increased to ambient temperature.

6.24 FITTING or PRESSURE FITTING

Fitting means a valve, gauge, regulating or controlling device, flange, pipe fitting or any other appurtenance that is attached to, or forms part of, a boiler, pressure vessel, fired heater pressure coil, thermal liquid heating system or pressure piping system.

6.25 HE (or HIS or HIM)

Within this written Quality Control System and its implementation “He” (or “His” or “Him”) refers to the position within the organization and not necessarily the gender of the individual in the position.

6.26 **INITIATE** To originate, set going, be instrumental in the starting of.

6.27 INSPECTION AND TEST PLAN (ITP)

An individually prepared list of inspection requirements for each job. Each item of the ITP must be checked off as completed by a Quality Control Inspector. The Authorized Inspector will indicate his hold point(s) on the ITP. Customers may also indicate their hold or witness points.

6.28 JOB FILE

A file, which contains all of the records documenting the quality control of the manufactured item as well as any other documentation as required by the customer. This file shall be assigned a unique number to identify the job.

SECTION 6 DEFINITIONS

6.29 JURISDICTION

As applicable to this Quality Control System a jurisdiction is a governmental entity with the power, right or authority (or an organization delegated this authority by government) to interpret and enforce law, rules or ordinances pertaining to boilers, pressure vessels or other pressure retaining items.

6.30 M.T.R. Material Test Report

A document, or documents, on which are recorded are the results of tests, examinations, repairs, or treatments required by the basic material specification to be reported.

6.31 N.D.E. Non-Destructive Examination

6.32 PRESSURE PIPING SYSTEM (Under the Jurisdiction of the Safety Codes Act)

Pressure Piping System means pipes, tubes, conduits, fittings, gaskets, bolting and other components that make up a system for the conveyance of an expansible fluid under pressure and may also control the flow of that fluid. The Pressure Equipment Safety Regulation (PESR) does not apply to a Pressure Piping System that is fully vented or operating with one or more pressure relief devices with set pressure not exceeding 15 psi (103 kPa) and sized so that the operating pressure cannot exceed 15 psi (103 kPa). The Safety Codes Act and Pressure Equipment Safety Regulation do not apply to pressure piping under the jurisdiction of the Alberta Oil and Gas Conservation Act and Regulations or the Alberta Pipeline Act and Regulation (see Alberta Energy and Utilities Board (EUB) document “EUB Reference Tool for Interpreting Jurisdictional Relationships for Pipeline, Pressure Equipment, and Pressure Piping”). There is also a partial exemption from some requirements of the PESR for pressure piping meeting the requirements of PESR paragraph 4(2).

6.33 PROCEDURE QUALIFICATION RECORD (PQR)

The document that records what occurred during the welding of a test coupon and the results of testing of the coupon. A Procedure Qualification Record is used to support one or more Welding Procedure Specifications. With the exception of that allowed by ASME Code Section IX paragraph QW-200.2, revisions to Procedure Qualification Records are not permitted without re-qualification of the PQR.

SECTION 6 DEFINITIONS

6.34 PROJECT MANAGER

An employee of Exchanger Industries Limited who is assigned to oversee all aspects of a specific job and to act as the point of contact between Exchanger Industries Limited, the Customer and the Jurisdiction with respect to that job.

6.35 PRESSURE VESSEL

Means a vessel used for containing, storing, distributing, processing or otherwise handling an expansible fluid under pressure.

6.36 PROGRAM LIST

A list of all programs in-house showing their approval status and giving the functional responsibilities (Exhibit # 8.5).

6.37 QUALITY CONTROL

That department of the organization concerned with quality and comprising the Quality Control Manager, Chief Inspector, Inspectors and any subcontracted inspection service employed by Exchanger Industries Limited.

6.38 QUALITY CONTROL MANAGER (Manager of Quality Control)

An employee of Exchanger Industries Limited designated by the President to have the responsibility and authority to maintain a Quality Control System, and the organizational freedom to recognize quality control problems and provide solutions to these problems.

6.39 QUALITY CONTROL CHIEF INSPECTOR (Chief Inspector)

An employee of Exchanger Industries Limited designated by the Quality Control Manager to perform the quality control duties as defined in this Quality Control Manual. The Quality Control Chief Inspector reports directly to the Quality Control Manager on any quality related function.

6.40 QUALITY CONTROL SHOP INSPECTOR (Inspector, Field Inspector)

An employee of Exchanger Industries Limited designated by the Quality Control Manager to perform the quality control duties as defined in this Quality Control Manual. The Quality Control Inspector reports directly to the Quality Control Chief Inspector on any quality related function.

SECTION 6 DEFINITIONS

6.41 RECEIVER

An employee of Exchanger Industries Limited in the shipping and receiving department who is responsible for the receipt of materials per Section 10 of this Quality Control Manual.

6.42 REPAIR (In-Service Equipment)

The work necessary to restore a pressure-retaining item to a safe and satisfactory operating condition provided there is no deviation from the original design.

6.43 RESPONSIBLE, ANSWERABLE, ACCOUNTABLE

Where a department is referenced, the Department Head shall be the responsible person.

6.44 SNT-TC-1A

Recommended Practice No. SNT-TC-1A. Personnel Qualification and Certification in Non-destructive Testing. The American Society for Non-destructive Testing, Inc. Latest ASME Code of construction accepted Edition and Addenda.

6.45 STAMPING

Permanent marking of materials using die stamps or mechanical engraving equipment.

6.46 T.E.M.A.

Tubular Exchanger Manufacturing Association and the standard published by them.

6.47 SPECIFICATIONS

Customer's specifications and/or Bill of Materials and/or special requirements.

6.48 WELDER

Unless specifically differentiated as Welding Operator(s) within this Quality Control Manual, Welder(s) shall be understood to include any individual who performs manual or semiautomatic welding and any individual who operates machine or automatic welding equipment.

SECTION 6 DEFINITIONS


6.49 Welding Examiner

An employee of Exchanger Industries Limited designated by the Quality Control Manager (or in the case of designation of Quality Control Manager as Welding Examiner, designation by the individual who has signed the Statement of Authority in this Quality Control Manual) to perform the duties as defined in this Quality Control Manual. The Welding Examiner reports directly to the Quality Control Manager. The Welding Examiner must hold a Welding Examiner Certificate of Competency issued pursuant to the Alberta Pressure Welders Regulation and/or has been accepted by ABSA as a Welding Examiner.

6.50 WELDING PROCEDURE SPECIFICATION (WPS)


The document that describes in detail all of the variables which are essential, supplementary essential, and non-essential to the welding process as specified by the ASME Code to provide direction to the Welder or Welding Operator for making production welds in accordance with Code requirements. The WPS shall also reference the supporting Procedure Qualification Records. The WPS may be revised if there is a change in a non-essential variable. Any change to an essential or supplementary essential variable requires re-qualification of the WPS (i.e., new or additional PQRs to support the change in essential or supplementary essential variables).

SECTION 7 MANUAL CONTROL

- 7.0 The purpose of this section is to describe the system for preparing, revising, approving and controlling the distribution of this Quality Control Manual.
- 7.1 The Quality Control Manager is responsible for the control and implementation of this system. Department duties include:
- a) Reviewing the Quality Control Manual and quality system every 12 months coincident with the issue of any Code Edition or Addenda and revising the Quality Control Manual and/or system as necessary to incorporate any required changes within 6 months of the issue date of the new Edition or Addenda. This review shall be documented by letter to file.
 - b) Approving all proposed changes and ensuring that all revisions have been accepted by the Authorized Inspector prior to implementation. Quality Control Manager's approval and Authorized Inspector's acceptance shall be indicated by signature and date in the place provided at the end of the Table of Contents (**Section 2**). The Table of Contents will indicate the revision number and date for each section and exhibit. The Table of Contents will be revised each time one or more sections or exhibits are revised.
 - c) Maintaining a list of controlled Quality Control Manual holders, showing assigned Quality Control Manual number and revision status.
 - d) Inserting revised sections in all controlled in-house Quality Control Manuals, destroying the obsolete pages (**except as noted below**), and distributing revisions and a revision summary through Document Control to outside organizations holding controlled copies of the Quality Control Manual, using the Document Transmittal (**Exhibit 7.1**).
 - e) If Certificates shown in Section 1 are those in effect at the time of an audit, and if these certificates are changed as a result of the audit, these certificates will be updated without an additional revision. (**I.E. as a result of a new edition of the manual**). 
 - f) The Quality Control Manager will keep one scored through copy of every obsolete revision.

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SECTION 7 MANUAL CONTROL

- 7.2 Indication of revision status is comprised of the Edition number preceding a decimal point and revision number following the decimal point. Revision indication begins at 1.0 for the first Edition initial issue. The portion of the revision number following the decimal point will increase by 1 for each additional revision.
- 7.3 Revisions shall be by complete section including Exhibits. Section page numbers will include the Exhibits. When this Quality Control Manual is revised in its entirety, it shall be issued a new Edition, Revision 0.
- 7.4 Sections not revised will maintain their current revision number.
- 7.5 Indication of revision status will be shown on each page of the Quality Control Manual and on each Exhibit. The specific revision will be indicated by a triangle containing the revision number as shown on the right *and a change in type font* or background in the affected area. 
- 7.6 Uncontrolled Quality Control Manuals may be issued to outside organizations for information only, and shall not be used within Exchanger Industries Limited. "UNCONTROLLED COPY" shall be prominently indicated at the bottom of each page of these Quality Control Manuals.
- 7.7 The Quality Control Manager will maintain an uncontrolled electronic version of the Quality Control Manual in a restricted area on the Company website.



SECTION 7 MANUAL CONTROL

EXHIBIT 7.1 DOCUMENT TRANSMITTAL

Electronic Transmittal

CUSTOMER:
Attention:
Mailing Address:

Email:
cc:

Return Address:

Exchanger Industries
Document Control
5505 - 52 Street SE
Calgary, Alberta T2C 2W8
403-279-8242

Fax:
document_control@exchangerindustries.com

Project:	
Equipment Title:	
Item No:	
Project No:	
P.O. No:	

EI Job:	
Parent Job:	
Date:	

Transmittal

Message:
The following documents are enclosed for your review and/or approval. All problems with the Transmittal should be directed to document_control@exchangerindustries.com. All Project questions should be directed to via email or phone at:
Please return one (1) stamped copy of the approved documents:

Document Description or Title	Other Marks on Document				Quantity or Code EM=E-mail FTP=downl oad	Electronic Format
	Document Number	Customer Code	Sub	Rev		

Notes:

Comments / Special Instructions

Important Note: One (1) set of approved/marked-up documents are to be returned to Exchanger Industries within one (1) week [5_working_days] after document transmittal date. Fabrication schedule will be impacted if returned documents are not received within this time frame.

PLEASE SIGN AND RETURN THE ACKNOWLEDGEMENT COPY OF THIS TRANSMITTAL TO EXCHANGER INDUSTRIES WITHIN 24 HOURS OF RECEIPT.

RECIEVED: _____ DATE: _____

Page 1 of 1

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SECTION 8 DRAWINGS AND DESIGN CALCULATIONS

- 8.0 The purpose of this section is to describe the system for preparation, review, approval, distribution and retrieval of drawings, design calculations, specifications and instructions.
- 8.1 When an order is received, the Vice-President of Operations will assign a separate job number and file to each Code item ordered.
- 8.2 The Engineering department is responsible for the maintenance of the job file and the production of drawings and calculations. The following requirements will be met.
- a) A Project Manager, Drafter, Thermal Designer and Mechanical Designer are assigned as required and their names are listed on the job sheet.
 - b) The Project Manager will maintain a job file and drawing files for each Code item identified by the job number and identify complex items.
 - c) The Mechanical Designer will produce a set of calculations in accordance with the applicable ASME Code, Edition and Addenda, and the job specifications. Each sheet of the calculations will have a page number, the job number, the customer's identification, the designer's initials, the date and space for the checker's initials.
 - d) If the job is complex, or if specific parts of the design are unusual¹, the Engineering Department shall provide assistance in the design or the checking of the calculations and drawings. The Manufacturing and Quality Control Departments may also be consulted.
 - e) For routine calculations, the Senior Drafting Lead will be responsible for checking the calculations.
 - f) The Engineer directly involved will check that the calculations that required the assistance of the Engineering Department were applied correctly.
 - g) The Senior Drafting Lead will check all drawings.
 - h) Once a full set of calculations has been completed, the pages will be numbered and a Cover Sheet (**Exhibit 8.7**) and Table of Contents (**Exhibit 8.8**) will be generated. This cover sheet will contain the Job Number, the customer's data, space for the initials of the person approving the overall set, a list of all revisions and the initials of the person who approved them.
 - i) A form statement on impact testing requirements, externally applied loads and compliance with UG-22 will be attached as page 3 (**Exhibit 8.9**).

¹ This will have been determined at the proposal stage.

SECTION 8 DRAWINGS AND DESIGN CALCULATIONS

- j) The Senior Drafting Lead will normally approve the calculation set or revisions unless engineering assistance or stamping is required, in which case the Engineering Manager will approve the calculations.
- k) Customer supplied designs and drawings will have a set of calculations and drawings generated and checked as above. Customer drawings may not be issued to the shop for Code related items.
- l) Drawings, specifications and calculations will be submitted to ABSA or the applicable jurisdiction for acceptance. The Design Registration Application Form AB-31 will accompany the drawings and calculations in Alberta.
- m) The drawings and calculations for previously designed items will be checked to ensure that the applicable Code Edition and Addenda are met. The review and approval shall be documented by signature and date on the drawings and the design calculation cover sheet. If there is no change in metallurgy or design, such drawings and calculations need not be submitted to ABSA or the applicable jurisdiction.
- n) When drawings or calculations are revised and the revision affects the design, the revised items will be resubmitted to ABSA or the applicable jurisdiction. See 8.5 below.
- o) Revisions to drawings will be recorded on the revision block and all revised items will be identified with a triangle containing the revision number adjacent to the revised item. See 8.5 below.
- p) Revisions to calculations will be recorded and approved on a new calculation cover sheet. All revised calculations will be marked with a revision number in the upper right corner of the page. The obsolete calculation will be scored through, attached to the old cover sheet and appended to the back of the calculation set in the job file for reference purposes. See 8.5 below.
- q) Changes affecting the thermal design² will be referred to the Thermal Designer or the Engineering Manager.
- r) Drawings for Code work will be approved by the Senior Drafting Lead . The drawings will then be stamped “Approved For Construction” and initialed before being issued to the shop. As Exchanger Industries Limited uses multi-part drawings, only the outline drawing (**Sheet 1**) requires this stamp.

² (Generally changes in configuration, nozzles, tube count, baffle count, etc.).

SECTION 8 DRAWINGS AND DESIGN CALCULATIONS

8.3 The drawings compiled by the Drafting Department include the following information:

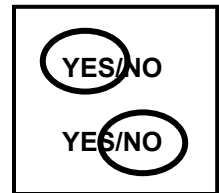
- a) Drawing title, job no. (serial number), CRN (when known)
- b) Drawing number, revision number and details of revisions, date
- c) Dimensions with tolerance where applicable³
- d) Design pressure
- e) The maximum allowable working pressure (**MAWP**) at coincident maximum design temperature.
- f) The maximum allowable external working pressure (**MAEWP**) if external pressure is considered in the design
- g) The maximum design metal temperature and the minimum design metal temperature (**MDMT**) at MAWP
- h) Non-destructive examinations and heat treatment requirements
- i) Welding procedure specifications for each weld
- j) Weld details
- k) Bill of material list compiled on the drawing and/or on the Material Data Sheet (**Exhibits 10.1 and 10.2**) will list Code material per SA or SB specifications
- l) Code Edition, year and Addenda, and indication of any Code cases used
- m) Impact test requirements or exemption statement (**Exhibit 8.9**)
- n) Notes identifying additional requirements
- o) DCR Number (**Exhibits 8.1 to 8.4**)
- p) Corrosion allowance
- q) Indication of special service, when designated⁴.
- r) Hydrostatic Test Pressure
- s) Heating Surface
- t) Volume

³ Unless otherwise noted, tolerances are per TEMA or API-660 or API-661.

⁴ e.g. Lethal Service

SECTION 8 DRAWINGS AND DESIGN CALCULATIONS

- 8.4 Drawings will be submitted to the Customer and Authorized Inspection Agency for their approval in accordance with their specific requirements.
- 8.5 Upon the return of the approved drawings from the customer, the drawings and calculations will be issued in the following manner.
- The drawings are issued a Drawing and/or Change Release (DCR) Number.
 - A DCR form (Exhibits 8.1 or 8.3) is filled out noting the number of drawings issued and to whom. One copy of the DCR is attached to each set of drawings.
 - One extra copy of the DCR form accompanies the drawings sent to the Plant Superintendent and the Quality Control Chief Inspector. This extra copy must be signed and dated and returned to the Senior Drafting Lead to acknowledge the receipt of the drawings.
 - The Plant Superintendent will distribute the shop drawings as required.
 - A DCR is not required for drawing revisions prior to the issue of the drawings to the shop.
- 8.6 Subsequent revisions to the drawing and calculations will be handled in the following manner.
- The revisions are issued a separate DCR number and a DCR form (Exhibits 8.2 or 8.4) is filled out.
 - The DCR number is entered on Sheet 1 of the drawing and any other affected sheets.
 - The Calculations must be reviewed for any changes. If they remain current, NO is circled in the calculation box, if not, YES is circled and the calculation revision number must be marked on the DCR. The revised calculation sheets shall be sent to the Quality Control Chief Inspector and to the Jurisdiction if required.
 - The ITP must be reviewed for any changes. If they remain current, NO is circled in the ITP box, if not, YES is circled and the specific changes to the ITP must be tabulated and attached to the DCR sent to the Quality Control Chief Inspector.
 - The appropriate quantities of drawings are made to match the quantities issued on the original DCR. The revised drawings are stamped and the changes circled in red. One copy of the DCR is attached to the revised drawings.



SECTION 8 DRAWINGS AND DESIGN CALCULATIONS

- f) One extra copy of the DCR form accompanies the drawings sent to the Plant Superintendent and the Quality Control Chief Inspector. Any information required from the obsolete drawings not on the revised drawings must be transferred before the drawings are returned.
- g) The Plant Superintendent is responsible for assuring that the revised drawings are distributed to the shop and that the outdated drawings are returned to the Senior Drafting Lead along with his extra copy of the DCR signed.
- h) The Quality Control Chief Inspector is responsible for assuring that his set of drawings and calculations are revised and that the outdated drawings and calculations are returned to the Senior Drafting Lead along with his extra copy of the DCR signed.
- i) The Senior Drafting Lead will check that the outdated drawings and calculations returned are the correct sheets and quantities to assure no outdated drawings remain in the shop, and the returned copies of the calculations.
- j) The Senior Drafting Lead will initial the DCR to confirm this has been done, destroy all outdated drawings and place the DCR in a master file.
- k) When the job is complete all but the Original DCR may be destroyed.

8.7 A copy of the relevant Code books shall be available in the Quality Control Chief Inspector's office for use of the shop floor personnel and Authorized Inspector.

8.8 It is the Drafting Department's responsibility to have all essential drawings, technical requirements, contract change information, work instruction and inspection instructions available at the time and place of production. Access to these shall be available for the Authorized Inspector.

SECTION 8 DRAWINGS AND DESIGN CALCULATIONS

8.9 Typical distribution of documents:

DEPARTMENT / ENTITY	DOCUMENTS & REVISIONS
VICE PRESIDENT OPERATIONS	1 Set Drawings
ENGINEERING	If professional engineering stamp applied, one copy to stamping Engineer.
PROJECT MANAGER	Maintain hard copies of drawings and calculations in file
DRAFTING	Maintain hard copies and electronic originals in file
MANUFACTURING	(S&T) - 7 Sets Drawings; 8 DCR (A/C) - 7 Sets Drawings; 8 DCR
QUALITY CONTROL	2 Sets Drawings; 3 DCR One set of Calculations to Quality Control
SCHEDULING	1 Set Drawings
PURCHASING	1 Set Drawings; 1 DCR
STOCK ROOM	1 Set Drawings; 1 DCR
AUTHORIZED INSPECTION AGENCY	As required by Authorized Inspection Agency.
AUTHORIZED INSPECTOR	Free access to Quality Control copies.
CUSTOMER	Approval copies of calculations and drawings in accordance with purchase order requirements.

Lesser quantities may be issued for specific items at the discretion of the Project Manger.

On request of the Project Manager or Engineering Manager, As-Built drawings to completed items may be issued only to the Quality Control Department and/or Customer and/or Authorized Inspection Agency.

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SECTION 8 DRAWINGS AND DESIGN CALCULATIONS

8.10 Design Computer Program Control

- a) The Engineering Manager shall ensure that a system to verify computer-generated calculations is maintained.
- b) Programs developed in-house shall be modified, verified, and approved only by persons designated by the Engineering Manager. An unprotected version of the program shall be stored in a secure/quarantined location and used for modification or verification.
- c) The Engineering Manager shall ensure that commercial programs are applicable and have had appropriate testing.
- d) The person verifying/approving the revision shall not be the person making the revision.
- e) A hardcopy list of all programs suitable for design shall be maintained. This Program List (**Exhibit 8.5**) is to identify each program with a unique program number/name and the currently issued version number.
- f) The following shall be shown in the in-house program output header:
 - i. program number and version number
 - ii. run/printout date
 - iii. revision number
 - iv. designer's initials
 - v. space for checker's initials
- g) A Program Revision Log (**Exhibit # 8.6**) is to be kept by the Engineering Manger within the file under the tab marked „Notes“. The persons initiating and approving the revision will be recorded by initial the Program Revision Log and the Program List. When this has been done, the program will be password protected.

SECTION 8 DRAWINGS AND DESIGN CALCULATIONS

- h) Prior to the issue for design use, any program modification, new program, or commercial program is to be verified by hand calculations. The hand calculations shall be kept in the hardcopy file and made available to the Authorized Inspector.
- i) Programs shall be verified before use when Code Edition and Addenda change or if the programs are revised.
- j) If there is no revision associated with a program for a change in the Code Edition or Addenda, the existing hand calculation shall be noted as such and kept in the program file. The Code Edition and Addenda and program version number shall be updated in the program output header, and the Program List updated.
- k) On approval, programs developed in-house are to be issued a new version number, have the words "Program Being Modified" replaced with the company name, be password protected and copied to a working directory of the network.
- l) A hardcopy listing of the program output is to be made and stored with the verification calculations and, if applicable, a listing of the source code
- Fortran or Basic executable files require a listing of the source code.
 - Spreadsheet macros require a listing of the source code.
 - Spreadsheets must be internally documented
- m) Electronic copies of out-dated programs are to be deleted or removed from the Engineering server.

SECTION 8 DRAWINGS AND DESIGN CALCULATIONS
EXHIBIT 8.1 DRAWING AND/OR CHANGE RELEASE
(Shell & Tube Issue)

DRAWING AND/OR CHANGE RELEASE					
DRAWING NUMBER	ISSUE	REV.	REASON	SHEETS AFFECTED	DESCRIPTION OR REMARKS
-	NI	-	---	---	<p>(7) SETS TO PLANT SUPERINTENDENT. (1) WITH (2) DCR'S</p> <p>* (2) SETS TO Q.C. (1) WITH (2) DCR'S.</p> <p>(1) SET TO STOCK ROOM WITH (1) DCR.</p> <p>(1) SET TO JAS WITH (1) DCR.</p> <p>(1) SET TO PURCHASING.</p> <p>JOHN MICHELIN: (1) COPY OF DRAWINGS, CALC'S, AND THERMAL C/W 1 DCR</p> <p>(1) COPY OF CALCULATIONS, ITP & CUSTOMER SPECIFICATIONS TO Q.C.</p> <p>*IF MORE THAN ONE UNIT: PROVIDE EXTRA COPIES OF SHT NOZZLE DETAILS FOR (1) Q.C. SET.</p>
	PREPARED	APPROVED			D.C.R. NUMBER
NAME	-				NI
DATE	-				

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SECTION 8 DRAWINGS AND DESIGN CALCULATIONS

EXHIBIT 8.2 DRAWING AND/OR CHANGE RELEASE (Shell & Tube Revision)

DRAWING AND/OR CHANGE RELEASE					
DRAWING NUMBER	ISSUE	REV.	REASON	SHEETS AFFECTED	DESCRIPTION OR REMARKS
-	-	-			<p>* (7) COPY TO PLANT SUPERINTENDENT. (1) WITH (2) DCR'S.</p> <p>* (2) COPIES TO Q.C. (1) WITH (2) DCR'S. (1) COPY TO STOCK ROOM.</p> <p>(1) COPY TO PURCHASING WITH (1) DCR. (1) COPY OF SHT 1&1A TO DON IF PAINT CHANGED. (1) COPY TO JAS WITH (1) DCR</p> <p>JOHN MICHELIN: (1) COPY OF DRAWINGS, CALC'S, AND THERMAL C/W 1 DCR</p>
					<p>DRAWING CHANGE AFFECTS CALCULATIONS YES/NO. IF YES (1) COPY OF REV. TO Q.C.</p>
<p>DRAWING CHANGE AFFECTS I.T.P. YES/NO. IF YES (1) COPY OF REV. ___ TO Q.C.</p>					
<p>*IF MORE THAN ONE UNIT: PROVIDE EXTRA COPIES OF SHT & NOZZLE DETAILS FOR (1) Q.C. SET.</p>					
					<p>DRAWING CHANGE AFFECTS MATERIAL LIST YES/NO. IF YES WAS MATERIAL LIST REVISED ___</p>
	PREPARED	APPROVED			D.C.R. NUMBER
NAME	-				-
DATE	-				

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SECTION 8 DRAWINGS AND DESIGN CALCULATIONS
EXHIBIT 8.3 DRAWING AND/OR CHANGE RELEASE
(Air Cooler Issue)

DRAWING AND/OR CHANGE RELEASE																				
DRAWING NUMBER	ISSUE	REV.	REASON	SHEETS AFFECTED	DESCRIPTION OR REMARKS															
-	NI	-	---	---	(7) COMPLETE SETS TO PLANT SUPERINTENDENT (1) WITH 2 DCR'S & (6) WITH 1 DCR *(2) COMPLETE SETS TO Q.C. C/W CALCULATIONS, ITP & CUSTOMER SPEC'S (1) WITH 2 DCR'S (1) COMPLETE SET TO STOCK ROOM WITH 1 DCR (3) COPIES SHEETS ISSUED FOR FABRICATION (PLANT SUPERINTENDENT) WITH 1 DCR EACH (SHT 1&1A, HEADER BOX, NAME PL, SIDEFAME, HEATING COIL, FAN SHAFT, DRIVE SUPPORT, BELT & FAN GUARD) (1) COPY SHEETS ISSUED TO PURCHASING FOR FABRICATION (OUTLINE, LOUVRES, BUG/HAIL SCREENS) WITH 1 DCR (1) COMPLETE SET TO PURCHASING WITH (1) DCR (1) COPY TO JAS WITH (1) DCR															
<u>TEMPORARY SHIPPING BRACE DRAWINGS.</u> (IF REQUIRED - REPEAT UNITS ONLY) (2) COPIES TO PLANT SUPERINTENDENT. (1) COPY TO Q.C. (1) COPY TO STOCK ROOM				} NO DCR REQUIRED.	JOHN MICHELIN - (1) COPY OF DRAWINGS, CALC'S, AND THERMAL C/W 1 DCR *IF MORE THAN ONE IDENTICAL HEADER BOX: PROVIDE EXTRA COPIES OF HEADER DRAWINGS FOR Q.C. SET															
			<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width: 20%;"></td> <td style="width: 20%;">PREPARED</td> <td style="width: 20%;">APPROVED</td> <td style="width: 40%;"></td> </tr> <tr> <td>NAME</td> <td align="center">-</td> <td></td> <td></td> </tr> <tr> <td>DATE</td> <td align="center">-</td> <td></td> <td></td> </tr> </table>			PREPARED	APPROVED		NAME	-			DATE	-			<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width: 80%;"></td> <td style="width: 20%;">D.C.R. NUMBER</td> </tr> <tr> <td></td> <td align="center">NI-</td> </tr> </table>		D.C.R. NUMBER	
	PREPARED	APPROVED																		
NAME	-																			
DATE	-																			
	D.C.R. NUMBER																			
	NI-																			

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SECTION 8 DRAWINGS AND DESIGN CALCULATIONS
EXHIBIT 8.4 DRAWING AND/OR CHANGE RELEASE
(Air Cooler Revision)

DRAWING AND/OR CHANGE RELEASE					
DRAWING NUMBER	ISSUE	REV.	REASON	SHEETS AFFECTED	DESCRIPTION OR REMARKS
-	-	-	-		(7) SETS TO PLANT SUPERINTENDENT. 8 DCR'S *(2) SETS TO Q.C. (1) WITH 2 DCR'S (1) SET TO STOCK ROOM WITH 1 DCR (3) COPIES HEADER DETAIL SHEETS & FAN SHAFT, DRIVE SUPPORT DETAILS TO PLANT SUPERINTENDENT. (1) COPY OUTLINE, LOUVRE, BUG/HAIL SCREEN TO SUPPLIER WITH 1 DCR (1) COPY DOWN TO PURCHASING WITH (1) DCR (1) COPY TO JAS (1) COPY SHEET 1/1A - Q.C./DONNIE PAINT CHANGE JOHN MICHELIN - (1) COPY OF DRAWINGS, CALC'S, AND THERMAL C/W 1 DCR
DRAWING CHANGE AFFECTS I.T.P. YES/NO. IF YES (1) COPY OF REV. ___ TO Q.C.					
DRAWING CHANGE AFFECTS MATERIAL LIST YES/NO. IF YES WAS MATERIAL LIST REVISED ____					
DRAWING CHANGE AFFECTS CALCULATIONS YES/NO. IF YES (1) COPY OF REV. ___ TO Q.C.					
DRAWING CHANGE AFFECTS SHIPPING/ASSEMBLY YES/NO. IF YES REVISED COPIES TO STOCK ROOM					*IF MORE THAN ONE IDENTICAL HEADER BOX: PROVIDE EXTRA COPIES OF HEADER DRAWINGS FOR Q.C. SET.
	PREPARED	APPROVED			D.C.R. NUMBER
NAME					-
DATE					

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SECTION 8 DRAWINGS AND DESIGN CALCULATIONS

EXHIBIT 8.5 PROGRAM LIST

EXCHANGER INDUSTRIES 2011 Program List					
Item	Programs	Version	Location	Type	Approved
1	Zick	Teams 25.0 & 44-V2.03	BJAC / Home Eng - Zick	.xls	CAZ
2	Lift-ear	84-V2.04	Home Eng - Zick	.xls	CAZ
3	Compression	90-V3.02	Home Eng - Zick	.xls	CAZ
4	Lift-ear Stress	84-V2.03	Home Eng - Zick	.xls	CAZ
5	Seismic And Wind Loads	87-V1.01	Home Eng - Zick	.xls	CAZ
6	Vertical Ring	86-V1.01	Home Eng - Zick	.xls	CAZ
7	Cone Reinforcement (APP 1-5)	Teams 25	BJAC		CAZ
8	Cover Sheet	205-V2.07	Home Eng - Cover Contents	.xls	CAZ
9	Index (Table Contents)	01-V2.03	Home Eng - Cover Contents	.xls	CAZ
10	UG 22	206-V1.09	Home Eng - Cover Contents	.xls	CAZ
11	Channel Cover	Teams 25	BJAC		CAZ
12	Davit	295-V2.06	Home Eng - Cover Davit	.xls	CAZ
13	Hogged-Out Cover	45-V4.04	Home Eng - Cover Davit	.xls	CAZ
14	Internal Pressure(Cyl, SE Head, Tube)	Teams 25	BJAC		CAZ
15	External Pressure (Cyl, SE Head, Tube)	Teams 25	BJAC		CAZ
16	UG-45 (Nozzle Neck THK)	Teams 25	BJAC		CAZ
17	Stiffening Ring	Teams 25	BJAC		CAZ
18	Repad (nozzle Reinforcement)	Teams 25	BJAC		CAZ
19	Lift Lug for Channel Covers	85-V2.01	Home Eng	.xls	CAZ
20	Repad (External Pressure)	Teams 25	BJAC		CAZ
21	APP. 1-7 (Large Opening)	Teams 25	BJAC		CAZ
22	TSHT UHX Fixed	Teams 25	BJAC		CAZ
23	TSHT C-Type	Teams 25	BJAC		CAZ
24	TSHT Gasket	Teams 25	BJAC		CAZ
25	TSHT Bolt	Teams 25	BJAC		CAZ
26	Floating Head	Teams 25	BJAC		CAZ
27	Flange Design	Teams 25	BJAC		CAZ
28	Flange Check	Teams 25	BJAC		CAZ
29	Bundle Pulling Loads	89-V1.03	Home Eng	.xls	CAZ
30	Box 1	52-V2.07	Home Eng - Box Headers	.xls	CAZ
31	Box 2	53-V2.05	Home Eng - Box Headers	.xls	CAZ
32	Box 3	55-V2.06	Home Eng - Box Headers	.xls	CAZ
33	Ligament Efficiency	59-V2.03	Home Eng - Box Headers	.xls	CAZ
34	Box Reinforcement	43-V2.02	Home Eng - Box Headers	.xls	CAZ
35	Box 1 External Pressure	42-V2.03	Home Eng - Box Headers	.xls	CAZ
36	Split Header	109-V4.04	Home Eng - AC Mech	.xls	CAZ
37	Nozzle/Section Loads	252-V2.07	Home Eng - AC Mech	.xls	CAZ
38	Nozzle Neck Stress	65-V3.03b	Home Eng - AC Mech	.xls	CAZ
39	Column Loads	83-V5.06	Home Eng - AC Mech	.xls	CAZ

✓
CAZ

SECTION 8 DRAWINGS AND DESIGN CALCULATIONS

EXHIBIT 8.6 PROGRAM REVISION LOG

(Log is in Electronic Format, Sample printed from _ Box Headers .xls)

Date	Initials	Sheet Versions	Sheet Versions								Approved by	Comments			
			A	B	C	D	E	F	G	H					
		Program V3.10	52-V2.07		53-V2.05		55-V2.06		43-V2.02		42-V2.04		58-V2.03		
		Box1		Box1a	Box2	Box3	Box+Rein	Box Ext	BoxExt2	Ligament					
June 13, 2001	TJB	3													Pulled Ver. 3.00 into this
August 14, 2001	TJB	3													Removed references to old spreadsheets (i.e. cell names from Tom1_Aircoler). Changed K _a limitation to be a minimum of 5.5 (c.f. Fig-14-14(a)).
August 20, 2001	TJB							2.00							
September 24, 2001	TJB		2.00		2.00	2.00	2.00	2.00	2.00		2.00				Changed width of columns to establish Date as at least 18.85-pts.
			2.00		2.00	2.00	2.00	2.00	2.00		2.00				
September 26, 2001	TJB	3.01													Removed "Under Construction" Warning because Hand Calcs are complete. Moved "Tables" portion of "Filing" closer to the top and moved the other stuff out of initial screen view
December 12, 2001	TJB	3.01	2.00		2.00	2.00	2.00	2.00	2.00		2.00				Added Revision level to output sheets and GET/SAVE MACROS
December 18, 2001															Approved for release 2000
January 4, 2002	TJB	3.02	2.01		2.01	2.01		2.01							Updated to ASME_2001.A01 data tables
January 14, 2002	RD				2.01	2.01									Header width calculated Value (was input). Cell B22 both Sheets.
January 14, 2002	TJB										2.01				Reference in Title Block. (was just paragraph reference)
January 17, 2002	DSL	3.03													Calculations are not changed. Existing hand calculations may be retained.
January 25, 2002	YJ						2.01								Approved for 2001 ASME Code Update. Added comments to some cells.
February 5, 2002	TJB	3.04													Allow for use of ThermoTech Endrgy Systems in Calculation Title Block.
March 1, 2002	TJB		2.01		2.01	2.01									Cell C38 (Crossover Area Units) blanked if unperforated. No revision number assigned - Cosmetic. Corroded Brace Height Set to Zero at cell D88 if Swage not used
April 22, 2002	YJ	3.04			2.01	2.01									Corrected MAWP MACRO to re-initialize flag1. Box2 width & Box3 width dropped from Get/save MACRO
April 23, 2002	YJ	3.04			2.01	2.01									Revised MAWP errorflags to address only issues surrounding max allowable code stress.
April 24, 2002	YJ	3.04			2.01	2.01									Revised MAWP errorflags to address only issues surrounding max allowable code stress. Changed wording of EndPlateWidth to End Plate Length
July 29, 2002	YJ	3.05	2.02												Removed corrosion from End plate flag in BOX2 (A82) & BOX3 (A83). Comparing actual thickness to minimum required in corroded condition.
August 14, 2002	PM														Revised ligament efficiency calculation in Filing applied to all locations requiring efficiency, removing local calculation.
August 20, 2002	YJ	3.06	2.03	1.01	2.02	2.02		2.02		2.02					Restructured Error Flag Boxes. Moved Macro Buttons. Reviewed and corrected MAWP's.
October 30, 2002	MR														Incremented program version #. Corrected a and K cell locations. Added comments.
May 12, 2003	RD	3.07								1.00					Copied BOX1 into BOX1a and for boxes with aspect ratios h/H less than 1. Ligament efficiency stays with tubeshet, not Long Side. Added flags for checking. Added data to filing macro. Moved title comment from Filing to each sheet and added data to filing macro. BOX1a modified by PM checked by YJ
May 10, 2004	MR	3.08	2.04	1.02	2.03	2.03									Approved for use. Correct spelling in Save Macro
July 23, 2004	MR	3.09	2.05	1.03	2.04	2.05	2.02	2.03	1.01	2.03					Renamed EXTBOX to Box Ext 1 Add Box Ext 2 for boxes with aspect ratios > 1 Section VIII Appendix 13 did not change in 2002 Addenda. Hand calculations remain adequate.
November 9, 2004	AS														Added specific evaluate MAWP calculation in BOX1, 1a, 2 & 3 Add final check for endplate MAWP in MAWP macro. Section VIII Appendix 13 did not change in 2003 Addenda. Hand Calculations remain adequate.
January 6, 2005	AS														Removed references to Section lid programs. Stresses and Moduli are now input. Limits on Ka and Kb to be GREATER than 5.5 (was LT)
January 4, 2006	AS														Section VIII Appendix 13 did not change in 2004 Edition. Hand Calculations remain adequate.
April 25, 2006	WZ				2.05	2.06									Section VIII Appendix 13 did not change in 2005 Addenda. Hand Calculations remain adequate.
June 1, 2006	AS		2.06	2.04											Include efficiency for wrappers with butt joints. Add Code Edition / Addenda references in title. Remove Box1a Setup Box1 for Oversquare labels at F26-F35
January 4, 2007															Section VIII Appendix 13 did not change in 2006 Addenda. Hand Calculations remain adequate.
January 8, 2008															Section VIII Appendix 13 did not change in 2007 Edition & Addenda. Hand Calculations remain adequate.
May 21, 2008	JJM														Wrapper longside corrected. Add SA-516-70 stress advisory calculation
November 27, 2008	PM														Add API min thickness warnings... improved overstress warnings. Remove BoxExt2 for oversquare headers - handle in BoxExt Automate reading of Figure 13-14a - apply individual K factors to each plate
January 28, 2009	PM							2.04							No changes in A08 - Hand calculations are adequate. Increased clearance issues flag for crossover holes from 1 to 1 1/2 Stay I
April 14, 2009	PM														Put detailed note on cross over area units detailing requirements.
April 29, 2009	AS		2.07												Correct oversquare labels at F28 and F34 L2 J2 shortbox connections L/H <-> L/H look-up corrected (were backwards) Stay Perforation clearance increased to 45" from tubeshet.
January 25, 2010	BG				2.05	2.06									No changes in A09 - Hand calculations are adequate.
March 4, 2010	DF				2.07	2.05									Changed no formulas, but reset all of the worksheet references on BOX3 to workbook references (SAVE was failing). Added Ext Length1 Range name on Box Ext, and changed the SAVE to save Length1 instead of Length, so the GET would be correct. Changed code so it saves Comment 1 instead of Comment 1a. (There is no Comment 1a. Added code so that it automatically adds the "1" to the Path, so it doesn't create a filename with the Path.
March 18, 2010	DF														Fixed the GET routine so it doesn't try to read the Box 1A information that was commented out of the SAVE routine earlier. Changed BOX1 print options so comments aren't printed and so the buttons aren't printed.
September 28, 2010	DF							2.06							Made Allowable Stress an input.



Revision Number 11.2

Revision Date: August 23, 2011

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SECTION 8 DRAWINGS AND DESIGN CALCULATIONS

EXHIBIT 8.7 CALCULATION COVER SHEET

page 1.1

EXCHANGER INDUSTRIES

Page 1
Sheet Count 52

MECHANICAL DESIGN CALCULATION COVER SHEET

205 V2.08

Design Code: **ASME Section VIII Div 1**
2007 Edition 2009 Addenda

Date January 5, 2011

Customer (Customer's Name)
 Owner (Optional Customer Data)
 Location (Site Location)
 Customer Reference (Purchase Order)
 E.I. Job No. (Job Number)
 Item (Item Number)
 Prepared by xxx
 Description (Unit Description)
 Notes (Up to 5 Lines
 of clarifying notes,
 and descriptions ,
 special conditions and
 material requirements)

File: (Job Number) (Item Number)
Calcs TOC Rev 3

Checked by _____

Design Conditions	Shellside	Tube	
Pressure	150	375	psi
Temperature	300	300	°F
Vacuum	15 psi @ 300°F	7.3 psi @ 300°F	°F
MDMT	-20	-38	°F
Corrosion	0.125	0.125	inch
PWHT	No	No	
UT / Radiography	Spot (RT3), RT1 Cone	UW-11a5b (RT2)	

Calculation Set Revision Number	Description and Page Number	UG-22 Checked?	DWG Changed?	Date	Approved
0	Initial Issue -- All Pages	Yes	N/A	20-Aug-10	KRB
1	Page 1, 2, 15.1-15.3, 20, added page 11a.1 - 11a.9, 19a	No	Yes	19-Oct-10	KRB
2	Page 1, 2, 15.1, 15.2, 19a, 20	No	No	25-Nov-10	TB

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SECTION 8 DRAWINGS AND DESIGN CALCULATIONS

EXHIBIT 8.8 CALCULATION TABLE OF CONTENTS

EXCHANGER INDUSTRIES

61 V2.03

Customer (Customer's Name)
 Job (Job Number)
 Item (Item Number)

Date January 5, 2011
 Dsgn xxx
 Chkd

File (Job Number) (Item Number) Calcs TOC Rev 3

Document	# Pages	Table of Contents	Rev	Date
1		Cover Sheet	3	30-Dec-10
2		Table of Contents	0	5-Jan-11
3		UG-22 Check list	0	20-Aug-10
4		Shell Cylinder	0	20-Aug-10
5		Shell Stiffening Ring	0	20-Aug-10
6		Vapor Belt Cone	0	19-Aug-10
7		Vapor Belt Cone Thickness	0	19-Aug-10
8		Channel Cone	0	18-Jun-10
8.1		Channel Cone Thickness	0	20-Aug-10
9		Vapor Belt Cylinder	0	20-Aug-10
10		Tubes	0	19-Aug-10
11	10	Tubesheet (11.1-11.10)	0	20-Aug-10
11.1	9	Tubesheet at Hydrotest (11.1.1-11.1.9)	1	19-Oct-10
12	3	Front / Rear Head Flange at Tubesheet (12.1 - 12.3)	0	19-Aug-10
13	3	Shellside Nozzle A/C (13.1 - 13.3)	0	20-Aug-10
14	4	Shellside Nozzle F (14.1 - 14.4)	0	20-Aug-10
15	3	Shellside Nozzle G/H (15.1 - 15.3)	2	25-Nov-10
16	4	Tubeside Nozzle E (16.1 - 16.4)	3	30-Dec-10
17		Vertical Support Ring	0	20-Aug-10
18		Wind / Sismic Loads	0	20-Aug-10
19		Lifting Lug	0	20-Aug-10
19.1		Channel Lifting Lug	2	25-Nov-10
20		MAWP	2	25-Nov-10



SECTION 8 DRAWINGS AND DESIGN CALCULATIONS

EXHIBIT 8.9 STATEMENT ON UG-22 LOADS AND IMPACT TESTING REQUIREMENTS

EXCHANGER INDUSTRIES		206-V1.09	Page 3
ASME Section VIII Div 1 2007 Edition 2009 Addenda Calculation Checklist			
Customer (Customer's Name)		Date January 5, 2011	
E.I. Job No. (Job Number)		Dsgn xxx	
Item (Item Number)		Chkd	
		File (Job Number) (Item Number) Calcs TOC Rev 3	
		Rev 0	
		Shellside	Tubeside
UG-22	Are the Primary Membrane Stress Calculations Included ?	Yes	Yes
	Are the Support Calculations Included ?	Yes	Yes
	Are the Nozzle Loadings Included ?		
	Are the Attachment / Lifting Loadings Included ?	Yes	Yes
	Are the Thermal Loadings Included ?	Yes	Yes
	Are the Dynamic, Cyclic, or Shock Loadings Included ?	No	No
	Are the Weather and Seismic Loadings Included ?	Yes	Yes
Supplemental	Is the Unit In Lethal Service ?	No	No
	Is the Unit In Sour or Hydrogen Service ?	No	No
	Is the Unit Generating Steam Over 50 psi ?	No	No
	Is the Material P-No 1, Gr-1 or 2 ?	Yes	Yes
		Shellside	Tubeside
		Tubesheet	Flat Cover
Impact Testing	Required Per UCS-66	Required Per UCS-66	Required Per UCS-66
		Shellside	Tubeside
UG-20 f 1	Is the Material listed on UCS-66 Curve A and ½ inch thick or less ?	No	No
	Is the Material listed on UCS-66 Curve B, C or D and 1 inch thick or less ?	Yes	Yes
	Vessel is exempt per this Paragraph	Yes	Yes
		Shellside	Tubeside
UG-20 f 2	Will the Vessel be hydro tested per UG-99b, UG-99c or 27-3 ?	Yes	Yes
	Vessel is exempt per this Paragraph	Yes	Yes
		Shellside	Tubeside
UG-20 f 3	Is the Design Temperature above 650°F (343°C) or Below -20°F (-29°C)	No	Yes
	Vessel is exempt per this Paragraph	Yes	No
		Shellside	Tubeside
UG-20 f 4	Are Thermal or Mechanical Shock Loads Controlling ?	No	No
	Vessel is exempt per this Paragraph	Yes	Yes
		Shellside	Tubeside
UG-20 f 5	Are Cyclic Loads Controlling ?	No	No
	Vessel is exempt per this Paragraph	Yes	Yes
		Flat Cover	Tubesheet
	Tubesheet / Flat Cover Listed on UCS-66 Curve A and below 2 inch thick ?		No
	Tubesheet / Flat Cover Listed on UCS-66 Curve B, C or D and 4 inch thick or less ?		No

SECTION 9 SECURITY

9.0 Security:

- 9.1 Copies of computer programs are stored off-site and locked in a fire-proof cabinet on-site.
- 9.2 The customer's drawings and data shall be kept in the job file and are not available to casual observers.
- 9.3 If more stringent security is required, the details shall be stated in the customer's purchasing documents.

SECTION 10 MATERIAL CONTROL

10.0 The purpose of this section is to describe the system for procurement, receiving, identification and use of all Code material to ensure compliance with the Code and design specifications.

10.1 Material Data Sheet and Specifications

10.1.1 The Material Data Sheet is compiled by the Drafting Department and forwarded to the Purchasing Department (**Exhibits 10.1 and 10.2**).

10.1.2 All materials used as pressure parts shall be in accordance with ASME Section II and any other materials permitted by the applicable Code Section and are to be specified by the Drafting Department. Material to be used as pressure parts are ordered by the Purchasing Department from the Material Data Sheet, in conjunction with the drawings and the applicable Code Sections.

10.1.3 Proposed substitution of materials must be referred back to the Engineering Manager for his approval and, if necessary, revised drawings and calculations must be re-submitted to the jurisdiction (**as applicable**) for their acceptance. In all cases, revised drawings shall be submitted to the Authorized Inspector for concurrence.

10.1.4 Prior to placing an order with a supplier of formed material (shells, heads, reinforcing pads, manway nozzle necks, etc.) the Quality Control Manager shall determine if the supplier uses a coded marking system to maintain traceability to the Material Test Reports. If the supplier uses a coded marking system, the Quality Control Manager shall require that a written description of the coded marking system be provided for his review and approval. The formed material supplier's marking system shall also be acceptable to the AI, and shall be retained on file by the Quality Control Manager.

10.1.5 If material is to be supplied by the customer, the material must meet all the requirements of this section except that there will be no Purchase Order issued and receiving will be in accordance with the Free Issue Material Receiving Procedure.

10.1.6 The Purchasing Manager signs the Purchase Order and distributes it per the distribution list in 10.1.8. Purchase Orders are issued to selected suppliers or supply houses that have a listing of reputable supply. The Quality Control Manager shall approve Purchase Orders for welding supplies for Code work and for Code materials prior to issuance to Vendors.

SECTION 10 MATERIAL CONTROL

10.1.7 The purchase order for Code Material (**Exhibit 10.3 or 10.4**) shall contain, as applicable, the following requirements in consistent units of measurement (**as applicable to the product ordered**):

- a) Job Number and Purchase Order Number.
- b) Supplier's name and address.
- c) The ASME material specification number (**or other specification allowed by the Code of construction**) and description of the part being ordered, including grade or class of material.
- d) The SFA specification and AWS classification (**and/or other requirements as qualified by the applicable Welding Procedure Specification**) on all Purchase Orders for welding consumables
- e) Special process requirements such as normalizing and NDE.
- f) A request for a copy of the Material Mill Test Reports and any special test requirements.
- g) Drawings or specifications needed to make the part.
- h) A statement for cold formed carbon steel heads, shells and any other pressure retaining parts that they must be in accordance with UG-79 (or UHA-44 where applicable) of Section VIII Division 1 of the ASME Code.
- i) A requirement that all Code required material markings must be accurately transferred to formed material such as shells, heads, reinforcing pads, manway nozzle necks, etc.
- j) If a coded marking system is used to maintain traceability to the original required material markings and the MTR, the coded marking system used must have prior acceptance by Exchanger Industries Limited and the AI.
- k) When items are fabricated by welding and are supplied by a sub-contractor, the purchase order shall require a Manufacturer's Partial Data Report per Code requirements.
- l) Instructions that a Welding Procedure Specification qualified to ASME Code Section IX must be used for all tack welds.
- m) A statement that all fitting designs must be registered with ABSA or the applicable jurisdiction, as required.
- n) Quality Control Manager and the Purchasing Manager's approval signature.

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SECTION 10 MATERIAL CONTROL

10.1.8 Copies¹ of the Purchase Order are sent to:

- a) Supplier
- b) Purchasing
- c) Numerical File
- d) Costing
- e) Shipping / Receiving

10.2 Receipt of Material:

10.2.1 The Receiver is responsible for receiving inspection and compares the Packing Slip to the Purchase Order. Then using the Purchase Order for reference, checks the material received as follows:

- a) For flanges, forgings, etc the Receiver shall compare the heat number, specification, and grade of material to the Material Test Report and confirm the size, rating, etc is correct to the Purchase Order.
- b) For plate material, rolled shell cylinders and formed heads, the Receiver shall locate and compare the heat number, plate identifier (**where applicable**), specification and grade of material to the Material Test Report and complete the Receiving Report (**Exhibit 10.6**) recording each of the following: heat number, slab number (**where applicable**), specification and grade of material, size and minimum thickness and copying the actual material markings in the space provided.
- c) For pipe materials, the Receiver shall compare the heat number, specification and grade of material to the Material Test Report and complete the Receiving Report (**Exhibit 10.7**) recording each of the items on the report as applicable and copying the actual pipe markings in the space provided.
- d) When the Purchase Order indicates that an impact test coupon will accompany a head or shell, the Receiver will move the coupon to a segregated area and check off the coupon box on the receiving report.
- e) If the material is identified by a coded marking, the material must be checked to the marking system; the coded marking box must then be checked off on the receiving report; if the marking system is not available to the Receiver, the material must be put on hold and referred to the Control Department to verify the acceptability of the markings and system.

¹ Copies may be partial – shipping copies are unprinted printouts.

SECTION 10 MATERIAL CONTROL

- 10.2.2 When the material received is for a particular job, the Receiver shall paint the job number on each item or lot and place into storage until needed.
- 10.2.3 Materials requiring color coding will be marked by the Receiver after unloading before being dispatched to the appropriate storage area. See Paragraph 10.4 for color codes.
- 10.2.4 Any deviations concerning quality will be brought to the attention of the Quality Control Department for resolution per the non-conformance section of this manual. Any shipping damage will be marked on the packing slip by the receiver.
- 10.2.5 The Purchasing Department is also responsible for comparison of the Packing Slip to the Purchase Order.
- 10.3 Acceptance of Material:
- 10.3.1 Acceptance of material from the carrier occurs when the Packing Slip is signed by the Receiver.
- 10.3.2 Final acceptance occurs when the Material Test Report and Receiving Report (**where applicable**) are submitted to the Quality Control Department by the Receiver and the Quality Control Department checks that the material meets the physical and chemical requirements of the applicable Addenda of ASME Code Section II. If material is found to be unacceptable, it shall be immediately placed on hold.
- 10.3.3 Once the material is accepted, the Quality Control Inspector shall place the Exchanger Industries Limited material checked stamps (**Exhibit 10.8**) on each Material Test Report then sign, date and (**when applicable**) indicate minimum thickness and, for plate material, enter the plate into the list of acceptable plate materials.

SECTION 10 MATERIAL CONTROL

10.4 Stock Material:

10.4.1 Materials may be drawn from an inventory of stock plates, tubes or pipe. The Purchasing Department has an inventory list of material in stock. When a Cut List (**Exhibit 10.9 and 10.10**) is issued, receiving moves the plate material from stock to the burning table. The Burner cross checks the material identification with the list of acceptable materials as issued by the Quality Control Department before cutting. The Burner transfers the heat number, slab number, specification and grade of material before cutting and records that information on the Cut List.

10.4.2 Stock piping is identified by heat number and colour coding that runs the full length of the pipe as follows:

- a) SA-106-GRB – pink
- b) SA-333-GR6 – blue

When stock pipe material is used for nozzles, the Quality Control Inspector will assure that the heat number is transferred in such a way that both pieces remain identified and that the marking on the piece to be used will not be lost in fabrication.

10.4.3 Forgings and plate, which are extensively machined, will have the heat numbers transferred onto the shop drawing until the piece is completed and the heat numbers re-stamped.

10.4.4 For boiler construction, there shall remain visible on shell plates, furnace sheet, and heads one group of the plate manufacturer's stamps, consisting of the manufacturer's name, plate identification number, material specification number with grade, class, and type as appropriate, except that heads containing tube holes and buttstraps shall have visible at least a sufficient portion of such stamps for identification.

SECTION 10 MATERIAL CONTROL

- 10.4.5 For non-pressure parts that are welded to a pressure part shall be treated in the following manner.
- a) The material shall be of weldable quality or traceable as required by the applicable code to a "P" grouping through the purchase order.
 - b) Structural steel will only be ordered from P-1 materials, i.e.: SA-36, CSA G40.21 Grade 38W or Grade 44W.
 - c) P-1 structural steel used for a non-pressure attachment will be color coded white
 - d) When a piece of structural steel is cut for use as a temporary attachment that piece will be marked and the remaining piece will have the cut end marked with white paint.
 - e) SA-179 / SA-214 tubing spacers for use in the assembly of header boxes will be color coded yellow and maintained in a separate bin in the header assembly area.
 - f) P-1 flat-bar strips used in the assembly of header boxes will be kept in a separate bin in the header assembly area and colour coded white.
 - g) The Foreman will assure that an adequate supply is maintained in the bins.
 - h) Run-off tabs will be made from assorted sizes to SA-516-70 and kept in a separate bin. Each piece will be stamped for identification and a list of heat numbers will be maintained by Quality Control.
- 10.4.6 When stock plate is used, the Quality Control Inspector will verify the materials meet the physical and chemical requirements of the applicable Code of Construction. Plate used for pressure retaining parts shall be traceable to the original code required marking through the use of the Receiving Report for Plate and a coded marking consisting of the heat number and plate identifier. Once accepted the Quality Control Department will apply the Exchanger Industries Limited material check stamp as in Section 10.3.1.
- 10.4.7 All coded markings used shall be acceptable to the Authorized Inspector.

SECTION 10 MATERIAL CONTROL

10.5 Responsibility

10.5.1 The Quality Control Department's responsibility is to ensure that:

- a) Material is identified and is correct at all stages of fabrication.
- b) Careless or improper handling is prevented.
- c) Procedures relating to cleanliness, heat treatments, and charpy or non-destructive testing are carried out to the specifications.
- d) Proper records are available on the material used.
- e) Non-conforming material is identified and removed immediately.
- f) The heat numbers off the vessel are recoded onto a vessel drawing by the Quality Control Inspectors.

10.6 Transfer of Markings

10.6.1 If material markings are to be covered or removed in the manufacturing process, they will be transferred as soon as it becomes obvious that this will occur; either to another part of the material or, if this is not practical, to the appropriate drawing. Examples:

- a) Forging markings must be copied to the Machine Shop drawings before rough cutting starts.
- b) Fittings whose markings will be welded over must be copied to the Welder's drawings as soon as it is obvious this will happen.
- c) Shell markings that fall within an opening cut-out must be transferred to an adjacent, exposed part of the shell and highlighted before cutting the opening.



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SECTION 10 MATERIAL CONTROL

EXHIBIT 10.1 MATERIAL DATA SHEET (Shell & Tube)

(Note: A manual version is available for parts – bundles and channels etc.)

Exchanger Industries Shell & Tube Estimate

J:\all_jobs\job2010.103181\Bill of Materials\10-3181 BOM
Page 1 of 1

AES Job Number: 10-3181		Version: 4.49										
Shells 2	Customer: Suncor Energy Item No: 55E-204E&F	Estimator: nicole	Date: 16/07/2010									
PART	Each Qty	Total Qty	Material	O.D. (in)	I.D. (in)	Thk. (in)	Overall Length (in)	PO #	PO Date	PO ETA	PO Vendor	PO Rcd
Details												
Inlet Tubesheet	1	2	SA-516-70N	42	No	2.875						
			IT @ -44.5F 18/12 ft lb									
Tubes	626	1252	SA-179	1		0.083	240					
Tubes	626	1252	SA-334-6	1		0.083	240					
Transverse Baffles	12	24	SA-36	40		0.375						
Support Baffles	1	2	SA-36	40		0.625						
Tie Rods	10	20	SA-36	0.5			226.375					
Spacers	10	20	SA-214	0.75		0.083	226.375					
Seal Strips	4	8	SA-36	2.75		0.25	169.125					
Seal Strips	4	4	SA-36	3.75		0.25	169.125					
Impact Plate	2	4	SA-516-70N	15"		0.25						
Floating Tubesheet	1	2	SA-516-70N	40		2.875						
			IT @ -44.5F 18/12 ft lb									
Split Ring	1	1	SA-516-70N	45.875		5"						
Test Head	1	1	SA-516-70N	44.125		3.5"						
Split Ring	1	1	SA-516-70N	44.125		5"						
hydro gasket	4	4	SIDJ	42	41	0.125						
hydro gasket	2	2	SIDJ	40	39	0.125						
Hydro stud	56	56	Sa-193-B7	0.75			12.75					
hydro nut	112	112	SA-194-2H		0.75							
Hydro stud	32	32	Sa-193-B7	1			11.25					
hydro nut	64	64			1							

Totals			
Revision	Originator	Check	
	Date	Date	Initials
1st Issue	DEC 17/10		
①			
②			
③			
④			
⑤			

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SECTION 10 MATERIAL CONTROL

EXHIBIT 10.2 MATERIAL DATA SHEET (Air Cooler) (Note: A manual version is available for parts)

JOB#: _____									
NOTES	ITEMS	# REQ'D	SIZE & DESC.	MATERIAL	PO#	DATE ORD.	ETA	SOURCE	DATE REC'VD
	Chemistry								
	Chemistry								
	Country of Origin								
	NACE MR0103								
	NACE MR0175								
	Apprv'd Manufacturers List								
	Headers								
	Headers								
	Blind Flange								
	Blind Flange								
	Nozzles		RFWN SCH.						
	Nozzles		RFWN SCH.						
	RFLWN		RFLWN	LG					
	RFLWN		RFLWN	LG					
	Pipe		RFLWN	LG					
	Pipe		SCH. (Thk) x	LG					
	Pipe		SCH. (Thk) x	LG					
	Swages		SCH.						
	Swages		SCH.						
	Couplings								
	Couplings								
	T.O.L.								
	T.O.L.								
	TEE		SCH. TEE						
	Tubes		OD x BWG	LG					
	Tubes		OD x BWG	LG					
	Al. & Zinc								
	Header Plugs								
	Header Gasket								
	Header Plugs								
	Header Gasket								
	Duralon 8500 strip		" wide x "long x Thk						
	Plywood Section Covers								
	Galvanized Structure								
	Structural BOM								
	Bolted Access Panel								
	Fans		MOORE# API 661						
	Fans		DIA. BLADES RPM						
	Fans		ACRM ,STATIC						
	Fans		ELEV. ,AMB						
	Fans		DIA. BUSH C/W KWY						
	Fans		BLADE ANGLE						
	Inlet Bell								
	Motors		HP, RPM 575/360						
	Motors		TEFC, TECO-WESTING HOUSE						
	Bases		T, DIA. SHAFT, KWY						
	Bearings								
	Bearings								
	Sheaves								
	Sheaves								
	Bushings								
	Bushings								
	Belts / Gear Dr.								
	Vibration Sw.								
	Anti-Rotation								
	RTD								
	Louvers / Bug / Hail								
	Actuators								
	Actuators								
	Heaters								
	Heater Pipe								
	Louvre Clips								
	Column Conn. Pl.								
	Davit								
	Safety Gate								
	Door								
	Teflon Pad		1/16" Teflon / 3/16" C.S.						
	Teflon Pad		1/16" Teflon / 3/16" C.S.						
	Teflon Pad		1/16" Teflon / 3/16" C.S.						
	Studs								
	Studs								
	Nuts								
	Nuts								
	Gasket								
	Gasket								

Customer: _____ Material Required By: _____
 Item#: _____ Unit Ship Date: _____

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SECTION 10 MATERIAL CONTROL
EXHIBIT 10.3 PURCHASE ORDER
(For Manually generated Purchase Orders)

PURCHASE ORDER



No 84680

THIS NUMBER MUST APPEAR ON
ALL INVOICES AND PACKAGES

TO _____

DATE _____

SHIP VIA _____

F.O.B. _____

DATE REQ'D _____

INVOICE TO:

Exchanger Industries
5505 52nd St. S.E., Calgary, Alberta T2C 2W8
Telephone: (403) 236-0168
Fax: (403) 279-2101
Website: www.exchangerindustries.com

SHIP TO:

Exchanger Industries
5505 52nd St. S.E., Calgary, Alberta
Telephone: (403) 236-0168

PLEASE SUPPLY THE FOLLOWING GOODS SUBJECT TO CONDITIONS SPECIFIED BELOW:

ITEM NO.	QUANTITY	DESCRIPTION	PRICE

TERMS AND CONDITIONS OF THIS ORDER

- 1. Deliver to goods without a purchase order.
- 2. Acknowledge receipt of this order specifying prices and a definite shipping date.
- 3. Make no substitution or change without authority from us.
- 4. We reserve the right to cancel this order if shipment is not made as promised.
- 5. This order must not be billed at higher prices than quoted.
- 6. Shipment from United States require in addition to regular invoice, four copies of Canadian customs invoices properly executed, showing country of origin, price for home consumption at time of shipment, and contents of each package.
- 7. All Code materials (SA- or SB Specifications) must comply with the following:
 - a. Mill test certificates / reports are required with shipment.
 - b. Materials must comply with the latest edition of ASME Section II material Specification and the applicable general specification for the product form.
 - c. All Code material markings must be on the item or, accurately transferred to the item or, if a special marking system is used to maintain traceability to the MTR for formed items, the system used must be accepted by Exchanger Industries prior to confirming this order.
 - d. Fitting design must be registered with the Alberta Boilers Safety Association.
 - e. Formed items are to meet the requirements of ASME Section VIII, Div 1, UCS-79 d.
 - f. Tack welds shall be welded using welders and procedures qualified to ASME Section IX.
 - g. Exchanger Industries maintains the right to perform Quality Surveillance at the suppliers facility.



SECTION 10 MATERIAL CONTROL

EXHIBIT 10.4 PURCHASE ORDER

(For Computer Generated Purchase Orders)

PURCHASE ORDER TO REUSE P O INVOICE TO: Exchanger Industries 5505 52nd St. S.E., Calgary, Alberta T2C 2W8 Telephone: (403) 236-0166 Fax: (403) 279-2101 Website: www.exchangerindustries.com	 EXCHANGER INDUSTRIES LIMITED	NO 01581 <small>THIS NUMBER MUST APPEAR ON ALL INVOICES AND PACKAGES</small>	DATE December 7, 2010 SHIP VIA your means F.O.B. PREPAID DATE REC'D December 15, 2010 SHIP TO: Exchanger Industries 5105 54th Ave. S.E., Calgary, Alberta T2C 2M2 Telephone: (403) 203-4587
---	---	---	---

PLEASE SUPPLY THE FOLLOWING GOODS SUBJECT TO CONDITIONS SPECIFIED BELOW.

PLEASE CONFIRM RECEIPT OF PURCHASE ORDER										
MATERIAL MUST COMPLY WITH THE LATEST EDITION OF ASME SECTION II MATERIAL SPECIFICATION AND THE APPLICABLE GENERAL SPECIFICATION FOR THE PRODUCT FORM.										
QTY (per set)	SETS	OD	THICKNESS (BWG)	LENGTH	MATERIAL	JOB	UNIT PRICE	TOTAL		
575		1"	0.083" (14) m/w	16' 6"	SA-179 smls	00-0000				
575	1	1"	0.083" (14) m/w	U-tubes	SA-179 smls	00-0000				
QTY (Pieces)	TYPE	OD	ID	THICK	MATERIAL	JOB	UNIT PRICE	TOTAL		
1	Disc Forged	56"		5"	SA-105N	00-0000				
1	Ring Forged	56"	46"	5"	SA-350-LF2 Cl.1	00-0000				
QTY (Pieces)	TYPE	OD	ID	THICKNESS NOM	MIN	SF / RAD	MATERIAL	JOB	UNIT PRICE	TOTAL
1	2:1 SE Head		56"	3/4"	5/8"	2"	SA-516-70N			
1	Dished Head	42"		3/4"	5/8"	22"	SA-516-70N			
QTY (Pieces)	TYPE	ID	ID2	THICK	LENGTH	MATERIAL	JOB	UNIT PRICE	TOTAL	
1	Cylinder	56"		3/4"	96"	SA-516-70N				
1	Concentric Cone	56"	42"	3/4"	20"	SA-516-70N				
QTY (Pieces)	TYPE	SIZE	CLASS	SCH	LENGTH	MATERIAL	JOB	UNIT PRICE	TOTAL	
1	RFWN	12"	150	XH		SA-105N	00-0000			
1	RFLWN	12"	150		9"	SA-350-LF2 Cl.1	00-0000			

TERMS AND CONDITIONS OF THIS ORDER

- Deliver no goods without a purchase order.
- Acknowledge receipt of this order specifying prices and a definite shipping date.
- Make no substitution or change without authority from us.
- We reserve the right to cancel this order if shipment is not made as promised.
- This order must not be billed at higher prices than quoted.
- Shipment from the United States requires, in addition to regular invoice, four copies of Canadian customs invoices properly executed, showing country of origin, price for home consumption at time of shipment, and contents of each package.

PURCHASE ORDER TOTAL (CAD)

- All Code materials (SA- or SB- Specifications) must comply with the following:
 - Mill test certificates / reports are required with shipment.
 - Materials must comply with the latest edition of ASME Section II material specification and the applicable general specification for the product form.
 - All Code material markings must be on the item or accurately transferred to the item or, if the code marking system is used to maintain traceability to the MTR for formed items, the system used must be accepted by Exchanger Industries prior to confirming this order.
 - Fitting design must be registered with the Alberta Boilers Safety Association.
 - Formed items are to meet the requirements of ASME Section VII, Div 1, UCS-70d.
 - Tack welds shall be welded using welders and procedures qualified to ASME Section IX.
 - Exchanger Industries maintains the right to perform Quality Surveillance at the supplier's facility.

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SECTION 10 MATERIAL CONTROL

EXHIBIT 10.5 PURCHASE ORDER TERMS & CONDITIONS (included on all purchase orders)

TERMS AND CONDITIONS OF THIS ORDER

1. Deliver no goods without a purchase order.
 2. Acknowledge receipt of this order specifying prices and a definite shipping date.
 3. Make no substitution or change without authority from us.
 4. We reserve the right to cancel this order if shipment is not made as promised.
 5. This order must not be billed at higher prices than quoted.
 6. Shipment from the United States requires, in addition to regular invoice, four copies of Canadian customs invoices properly executed, showing country of origin, price for home consumption at time of shipment, and contents of each package.
-
7. All Code materials (SA- or SB- Specifications) must comply with the following:
 - a. Mill test certificates / reports are required with shipment.
 - b. Materials must comply with the latest edition of ASME Section II material specification and the applicable general specification for the product form.
 - c. All Code material markings must be on the item or accurately transferred to the item or, if the code marking system is used to maintain traceability to the MTR for formed items, the system used must be accepted by Exchanger Industries prior to confirming this order.
 - d. Fitting design must be registered with the Alberta Boilers Safety Association.
 - e. Formed items are to meet the requirements of ASME Section VII, Div 1, UCS-79d.
 - f. Tack welds shall be welded using welders and procedures qualified to ASME Section IX.
 - g. Exchanger Industries maintains the right to perform Quality Surveillance at the supplier's facility.



SECTION 10 MATERIAL CONTROL
EXHIBIT 10.6 RECEIVING REPORT FOR PLATE (CANS/HEADS)

5505 52nd Street SE, Calgary, Alberta T2C 2W8
Telephone (403) 236-0166 Fax (403) 279-9242 Website: www.exchangerindustries.com

RECEIVING REPORT FOR PLATE (CANS / HEADS)
Revision 4

Job # _____ Date: _____
P.O. # _____

MATERIAL SPECIFICATION: _____
MATERIAL GRADE: _____
HEAT NUMBER: _____
PLATE IDENTIFIER: _____
LENGTH (Head ID) _____
WIDTH (Can ID or Head Depth) _____

THICKNESS: _____ MICROMETER NO: _____
DIAMETER: _____ **COUPON RECEIVED AND STORED**
NORMALIZED: _____ **CODED MARKINGS USED AND CHECKED**
EXAMINED & IMPACT TESTED @: _____

MATERIAL RECEIVED BY: _____
M.T.R. RECEIVED & VERIFIED:
QUALITY CONTROL: _____
DATE: _____

Record Actual Material Identification Markings

UNCONTROLLED COPY



SECTION 10 MATERIAL CONTROL

EXHIBIT 10.7 RECEIVING REPORT FOR PIPE

5505 52nd Street SE, Calgary, Alberta T2C 2W8
Telephone (403) 236-0166 Fax (403) 279-8242 Website: www.exchangerindustries.com

RECEIVING REPORT FOR PIPE

Revision 4

Job # _____	Date: _____
P.O. # _____	
NAME OF MANUFACTURER _____	
NUMBER OF PIPES _____	
MATERIAL SPECIFICATION _____	
SCHEDULE _____	
HEAT NUMBER _____	
DIAMETER _____	
LENGTH _____	
MINIMUM WALL THICKNESS _____	MICROMETER NO _____
WEIGHT IF OVER 4" NPS _____	<input type="checkbox"/> CODED MARKINGS USED AND CHECKED
HYDRO TEST PRESSURE OR NDE _____	
SEAMLESS OR WELDED _____	RECORD ACTUAL PIPE MARKINGS <div style="border: 2px solid black; height: 200px; width: 100%;"></div>
CVN TEST TEMPERATURE IF SA-333 _____	
OTHER _____	

MATERIAL RECEIVED BY _____	
M.T.R. RECEIVED & VERIFIED QUALITY CONTROL	
BY _____	
DATE _____	

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SECTION 10 MATERIAL CONTROL
EXHIBIT 10.8 MATERIAL CHECKED STAMPS

<p>MATERIAL CHECKED TO ASME SECTION II BY EXCHANGER INDUSTRIES</p> <p>DATE: _____</p> <p>SIGNATURE: _____</p> <p>MIN. THK.: _____</p>
--


CONFORMS TO 2010 EDITION _____

CONFORMS TO 2007 EDITION _____
2009 ADDENDA

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SECTION 10 MATERIAL CONTROL EXHIBIT 10.9 SHELL & TUBE CUT LIST



5505 52nd Street SE, Calgary, Alberta T2C 2W8
Telephone (403) 236-0199 Fax (403) 279-6242 Website: www.exchangerindustries.com

SHELL AND TUBE CUT LIST

JOB NO: _____ DATE: _____


Revision 2

T.S. "A"	_____ pcs	_____	Thk to finish	_____ O.D.	S.A. _____	Gr. _____	HT # _____
T.S. "B"	_____ pcs	_____	Thk to finish	_____ O.D.	S.A. _____	Gr. _____	HT # _____
			The Actual size				
Baffles	_____ pcs	_____	to finish	_____ O.D.	S.A. _____	Gr. _____	HT # _____
Channel Cov	_____ pcs	_____	Thk to finish	_____ O.D.	S.A. _____	Gr. _____	HT # _____
Test Cover	_____ pcs	_____	Thk to finish	_____ O.D.	S.A. _____	Gr. _____	HT # _____
Split Ring	_____ pcs	_____	Thk to finish	_____ O.D.	S.A. _____	Gr. _____	HT # _____
			AND _____	_____ O.D.	S.A. _____	Gr. _____	HT # _____
Saddles	_____	_____	As per Drawing		S.A. _____	Gr. _____	HT # _____
Saddle Reports	_____	_____			S.A. _____	Gr. _____	HT # _____
Nozzle Reports	_____	_____			S.A. _____	Gr. _____	HT # _____
Long Baffle	_____	_____			S.A. _____	Gr. _____	HT # _____
Impact Plate	_____	_____			S.A. _____	Gr. _____	HT # _____
Partition Plate	_____	_____			S.A. _____	Gr. _____	HT # _____
Weir Plate	_____	_____			S.A. _____	Gr. _____	HT # _____
Lift Lugs	_____	_____			S.A. _____	Gr. _____	HT # _____
Pig Baffles	_____	_____			S.A. _____	Gr. _____	HT # _____
					S.A. _____	Gr. _____	HT # _____
					S.A. _____	Gr. _____	HT # _____
					S.A. _____	Gr. _____	HT # _____
					S.A. _____	Gr. _____	HT # _____
					S.A. _____	Gr. _____	HT # _____
					S.A. _____	Gr. _____	HT # _____
					S.A. _____	Gr. _____	HT # _____
					S.A. _____	Gr. _____	HT # _____
					S.A. _____	Gr. _____	HT # _____



SECTION 10 MATERIAL CONTROL

EXHIBIT 10.10 AIR COOLED CUT LIST



5505 52nd Street SE, Calgary, Alberta T2C 2W8
Telephone (403) 236-0166 Fax (403) 279-8242 Website: www.exchangerindustries.com

AIR COOLED CUT LIST

JOB NO: _____ Date: _____

Revision 2.1

Tube and Plug Sheets

_____ Pcs	_____ Plate	_____ Plate	_____ Wide x	_____ Long - S.A.	_____ Gr.	_____ HT #	
_____ Pcs	_____ Plate	_____ Plate	_____ Wide x	_____ Long - S.A.	_____ Gr.	_____ HT #	
_____ Pcs	_____ Plate	_____ Plate	_____ Wide x	_____ Long - S.A.	_____ Gr.	_____ HT #	
_____ Pcs	_____ Plate	_____ Plate	_____ Wide x	_____ Long - S.A.	_____ Gr.	_____ HT #	

Wrapper Plates

_____ Pcs	_____ Plate	_____ Plate	_____ Wide x	_____ Long - S.A.	_____ Gr.	_____ HT #	
_____ Pcs	_____ Plate	_____ Plate	_____ Wide x	_____ Long - S.A.	_____ Gr.	_____ HT #	
_____ Pcs	_____ Plate	_____ Plate	_____ Wide x	_____ Long - S.A.	_____ Gr.	_____ HT #	
_____ Pcs	_____ Plate	_____ Plate	_____ Wide x	_____ Long - S.A.	_____ Gr.	_____ HT #	

End Plates

_____ Pcs	_____ Plate	_____ Plate	_____ Wide x	_____ Long - S.A.	_____ Gr.	_____ HT #	
_____ Pcs	_____ Plate	_____ Plate	_____ Wide x	_____ Long - S.A.	_____ Gr.	_____ HT #	
_____ Pcs	_____ Plate	_____ Plate	_____ Wide x	_____ Long - S.A.	_____ Gr.	_____ HT #	
_____ Pcs	_____ Plate	_____ Plate	_____ Wide x	_____ Long - S.A.	_____ Gr.	_____ HT #	

Stay Plates

_____ Pcs	_____ Plate	_____ Plate	_____ Wide x	_____ Long - S.A.	_____ Gr.	_____ HT #	
_____ Pcs	_____ Plate	_____ Plate	_____ Wide x	_____ Long - S.A.	_____ Gr.	_____ HT #	
_____ Pcs	_____ Plate	_____ Plate	_____ Wide x	_____ Long - S.A.	_____ Gr.	_____ HT #	
_____ Pcs	_____ Plate	_____ Plate	_____ Wide x	_____ Long - S.A.	_____ Gr.	_____ HT #	
				_____ S.A.	_____ Gr.	_____ HT #	
				_____ S.A.	_____ Gr.	_____ HT #	
				_____ S.A.	_____ Gr.	_____ HT #	
				_____ S.A.	_____ Gr.	_____ HT #	
				_____ S.A.	_____ Gr.	_____ HT #	
				_____ S.A.	_____ Gr.	_____ HT #	
				_____ S.A.	_____ Gr.	_____ HT #	
				_____ S.A.	_____ Gr.	_____ HT #	
				_____ S.A.	_____ Gr.	_____ HT #	
				_____ S.A.	_____ Gr.	_____ HT #	

SECTION 11 EXAMINATION & INSPECTION PROGRAM

- 11.0 The purpose of this section is to describe the system for verifying that items are constructed in accordance with the Code, design specifications and this Quality Control Manual.
- 11.1 The Project Manager will develop an individual Inspection and Test Plan (**Exhibit 11.1**) for each Code unit. The Quality Control Inspector shall perform all examination functions specified on the Inspection and Test Plan and will initial and date each function when completed.
- 11.2 The Quality Control Department is responsible for:
- a) Implementation of Inspection and Test Plan, for verifying all inspection points, performing the inspection required to identify deviations and for initialing and dating each function when completed.
 - b) Establishing a job file to contain the drawings, design calculations, material reports, material test reports, Inspection and Test Plan, heat treatment instruction sheet and time-temperature charts, nondestructive examination reports, physical test reports, nonconformity reports, manufacturer's data reports with partial data reports attached, and a nameplate stamping facsimile.
 - c) Notifying the Authorized Inspector reasonably in advance of any hold points. Work shall not proceed beyond an established hold point until the Authorized Inspector has released the hold by signing the Inspection & Test Plan.
- 11.3 The Manufacturing Department is responsible for manufacturing according to drawings and specifications and for co-operation in presenting the items for inspection.
- 11.4 The Authorized Inspector shall be presented with the design calculations, fabrication drawings, and the Inspection and Test Plan prior to commencement of construction so that he may establish his required hold points and inspection (**witness**) points.
- 11.5 The Quality Control Department will allow the customer's inspector access to the Inspection and Test Plan to mark hold and inspection (witness) points, if required.
- 11.7 The Chief Inspector shall notify the Authorized Inspector of approaching hold points or inspection points. A hold point shall not be by-passed until initialed and dated by the Authorized Inspector.

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SECTION 11 EXAMINATION & INSPECTION PROGRAM

11.8 The Chief Inspector shall notify the customer's inspector of approaching hold points or inspection points in accordance with purchasing requirements.

11.9 In Progress Inspection - by the Quality Control Department

As the Code items are constructed, inspection shall consist of:

- a) Checking that all material is identified with A.S.M.E. specifications and heat numbers or colour coding and that numbers are transferred and traceable throughout construction.
- b) Checking that material is as specified on drawings and that it is dimensionally correct and contains no visible defects. Fabrication drawings will be used to record heat numbers and material thickness checks.
- c) Preparing a Material Control Sheet (Exhibit 11.6) for each Code item manufactured which correlates the job number, part description, material specification, heat number and plate identifier for each pressure part. The Material Control Sheet is to be signed and dated by the Quality Control Inspector upon acceptance.
- d) Fit-ups are checked and marked on the shop drawing, weld preparations and overall dimensions are checked and marked on the Quality Control copy of the drawing using colored highlighters to identify the inspector that made the check.
- e) Performing or Sub-contracting any non-destructive testing specified as per Section 17 of this Quality Control Manual.
- f) Checking that heat treatments are specified on drawings.
- g) Referring weld repairs to the Authorized Inspector prior to performing such repairs.

SECTION 11 EXAMINATION & INSPECTION PROGRAM

11.10 Final Inspection

11.10.1 The final clearance of conformance to drawings and specifications occurs when:

- a) The hydrostatic test is applied in accordance with the pressure shown on the approved drawing and to the procedure on Section 12 of this Manual and witnessed by the Authorized Inspector, Quality Control and Customer's Inspector when requested.
- b) A final dimensional check has been performed.
- c) Material Test Reports are presented to the Authorized Inspector for his review and concurrence.
- d) The Manufacturer's Data Report is completed by a Quality Control Inspector in accordance with the approved drawing, certified and presented to the Authorized Inspector for his signature. Copies are to be supplied to Authorized Inspector, Authorized Inspection Agency, if requested and the wrap-up book and the job file.
- e) The Quality Control Inspector has checked the stamping of the nameplate (Exhibits 11.2; 11.3; or 11.4) against the Manufacturer's Data Report.
- f) For Section VIII Division 1, the Code symbol stamp will be applied only with the concurrence of the Authorized Inspector by the Quality Control Chief Inspector.
- g) For Section I, the Code symbol stamp will be applied by the Quality Control Chief Inspector. The Authorized Inspector must witness this. To verify this, there must be a hold point on the Inspection and Test Plan.
- h) Boiler External Piping shall be stamped in accordance with PG-109.2 adjacent to the welded joint farthest from the boiler.
- i) The nameplate installation has been verified by the Quality Control Inspector. The nameplate serial number is matched to the serial number stamped on the Code item.
- j) Paint and preparation for shipping has been checked.
- k) All examination functions specified on the Inspection and Test Plan have been completed.
- l) Release for shipment has been completed (**Exhibit 11.5**).

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SECTION 11 EXAMINATION & INSPECTION PROGRAM

11.11 Code Stamping and Manufacturer's Data Reports

- a) The custody of the Code Symbol stamps is the responsibility of the Quality Control Chief Inspector.
- b) A Manufacturer's Data Report shall be prepared, certified and distributed (see **Section 21.2**) for a complete Code item to which a Code Symbol stamp is applied. Manufacturer's Partial Data Reports, if applicable, shall be appended to originals and all copies of Manufacturer's Data Report for each Code item.
- c) For items not Code stamped, the CSA B51 Manufacturer's Data Report shall be used

11.12 The Quality Control Chief Inspector shall be responsible for the registration of code item with the National Board of Boiler and Pressure Vessel Inspectors, when required. The Quality Control Chief Inspector shall;

- a) be responsible for the control and issuance of National Board Registration numbers, and the National Board Stamp,
- b) assign National Board Registration numbers in sequence, progressing upwards without skips or gaps of unused numbers or duplications, starting with the number 1,
- c) maintain a log book showing the National Board Number, date issued, manufacturer's serial number, type of Code item, and date of transmittal to the National Board, and
- d) submit to the National Board, within 60 days of certification, an original of all Manufacturer's Data Reports for code item requiring National Board registration.

SECTION 11 EXAMINATION & INSPECTION PROGRAM

EXHIBIT 11.1 INSPECTION AND TEST PLAN

EXCHANGER INDUSTRIES

INSPECTION AND TEST PLAN

This information is proprietary and shall not be used without the express written permission of Exchanger Industries

<p style="text-align: center;">For Sample</p> <p>EI Job Number Sample</p> <p>Item Number Sample</p> <p>Cust'r Reference Sample</p>	<p style="text-align: right;">Dsg xyz</p> <p style="text-align: right;">Chk'd</p> <p style="text-align: right;">Date February 7, 2008</p> <p style="text-align: right;">File I1234xx</p> <p style="text-align: right;">V3.03</p>
--	--

Activity Number	Description Inspection / Test	Procedure #	Specific Instructions for Inspection / Test	Authorized Inspector			Customer Representative			E.I. Personnel		Rev #
				Date:	*	Initials	Date:	*	Initials	Date:	Initials	
1	Customer Specs Reviewed & OK'd		Engineering Check-off Sheets									
2	Drawings and Calculations to Shop		Drafting Check-off Sheets									
3	Materials Ordered		EI QC Manual / P.O.									
4	Registered Drawings to Shop		CRN # _____									
5	A.I. Hold Points Established											
6	Customer Hold Points Established											
7	WPS Approval		Note 4									
8	PQR Approval		Note 4									
9	MTR Review & Heat # Verification		EI QC Manual / Note 4									
10	M P T Bevel & Exposed Cut Edges		Note 3									
11	UT Corner Welds		Note 3									
12	Radiography		Note 3									
13	Dimensional Verification	6	Note 2									
14	Final Internal Tubeside											
15	P W H T Header Boxes		Note 5									
16	Hardness Testing		Note 3									
17	Hydrostatic Test Tubeside	Q	psi Gage # _____									
18	Final External											
19	Finish Paint	12	Note 2 Construction notes									
20	Nameplate Complete	Q	Note 2 / Note 4 / Photocopy									
21	Data Report Complete	Q	One Hardcopy Four Electronic									
22	Shipping Covers	10	Plywood / Plastic									
23	Final Shipping Release	10	Note 4									
24	Shipping Photo	10	Note 4									

Notes:

Exchanger Industries Standard Procedures (#)

1. (Q) Per QC Manual	(10) Packaging and Shipping		
(B) Visual Examination	(12) Paint Inspection		

2. EI Drawing Number Sample
3. IRIS Procedures - See NDE notes on Drawing Sample
4. Record to be maintained in QC Job file for incorporation into Data Report.
5. PWHT to be performed by Exchanger Industries per QC Instructions.

* Indicate Hold / Witness / Review points on bar: (H), (W), (R), etc. Approved: _____ Date: _____ Rev: _____

SECTION 11 EXAMINATION & INSPECTION PROGRAM
EXHIBIT 11.2 SHELL & TUBE NAMEPLATE

NB				
<div style="border: 1px solid black; padding: 5px; width: 40px; margin: 0 auto;">U</div>	CERTIFIED BY EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA, CANADA			
W	MAMP: SHELL	- PSIG	AT	- °F
-	MAEWP: SHELL	- PSIG	AT	- °F
-	MAMP: TUBE	- PSIG	AT	- °F
-	MAEWP: TUBE	-	AT	-
-	MDMT: SHELL	- °F	AT	- PSIG
-	MDMT: TUBE	- °F	AT	- PSIG
SERIAL NO.	-	YEAR MFD.	-	
-				
-				
-				
-				
-				
-				
-				
PROV. REG.	-	CRN	-	

CAUTION The Code required pressures and temperatures on this Heat Exchanger relate to the basic design conditions. The Heat Exchanger design has been evaluated for specific operating conditions and shall be re-evaluated before it is operated at different operating conditions.

ADD TO DETAIL IF FIXED WELDED TSHT UNIT. (NEN BEM ETC.).


SECTION 11 EXAMINATION & INSPECTION PROGRAM

EXHIBIT 11.3 AIR COOL NAMEPLATE

NB						
CERTIFIED BY EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA, CANADA						
U	MAWP:	-	PSI	AT	-	°F
	MAWP:	-	KPA	AT	-	°C
W	MAEWP:	-	PSI	AT	-	°F
	MAEWP:	-	KPA	AT	-	°C
HT	MDMT:	-	°F	AT	-	PSI
	MDMT:	-	°C	AT	-	KPA
SERIAL NO.		-	YEAR MFD.		-	
-						
PROV. REG.					CRN	

SECTION 11 EXAMINATION & INSPECTION PROGRAM

EXHIBIT 11.4 POWER BOILER NAMEPLATE

	<div style="border: 1px solid black; width: 100%; height: 20px; margin-bottom: 10px;"></div> <p style="margin: 0;"><small>CERTIFIED BY</small> EXCHANGER INDUSTRIES LIMITED <small>CALGARY, ALBERTA, CANADA</small></p>												
<div style="border: 1px solid black; width: 40px; height: 40px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"><div style="border: 1px solid black; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center; margin: 0 auto;">S</div></div>	<table style="width: 100%; border-collapse: collapse;"><tr><td style="width: 80%;">MANUFACTURER'S SERIAL NO.</td><td style="width: 20%;"><div style="border: 1px solid black; height: 20px;"></div></td></tr><tr><td>MAXIMUM ALLOWABLE WORKING PRESSURE</td><td><div style="border: 1px solid black; height: 20px;"></div></td></tr><tr><td>HEATING SURFACE OR KILOWATTS</td><td><div style="border: 1px solid black; height: 20px;"></div></td></tr><tr><td>YEAR BUILT</td><td><div style="border: 1px solid black; height: 20px;"></div></td></tr><tr><td>RATED STEAM CAPACITY</td><td><div style="border: 1px solid black; height: 20px;"></div></td></tr><tr><td>CRN</td><td><div style="border: 1px solid black; height: 20px;"></div></td></tr></table> <div style="border: 1px solid black; width: 100%; height: 20px; margin-top: 10px;"></div>	MANUFACTURER'S SERIAL NO.	<div style="border: 1px solid black; height: 20px;"></div>	MAXIMUM ALLOWABLE WORKING PRESSURE	<div style="border: 1px solid black; height: 20px;"></div>	HEATING SURFACE OR KILOWATTS	<div style="border: 1px solid black; height: 20px;"></div>	YEAR BUILT	<div style="border: 1px solid black; height: 20px;"></div>	RATED STEAM CAPACITY	<div style="border: 1px solid black; height: 20px;"></div>	CRN	<div style="border: 1px solid black; height: 20px;"></div>
MANUFACTURER'S SERIAL NO.	<div style="border: 1px solid black; height: 20px;"></div>												
MAXIMUM ALLOWABLE WORKING PRESSURE	<div style="border: 1px solid black; height: 20px;"></div>												
HEATING SURFACE OR KILOWATTS	<div style="border: 1px solid black; height: 20px;"></div>												
YEAR BUILT	<div style="border: 1px solid black; height: 20px;"></div>												
RATED STEAM CAPACITY	<div style="border: 1px solid black; height: 20px;"></div>												
CRN	<div style="border: 1px solid black; height: 20px;"></div>												



SECTION 11 EXAMINATION & INSPECTION PROGRAM

EXHIBIT 11.5 RELEASE FOR SHIPMENT



Revision Number 2.1	Date: Friday, August 12, 2011
---------------------	-------------------------------

Shipping Check List to be Completed by Q.C.		Yes	No
1	Is crating, tarping, rust inhibitor, shrink wrap, etc required?		
2	Does the unit require export packaging?		
3	Is documentation required to ship with units? I.E. Databooks, Shipping Release..		
4	Mark candidate's unique ID Number/Symbol on test coupons.		
5	Customer's Inspector (_____) to witness loading.		

Remarks:

Quality Control (Signature)

Date

The Following to be completed by shipping		Date	Initials
1	Are the ends of the bundles protected (I.E. Plywood)		
2	Check for paint damage from handling (I.E. Chain Marks)		
3	Is the unit properly chained, blocked, etc.?		
4	Does the unit require stencilling , and/or stickers for bolting? Stickers required on all shell & tube bolting locations.		
5	Photographs taken of unit when loaded?		
6	Are spare parts per shipping list loaded?		
7	Are points 1 through 4 completed?		

Remarks:

Shipping (Signature)

Date

RELEASE FOR SHIPMENT

JOB NUMBER _____

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Revision Number 11.2	Revision Date: August 23, 2011	Section 11 Page 10 of 10
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SECTION 11 EXAMINATION & INSPECTION PROGRAM

EXHIBIT 11.6 MATERIAL CONTROL SHEET



EXCHANGER INDUSTRIES LIMITED

5505 52nd Street SE, Calgary, Alberta, T2C 2N8
Telephone (403) 238-6166 · Fax (403) 279-8242 · Website: www.exchangerindustries.com

Revision Number 2.1	Date: Monday, August 15, 2011
---------------------	-------------------------------

MATERIAL CONTROL SHEET Job Number _____ Revision _____

Part Description	Material Specification	Heat / Slab Number	Part Description	Material Specification	Heat / Slab Number

The Above Materials meet the requirements of ASME Section II. _____ Edition _____ Addenda

_____ _____
Quality Control Signature Date

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SECTION 12 HYDROSTATIC TEST PROCEDURE

- 12.0 The purpose of this section is to describe the controls used for conducting pressure tests in accordance with the Code. The Quality Control Chief Inspector is responsible for implementing the following requirements.
- 12.1 The Code item must be properly blocked to permit examination of all parts during the test, to ensure adequate venting and to guard against undue strains caused by the water load.
- 12.2 All hydrostatic tests performed in the shop will be undertaken with a maximum regard to personnel safety. All unauthorized personnel will stay clear of the area where the test is being performed.
- 12.3 Ensure that all necessary flanges and pressure parts are bolted and secure prior to filling the Code item with water ensure that vents are open. It is essential that no air locks be left in the Code item before plugging vents.
- 12.4 Water used for hydrotesting Section 1 Code items shall be at 70⁰F minimum.
- 12.5 The metal temperature should be at least 30°F above the MDMT but not exceeding 120°F for ASME Section VIII Division 1 Code items. The water and metal temperature shall not be less than the minimum design metal temperature of the item.
- 12.6 For Section VIII Division 1 Vessels:
- The pressure will be increased gradually to the hydrostatic test pressure as stated on the accepted drawings and held;
- (1) for a minimum of 15 minutes for vessels without nozzle reinforcing pads
or,
 - (2) for a minimum of 60 minutes when the vessel has nozzle reinforcing pads.
- 12.7 For power boilers, hydrostatic pressure tests shall be applied by raising the pressure gradually to the test pressure specified on the drawing. The pressure shall be under proper control at all times. Close visual inspection for leakage is not required during this stage.

SECTION 12 HYDROSTATIC TEST PROCEDURE

- 12.8 Two calibrated pressure gauge shall be connected directly to the item. The gauge shall preferably have a dial graduated over a range of about double the intended test pressure, but in no case shall the range be less than 1.5 times the test pressure nor more than 4 times the test pressure.
- 12.9 Check that all low pressure filling lines and other appurtenances that should not be subjected to the test pressure are disconnected before any pressure is applied.
- 12.10 Do not leave items unattended while pressurized.
- 12.11 If a pneumatic test is required, a pneumatic test procedure will be submitted to the ABSA Design Survey Section for acceptance prior to use. Coincident with the acceptance of a specific pneumatic test procedure, all nondestructive examinations related to pneumatic testing that are required by the construction Code (e.g., UW-50) shall be performed. Guidelines for the preparation of a pneumatic testing procedure are provided in Exhibit 12.1.
- 12.12 Following the application of the hydrostatic test pressure, and inspection shall be made of all joints and connections. This inspection shall be made at a pressure not less than that required by the applicable construction Code. The pressure will be held for a sufficient time for the AI to complete his inspection.
- 12.13 Results of all pressure tests, including record of pressure gauges (gauge numbers) used, shall be documented on the ITP.
- 12.14 After inspection by the Authorized Inspector, the Quality Control Inspector and customer's inspector (**where requested**), the Code item may then be de-pressurized and drained.

SECTION 12 HYDROSTATIC TEST PROCEDURE

EXHIBIT 12.1 GUIDELINES FOR THE PREPARATION OF A PNEUMATIC TESTING PROCEDURE

Due to the large energy storage in compressed gas and hence the potential hazard of a sudden release of this energy, pneumatic testing should be avoided if at all possible.

The testing procedure must be submitted to ABSA for acceptance before any testing can be carried out.

The testing procedure must be accompanied by detailed justifications as to why a standard hydrostatic test is not feasible.

In addition to strict adherence to the respective Code sections (e.g., ASME Code Section VIII, Div. 1, paragraph UG-100, or ASME Code B31.3, paragraph 345.5), the testing procedure should contain, as a minimum, the following information:

- a) Lists of all personnel within the testing area and designated personnel in charge of testing.
- b) Test boundaries of the pressure system with specified maximum pressure X volume (PV) limits, including listings of piping and/or equipment to be included in the test.
- c) Test site preparations and related precautions undertaken including removal of unauthorized personnel, isolation of test site, etc.
- d) Test media, pressure source and pressure and temperature ranges of testing.
- e) Provision of Pressure Relief Valves, which must be sized to handle the maximum output of the pressure source to avoid excessive testing pressure.
- f) Material specification involved in the test. For materials whose resistance to brittle fracture at low temperature has not been enhanced, a test temperature above 60 degrees F (16 degrees C) may be considered in reducing the risk of brittle fracture during pneumatic testing.
- g) Exposure of all joints including weld joints, threaded/flanged connections, etc. All post-weld heat treatment shall be completed. Should a piping system be tested, all equipment and pressure vessels shall be disconnected from the piping or isolated by blinds or other means.
- h) Method of testing with details of pressure steps, holding time inspection methods, etc.
- i) Precautions taken to prevent gas expansion temperature drop and thermal stresses due to temperature gradients.
- j) Reference should be made to the Canadian Registration Numbers (CRN) of the system/vessels to be tested.

SECTION 13 CORRECTION OF NON-CONFORMITIES

- 13.0 The purpose of this section is to describe the system for identifying, documenting, and resolving non-conformities found at receiving, during construction, examination, or testing.
- 13.1 A non-conformity is any condition, which does not meet the requirements of the Code, the customer's contractual requirements or this Quality Control Manual.
- 13.2 There are two types of non-conformities:
- Primary (**Class A**) All non-conformities whose resolution requires the approval of the Authorized Inspector and/or a change in the Design Drawings. These will be documented with a Non-Conformance Report (**Exhibit 13.1**) as detailed below.
- Secondary (**Class B to E**) All other non-conformances; these will be handled by the Non-Conformance Report Procedure QP-06.
- 13.3 Repairs to weld metal that are identified by planned quality control examinations and documented on another record shall be completed in full accordance with the Code, this Quality Control Manual and the original Job Specifications, but need not be documented on a Non-Conformance Report.
- No repairs by welding to base materials shall be undertaken without prior concurrence of the Authorized Inspector, except those pre-approved (**See Exhibit 14.3**). Pre-approved repairs should not be documented on a Class A Non-Conformance Report.
- Normal rework, re-rolling or re-machining operations shall not be considered a Class A Non-Conformance and shall not be documented as such.
- 13.4 Any non-conformity found during the material receiving or the manufacturing process by workmen, foremen or inspectors shall be referred to the Quality Control Chief Inspector who shall be responsible for identifying and ruling on the non-conformity. If there is any questions as to the Class the Quality Control Chief Inspector shall refer it to the Quality Control Manager or the Vice President of Production.
- 13.5 Materials at receiving which are obviously non-conforming or without the proper documentation may be returned immediately to the supplier. In this case, a Class D Secondary Non-Conformance Report will be completed and sent to the Quality Control Chief Inspector by the Receiver.

SECTION 13 CORRECTION OF NON-CONFORMITIES


- 13.6 When a non-conformity is detected, the Quality Control Chief Inspector will make a report (**Exhibit 13.1**).
- 13.6.1 The Quality Control Department will call on the Engineering and Manufacturing Departments for assistance as required to make an evaluation.
- 13.6.2 During this time the part will be tagged “HOLD DO NOT USE” (**Exhibit 13.2**). The other side of the tag will read “REASON FOR HOLD” and will detail the non-conformity.
- 13.6.3 If an item is too large or it is not feasible to attach a red tag, the item will be stenciled “QC HOLD” (**Exhibit 13.3**) with a high contrast paint.
- 13.6.4 A hold notation will be added to the ITP by the Quality Control Chief Inspector.
- 13.7 The disposition of non-conformity will be reject, rework, and repair by welding or use as is. If the disposition of the non-conformity is to “repair by welding”, a repair procedure will be developed by the Quality Control Chief Inspector and documented in the “corrective action” area of the form. Any additional inspection functions required to complete the repair must be added to the ITP. The procedure and the revised ITP must be presented to the Authorized Inspector for acceptance and for the assignment of hold points prior the start of the repair.
- 13.8 If additional operations are required to correct the non-conformity, they must be documented in the “corrective action” area of the form. If there is insufficient space, the documentation shall be made on the back of the report form or additional pages may be attached.
- 13.9 If the non-conformity involves the design, the Engineering Department shall make the resolution with assistance of the Quality Control Department and concurrence of the Authorized Inspector.

SECTION 13 CORRECTION OF NON-CONFORMITIES

- 13.10 Whether the part is rejected or reworked, (re-rolled, re-machined, etc.), a report will be issued by the Quality Control Department under the job file number defining the disposition of the non-conformities. When the non-conformity has been resolved the Quality Control Department will approve the corrective action described on the Non-conformity Report.
- 13.11 When all points on the ITP have been signed off by the Authorized Inspector and the non-conforming item is released, the Quality Control Department may then remove hold tags and inform the Manufacturing Department of the release. If the part has been stenciled, the Quality Control Department will overspray with a "QC RELEASE" (Exhibit 13.3) stencil, or, if required, supervise the removal of the "QC HOLD" stencil.
- 13.12 A copy of the Non-Conformance Report shall be kept in the job file.
- 13.13 The Quality Control Chief Inspector shall be responsible for maintaining a file of non-conformities and make these available to the Authorized Inspector for his review and concurrence.
- 13.14 The Quality Control Manager will review all non-conformity reports periodically and initiate corrective action to prevent re-occurrence.

SECTION 13 CORRECTION OF NON-CONFORMITIES

EXHIBIT 13.1 NON-CONFORMANCE REPORT



EXCHANGER
INDUSTRIES
LIMITED

5505 52nd Street SE, Calgary, Alberta T2C 2W8
Telephone (403) 238-0168 Fax (403) 279-8242 Website: www.exchangerindustries.com

(Text box edges shown for clarity)

Job Number Non Conformance Report Number

Description of the Non-Conformity Class A

Examples of Class A Non-Conformance

- *Nozzle Misplaced*
- *Material Markings Covered*
- *Weld Procedure incorrect*

Quality Control Inspector Date

Disposition

Examples of Disposition for Above

- *Opening must be repaired*
- *Traceability must be established*
- *Weld must be removed and replaced*

Quality Control Date

Engineering Date

Authorized Inspector Date

Corrective Action

Examples of Corrective Action for Above

- *Fitter and Lead Hand to review checking procedure*
- *Traceability must be established*
- *Weld Procedure assignment to be reviewed with Engineering and Drafting*

Approved By Quality Control Date
Chief Inspector

Accepted By Authorized Inspector Date

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SECTION 13 CORRECTION OF NON-CONFORMITIES

EXHIBIT 13.2 HOLD TAG (both sides) (TAG COLOR IS RED)

ITEM IDENTIFICATION

HOLD - DO NOT USE

SIGNED DATE:/...../.....

NON-CONFORMANCE REPORT No.:

TO BE REMOVED ONLY BY AUTHORITY OF QUALITY CONTROL MANAGER.

REASON FOR HOLD

.....
.....
.....

QUALITY CONTROL INSPECTOR

DATE:/...../.....

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SECTION 13 CORRECTION OF NON-CONFORMITIES

EXHIBIT 13.3 HOLD AND RELEASE STENCILS (Color to be of suitable contrast)



SECTION 14 WELDING PROCEDURES AND QUALIFICATIONS

- 14.0 The purpose of this section is to describe the system for controlling welding procedures, welding operations, and welder performance qualifications to ensure compliance with ASME Code Section IX and the referencing construction Code.
- 14.1 Qualified welders who hold a valid Alberta Performance Qualification Card will perform all welding using a qualified Welding Procedure Specifications. Welding shall conform to the requirements of applicable sections of the ASME Code and the additional requirements imposed by the Alberta Safety Codes Act. All welding qualifications shall be in accordance with Section IX or any additional construction Code requirement.
- 14.2 Welding Procedure Specifications are to include all variables required by the process by ASME Code Section IX and the intended range of production welding. The required test welds are made under the supervision of the Quality Control Department. The test welds are tested by a qualified material testing subcontractor whose report of test results is reviewed by the Quality Control Department. If acceptable, the Quality Control Shop Inspector prepares and certifies the Procedure Qualification Record (**PQR**), which lists the actual variables used in making the qualification test welds.

The WPS lists all the essential, non-essential and supplementary variables. A WPS may be revised whenever there is a change in a non-essential variable. A new WPS shall be prepared and qualified if an essential variable is changed.

The WPS and PQR including test results shall be submitted to ABSA for registration.

- 14.3 Welding Procedures, Procedure Qualification Records and the Performance Qualification Records will be controlled by number, date and revision. All registered procedures are retained by the Quality Control Department and copies are given to the Foreman who assigns and supervises the welder. The Quality Control Department issues each welder with an identifying number or symbol. This symbol (**stamp**) must be kept separate for 6 months after a welder leaves before it may be re-issued. All welds (**including non pressure parts to pressure parts**) on pressure vessels must be stamped adjacent to the weld, long and circ seams shall be stamped at 3 foot intervals. The Quality Control Department shall verify that all welds have identification stamps and for material upon which stamping is prohibited, the welders symbols shall be recorded on a drawing of the unit.

SECTION 14 WELDING PROCEDURES AND QUALIFICATIONS

- 14.4 Copies of Welding Procedure Specifications shall be available to welding personnel.
- 14.5 All welders and welding operators to be used for Code welding are qualified to ASME Section IX and the Code sections to be used for construction under the supervision of the Plant Superintendent.

Welders shall be re-qualified whenever:

- a) There is a change in a performance essential variable.
 - b) The welder or welding operator has not used the specific process during a six (6) month period.
 - c) Whenever there is a reason to question his ability to make weld in accordance with the specification.
- 14.6 The Foreman assigns welding tasks to welders on the welder's list (Exhibit 14.1) based on the qualifications and performance essential variables detailed on the Log of Welder's Performance Qualification and Welder/Welding Operator Qualification Records providing that qualifications in the process remain valid in accordance with the Log of Welder's Performance Qualification (Exhibit 14.2). These lists and logs are maintained by the Quality Control Chief Inspector.

Additionally the Foreman shall verify that welders have valid performance qualification cards for all essential variables issued by ABSA or an accredited Agency before the commencement of work.

- 14.7 The Quality Control Department shall be responsible for reviewing and verifying that the welding procedure specified on the drawings are properly qualified and are used and that the welder is qualified. If the procedures on the drawing are not suitable for the welding undertaken or if construction requirements dictate a change, the Quality Control Chief Inspector will put that part of the unit on hold, mark up the drawing and return a copy to the Engineering Manager for revision.
- 14.8 The Quality Control Department will ensure that all weld repairs to materials are referred to the Authorized Inspector for his acceptance prior to repair, unless the method and extent of repair has been pre-accepted by the Authorized Inspector. (See exhibit 14.3).

SECTION 14 WELDING PROCEDURES AND QUALIFICATIONS

- 14.9 The Authorized Inspector may require re-qualification of the welders or welding procedure specifications if there is reason to question their ability to make sound welds.
- 14.10 A test can be conducted at any time when there is adequate reason to question the welder's ability by the Quality Control Chief Inspector.
- 14.11 Ensuring that all tack welds are made using procedures qualified to ASME Code Section IX. If tack welds are made by a subcontractor, they shall be completely removed. Tack welds left in place shall be made by welders qualified in accordance with ASME Code Section IX.
- 14.12 Verifying that tack welds left in place are properly prepared for incorporation into the final weld and visually examined for defects; if found defective they will be completely removed.
- 14.13 Exchanger Industries Limited has had several name changes in the past. Former names include:
- a) Exchanger Industries, A Division of Premetalco Inc.
 - b) Exchanger Industries Limited
 - c) Exchanger Sales and Service (Alberta) Ltd.
 - d) Exchanger Sales and Service Ltd.



In accordance with ASME Section IX, QW201.1 WPS's and PQR's are yet retained under some of the names above; these are labeled "Non-Active" on the weld procedures list and must have the name updated before they can be used. Exchanger Industries Limited hereby takes full responsibility for these WPS's and PQR's.

SECTION 14 WELDING PROCEDURES AND QUALIFICATIONS

EXHIBIT 14.1 WELDER'S LIST (SAMPLE)

DAY SHIFT

22	SHAWN OULLETTE	
N	CENON TUMOLVA	SUB-ARC
O	RON BLACK	SUB-ARC
D	MARK DOERKSEN	
J	ASHRAF MOHAMMED	
88	MUHAMMED SADDEN	
G	SAHIB KHAMBA	SUB-ARC
TT	SEAN MACFARLANE	
DD	ROB LEE	SUB-ARC
AA	PHILLIP EDDY	SUB-ARC
ZZ	AL MORROW	SUB-ARC ONLY
B	GURDIP SAINI	SUB-ARC ONLY



SECTION 14 WELDING PROCEDURES AND QUALIFICATIONS
EXHIBIT 14.2 LOG OF WELDER'S PERFORMANCE QUALIFICATION

EXCHANGER INDUSTRIES LIMITED

Log of Welder's Performance Qualification

NAME: _____
 STAMP NO: _____ FILE NO: _____

PROCESS/ G.M.A.W TRANSFER/ G.T.A.W. CURRENT	POSITION/ PROGRESSION	MATERIAL GROUP	FILLER METAL SOLID OR CORED/ INSERT	WELD THICKNESS QUALIFIED/ MIN PIPE DIA	WELD PROCEDURE (WPS #)	BACKING/ BACKING GAS	

2008	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
S.M.A.W.												
G.M.A.W.												

2009	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
S.M.A.W.												
G.M.A.W.												

2010	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
S.M.A.W.												
G.M.A.W.												

*= Each welder, while employed by Exchanger Industries (A Division of Premetaco Inc.), must use each process at least once in any six month period to keep tickets valid. Check applicable column if each process has been used or not

SECTION 14 WELDING PROCEDURES AND QUALIFICATIONS

EXHIBIT 14.3.1 ABSA PRE-APPROVED REPAIRS

1.0 Objective and Scope

- 1.1 The objective of this document is to define an acceptable method and extent for weld material repairs and minor repairs/restorations to base material such as those required after the removal of construction fixtures, and to provide the limitations and specific requirements surrounding the pre-acceptance.
- 1.2 The scope of this pre-accepted method is restricted to new construction activities on items constructed to the ASME Code, Section VIII, Division 1, that consist of Part "UCS" and Part "UHA, P-8" materials. For new-construction repairs that are outside of this scope and the additional limitations described in this document, the Authorized Inspector must be contacted prior to commencement of any repair.
- 1.3 When repairs or alterations to in-service pressure equipment have been properly initiated (i.e., signed-on) in accordance with the accepted quality system and the proposed repair/alteration procedure has been accepted by the owner and the AI, this pre-accepted method and extent of subsequent repairs may be utilized under the following conditions. For shop repair or alteration activities on items originally constructed to Section VIII, Division 1, that consist of Part "UCS" and Part "UHA, P-8" materials, the concurrence of the owner must also be obtained prior to utilizing the provisions of this document.
- 1.4 Caution is also advised when applying the provisions of this document for new-construction activities in conjunction with an owner's specification. For some service conditions the owner's specification may impose requirements (e.g., additional nondestructive examination prior to and/or after repair welding) that exceed the minimum ASME Code requirements, which this document is intended to comply with. Additionally, the owner's specification may require a report of the location(s) and extent of material repairs made by welding

SECTION 14 WELDING PROCEDURES AND QUALIFICATIONS

EXHIBIT 14.3.2 ABSA PRE-APPROVED REPAIRS

2.0 Introduction

- 2.1 Within ASME Section VIII, Division 1, paragraph UG-78 requirements, there is no distinction between base material repairs and weld material repairs. In accordance with paragraph UG-78 “defects in material may be repaired provided acceptance by the Inspector is first obtained for the method and extent of repairs.” Material is defined in Section VIII, Division 1, Appendix 3 as, “any substance or product form which is covered by an SA, SB, or SFA material specification in Section II or any other material permitted by the Code.”
- 2.2 In addition to paragraph UG-78, Section VIII, Division 1 provides rules in paragraphs UG-90(b)(8) and UW-42, regarding the repair and thickness restoration of base material.
- 2.3 In addition to paragraph UG-78, Section VIII, Division 1 provides rules in paragraphs UG-90(b)(8) and UW-38, regarding the repair of weld defects. Paragraph UW-38 specifies that “Defects, such as cracks, pinholes, and incomplete fusion, detected visually or by the hydrostatic or pneumatic test or by the examinations prescribed in UW-11 shall be removed by mechanical means or by thermal gouging processes, after which the joint shall be rewelded [see UW-40(e)].”

SECTION 14 WELDING PROCEDURES AND QUALIFICATIONS

EXHIBIT 14.3.3 ABSA PRE-APPROVED REPAIRS

3.0 Limitations of Pre-Acceptance

Limitations Common to Base Material and Weld Material Repairs

- 3.1 There is NO pre-acceptance of method or extent of repairs to base material or welds following postweld heat treatment [refer to UCS-56(e) & (f)].
- 3.2 There is NO pre-acceptance of method or extent of repairs to base material or welds in which defects are identified during the pressure testing required by the ASME Code or the accepted repair/alteration procedure.
- 3.3 Weld repairs to base material or welds must be performed within all of the variables (essential, supplementary essential and nonessential) of a Welding Procedure Specification (WPS) that is included on the construction drawing [or the drawing must be revised to add the repair WPS].
- 3.4 The joint details actually used in the weld repair must be provided to the welder either on the construction drawing, within the Welding Procedure Specification or through supplementary instructions acceptable to the AI (depending upon where joint details and joint dimensions are provided under the Manufacturer's quality system).

Additional Base Material Repair Limitations

- 3.5 There is NO pre-acceptance of base material repairs if the vessel minimum design metal temperature (MDMT) is colder than -20°F or if the base material or Welding Procedure Specification is required to be impact tested by the vessel design.

SECTION 14 WELDING PROCEDURES AND QUALIFICATIONS

EXHIBIT 14.3.4 ABSA PRE-APPROVED REPAIRS

Base Material

- 3.6 In accordance with Code requirements the repair welding metal restoration/build-up is subject to the provisions of ASME Section VIII, Division 1, paragraph UW-42
- 3.7 The following sub-paragraphs describe base material defects that are included in the pre-acceptance with the provision that the depth of base material restoration or build-up does not exceed the lesser of one-quarter of one inch or 25% of the base material thickness and the area of restoration or build-up shall not exceed six square inches at any location.
- 3.7.1 Base material removed during the separation of temporary attachments from the vessel or, undercut of base material caused by welds joining a temporary attachment to the vessel.
- 3.7.2 Mechanical damage that may occur when objects are brought into contact with the vessel.
- 3.7.3 Excessive grinding, causing a reduction in the base material thickness.
- 3.7.4 Defects such as “pits or pock marks” (i.e. an area that is sunken or depressed below the adjacent surface) in the base material
- 3.7.5 Other material imperfections (e.g. laps, laminations, shucks).

Base Material Adjacent to Permanent Weld

- 3.8 The following sub-paragraph describes base material defects included in the pre-acceptance with the understanding that they are part of the weld joint and would be included in Code required non-destructive examinations (e.g. full or spot radiography) of the welded joint.
- 3.8.1 Undercut of base material caused by the welding of permanent vessel welds and the restoration of base material removed when bridge tacks are eliminated on permanent weld joints.

SECTION 14 WELDING PROCEDURES AND QUALIFICATIONS

EXHIBIT 14.3.5 ABSA PRE-APPROVED REPAIRS

Additional Weld Material Repair Limitations

- 3.9 If notch-toughness is a consideration [i.e. when an impact tested WPS is required or the provision of paragraph UCS-67(a)(2) are utilized to avoid the requirement for an impact test WPS]. All weld repairs to weld metal using a different WPS than that used for the original weld are to be referred to the Authorized Inspector for his acceptance prior to the repair. When weld metal repairs are undertaken, using the same WPS as the original weld, care shall be taken to ensure that the repair welding is performed in accordance with all WPS variables and particularly in accordance with all supplementary essential variables (e.g. position, interpass temperature limits and heat input limits). Additionally, caution is advised regarding the positions of repair welding [refer to UG-84(l)(3)(a)].

4.0 Identification of Defects

- 4.1 The pre-accepted method and extent of base material and weld defect repair is limited to repair or removal of defects within the limitations of pre-acceptance that are identified by visual examinations, the examinations prescribed in UW-11, or any other weld defects identified by any other type of NDE.

SECTION 14 WELDING PROCEDURES AND QUALIFICATIONS

EXHIBIT 14.3.6 ABSA PRE-APPROVED REPAIRS

5.0 Removal of Defects and Preparation of Repair Area

- 5.1 For defects in the base material, the base material containing the defect shall be removed by mechanical means (e.g., grinding). If either the depth of the base material removed or the area of repair exceed the limitation in paragraph 3.7 the AI must be contacted to accept the repair procedure [for Part "UCS" materials the requirements of paragraph UCS-56(f) should be reviewed for guidance in considering the repair of defects requiring greater repair depth or area, and for defects outside of the defect type limitations (e.g., cracks)].
- 5.2 For defects in welds, the weld area containing the defect shall be removed by mechanical means or by thermal gouging processes. After arc gouging, all slag and detrimental discoloration of material that has been molten shall be removed by mechanical means, prior to proceeding (refer to UG-76).
- 5.3 After defect removal the material shall be visually examined to determine that no defects remain. At the Manufacturer's discretion, use of a suitable NDE method such as magnetic particle (MT) or liquid penetrant (PT) may be necessary to assure complete removal of the defect.
- 5.4 After defect removal, and subsequent examination to confirm defect removal, if the remaining material thickness exceeds that required by the design (for the location under consideration) it may be suitable to conclude the repair without material restoration. The designer should be contacted to confirm the acceptability of this option. A tapered transition having a length not less than three times the offset between adjacent surfaces shall be provided.
- 5.5 When material restoration is required, the weld preparation shall conform to groove weld dimensional details provided (in accordance with paragraph 3.4). If the defect penetrates the full thickness of the material (weld), the repair shall be made with a complete penetration weld in accordance with the original design. If the design requires a Type No. (1) joint, in accordance with Table UW-12, and there is access from one side only then provision must be made for visual examination of the joint from both sides in addition to providing for any required NDE.

SECTION 14 WELDING PROCEDURES AND QUALIFICATIONS

EXHIBIT 14.3.7 ABSA PRE-APPROVED REPAIRS

6.0 Examination Prior to Welding

- 6.1 Prior to welding, the area prepared for welding shall be visually examined to confirm that the repair area has been cleaned, and is free of oil, dirt and any other contaminants in preparation for welding.

7.0 Repair Welding

- 7.1 For the repair of defects in the base material, when material restoration is required, repair welding shall be in accordance with a Welding Procedure Specification that meets the requirements of paragraph UW-42. The Welder's performance qualifications shall be verified as acceptable for the performance variables of the repair weld prior to commencing the repair weld.
- 7.2 For the repair of defects in welds, repair welding shall be in accordance with the Welding Procedure Specification designated for the repair weld (as specified in paragraph 3.3 and as limited by paragraph 3.9). The Welder's performance qualifications shall be verified as acceptable for the performance variables of the repair weld prior to commencing the repair weld.
- 7.3 For Part UCS materials it is recommended that the weld metal be deposited by the manual shielded metal arc process using properly conditioned low hydrogen electrodes and that the maximum bead width not exceed four times the electrode core diameter (if the WPS being used for the repair welding specifies lesser bead width, the requirements of the WPS shall govern).

SECTION 14 WELDING PROCEDURES AND QUALIFICATIONS

EXHIBIT 14.3.8 ABSA PRE-APPROVED REPAIRS

8.0 Examination After Repair Welding

- 8.1 For repairs to base material, the repair welds shall be visually examined after completion. In addition to visual examination the repair welding shall be examined as specified by the Code and in accordance with paragraph 3.6 or 3.8, as applicable. As specified in paragraph 3.6 and by Section VIII, Division 1, paragraph UW-42: "All weld metal buildup must be examined over the full surface of the deposit by either magnetic particle examination to the requirements of Appendix 6, or by liquid penetrant examination to the requirements of Appendix 8."
- 8.2 For repairs to weld material, the repair welds shall be visually examined after completion. If Code-required NDE identified the defect then the completed repair shall be examined by the same NDE method that was used prior to the repair, in accordance with Code requirements. For weld units subject to UW-52 specified radiography, if weld material repairs or adjacent base material undercut repairs are in a location that is not examined by Code required radiography then care must be taken to ensure UW-52 requirements are satisfied with the inclusion of repairs in the weld unit. Additionally, if the weld defect is disclosed by radiography performed in accordance with UW-52 then the requirements of UW-52(d) must be met. At the Manufacturer's discretion the examination after welding may include NDE exceeding Code requirements.
- 8.3 For Part UCS P-No. 3, Group 3 materials the nondestructive examination shall be made after the material has been at ambient temperature for a minimum period of 48 hours to determine the presence of possible delayed cracking of the weld. If the NDE is by the magnetic particle method, only the alternating current yoke type is acceptable.



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SECTION 14 WELDING PROCEDURES AND QUALIFICATIONS

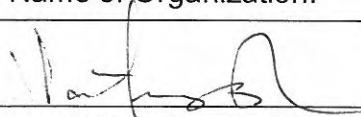
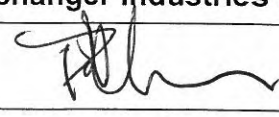
EXHIBIT 14.3.9 ABSA PRE-APPROVED REPAIRS

9.0 Acceptance of Repairs

- 9.1 Under the specific method and extent of base material and weld repair described in this document it is not mandatory that the Authorized Inspector accept the specific repair procedure prior to the Manufacturer's commencing the repair. Subject to the requirements of the construction Code, the Authorized Inspector must always be informed of and accept the completed repair.
- 9.2 Unless otherwise specified by the Manufacturer's Quality Control System, it shall not be required to document repairs that are conducted in accordance with this pre-accepted method and extent on a Nonconformity Report.
- 9.3 If repairs are conducted, within the scope and limitations defined in this document, on base material or welds that were previously inspected and accepted by the AI (e.g., due to results of additional examinations and/or evaluation against acceptance criteria that may exceed Code requirements), the completed repair shall subsequently be presented to the AI for acceptance.

10.0 Approval and Acceptance of Pre-Authorized Method and Extent for Repair of Defects in Welds and Base Materials.

- 10.1 The signature of the Quality Control Manager and Authorized Inspector following this paragraph shall indicate their respective approval and acceptance of the provisions contained in this document, which shall be implemented at the organization named below.

Name of Organization:	Exchanger Industries Limited
	
Authorized Inspector Acceptance	Quality Control Manager Approval
Date Sept. 16/11	Date Sept 16/11

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SECTION 15 WELDER/OPERATOR PERFORMANCE QUALIFICATION TESTING

15.1 The purpose this section outlines the system to control welder and welding operator performance qualification tests of Exchanger Industries Limited' employees in accordance with the Code and the issuing of performance cards pursuant to Alberta Pressure Welder's Regulations. All applicable requirements defined in other sections of this Quality Control Manual shall also apply to welder and operator performance tests conducted except as modified herein.

15.2 Material Control and Traceability

15.2.1 The Welding Examiner's duties include:

- a) Controlling welding coupon material.
- b) Verifying that each welding coupon is identified with an established coded marking to show the material specification and grade.
- c) Controlling the issue of test coupons to candidates.
- d) Issuing a unique identification symbol to each candidate.
- e) Ensuring that each coupon is marked with the candidate's identification symbol.

15.3 Performance Qualification Program

15.3.1 The Quality Control Manager is responsible for:

- a) Designating the Welding Examiner.
- b) Maintaining a file for each Welding Examiner containing all relevant documentation including a letter of appointment signed by a company official and accepted by signature of an ABSA Inspector.
- c) for notifying ABSA, in writing, if the Welding Examiner's employment is terminated.

15.3.2 The Quality Control Chief Inspector's duties include:

- a) To verify that the individual to be assigned Welding Examiner's duties has the required experience, ability, achievement and qualifications, and ensure that supporting documentation has been accepted by the ABSA before the examiner is appointed.
- b) To maintain a file for each Welding Examiner containing all relevant documentation and a letter of appointment signed by Quality Control Chief Inspector.
- c) To ensure that the Examiner is fully conversant with all applicable requirements defined in the Quality Control Manual.
- d) To monitor the standards employed by the Welding Examiner.

SECTION 15 WELDER/OPERATOR PERFORMANCE QUALIFICATION TESTING

15.4 Welding Examiner

- 15.4.1 The Welding Examiner reports directly to the Quality Control Manager. The Welding Examiner must hold a Welding Examiner Certificate of Competency issued pursuant to the Alberta Pressure Welders Regulation and/or have qualifications that have been accepted by ABSA, as a Welding Examiner.
- 15.4.2 The Welding Examiner's duties include the following:
- a) To verify that each applicant has a valid Certificate of Competency issued by ABSA (**Grade "B", Grade "C", Machine Operator Certificates as applicable**), and retain a copy of the Certificate/Initial Performance Qualification Cards on file.
 - b) To review the welding procedure requirements and test standards with candidate and Foreman.
 - c) To verify that the qualification test is performed in accordance with the Welding Procedure Specifications and ASME Section IX requirements and additional Alberta testing requirements. Refer to Examination and Test Procedure (**Exhibit 15.1**) for examinations that must be completed and the items that must be checked.
 - d) To develop additional Examination and Test Procedures when applicable, i.e. Fillet weld tests and any special processes per Q.W. 380.
 - e) To prepare performance qualification records (**Exhibit 15.2 and Exhibit 15.3**) for each test certifying if passed and documenting if failed.
 - f) Issue performance qualification card (**Exhibit 15.4**) upon satisfactory completion of test. Each card shall be certified by the Welding Examiner and Welder/Operator.

SECTION 15 WELDER/OPERATOR PERFORMANCE QUALIFICATION TESTING

- g) Supervising and documenting, on a Welder Qualification Record (**Exhibit 15.2**), the initial performance qualification test for all Grade C Pressure welders. The initial performance qualification test for Grade C Pressure Welders is always administered by an ABSA Inspector. If the candidate is successful a Grade C Pressure Welder Certificate of Competency is issued by ABSA.

When the initial Grade C performance qualification test is one of the following two tests;

- (1) NPS 2 pipe, schedule 160, 6G position, open root – no backing, or
- (2) NPS 6 pipe, schedule 80, 2G and 5G positions, open root – no backing,

then additional performance qualification tests may be completed by Exchanger Industries Limited without limitations on the scope of the additional qualification. It is important to note that any additional Grade C Pressure Welder performance qualifications will also expire on the expiry date of the Grade C Pressure Welder Certificate of Competency.

If the initial Grade C test is not one of the two tests described above, additional performance qualification tests must not include any of the following changes from the initial Grade C Pressure Welders performance qualification test;

- (1) a change in product form from plate to pipe,
- (2) a change to all-position qualification, or
- (3) a change to open root – no backing qualification.

Additionally, under no circumstances may a Welder Performance Qualification Card be issued to a Grade C Pressure Welder. The required Welder Qualification Record (AB-76A) is deemed to fulfil the Alberta requirement for a Performance Qualification Card.

- 15.4.3 The Welding Examiner shall not conduct a performance qualification test or issue a performance qualification card for himself.

SECTION 15 WELDER/OPERATOR PERFORMANCE QUALIFICATION TESTING

15.5 Nondestructive Examination

- 15.5.1 The Welding Examiner, in addition to supervising the performance qualification tests, shall visually examine the test coupons as described in the Welder Performance Qualification Examination And Test Procedure and as required by the Code. If NDE is used as part of the performance qualification test then the Welding Examiner must ensure that radiographic film interpretation sheets and NDE reports for Welders or Welding Operators to be qualified by NDE are identified with the candidate's symbol and meet all of the applicable Code requirements.
- 15.5.2 The acceptance standards required for nondestructive examination shall be as specified by ASME Code Section IX. Visual examination standards shall be as required by Section IX along with the additional criteria provided by ASME Code Section VIII, Division 1 (**Section VIII, Division 1, ASME B31.1 or 3 as applicable**).

15.6 Record Retention

- 15.6.1 The Welding Examiner is responsible for all performance qualification test records and will ensure:
- a) That performance qualification records, physical test results and NDE Reports are identified with welder/operator Identification Number/Symbol, and are retained on file for as long as the performance qualification remains valid but at least three years. Reports of NDE required under the Code shall be retained for minimum period specified therein.
 - b) That the test coupons and specimen are marked with welder/operator Identification Number/Symbol and are retained for at least ninety days if the candidate fails the qualification test, and thirty days if the candidate passes.

SECTION 15 WELDER/OPERATOR PERFORMANCE QUALIFICATION TESTING


15.7 Welder Performance Qualification Card

15.7.1 In accordance with the Alberta Pressure Welders Regulations:

- Section 8(6), the expiry date of the Welder Performance Qualification Card shall be no later than 24 months following the date issued.
- Section 8(8) the expiry date of the Welder Performance Qualification Card issued to an employee of Exchanger Industries Limited, with respect to a Grade B Pressure Welder Certification of Competency or Machine Welding Operator Certificate of Competency, may be extended by 6-month periods beyond the original 24 month expiry while the employee is employed by Exchanger Industries Limited under the following conditions:
 - a) Exchanger Industries Limited is the testing organization that conducted the employee's performance qualification test.
 - b) Documented evidence of the Continuity Log is verified as required by the Code. See 14.1
 - c) The employee is continuously employed by Exchanger Industries Limited.
 - d) Based on the records maintained in the Continuity Log, the Welding Examiner employed by Exchanger Industries Limited makes entries on the employee's Welder Performance Qualification Card to document the confirmation of continuity with respect to the process(es) represented on the Welder Performance Qualification Card.
 - e) That the Job Number and Weld Identification number(s) are kept with the Welder's Record Log if the welder/operator is qualified using production welds.

SECTION 15 WELDER/OPERATOR PERFORMANCE QUALIFICATION TESTING

EXHIBIT 15.1 PERFORMANCE QUALIFICATION TEST PROCEDURE



**EXCHANGER
INDUSTRIES
LIMITED**

5905 53rd Street SE, Calgary, Alberta T2C 2W8
Telephone (403) 236-1186 Fax (403) 273-8262 Website: www.exchangerindustries.com

Revision Number 2.1	Date: Friday, August 12, 2011
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WELDER/OPERATOR PERFORMANCE QUALIFICATION TEST PROCEDURE

No	Description	Code Reference	Examiner
1	Review Welding Procedure Specification and establish Welder performance test requirements.		
2	Verify that test coupon material spec., grade, thickness, diameter, weld joint preparations are correct.	QW-423, QW-452, QW-452.4	
3	Instruct candidates re test procedure, acceptance standards, time limit and Welding Procedure Specification requirements.		
4	Mark candidate's unique ID Number/Symbol on test coupons.		
5 *	Examine fit-up and tack welds.	¹ UW-31, UW-33	
6 *	Verify test position.	QW-110, QW-120	
7 *	Examine root (penetration, profile, fusion, reinforcement, reduction in thickness, etc.).	¹ UW-35	
8 *	Examine complete weld surface condition reinforcement, penetration, fusion, contour, etc.	QW-191, QW-302.4 ¹ UW-35	
9	Outline position of bend test specimens.	QW-302.3, QW-463, QW-160	
10	Verify that specimen size and thickness are acceptable after preparation. Mark candidate and specimen number on each specimen.	QW-462.2, QW-462.3	
11	Verify test jig tolerances.	QW-162, QW-466	
12	Examine specimens after bending.	QW-163, QW-302.4	
13	Review reports of any subcontractor used to perform physical tests, (Bend tests, etc.).		
14	Review radiographs, film and interpretation sheets.	QW-302.2, QW-191	
15	Prepare and certify Welder/Welding Operator performance qualification record form.		
16	Prepare and certify Welder Performance Qualification card.		

¹ Additional visual examination requirements are specified by ASME Section VIII, Division 1.

* Hold point, Welder may not continue without authorization from Examiner.



SECTION 15 WELDER/OPERATOR PERFORMANCE QUALIFICATION TESTING

EXHIBIT 15.2 QW-484-4H WELDER/WELDING OPERATOR PERFORMANCE QUALIFICATION FORM (Manual & Semi-automatic. See Also ABSA Form AB-76 A/B)

QW-484-4H WELDER/WELDING OPERATOR PERFORMANCE QUALIFICATIONS (WPQ)			
Welder's name _____	File number _____	Stamp no. _____	
Welding process (es) _____	S.M.A.W.	Type _____	manual
Identification of WPS followed by welder during welding of test _____	M-6A	W.P. Registration No. _____	317.2
Base material (s) welded _____	SA106-B	Thickness _____	.344"
Manual or Semiautomatic Variables for Each Process (QW-350)		Actual Values	Range Qualified
Backing (metal, weld metal, welded from both sides, flux, etc.) (QW-402) _____		F-3 none, F-4 weld metal	F-3 with or without, F-4 with
ASME P-No. _____ 1 _____	to ASME P-No. (QW-403) _____	P-1 to P-1	P-No. 1 through P-No.11
<input type="checkbox"/> Plate <input checked="" type="checkbox"/> Pipe (enter diameter, if pipe) _____		2" SCH. 160	1" O.D. & over
Filler metal specification (SFA): _____ 5.1 _____	Classification (QW-404) _____	E-6010 & E-7018	
Filler metal F-No. _____		3 & 4	3 / 4, 2, 1
Filler metal product form [solid/cored/flux-cored - GTAW/PAW (QW-404)] _____		n/a	n/a
Consumable insert for GTAW or PAW _____		n/a	n/a
Weld deposit thickness for each welding process _____	E-6010 (root pass only)	E-6010 (.093")	E-6010 (.186")
		E-7018 (.251")	E-7018 (.502")
Process 1: _____ S.M.A.W. _____	3 layers minimum <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	3 layers min.	.688"
Process 2: _____ n/a _____	3 layers minimum <input type="checkbox"/> Yes <input type="checkbox"/> No	n/a	n/a
Welding position (1G, 5G, etc.) (QW-405) _____		2G	Horizontal, & Flat
Progression (uphill/downhill) _____		Horizontal	Horizontal, & Flat
Backing gas for GMAW (QW-408) _____		n/a	n/a
GMAW transfer mode (QW-409) _____		n/a	n/a
GTAW welding current type/polarity (QW-409) _____		n/a	n/a
Guided Bend Test Results			
Guided Bend Tests Type _____	<input type="checkbox"/> QW-462.2 (Side) Results	<input checked="" type="checkbox"/> QW-462.3 (a) (Trans. R & F) Type	<input type="checkbox"/> QW-462.3 (b) (Long. R & F)
Root Bend		Pass	
Face Bend		Pass	
Visual examination results (QW-302.4) _____	ACCEPTABLE		
Radiographic test results (QW-304 and QW-305) _____			
Welding and Mechanical tests conducted by _____	EXCHANGER INDUSTRIES LIMITED	Laboratory test no. _____	
We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.			
Accredited Organization _____	EXCHANGER INDUSTRIES LIMITED	AODP No. _____	7015
Certified By _____		Date _____	
RECORD INFORMATION			
P.Q. Card No. (When issued) _____	Date Coupon is to be retained (if failed): _____		

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Revision Number 11.2

Revision Date: August 23, 2011

Section 15 Page 8 of 9

SECTION 15 WELDER/OPERATOR PERFORMANCE QUALIFICATION TESTING

**EXHIBIT 15.3
QW-484-3 WELDER/WELDING OPERATOR
PERFORMANCE QUALIFICATION FORM
(Machine See Also ABSA Form AB-76 A/B)**


QW-484-3 WELDER/WELDING OPERATOR PERFORMANCE QUALIFICATIONS (WPQ)			
Welder's name	File number	Stamp no.	
Welding process (es) used	S.A.W.	Type	Machine
Identification of WPS followed by welder during welding of test coupon	C-5	W.P. Registration No.	317.2
Base material (s) welded	SAS16-70N	Thickness	2.250"
Manual or Semiautomatic Variables for Each Process (QW-350)			
Backing (metal, weld metal, welded from both sides, flux, etc.) (QW-402)		Actual Values	Range Qualified
ASME P-No. 1 to ASME P-No. (QW-403)		weld metal	with backing
(X) Plate () Pipe (enter diameter, if pipe)		P-1 to P-1	P-1 through P-11
Filler metal specification (SFA) 5.17 Classification (QW-404)		n/a	n/a
Filler metal F-No.		EM-12K	
Filler metal F-No.		6	6
Filler metal product form (solid/cored/flux-cored - GTAW/PAW (QW-404))		n/a	n/a
Consumable insert for GTAW or PAW		n/a	n/a
Weld deposit thickness for each welding process 125" thk. (E-7018 S.M.A.W. backing)		2.125"	max.
Process 1: S.M.A.W. 3 layers minimum	Yes <input checked="" type="checkbox"/> No	2 layers	250"
Process 2: S.A.W. 3 layers minimum	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	3 layers min.	max. to be welded
Welding position (1G, 5G, etc.) (QW-405)		1G	flat
Progression (uphill/downhill)		flat	flat
Backing gas for GTAW, PAW, or GMAW; fuel gas for OFW (QW-406)		n/a	n/a
GMAW transfer mode (QW-409)		n/a	n/a
GTAW welding current type/polarity (QW-409)		n/a	n/a
Machine Welding Variables for the Process Used (QW-361.1 & QW-361.2)			
Direct/remote visual control		direct	direct
Automatic voltage control (GTAW)		n/a	
Automatic joint tracking		manual	manual or automatic
Welding position (1G, 5G, etc.)		1G	flat
Consumable insert		n/a	
Backing (metal, weld metal, welded from both sides, flux, etc.)		weld metal	with backing
Single or multiple pass (per side)		multiple	single or multiple
Change from automatic to machine		n/a	n/a
Filler for EBW or LBW		n/a	n/a
Laser type		n/a	n/a
Drive Type for FRW		n/a	n/a
Vacuum type for EBW		n/a	n/a
Guided Bend Test Results Per QW-482 n/a			
Visual examination results (QW-302.4)	Production weld		
Radiographic test results (QW-304 and QW-305)	Laboratory test		
Welding and Mechanical tests conducted by	EXCHANGER INDUSTRIES LIMITED		
We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.			
Accredited Organization	EXCHANGER INDUSTRIES LIMITED	AOPP No.	7015
Certified By		Date	
RECORD INFORMATION			
P.O. Card No. (When issued)	Date Coupon is to be retained (if failed):		

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SECTION 15 WELDER/OPERATOR PERFORMANCE QUALIFICATION TESTING

EXHIBIT 15.4 WELDING PERFORMANCE QUALIFICATION CARD

Front Side

	EXCHANGER INDUSTRIES <small>A.O.Q.P. No.</small>	7015 <small>A.O.Q.P. No.</small>	PERFORMANCE QUALIFICATION		
	WELDING PERFORMANCE QUALIFICATION CARD			Process(es) _____	Material (P-No.) _____
(Name) _____	(ABS File No.) _____		Filler Metal Group (F-No.) _____	Min. Outside Pipe Diameter _____	
<p style="font-size: small;">This card is issued pursuant to the Alberta Safety Codes Act and the Pressure Welders Regulations. The performance qualification is in accordance with Section IX of the ASME Code and subject to the limitations on the reverse side.</p>			Max Deposited Weld Metal _____	Position(s) Qualified _____	
			Backing _____	Backing Gas _____	
Date of Test _____	Signature of Welder or Machine Welding Operator _____		Progression _____		
The performance qualification is valid for two years from date of test unless extended inside the card.			P.Q. Expiry Date _____	Welding Examiner Signature _____	Certification No. _____
Welding Examiner (print/type) _____	Card No.	599			

Back Side

	EXCHANGER INDUSTRIES <small>A.O.Q.P. No.</small>		7015 <small>A.O.Q.P. No.</small>		PERFORMANCE QUALIFICATION		
	WELDING PERFORMANCE QUALIFICATION CARD			Process(es) _____	Material (P-No.) _____		
(Name) _____	(ABS File No.) _____		Filler Metal Group (F-No.) _____	Min. Outside Pipe Diameter _____			
<p style="font-size: small;">This card is issued pursuant to the Alberta Safety Codes Act and the Pressure Welders Regulations. The performance qualification is in accordance with Section IX of the ASME Code and subject to the limitations on the reverse side.</p>			Max Deposited Weld Metal _____	Position(s) Qualified _____			
			Backing _____	Backing Gas _____			
Date of Test _____	Signature of Welder or Machine Welding Operator _____		Progression _____				
The performance qualification is valid for two years from date of test unless extended inside the card.			P.Q. Expiry Date _____	Welding Examiner Signature _____	Certification No. _____		
Welding Examiner (print/type) _____	Card No.	599					
Card No. 599 P.Q. EXPIRY DATE EXTENSION <small>In accordance with the Pressure Welders Regulation Sect. 419</small>							
				<small>Welding Examiner Signature</small> _____	<small>Date Confirmed</small> _____		
				<small>Welding Examiner Certification Number</small> _____	<small>Expiry Date (if revised from confirmation)</small> _____		

(Valid at Exchanger Industries Limited only)

SECTION 16 CONTROL OF WELDING MATERIAL

- 16.1 The purpose of this section is to describe the controls used to assure welding materials are handled properly.
- 16.2 All welding materials are ordered by the Purchasing Department to ASME Section II Material Specification, Part C. Purchase Orders are to be approved by Purchasing and Quality Control Managers.
- 16.3 All welding materials are stored in the stock room in the original containers until needed.
- 16.4 The following procedures for the handling of low hydrogen electrodes will be as follows:
- a) When the electrodes are removed from their sealed containers, they are to be placed in a controlled rod oven in accordance with Manufacturer's Specifications.
 - b) At the conclusion of the afternoon shift, enough electrodes shall be removed from their containers by the Foreman and placed in the rod oven to provide an adequate supply for the following day.
 - c) Each welder must record his symbol, the date, time, the number and size of electrodes removed from the rod oven on the Electrode Control Report (Exhibit 16.1).
 - d) Rods removed from the rod oven shall not be returned to the rod oven.
 - e) Electrodes that are to be used for Code work shall not be out of the rod oven for more than four (4) hours.
 - f) All electrodes out of the rod oven more than four (4) hours or electrodes left at the end of the shift shall no longer be used for Code welding.
 - g) The Foreman will collect unused rods and either discard if damaged or placed in a closed holding bin for re-baking or used in non-Code welding.
- 16.5 Before the Receiver accepts any welding materials, he must check them against a list of acceptable SFA / AWS numbers. Each container must be initialed by the Receiver with a permanent marker to show that this has been done.
- 16.6 Hoppers or bins that are used to hold or move Flux must be clearly tagged with the Flux identification.

SECTION 16 CONTROL OF WELDING MATERIAL

- 16.7 If sufficient rods have been collected in the holding bins to warrant re-baking, the following procedure shall be followed by the Receiver:
- a) Check the rod ovens at the start of the afternoon shift to establish how many rods can be placed in the ovens.
 - b) Place the amount of sound rods on the rod bake container.
 - c) Rods with painted ends shall not be baked a second time.
 - d) The rod bake container will be placed in the EI stress relieving oven and baked at 600 to 700⁰F for one (1) hour.
 - e) The rods will be allowed to cool to no less than 250⁰F before being removed from the oven.
 - f) Paint the stinger ends to the rods with heat resistant paint.
 - g) The baked rods shall be distributed to the rod ovens in the shop before the end of the afternoon shift.
- 16.8 When a drawing indicates that Production Charpy Tests are required, the coupon used shall meet the requirements of UG-84. The coupon shall be ordered with the plate material and shall be received and stored in accordance Section 10 of this Quality Control Manual. The test coupon shall be handled in accordance with the Exchanger Industries Limited Production Charpy Record Procedure QP-11 and documented on the Production Charpy Record form (**Exhibit 16.2**).



SECTION 16 CONTROL OF WELDING MATERIAL

EXHIBIT 16.1 ELECTRODE CONTROL REPORT

5505 52nd Street SE, Calgary, Alberta, T2C 2W8
Telephone (403) 236-0100 Fax (403) 279-5242 Website: www.exchangerindustries.com

Revision Number 2.1	Date: Thursday, August 18, 2011
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ELECTRODE CONTROL REPORT

Date	Welder Symbol	Time Removed	Size of Electrode	Quantity Removed

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SECTION 16 CONTROL OF WELDING MATERIAL


EXHIBIT 16.2 PRODUCTION CHARPY RECORD FORM

		5505-52nd Street S.E. Calgary, Alberta, T2C 2W8 Tel: 403-236-0166 Fax: 403-279-8242 www.exchangerindustries.com	
PRODUCTION CHARPY RECORD			
JOB NUMBER		ITEM NUMBER	
DESCRIPTION			
EVENT	CHECKED BY	SIGNATURE	DATE
Coupon Heat #			
Cylinder # - Heat #			
Welding Process			
Coupon Attached to Cylinder			
Root By			
Fill By			
Coupon Removed			
Coupon Sent for Testing			
Results Received			
Rev.1 - August 18, 2011		Page 2 of 3	

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SECTION 17 NON-DESTRUCTIVE TESTING

- 17.1 The purpose of this section is to describe the controls used to ensure that nondestructive examinations are completed in compliance with ASME Section V and the applicable referencing construction Code.
- 17.2 The Quality Control Manager is responsible for:
- a) Reviewing the subcontractor's qualifications, certifications, written practices and procedures for compliance with the Code and the latest Code accepted Edition and Addenda of SNT-TC-1A, and ensuring that these are available to the Authorized Inspector at his request.
 - b) Appointing, by a Certifying Statement and Appointment Letter (**Section 18**), the NDE subcontractors SNT-TC-1A Level III Examiner to act as the Level III Examiner for Exchanger Industries. The Appointment Letter must be accepted and signed by the Level III Examiner
 - c) Ensuring that, when magnetic particle (**MT**) examinations are performed by Exchanger Industries, the Examiners are qualified and certified in accordance with Appendix 6 of ASME Section VIII, Division 1. The MT examinations shall be performed in accordance with written procedures certified by the Quality Control Manager to be in accordance with ASME Section V, T-150.
 - d) Ensuring that all NDE is performed under the supervision of a Level II or Level III Examiner.
 - e) Ensuring that all interpretation is done by a Level II or Level III Examiner.
 - f) Ensuring that, when Exchanger Industries Examiners perform MT, the Examiners are certified by the Quality Control Manager and that their eye examination records are up-to-date and that the MT and/or PT procedures are demonstrated to the satisfaction of the AI prior to first use and re-qualified whenever essential variables are changed.
 - g) Ensuring all NDE procedures for Code required MT are demonstrated to the satisfaction of the Authorized Inspector prior to use and whenever an essential variable is changed. The Authorized Inspector may require the re-qualification of an NDE examination or procedure if there is reason to question its validity. 



SECTION 17 NON-DESTRUCTIVE TESTING

- 17.3 Radiography will be performed by a sub-contractor who may also perform Ultrasonic, Magnetic Particle, or Liquid Penetrant examinations when required under the supervision of the Quality Control Department.
- 17.4 All NDE shall be performed in accordance with written procedures, written practice and by personnel qualified and certified in accordance with their Employer's written practice using SNT-TC-1A as a guide and the latest construction Code applicable Edition and Addenda.
- 17.5 The Drafting Department is responsible for identifying on the drawing NDE requirements to assure compliance with customer's specifications, the ASME Code and other standards. The Engineering Department will state the mandatory examinations or special instructions on the ITP.
- 17.6 The Quality Control Chief Inspector is responsible for liaison with the NDE subcontractor. His duties include:
- a) Reviewing the qualifications of the NDE Examiners for conformance to Quality Control System requirements.
 - b) Notifying the Examiners of NDE requirements.
 - c) Identifying the welds to be examined.
 - d) Maintaining traceability of NDE reports to their locations on the Code item by stamping the weld number on the Code item or by recording the necessary information on a weld map or as-built drawing.
 - e) Reviewing and accepting by signature, all reports for MT, PT and UT examinations and making these records available to the AI for review and acceptance.
 - f) Filing all NDE reports and forwarding these to Document Control when the job is completed.
- 17.7 Non-mandatory examinations may be done at the request of the Quality Control Manager to assess the extent of any non-conformity, but no such examination will be done at customer request over those originally agreed to in writing unless a change order is processed covering both the cost of the examination and possible repairs.



SECTION 17 NON-DESTRUCTIVE TESTING

- 17.8 Training records, sub-contractors written practice and NDE procedures will be made available to the Authorized Inspector for his reviews. NDE procedures shall be demonstrated to the satisfaction of the Authorized Inspector prior to their use on Code items and the Authorized Inspector may call for requalification on NDE Examiners and/or procedures.
- 17.9 A calibrated densitometer and calibrated density strip shall be used for checking the density of radiography film.
- 17.10 Visual examination on boiler external piping shall be performed by personnel qualified and certified by the Quality Control Manager as required by ASME B31.1 – 136.4.2
- 17.11 The Quality Control Chief Inspector is responsible for checking qualifications of personnel performing NDE. Results of all NDE will be reviewed by the Quality Control Department and reports made available for review by the Authorized Inspector.
- 17.12 Reports for ultrasonic, magnetic particle, liquid penetrant and radiography (including film) shall be retained by Exchanger Industries for a minimum of three years.



Revision Number 11.1	Revision Date: August 23, 2011	Section 18 Page 1 of 1
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SECTION 18 – NON-DESTRUCTIVE EXAMINATION CERTIFICATION STATEMENT WITH NDE SUB-CONTRACTORS



5505 52nd Street SE, Calgary, Alberta T2C 2W8
Telephone (403) 236-0169 Fax (403) 279-8242 Website: www.exchangerindustries.com

CERTIFYING STATEMENT

I have reviewed the:

Written Practice:	Edition #6 Rev. 2
	(Edition Number and / or Revision Number of Written Practice)
NDE Procedures:	Edition # 4 Rev 2
	(Method and Edition Number and / or Revision Number of Procedures)
Personnel certification records and vision examination records of all examiners that will perform NDE at Exchanger Industries	

For

IRISNDT, Unit 3/4 285121 Wrangler Way, Calgary, AB T2P 2G6

(Name and Address of NDE Company)

It is my opinion that the specified NDE procedures are in accordance with ASME Section V requirements as referenced by the applicable construction Code and that the Written Practice complies in all respects with the requirements of the construction Code accepted Edition/Addenda of SNT-TC-1A.

Based upon my review of the above referenced documents I hereby certify that personnel performing and evaluating NDE have been qualified and certified in accordance with their employers written practice and that the demonstration of procedures(s) to the satisfaction of the AI, as required by the ASME Code, Section V, paragraph T-150, has been completed as specified within the Exchanger Industries written quality system.

Therefore:

IRISNDT are hereby appointed to perform: RT, MT, PT, UT
(Name of NDE Company) (RT, UT, PT, MT, ET, VT, and/or LT)

for: Exchanger Industries

(Name of Manufacturer)

APPOINTMENT OF LEVEL III EXAMINER

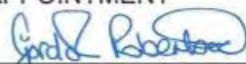
Gordon Robertson, Gordon Schultz, Brad Edison (RT, MT, PT only) is by this statement appointed to act as the Level III examiner for:
(Name of Level III Examiner)

Exchanger Industries in the following methods: RT, UT, MT, PT
(Name of Manufacturer) (RT, UT, PT, MT, ET, VT, and/or LT)

PETER MARTENS, P.ENG. JAN 4/2011 January 1, 2012
(Signature of QC Manager) (Date) (Appointment Expiry Date)

LEVEL III EXAMINER ACCEPTANCE OF APPOINTMENT

I hereby accept the appointment as indicated above.


(Signature of Level III Examiner)

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SECTION 19 HEAT TREATMENT

- 19.1 The purpose of this section is to describe controls that will be used to ensure that heat treatment is performed in accordance with the Code and job specifications.
- 19.2 When required, heat treatment may be done on-site or may be sub-contracted with written instructions issued by the Quality Control Inspector (**Exhibit 19.1 or 19.2**). The Quality Control Manager will review, accept and approve the subcontractor's facilities and written procedures¹, and ensure the furnace instrumentation is properly calibrated.
- 19.3 All material or items to be heat treated shall be identified by using Exchanger Industries Limited' job number using heat resistant marker or die stamping.
- 19.4 **For Exchanger Industries Limited Oven**
Time temperature charts will be required and shall have on each chart, the Part Stress Relieved Stamp (**Exhibit 19.3**) applied and filled out with the job number, part description, date and signature of the furnace operator² or supervisor. The furnace operator's name will be recorded on the instruction sheet (**Exhibit 19.1**).
- 19.5 **For sub-contractor Oven**
Time temperature charts will be required and shall have on each chart. the job number, part description, purchase order number, date and signature of operator or supervisor. The Sub-Contractor's furnace operator, the furnace heat/load number and the date will be recorded on the instruction sheet (**Exhibit 19.2**).
- 19.6 These charts will be reviewed by the Quality Control Inspector for conformance with the furnished procedure and Code requirements and if acceptable, will initial the ITP. The charts and written procedure shall be made available to the Authorized Inspector for his review and acceptance.
- 19.7 The Quality Control Department will review the sub-contractors procedures; facilities and check the calibration of the instruments and furnace have been completed. The on-site furnace shall be calibrated quarterly (**Exhibit 20.1**). Records will be maintained by the Quality Control Department and kept in the job file.
- 19.8 Items that have been heat treated shall be inspected by the Quality Control Department for any damage or loss of identification.

¹ Procedures shall be reviewed yearly, with review documented on a copy of the procedures on file.

² Due to the length of some PWHT cycles, multiple operators may oversee the heat. The furnace operator is the person who initially loads and programs the furnace.



Revision Number 11.2

Revision Date: August 23, 2011

Section 19 Page 2 of 4

EXHIBIT 19.1 EXCHANGER INDUSTRIES LIMITED OVEN – INSTRUCTION SHEET

5505 52nd Street SE, Calgary, Alberta T2C 2W8
Telephone (403) 236-0166 Fax (403) 279-8242 Website: www.exchangerindustries.com

STRESS RELIEVING REQUIREMENTS EXCHANGER INDUSTRIES' FURNACE Revision: 4.0

VESSEL : _____ JOB NO: _____

MATERIAL: Heads: _____ Max. Weld Thickness: _____
Shell/Pipe: _____ Max. Metal Thickness: _____
Tubes: _____

REQUIREMENTS:

- Job number and description required on heat treatment charts along with the operator's signature & date
- Reporting of thermocouple attachment method and location and verification of furnace thermocouple calibration is required.
- A sufficient number of thermocouples shall be located and maintain uniform distribution of temperature on all vessels and parts. Thermocouples shall be directly attached to the item or provision shall be made for thermocouple placement at bottom, center and top of the furnace charge in accordance with the ASME code.
- During the heating period, there shall not be a greater variation in temperature throughout the portion of the vessel being heated than 250°F (139°C) within any 15 ft. (4.6m) interval of length.
- During the holding period, there shall not be a greater difference than 150°F (83°C) between the highest and lowest temperature throughout the portion of the vessel being heat treated, except where the range is further limited by these instructions.
- If Capacitor Discharge welding is used to attach thermocouples an ASME Code Section IX Welding Procedure Specification is required (WPS qualification is not required), and the energy output must be limited to 125 Watt-Seconds. [$0.5 \times \text{Capacitance in farads} \times \text{Voltage}^2 = \text{W-Sec}$]. No other welding is permitted on vessels or parts.

1. Furnace Temperature shall not exceed 600°F at the time the material is placed.
2. Maximum Heating Rate _____ °F per hour. (_____ °F per minute)
3. Holding Temperature _____ °F.
4. Holding Time _____ Minutes
5. Maximum Cooling Rate _____ °F per hour. (_____ °F per minute)
6. From 600°F the material may be cooled in Still Air.

Formula for calculating the Heating and Cooling Rates in °F/minute as required for the control setting is as follows:
Heating or Cooling rate in °F/hour ÷ 60 = °F/minute
EG: 400°F ÷ 60 = 6.66°F per min.

Prepared by: _____ Date: _____


Furnace Operated by: _____ Date: _____

Supervisor: _____ Date: _____

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EXHIBIT 19.2 SUB-CONTRACTOR OVEN – INSTRUCTION SHEET



5505 52nd Street SE, Calgary, Alberta T2C 2W8
Telephone (403) 236-0166 Fax (403) 279-8242 Website: www.exchangerindustries.com

Revision: 4.0

STRESS RELIEVING REQUIREMENTS SUB-CONTRACTOR'S FURNACE

SUBCONTRACTOR: _____ PO NO: _____

VESSEL: _____ JOB NO: _____

MATERIAL: Heads: _____ Max. Weld Thickness: _____

Shell/Pipe: _____ Max. Metal Thickness: _____

Tubes: _____

Diameter _____ Length _____ Weight _____

REQUIREMENTS:

- Job number and description required on heat treatment charts along with the operator's signature & date
- Reporting of thermocouple attachment method and location and verification of furnace thermocouple calibration is required.
- A sufficient number of thermocouples shall be located and maintain uniform distribution of temperature on all vessels and parts. Thermocouples shall be directly attached to the item or provision shall be made for thermocouple placement at bottom, center and top of the furnace charge in accordance with the ASME code.
- During the heating period, there shall not be a greater variation in temperature throughout the portion of the vessel being heated than 250°F (139°C) within any 15 ft. (4.6m) interval of length.
- During the holding period, there shall not be a greater difference than 150°F (83°C) between the highest and lowest temperature throughout the portion of the vessel being heat treated, except where the range is further limited by these instructions.
- If Capacitor Discharge welding is used to attach thermocouples an ASME Code Section IX Welding Procedure Specification is required (WPS qualification is not required), and the energy output must be limited to 125 Watt-Seconds [0.5 x Capacitance in farads x Voltage² = W-Sec] No other welding is permitted on vessels or parts.

1. Furnace Temperature shall not exceed 800°F (426 °C) at the time the material is placed.
2. Maximum Heating Rate _____ °F (_____ °C) per hour.
3. Holding Temperature _____ °F (_____ °C)
4. Holding Time _____ Minutes
5. Maximum Cooling Rate _____ °F (_____ °C) per hour.
6. From 800°F (426 °C) the material may be cooled in Still Air.

Special Instructions:

Prepared by: _____ Date: _____

Issued to: _____

Furnace Operated by: _____ Date: _____

Furnace Heat/Load No: _____

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EXHIBIT 19.3 PART STRESS RELIEVED STAMP

EXCHANGER INDUSTRIES	
JOB # _____	_____
PARTS STRESS RELIEVED	

DATE: _____	_____
SIGNATURE: _____	_____

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SECTION 20 CALIBRATION OF MEASUREMENT AND TEST EQUIPMENT

- 20.0 The purpose of this section is to describe the control and calibration of measuring and test equipment to ensure Code compliance.
- 20.1 The Quality Control Chief Inspector is responsible for the control of measuring and test equipment. His duties include:
- a) Maintaining a list of Calibrated Equipment frequency checks (Exhibit 20.1) consisting of equipment category, frequency of calibration, the standard used for calibration and who is responsible for calibrations.
 - b) Ensuring that all gauges, recorders and other instruments used for Code required measurements or inspections are identified with a serial number or identification number, and calibration expiry date.
 - c) Maintaining records of calibration for each item. Calibrations shall be performed against certified equipment having a known valid relationship to a recognized national standard. Where no such standard exists, the basis used for calibrations shall be documented.
 - d) Verifying the calibration of a subcontractor's impact test equipment prior to contracting to have impact tests performed.
 - e) Recalibrating any equipment that is suspected to be in error.
- 20.2 The maximum interval between pressure measuring device calibrations shall be twelve months. All other equipment used for Code required measurement or inspection shall be calibrated at intervals as recommended by the manufacturer or as established by the Quality Control Chief Inspector.
- 20.3 Pressure Gauges shall be calibrated against a dead weight tester traceable to a national standard.
- 20.4 The Quality Control Chief Inspector is responsible for the use of the test equipment. His duties include:
- a) Examining the equipment for visible damage and calibration status prior to use.
 - b) Ensuring that the range of pressure gauges used for any hydrotest is not less than 1.5 and not more than 4 times the test pressure.
 - c) Returning all equipment to the storage area after use.
 - d) Identifying any equipment that requires a calibration.
- 20.5 Any instrument found to be out of calibration, shall be found to be non-conforming. The subsequent non-conformance shall be dispositioned in accordance with Code requirements, including a review of all items that may have been measured using that instrument.

**EXHIBIT 20.1
CALIBRATION OF MEASUREMENT
AND TEST EQUIPMENT FREQUENCY CHECKS**

EQUIPMENT CATEGORY	FREQUENCY OF CALIBRATION	STANDARD USED	RESPONSIBILITY
Micrometers Verniers	3 months	Calibration block	
Pressure Gauges	12 months	Subcontract	
D.C. Clamp on ampmeter	12 months	Subcontract	
Kane May temperature indicator	12 months	Subcontract	
Rod ovens	6 months	Kane May temperature indicator	
Furnace calibration	3 months	Subcontract	
Welding machines	12 months	Subcontract	
MPI magnet	3 months	Test block	
Niton Analyzer	Daily	Internal Test Block	User

SECTION 21 RECORD RETENTION & CONTROL OF FINAL DOCUMENTATION

- 21.0 Upon completion of a Code item, the following records shall be compiled and retained by the Quality Control Department.
- a) Customer specifications
 - b) Drawings, calculations, specifications and any applicable proof test reports
 - c) Registered drawings
 - d) Non-conformance Reports and Dispositions
 - e) Inspection & Test Plan
 - f) Material Test Reports
 - g) Non-destructive examination reports including radiographs reports and/or film
 - h) Charpie tests, tensile tests and any other destructive examinations
 - i) Heat numbers, welding symbols and dimensional checks shall be record
 - j) Heat treatment procedures, records and charts
 - k) Manufacturer's Data Report and Partial Data Reports with attachments
 - l) Copies of the nameplate stamping / engraving
 - m) Hydrotest Reports and/or charts
 - n) Repair procedures and records
 - o) Weld Procedure Specifications and Welder Performance Qualifications
- 21.1 Exchanger Industries Limited will retain all the above data for a minimum of Five (5) years (see also Section 17.12).
- 21.2 Manufacturer's Data Report Distribution
- a) One (1) copy for the Authorized Inspector to forward to the Authorized Inspection Agency.
 - b) One (1) copy to the Jurisdiction having authority.
 - c) One (1) copy to the customer.
 - d) One (1) copy to the Quality Control Departments files.
 - e) One (1) copy to the National Board when required.

SECTION 22 AUTHORIZED INSPECTOR

- 22.0 The Authorized Inspector is an employee of the ASME accredited Authorized Inspection Agency and has been qualified in accordance with the ASME QAI-1, the Code and the National Board of Boiler and Pressure Vessels Inspector requirements.
- 22.1 The ASME accredited Authorized Inspection Agency is ABSA.
- 22.2 The Quality Control Chief Inspector is responsible for liaison with the Authorized Inspector.
- 22.3 The Authorized Inspector and the Authorized Inspector Supervisor shall have free access to all areas of the fabrication facilities involved in the manufacture of Code items to all documentation related to ASME Code construction. The Authorized Inspector shall also have access to all sub-contractors facilities that perform work on Code items.
- 22.4 A controlled copy of this Quality Control Manual shall be made available for the use of the Authorized Inspector.
- 22.5 The Authorized Inspector Supervisor shall be granted free access to all areas of the Code fabrication and to all documentation in order to perform annual audits as required by the National Board By-Laws.

SECTION 23 REPAIR / ALTERATION TO IN-SERVICE BOILERS & PRESSURE VESSELS

- 23.0 The purpose of this section is to describe the system for controlling the repairs and alterations of pressure vessels. The requirements of all other sections of this Manual shall apply for repairs or alterations except as modified below.
- 23.1 All repairs and alterations shall be in accordance with the Alberta Safety Codes Act, the latest Edition and Addenda of ANSI / NB-23, the National Board Inspection Code when an 'R' stamp is required and, insofar as possible, the latest Edition and Addenda of the applicable ASME Code Section.
- 23.2 Definitions
- 23.2.1 Repair – The work necessary to restore a Pressure Retaining Item to a safe and satisfactory operating condition, provided there is no deviation from the original design.
- 23.2.2 Alteration – Any change in the item described on the original Manufacturer's Data Report or which affects the pressure containing capacity of a Pressure Retaining Item. Non-physical changes such as an increase in the maximum allowable working pressure (**internal or external**) or design temperature to a Pressure Retaining Item shall be considered an alteration. A reduction in minimum temperature such that additional mechanical tests are required shall also be considered an alteration.
- 23.2.3 'R'-Stamp – If a repair or alteration is to be registered with the National Board, the 'R'-Stamp is required to be applied to the appropriate National Board Nameplate (**Exhibit 23.1**). All such work shall be in accordance with this Manual and Part RC of ANSI / NB-23, the National Board Inspection Code. The 'R' stamp shall only be applied with the concurrence of the Authorized Inspector and is kept secured by the Chief Inspector.

SECTION 23 REPAIR / ALTERATION TO IN-SERVICE BOILERS & PRESSURE VESSELS

23.3 Repair / Alteration Procedures

23.3.1 The Manager of Manufacturing will assign a separate job number and file for each Pressure Retaining Item repair / alteration.

23.3.2 The Engineering Department will develop an individual Inspection and Test Plan (**Exhibit 11.1**) for all repairs / alterations. It will be presented to the Authorized Inspector before the work commences.

23.3.3 The Drafting Department will develop a detailed procedure for all repairs / alterations containing at least:

- a) Pressure Retaining Item description and Alberta (A) number if applicable.
- b) CRN or National Board Number, Original Manufacturer and Year Built.
- c) Owner and location of installation, Owners identification.
- d) Sketch/Drawings, weld details and welding procedure specification numbers.
- e) SA/SB material specifications and sizes of all material to be used.
- f) Non-destructive Examination and Heat Treatment requirements.
- g) Pressure Test requirements.
- h) Any additional requirements.

23.3.4 The Drafting Department shall obtain acceptance of repair / alteration procedure from the Authorized Inspector and Owner prior to start of work. When required by the Authorized Inspector, this procedure will be submitted to ABSA or the appropriate local Jurisdiction for acceptance.

23.3.5 If the Pressure Retaining Item is still under warranty, the Drafting Department will contact the Owner to obtain acceptance of proposed work from the original Manufacturer. For alterations, design calculations and drawings will be prepared in accordance with Section 8 of this Quality Control Manual.

SECTION 23 REPAIR / ALTERATION TO IN-SERVICE BOILERS & PRESSURE VESSELS

- 23.3.6 The Drafting Department will submit the alteration procedure, design calculations and drawings to ABSA or the appropriate local Jurisdiction for acceptance prior to start of work unless specifically exempt by the Authorized Inspector.
- 23.3.7 The Drafting Department will ensure that copies of all latest Repair / Alteration procedures, drawings and instructions are provided to Personnel responsible for repair / alteration per DCR system as detailed in Section 8.
- 23.4 The Quality Control Chief Inspector shall ensure that:
- 23.4.1 Registered welding procedures are used for all welded repairs or alterations,
 - 23.4.2 All welding is performed in accordance with Section 14 of this Manual and the applicable Section of the ASME Code.
 - 23.4.3 Material control is handled in accordance with Section 10 of this Manual.
 - 23.4.4 Nondestructive examination shall be performed in accordance with Section 17 of this Manual and the applicable Section of the ASME Code.
 - 23.4.5 Heat treatment shall be performed in accordance with Section 19 of this Manual and the applicable Section of the ASME Code.
- 23.5 The repaired or altered Pressure Retaining Item shall be hydrostatically tested, in accordance with Section 12 of this Manual and, unless specifically exempted by the Authorized Inspector,
- 23.5.1 As indicated on the Report of Repairs (**Form R-1**) or the Report of Alterations (**Form R-2**) if National Board Registration is required.
 - 23.5.2 As indicated on the Boilers and Pressure Vessels Repair or Alteration Report (**Form AB-40**) if National Board Registration not required.
 - 23.5.3 Repairs or Alterations that are not registered with the National Board shall not be recorded on an R-1 or R-2 form as permitted in paragraph 5.2.1 of ANSI / NB-23, the National Board Inspection Code.

SECTION 23 REPAIR / ALTERATION TO IN-SERVICE BOILERS & PRESSURE VESSELS

- 23.6 For Repairs or alterations required to be registered with the National Board, the following shall apply:
- 23.6.1 Upon satisfactory completion of the hydrostatic test of a repair, the Chief Inspector shall be responsible for:
- 23.6.1.1 The preparation and certification of National Board Form R-1 (**Report of Repairs**),
 - 23.6.1.2 Ensuring it is presented to the Authorized Inspector for review and certification.
 - 23.6.1.3 Submitting the registration with the National Board in accordance with paragraph 5.2.1.
 - 23.6.1.4 Entering the form number into the record log per paragraph 5.5c.
- 23.6.2 Upon satisfactory completion of the hydrostatic test of an alteration, the Chief Inspector shall be responsible for:
- 23.6.2.1 The preparation and certification, including the design certification area, of National Board Form R-2 (**Report of Alterations**)
 - 23.6.2.2 Ensuring it is presented to the Authorized Inspector for review and certification.
 - 23.6.2.3 Submitting the registration with the National Board in accordance with paragraph 5.5.
 - 23.6.2.4 Entering the form number into the record log per paragraph 5.5c.
- 23.6.3 One copy of the applicable Repair / Alteration form (**R-1 or R-2**) together with the attachments and one copy of each Partial Data Report shall be distributed to each of the following:
- 23.6.3.1 The Authorized Inspection Agency responsible for the inservice inspection of the item.
 - 23.6.3.2 The Owner or User.
 - 23.6.3.3 The Job file.
 - 23.6.3.4 The Jurisdiction (**if required**).
 - 23.6.3.5 The National Board, for registered repairs or alterations.

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SECTION 23 REPAIR / ALTERATION TO IN-SERVICE BOILERS & PRESSURE VESSELS

23.6.4 The appropriate repair or alteration Nameplate (**Exhibit 23.1**) shall be attached to the Pressure Retaining Item adjacent to the original nameplate with the following stampings:

23.6.4.1 The 'R' Stamping.

23.6.4.2 The name of the Repair / Alteration Organization.

23.6.4.3 The National Board Certificate Number.

23.6.4.4 The date of the Repair or Alteration.

23.6.4.5 Maximum allowable working pressure and temperature
(for Alterations).

23.6.5 The 'R' stamp shall only be applied with the concurrence of the Authorized Inspector.

23.6.6 For Repairs or alterations that are not required to be registered with the National Board, the following shall apply:

23.6.7 Upon satisfactory completion of the Repair / Alteration, the Quality Control Department will prepare and certify the Repair / Alteration Report Form (**Form AB-40**), and will present it to the Authorized Inspector for his certification,

23.6.8 One copy of the Repair / Alteration Report Form will be provided to the Owner, one copy to the Authorized Inspector, one copy to the Jurisdictional Authority (**if required**) and one copy will be placed in the Job File.

SECTION 23 REPAIR / ALTERATION TO IN-SERVICE BOILERS & PRESSURE VESSELS

23.6.9 When required by the Authorized Inspector, an identification plate (**Exhibit 23.2**) will be attached to Pressure Retaining Item adjacent to the original nameplate with the following stamping:

- a) Repaired, Altered, or Re-rated.
- b) Name of Repair / Alteration Organization.
- c) Date of Repair / Alteration.
- d) Maximum Allowable Working Pressure and Temperature.
- e) Minimum Design Metal Temperature at specified pressure (**when applicable**).
- f) Serial Number or Work Order number of repair organization.
- g) Canadian Registration Number.
- h) The 'R' stamp shall not be applied.

23.7 Record Retention

23.7.1 The Drafting Department will maintain a separate Job File for each vessel Repair / Alteration. The Job File will contain the following applicable documents, all identified with Job Number:

- a) Drawings.
- b) Repair / Alteration Procedure.
- c) Calculations.
- d) Purchase Orders.

23.7.2 The Quality Control Department will maintain a separate Job File for each Pressure Retaining Item Repair / Alteration. The Job File will contain applicable documents listed in Section 21 of this Manual. In addition, a separate, sequential log shall be kept of all 'R' forms registered with the National Board in accordance with 5.5c.


23.7.3 These records shall be retained for the period of time specified in Section 21 of this Quality Control Manual.


**SECTION 23 REPAIR / ALTERATION TO IN-SERVICE
BOILERS & PRESSURE VESSELS**

Exhibit 23.1

Repair / Alteration Nameplates

**For Items Requiring a National Board 'R' Stamp
(Engraved per drawing, exclusive of stamp)**

REPAIRED BY <u>EXCHANGER INDUSTRIES LIMITED</u>	
CERTIFICATE HOLDER	
	
<hr/>	
NATIONAL BOARD "R" CERTIFICATE NUMBER	DATE REPAIRED

ALTERED BY <u>EXCHANGER INDUSTRIES LIMITED</u>	
CERTIFICATE HOLDER	
	
<hr/>	
M.A.W.P.	- P.S.I.
<hr/>	
AT	- °F
<hr/>	
NATIONAL BOARD "R" CERTIFICATE NUMBER	DATE ALTERED

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**SECTION 23 REPAIR / ALTERATION TO IN-SERVICE
BOILERS & PRESSURE VESSELS**

**Exhibit 23.2
Repair / Alteration Nameplate
For Items Requiring Form AB-40
(Boilers and Pressure Vessels Repair or Alteration Report)**

(No National Board Registration or 'R' Stamp)

CERTIFIED BY EXCHANGER INDUSTRIES LIMITED CALGARY, ALBERTA, CANADA	
MANUFACTURER'S SERIAL NO.	<input type="text"/>
ITEM NO.	<input type="text"/>
MAXIMUM ALLOWABLE WORKING PRESSURE	<input type="text"/>
DESIGN TEMPERATURE	<input type="text"/>
MDMT	<input type="text"/>
DATE OF ALTERATION	<input type="text"/>
CRN	<input type="text"/>
<input type="text" value="A"/>	
<input type="text"/>	
<input type="text"/>	

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SECTION 24 NON-BOILER PRESSURE PIPING SYSTEMS

- 24.0 The purpose of this section is to describe the system for controlling the construction, repair, alteration or replacement of pressure piping systems. All other sections of this Quality Control Manual shall apply for pressure piping, except as modified below.
- 24.1 This Quality Control system shall also apply to the design and construction of non-boiler external pressure piping systems under the Safety Codes Act, ASME B.31.1 and ASME B.31.3 with the following exception.
- 24.2 Pre-Job Review
- a) The Project Manager shall contact the owner prior to the start of work to define the contract requirements and to establish whether the owner is responsible for activities such as: preparing spool drawings, assigning NDE and heat treatment contractors, performing pressure tests, preparing piping data reports (**AB83, AB81**), supplying material, and conducting specific Quality Control function as defined in this Quality Control Manual.
 - b) When part of the pressure piping involved in a contract is to be subcontracted, the Quality control Manager shall ensure that:
 - 1) The subcontractor has a valid Alberta Quality Program and welding procedures suitable for the scope of the subcontract work.
 - 2) The contract review procedure is conducted with the subcontractor.
 - 3) The Owner and/or Owner's Inspector is advised so that the necessary inspections can be conducted.
 - 4) The pressure piping Construction Data Reports, for the subcontracted work, are received and incorporated into the records required by the contract and this system.

NOTE:

The Project Manager shall make the owner aware that under Alberta Design and construction Regulations (paragraph 32(2)), the owner must have an Authorized Quality Control Program for the scope of work if the owner assumes responsibility for Quality Control functions such as material receiving inspection, material traceability, welder supervision and welders records, control of NDE on site, witnessing pressure test, and preparing quality control records. If the owner does not have an Authorized Quality Control Program for any of these functions, the Project Manager shall make the Owner aware that all requirements of this system must be met. The owner should also be made aware that the design of a pressure piping system constructed for use in Alberta must be registered when the aggregate internal volume of the piping that is not exempt from PESR requirements by PSER Paragraph 4(2) exceeds 500 liters (see PSER Paragraph 14(1)).

SECTION 24 NON-BOILER PRESSURE PIPING SYSTEMS

- 24.3 The Project Manager is responsible for reviewing the scope of work, design specifications, drawings and contract documents for the job. He will ensure that:
- a) The scope of work is defined.
 - b) The owner has approved the drawings for construction.
 - c) The material lists included ASME material specification numbers and grades, schedules, classes and sizes.
 - d) The welding procedures (**owner or contractors**) are specific and qualified for the job.
 - e) The responsibility for NDE, heat treatment and pressure testing are assigned.
 - f) The responsibility for quality control functions are defined (**owner or contractor**).
 - g) The responsibility for material supply is defined.
 - h) The responsibility for registering the drawings with the ABSA is defined.
- 24.4 All design calculations, specifications, and drawings shall comply with the ASME B.31.1 and ASME B.31.3 Codes, and the Alberta Safety Codes Act as per Section 8 of this manual.
- 24.5 Drawings and specifications are to be submitted in duplicate with ABSA General Engineering Requirements Form AB-96 when total capacity of piping system exceeds 0.5 cubic meters. All design drawings shall be certified by a Professional Engineer.
- 24.6 All pressure piping material will be ordered to a specification list in ASME B.31.1 and ASME B.31.3 as applicable.

SECTION 24 NON-BOILER PRESSURE PIPING SYSTEMS

- 24.7 Inspection and sign off will not be performed by the Authorized Inspector. All required examinations and inspections are the responsibility of the Quality Control Department and the Owner's Inspector.
- 24.8 An Examination Checklist (**Exhibit 24.1**) shall be used to record the completion of examinations and inspections and signed by the Chief Inspector at the time each function is completed. The Chief Inspector shall examine each system after completion and prior to test against the design specification and drawings.
- 24.9 A marked-up construction drawing may be used to record location and completion of radiographs and welders symbols.
- 24.10 A Construction Data Report for Piping Systems Form AB-83 shall be prepared and certified by the Quality Control Department for each system and presented to the owner's inspector for his review and signature. One copy will be provided to the owner and one will be retained on file for a minimum period of five years.
- 24.11 The Completion of Construction Declaration Form AB-81 must be completed for all pressure piping systems. The original is submitted to the ABSA, one copy is retained on file for a period of five years by Exchanger Industries Limited and one copy is submitted to the owner.

**SECTION 24 NON-BOILER PRESSURE PIPING SYSTEMS
EXHIBIT 24.1 EXAMINATION CHECKLIST FOR PRESSURE PIPING**

EXAMINATION CHECKLIST FOR PRESSURE PIPING

Customers Item #:	Drawing No.			
	Quality Control Inspr	Date	Cust. Inspr	Date
A.I. Inspector notified				
Welding Procedures qualified & registered with AIA				
Welders qualified to procedure				
Welders P.Q. Cards valid				
Material checked against drawings & specifications & for proper identification				
Radiography files, interpretation sheets reviewed				
NDE reports reviewed				
Heat treatment completed, chart filed				
Fabrication monitored for root spacing, preparation, alignment, preheat, etc.				
All welds identified with welders symbols				
Completion of NDE & Heat treatment recorded on construction drawings				
Visual of welds completed				
Deficiencies completed				
Pressure test checked				
Construction and test data report CB-81 completed				
Declaration for CB-81 completed				
Records delivered to owner				

SECTION 25 INSPECTION PROCEDURES FOR CATEGORY “A”, “B” AND “H” FITTINGS WHICH DO NOT REQUIRE AUTHORIZED INSPECTION

- 25.1 Category “A”, “B”, and “H” pressure fittings will be manufactured in accordance with this written quality system with the following exceptions:
- a) The Engineering Manager will complete the Statutory Declaration (**Exhibit 25.1**) for all items that qualify as pressure fittings, and submit this document in triplicate along with a Design Registration Application (**Exhibit 8.1**) to ABSA Design Survey.
 - b) If the design is the property of the customer, then the Engineering Manager must obtain a copy of the registered Statutory Declaration for the item and confirm that it meets the specifications indicated. The Engineering Manager will confirm that a CRN has been issued in accordance with the requirements of CSA B51.
 - c) ABSA Design Survey may require that unusual designs be proof tested in accordance with ASME Section VIII, Division 1, paragraph UG-101. The Quality Control Manager shall arrange to have these tests witnessed by the Authorized Inspector. The test will be documented on a Proof Test Report, which will be signed by the Quality Control Manager and Authorized Inspector attesting to the results of the testing.
 - d) An ITP (**Exhibit 11.1**) shall be initiated for each batch of pressure fittings manufactured. The Quality Control Inspector is responsible to initiate the ITP and sign off all applicable inspection tasks as they are completed.
 - e) Each fitting produced will, as a minimum, be identified in accordance with specification MSS SP-254. The full identification as shown below in sample form will be stamped either on a nameplate attached to the fitting or directly on the fitting.

**EXCHANGER INDUSTRIES
LIMITED**
REGISTERED PRESSURE FITTING
CRN 0A9999.2 S/N 9999999
MAWP 999 PSI AT 999 DEG. F


SECTION 25 INSPECTION PROCEDURES FOR CATEGORY “A”, “B” AND “H” FITTINGS WHICH DO NOT REQUIRE AUTHORIZED INSPECTION

- f) All pressure fitting design registrations expire 10 years after issue date. Prior to starting construction of a pressure fitting the Drafting Lead will verify that the CRN was issued or re-issued within 10 years. If the existing CRN is more than 10 years old the design shall be resubmitted.
 - g) Miniature pressure vessels registered as category “H” pressure fittings will be identified with a nameplate (**Exhibit 11.2-4**), or through direct stamping in compliance with ASME Section VIII, Division 1, paragraph UG-116 with the addition of the CRN number. The ASME Code Stamp shall not be applied to these vessels.
 - h) A Manufacturer’s Data Report for Miniature Pressure Vessels Form AB-24 shall be furnished for miniature pressure vessels registered as category “H” pressure fittings. Up to 5 days consecutive production of identical items may be documented on a single report.
- 25.2 The Quality Control Inspector is to inspect all fittings or flanges to ensure that the dimensions and markings are in accordance with ANSI B16.5.
- 25.3 The Authorized Inspector or the Authorized Inspector Supervisor reserves the right to audit this system for Code compliance, at any time, while Code work is in progress.


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SECTION 25 INSPECTION PROCEDURES FOR CATEGORY “A”, “B” AND “H” FITTINGS WHICH DO NOT REQUIRE AUTHORIZED INSPECTION

EXHIBIT 25.1 STATUTORY DECLARATION FORM AB-41



AB-41 2005-02


the pressure equipment safety authority
STATUTORY DECLARATION
Registration of Fittings

In this space, show facsimile of manufacturer's logo or trademark as it will appear on the fitting.

I, _____,

(company title, e.g. vice president, plant manager, chief engineer) (must be in a position of authority)

of _____

(name of manufacturer)

located at _____

(plant address)

do solemnly declare that the fittings listed hereunder, which are subject to the Safety Codes Act (check one)

comply with the requirements of _____ which specifies the dimensions,

(title of recognized North American Standard)

materials of construction, pressure/temperature ratings and identification marking of the fittings, or

are not covered by the provisions of a recognized North American standard and are therefore manufactured to comply with _____ as supported by the attached data which identifies the dimensions, materials of construction, pressure/temperature ratings and the basis for such ratings, and the marking of the fittings for identification.

I further declare that the manufacture of these fittings is controlled by a quality control program which has been verified by the following authority, _____ as being suitable for the manufacture of these fittings to the stated standard. The fittings covered by this declaration, for which I seek registration, are _____

In support of this application, the following information, calculations and/or test data are attached:

DECLARED before me at _____ in the _____ of _____

this _____ day of _____

(Month) (Year)

(print) _____ (Signature of Applicant)

(sign) _____ (A Commissioner for Oaths)

For Office Use Only

To the best of my knowledge and belief, the application meets the requirements of the Safety Codes Act and CSA Standard B51, Clause 4.2, and is accepted for registration in Category _____

Registration Number: _____ (For the Administrator/Chief Inspector of Alberta)

Date Registered: _____ Expiry Date: _____

The information you provide is necessary only for the administration of the programs as required by the Alberta Safety Codes Act and Regulations in the Boiler Discipline.

SECTION 26 FIELD CONTROL

26.0 This Quality Control Program applies to Field construction and repairs with the following additional requirements and exceptions:

26.1 Organization

- a) Organization of Quality Control personnel for field application is the same as shop requirements except that a Field Inspector will be chosen by the Quality Control Chief Inspector to be responsible for field implementation of the Quality Control Manual. This person will answer directly to the Quality Control Chief Inspector, with direct lines of communication to the Field Foreman.
- b) The Field Inspector must have a copy of the Quality Control Manual available for review by the Authorized Inspector.

26.2 Drawing Control

- a) The Field Inspector will keep one (1) copy of the Job drawing in a field file for his information.
- b) The Field Inspector will receive all field drawings and/or change release DCR forms per Section 8 of this Quality Control Manual. He will review all forms to ensure that all previous drawings have been destroyed or marked and filled and return all completed DCR's to the Quality Control Chief Inspector.

26.3 Material Control

- a) The Field Inspector will be issued a copy of the purchase orders for all materials on the Job. All materials will be dispatched from shop to the field location and will be received by the Field Inspector per the applicable paragraphs on material control in this Quality Control Manual, and checked against the purchase order.
- b) Copies of all receiving paperwork, along with copies of the Material Test Reports, will be forwarded to the Quality Control Chief Inspector at the shop, to be checked for the compliance to the ASME Code Section II and kept in the Quality Control Job File.
- c) Discard all consumables if they have been out of their sealed containers for over four hours.

SECTION 26 FIELD CONTROL

26.4 Examination and Inspection

- a) The requirements of the applicable paragraphs examination and inspection of this Quality Control Manual will be followed, with the exception that the Field Inspector in the field will perform the field functions of the Quality Control Chief Inspector, under the Quality Control Chief Inspector's supervision.
- b) The Field Inspector will contact the appropriate Authorized Inspection Agency for the region where the field operations are taking place. All Authorized Inspection Agency requirements will be followed.

26.5 All welding, heat treatment, NDE and calibration shall be in accordance with Sections 14 thru 20 of this Quality Control Manual.

26.6 Documentation

- a) The Quality Control Chief Inspector is responsible for insuring that all paperwork, including the Inspection and Test Plan, NDE Reports, etc. from the field are compiled in the Quality Control Job file at the shop location.
- b) The Field Inspector will be responsible to get the Authorized Inspector to sign off witnessing any hold points on the Inspection and Test Plan. He will ensure Manufacturer's Data Reports / Repair Alteration Reports are certified, and that nameplate facsimiles are completed. It is his responsibility to gather all paperwork from the field operation and delivering it to the Chief Inspector to be included in the Quality Control Job File at the shop.



Jacobs Engineering Canada

Jacobs Contract No. CE4160

Client: CNRL – Kirby North phase 1 Kirby North Plant

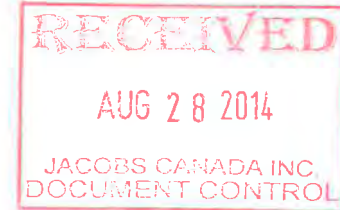
Supplier's Document Review Sheet

Equipment Numbers	Comments			
104-E-135, 104-E-136	JPI REV 2B - VERIFICATION			
Review Status Codes	Project / Req Title	CNRL – Kirby North phase 1		
<p><i>h</i></p> <input checked="" type="checkbox"/> 1 - Work May Proceed	Supplier	Exchanger Industries		
	<input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated	Doc. Description	EXCHANGER - SPARE PARTS LIST - 13-3353	
		<input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with Manufacture	Vendor Document No.	13-3353 SPARE PARTS LIST
	<input type="checkbox"/> 4 - STOP WORK per attached written instructions		Client Document No.	VP088996-M901-00004
	<input type="checkbox"/> 5 - Review Not Required: Work may proceed			
<p>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</p>	Purchase Order No.	Doc Cat.	Issue	
	CE416040-CC088996-00	M901	3	
BY : <u> <i>AA</i> </u>	Categories	M902		
DATE : <u> <i>h/sep/2014</i> </u>	Date Received	08/26/2014		



Suite 200, 5811 46th Street SE, Calgary, Alberta T2C 4Y5
Telephone (403) 236-0166 Fax (403) 279-8242 Website: www.exchangerindustries.com

SPARE PARTS LIST Commissioning/Startup



CUSTOMER: Jacobs Canada Inc

ITEM #: 104-E-135/136

LOCATION: Kirby North Phase One Project,
Conklin, AB

CRN #: W3077.2

E.I. JOB #: 13-3353

P.O. #: CE416040-CC088996-00

DESCRIPTION OF PART	QTY Commissioning /Startup	IDENTIFICATION	APPROXIMATE DELIVERY	PRICE EACH (Canadian Funds)
Gasket	2	Gasket MK.1 to Tubesheet 0.125" 316 S.S. Core. Flex, Graphite	3 Weeks	Included in PO
Gasket	2	Gasket MK.2 to Tubesheet 0.125" 316 S.S. Core. Flex, Graphite	3 Weeks	Included in PO
Stud	6	Channel to Shell 0.75" diameter x 8" x SA-193-B7	3 Weeks	Included in PO

*Price Excludes: All Taxes and Freight.
PRICES QUOTED ARE SUBJECT TO CHANGE.*

VPO88996-m901-00004



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SPARE PARTS LIST Commissioning/Startup

Nuts	6	Channel to Shell 0.75" diameter x SA-194-2H	3 Weeks	Included in PO
Bolts	2	Channel to Shell Collar Bolts 0.75" diameter x 8.75" x SA-193-B7	3 Weeks	Included in PO
Nuts	2	Channel to Shell Collar Bolts 0.75" diameter x SA-194-2H	3 Weeks	Included in PO

Price Excludes: All Taxes and Freight.
PRICES QUOTED ARE SUBJECT TO CHANGE.



Suite 200, 5811 46th Street SE, Calgary, Alberta T2C 4Y5
Telephone (403) 236-0166 Fax (403) 279-8242 Website: www.exchangerindustries.com

SPARE PARTS LIST 2 Year

CUSTOMER: Jacobs Canada Inc **ITEM #:** 104-E-135/136
LOCATION: Kirby North Phase One Project, Conklin, AB **CRN #:** W3077.2
E.I. JOB #: 13-3353 **P.O. #:** CE416040-CC088996-00

DESCRIPTION OF PART	QTY 2 Year	IDENTIFICATION	APPROXIMATE DELIVERY	PRICE EACH <i>(Canadian Funds)</i>
Gasket	2	Gasket MK.1 to Tubesheet 0.125" 316 S.S. Core. Flex, Graphite	3 Weeks	\$380.00
Gasket	2	Gasket MK.2 to Tubesheet 0.125" 316 S.S. Core. Flex, Graphite	3 Weeks	\$238.00
Stud	6	Channel to Shell 0.75" diameter x 8" x SA-193-B7	3 Weeks	Price Not Available
Nuts	6	Channel to Shell 0.75" diameter x SA-194-2H	3 Weeks	Price Not Available
Bolts	2	Channel to Shell Collar Bolts 0.75" diameter x 8.75" x SA-193-B7	3 Weeks	Price Not Available
Nuts	2	Channel to Shell Collar Bolts 0.75" diameter x SA-194-2H	3 Weeks	Price Not Available

*Price Excludes: All Taxes and Freight.
PRICES QUOTED ARE SUBJECT TO CHANGE.*



Canadian Natural

NONCONFORMANCE REPORT

KNP-NCR-004

IDENTIFICATION			
PROJECT: KIRBY NORTH	ATTENTION: Tom Baker	REV#: 0	DATE: 8 Oct 2015
ORIGINATOR/COMPANY : Milind Kulkarni/CNRL	CONTRACT #: PO CE416040-CC088996-00		
NCR CONTRACTOR: Exchanger Industries	CONTRACT #:		
NCR #: 001-2015	# of NCR ATTACHMENTS: Yes		

NCR DETAILS

DESCRIPTION OF NONCONFORMANCE: Briefly state what requirement has not been met. List drawing number, specification etc.

Review of the MRB's for the Tag's mentioned below indicates that some important quality checks were missed by EI (see details below:

- (A) 103-E-080 (13-3350):
 - a. Tube Rolling logs were not formally recorded.
- (B) 102-E-610 + 613 (13-3348):
 - a. Tube Rolling logs were not formally recorded.
- (C) 101-E-120 + 121 (13-3344):
 - a. Tube Rolling logs were not formally recorded.
- (D) 104-E-135 + 136 (13-3353) Sweet Service both Shellside + Channelside:
 - a. Hardness tests were not formally recorded for certain welds.
- (E) 107-E-305 (13-3354) Sweet Service both Shellside + Channelside:
 - a. Hardness tests were not formally recorded for certain welds.

The above was confirmed by Tom Baker as per attached email dated 23Aug2015

SUGGESTED DISPOSITION:

EI cannot generate these reports as the QA steps were missed during manufacturing.

ASSIGNED TO: Tom Baker	TITLE: Project Manager
RESPONSE REQUIRED DATE: ASAP	

CORRECTIVE ACTION RESPONSE

DISPOSITION: ACCEPT AS IS REPAIR REWORK REJECT ADMINISTRATIVE ACTION

PROPOSED CORRECTIVE ACTION: State justification. Include technical or administrative basis and supporting documentation i.e.: calculations or design changes or administrative directive.

MRB for the above tags would be reviewed and accepted without some of the important quality control reports.

APPROVAL / REJECTION RESPONSE (ORIGINATOR AND/OR CNRL)

APPROVAL / REJECTION OF ACTION: Provide detailed instructions for reworking or repairing items if being made to other than existing requirements. Identify instructions for managing and disposing of rejected items. Identify instructions for items to be returned to supplier. Identify what administrative action will occur.

of NCR APPROVAL / REJECTION ATTACHMENTS:

APPROVAL / REJECTION BY: Milind Kulkarni/Ward Conacher




POSITION: Technical/Projects

CORRECTION ACTION DUE DATE:

ENG. APPROVAL (If there is a deviation to the design):

VERIFICATION AND CLOSURE

DISPOSITION COMPLETED AS DIRECTED

<input type="checkbox"/> OTHER (SPECIFY):		
ORIGINATOR		
NAME: Milind Kulkarni	DATE: 8-Oct-2015	SIGNATURE: 
POSITION: Mechanical Engineer		
CNRL REPRESENTATIVE / NCR CONTRACTOR:		
NAME: Tom Baker	DATE: 13-Oct-2015	SIGNATURE: 
POSITION: Project Manager - Exchange/Industria		
FINAL CNRL NCR SIGN OFF:		
NAME: Ward Coacher	DATE: 13-Oct-2015	SIGNATURE: 
POSITION: PROJECT ENGINEER		

Milind Kulkarni

From: Tom Baker <Tom.Baker@exchangerindustries.com>
Sent: Sunday, August 23, 2015 5:59 PM
To: Wilson Liu
Cc: Milind Kulkarni
Subject: FW: MRB needing resubmission (PO CE416040-CC088996-00)

Wilson,

Review of certain MRB's and comments received indicates the following:

- (A) 103-E-080 (13-3350):
 - a. Tube Rolling logs were not formally recorded. Tube-to-Tubesheet Air-test was attested to on the ITP and hydrotest passed.
- (B) 102-E-610 + 613 (13-3348):
 - a. Tube Rolling logs were not formally recorded. Tube-to-Tubesheet Air-test was attested to on the ITP and hydrotest passed.
- (C) 101-E-120 + 121 (13-3344):
 - a. Tube Rolling logs were not formally recorded. Tube-to-Tubesheet Air-test was attested to on the ITP and hydrotest passed.
- (D) 104-E-135 + 136 (13-3353) Sweet Service both Shellside + Channelside:
 - a. Hardness tests were not formally recorded for certain welds. PQR-Coupon results indicates hardnesses would range from 140-BHN to 188-BHN.
- (E) 102-E-655 (13-3349):
 - a. Under review by CNRL.
- (F) 107-E-305 (13-3354) Sweet Service both Shellside + Channelside:
 - a. Hardness tests were not formally recorded for certain welds. PQR-Coupon results indicates hardnesses would range from 143-BHN to 199-BHN.

Yours truly,
Tom Baker

From: Wilson Liu [<mailto:Wilson.Liu@cnrl.com>]
Sent: August 10, 2015 2:24 PM
To: Document Control; DocCtrl, Kirby North CE4160
Cc: Tom Baker; Milind Kulkarni; MoShesh Charles
Subject: MRB needing resubmission
Importance: High

Hello Tom,

Please advise on current status of these MRB and when we can expect resubmission:

103-E-080 (Code 3 – Revise and resubmit) Invoice not billed
102-E-610 & 102-E-613 (Code 2 – Revise & resubmit) Invoice not billed
101-E-120 & 101-E-121 (Code 2 – Revise & resubmit) Invoice #30082 in ADP.
104-E-135 & 104-E-136 (Code 2 – Revise & resubmit) Invoice not billed
102-E-655 - Submitted Jul/30/2015 and currently under review by Milind Kulkarni) Invoice not billed
107-E-305 – submitted?

Thank you
Wilson

From: Document Control [mailto:Document.Control@exchangerindustries.com]
Sent: Thursday, July 30, 2015 1:58 PM
To: DocCtrl, Kirby North CE4160
Cc: Narasannagari, Babu; Wilson Liu; Tom Baker; Document Control; Milind Kulkarni
Subject: Transmittal 286, PO CE416040-CC088996-00, Item No 102-E-655, EI Job 13-3349 MRB R0

Good Afternoon,

Please find Transmittal 286 13-3349 MRB R0 and all associated documents within the zipped file attached to your file transfer site for your review and/or approval as per the screen shot below.

Current folder: I:\EXCHANGER INDUSTRIES\PO C088996\TO JACOBS (31)

Check Create Subfolder Subscription Public column

File Name	KB	Rev.	Last Modification	Last Modification	Last Modified by
1348.zip					
Transmittal 270 13-3349 MRB.zip	6311	0	2014/11/19	2014/11/19	THOMAS SINGLETON
Transmittal 271 13-3350.zip	5358	0	2014/11/20	2014/11/20	THOMAS SINGLETON
Transmittal 272 13-3353.zip	597	0	2014/11/28	2014/11/28	THOMAS SINGLETON
Transmittal 273 13-3347.zip	460	0	2014/12/04	2014/12/04	THOMAS SINGLETON
Transmittal 274 13-3345 MRB.zip	68385	0	2014/12/30	2014/12/30	THOMAS SINGLETON
Transmittal 275 13-3348 MRB.zip	62419	0	2014/12/31	2014/12/31	THOMAS SINGLETON
Transmittal 276 13-3351 MRB.zip	133574	0	2014/12/31	2014/12/31	THOMAS SINGLETON
Transmittal 277 13-3343 Parent.zip	944	0	2015/01/27	2015/01/27	THOMAS SINGLETON
Transmittal 278 13-3351 MRB.zip	77055	0	2015/02/04	2015/02/04	THOMAS SINGLETON
Transmittal 279 13-3347 MRB R2.zip	66010	0	2015/02/06	2015/02/06	THOMAS SINGLETON
Transmittal 280 13-3362 MRB R1.zip	54609	0	2015/02/06	2015/02/06	THOMAS SINGLETON
Transmittal 281 13-3348 MRB.zip	54730	0	2015/02/06	2015/02/06	THOMAS SINGLETON
Transmittal 282 13-3365 MRB R0.zip	68937	0	2015/02/06	2015/02/06	THOMAS SINGLETON
Transmittal 283 13-3348 MRB R1.zip	66549	0	2015/02/13	2015/02/13	THOMAS SINGLETON
Transmittal 284 13-3355 MRB R1.zip	72012	0	2015/03/09	2015/03/09	THOMAS SINGLETON
Transmittal 285 13-3346 MRB R2.zip	67755	0	2015/03/09	2015/03/09	THOMAS SINGLETON
Transmittal 286 13-3348 MRB R0.zip	48070	0	2015/07/00	2015/07/00	THOMAS SINGLETON

Once the MRB is approved, please sign the attached acceptance sheet and send back to me so we can proceed with printing the additional copies and/or CD.

If the acceptance sheet has not been received by Document Control within the 14-day period (by August 13, 2015), Exchanger Industries Limited can consider the book acceptable as submitted. At that time, we will submit the remaining books, close the order as complete, and will proceed to invoice any outstanding monies.

If you have any questions, please contact me.

Best Regards,

Tom Singleton

Document Management Group



**EXCHANGER
INDUSTRIES**

Office: 5811 - 48 Street SE Plant: 5805 - 54 Avenue SE
Calgary, AB T2C 4Y5 Calgary, AB T2C 2M2

Fx: 403-570-6678

Email: tom.singleton@exchangerindustries.com



Contract No.

Client:

Supplier's Document Review Sheet

Equipment Numbers	Comments		
104-E-135, 104-E-136	JPI REV 2 - VERIFICATION		
Review Status Codes	Project / Req Title	CNRL – Kirby North phase 1	
<input type="checkbox"/> 1 - Work May Proceed <input type="checkbox"/> 2 - Revise and Resubmit: Work may proceed subject to incorporation of changes indicated <input type="checkbox"/> 3 - Revise and Resubmit: DO NOT Proceed with manufacture <input type="checkbox"/> 4 - STOP WORK per attached written instructions <input type="checkbox"/> 5 - Review Not Required: Work may proceed <small>SUPPLIER PLEASE NOTE: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligation.</small>	Supplier	Exchanger Industries	
	Doc. Description	EXCHANGER - ELECTRICAL HEAT TRACING CALCULATIONS - CIRCUIT REPORT AND BOM	
	Vendor Document No.	13-3353 EHT CALCULATIONS	
	Client Document No.	VP088996-E201-00007	
	Purchase Order No.	Doc Cat.	Issue
CE416040-CC088996-00	E201	1	
BY : _____	Categories		
DATE : _____	Date Received	09/02/2015	

INFORMATION ONLY

Circuit Report & BOM

Project		Identification		Operating Temperatures		
Job Name	KIRBY NORTH PHASE 1	Record		1	Maintenance Temperature	30 °C
Project No.	TCASQ00016259	Circuit No.			Vessel Outer Wall Temp	32 °C
Project Ref.	CNRL	Vessel	104-E-135 / 136		Film Temperature	N/A °C
Designer	MP	Panel/Breaker No.			Heater Temperature	80 °C
Job No.	13-3353	Isometric No.			Max. Heater Temperature	169 °C

Vessel & Insulation			Product & Environment			Heater Performance Data		
Design Heat Loss	1425.	Watts	Min. Ambient Temperature	-45	°C	Number of Heaters	N/A	
Safety Factor	60	%	Startup Ambient Temperature	-45	°C	Heater Type	HTSX 12-2	
Heat Sink Factor	1.500		Max. Ambient Temperature	40	°C	Voltage	277	VAC
Vessel Orientation	Horizontal		Wind Speed	40	km/hr	Total Applied Power/Heat	1,679	Watts
Vessel Support	Saddles		Max. Exposure Temperature	150	°C	Start Up Current	8.37	Amps
Vessel Ends	2:1 Elliptical		Max. Product Temperature	204	°C	Operating Current	6.06	Amps
Vessel Bottom	Flat/Legs		Area Classification	Class I & II, Div 2		Number of Circuits	1	
Vessel Diameter	.6	m	T-Class Temperature Limit	230	°C	Design Cable Output	46.6	Watts/m
Vessel Length	6.4	m	Product Name	Water		U3	N/A	W/m ² -°C
Vessel Width	N/A	m	Product Density	962.86	kg/m ³	Circuit Length	31	m
Wall Material	Mild Steel		Product Specific Heat	4186.55	J/kg°K	Circuit Breaker Size	30	Amps
Wall Thickness	14.	mm	Product Thermal Conductivity	.72	W/m°K			
Insulation Type	MF (ASTM C612)		Product Viscosity	.00033	Pa-S			
Insulation Thickness	64	mm	Product Coeff. Cubical Expansion	.00038436				
Insulation Coverage	Full Insulation		Product Heat of Fusion/Vaporization					
Insulation K Value	.029	W/m°K	Normal Product Level	.6	m			
Mean Insulation Temp.	-7	°C	Minimum Product Level	.3	m			
Jacket Emissivity	Aluminum (.12)		Additional Load	400	Watts			

Catalog Number	Description	Quantity	Units	Unit/Extended Pricing
HTSX 12-2	Electric heat tracing cable	32	m	
AL-30H	Aluminum tape	1	Roll	
(see catalog for controllers)	Temperature controller	1	Each	
(see cat. for power connection kits)	Power connection kit	1	Each	
(see cat. for end termination kits)	End termination kit	1	Each	

