CALHEX INDUSTRIES LTD.
9515 - 48 th. Street S.E., Calgary, Alberta, T2C 2R1
Bus: (403) 225 - 4395
Fax: (403) 261 - 2761
{ CALHEX5 }

DATA BOOK

Installation, Maintenance and Operation Manuals

SHELL AND TUBE HEAT EXCHANGERS

Customer:	**EXCELSIOR ENGINEERING LTD.**
For:	**HUSKY OIL OPERATIONS**
Drawing Description:	**INLET GAS HEAT EXCHANGER**
Calhex Industries Job #:	**12-0779**
Tag#:	**E-102B**
Purchase Order #:	**8400547676**
Vendor Document #:	**12-0779**
C.R.N.#:	**V9688.21**
Location:	**Husky Oil Ansell Gas Plant** **Edson, AB**

CONTENTS

CALHEX INDUSTRIES LIMITED — Rev. No.: 2
9515-48th Street SE Calgary, Alberta — Cust. Ref. #: 3244

SHELL and TUBE HEAT EXCHANGER SPECIFICATION SHEET - Imperial Unit

Customer: EXCELSIOR ENGINEERING — **Prop. No.:** Q-12-2218
Address: Calgary, Alberta — **Date:** September 14, 2012
Plant Location: Husky Oil Operations LTD.: Ansell Gas Plant — **Ref. No.:** Q-12-2218 E-102B C2W R1
Service of Unit: Inlet Gas Heat Exchanger (Case 2 Winter) — **Item No.:** E-102B
TEMA type & Size (in): NEN 23 x 576 — **Connected In:** 1-serie / 1-parallel
Surface Area (ft²) ---> **Per Unit (eff.) / Per Shell (gross) / Per Shell (eff.):** 10570.3 / 4146.9 / 10570.3

PERFORMANCE OF ONE UNIT

Fluid Allocation		SHELL SIDE		TUBE SIDE	
Fluid Name		Discharge Gas		Inlet Gas	
Fluid Quantity (Total)	lb/hr	36,880.5		35,555.6	
Vapor (In/Out)	lb/hr	36,880.5	36,852.9	35,555.6	35,555.6
Liquid	lb/hr	–	27.6	–	–
Steam	lb/hr	–	–	–	–
Water	lb/hr	–	–	–	–
Non-Condensables	lb/hr	–	–	–	–
Temperature (In/Out)	°F	86.0	41.1	32.0	81.3
Density	lb/ft³	1.1154 V/L –	1.2171 V/L 41.93	0.3917 V/L –	0.3390 V/L –
Viscosity	cP	0.0110 V/L –	0.0110 V/L 0.306	0.0100 V/L –	0.0201 V/L –
Molecular Weight, Vapor					
Molecular Weight, Non-Condensables					
Specific Heat	Btu/lb-°F	0.5271 V/L –	0.5191 V/L 0.49	0.4858 V/L –	0.5001 V/L –
Thermal Conductivity	Btu/hr-ft-°F	0.0191 V/L –	0.0176 V/L 0.069	0.0162 V/L –	0.0184 V/L –
Latent Heat	Btu/lb				
Inlet Pressure	psia	307.50		101.00	
Velocity, Average	ft/sec	9.59		46.21	
Pressure Drop, Allow./Calc.	psi	4.35	3.51	10.15	2.61
Fouling Resistance (min)	ft²-hr-°F/Btu	0.0010		0.0010	

Total Heat Exchanged: 862,314 **Btu/hr** — **MTD (Corrected):** 6.4 °F
Transfer Rate (Btu/ft²-hr-°F) --> **Service / Clean:** 12.69 / 15.12

CONSTRUCTION OF ONE SHELL

Sketch:

	Shell Side			Tube Side		
Design/Vac./Test Pressure psig	400	FV	Code	400	FV	Code
Design Temperature (Max/Min) °F	163	/	-49	158	/	-49
No Passes per Shell	1			1		
Corrosion Allowance inches	0.0625			0.0625		
Connections Inlet:	(1)	8	300# RFWN	(1)	8	300# RFWN
Nom. Size & Outlet:	(1)	8	300# RFWN	(1)	8	300# RFWN
Rating (Inches) Intermediate:	(--)	---	--- ---	(--)	---	--- ---

SHELL DETAILS

Shell Cylinder / Head	SA-333-6	
Shell Cyl. ID / OD (in)	23.0000	24.0000
Kettle Cyl. ID / OD (in)	n/a	n/a
Shell Girth Flange(s)	n/a	
Aux.Shell Cyl./OD (in)	N/A	N/A
Expansion Jt. / Mat.	n/a	n/a
Shell Nozz. Flg.	SA-350-LF2	
Shell Nozz. Neck	SA-333-6	

BAFFLE & BUNDLE INTERNAL DETAILS

Stationary Tubesheet(s)	SA-516-70N
Floating Tubesheet	N/A
Baffle Material	G-44W (SA-36)
Baffle Type / Orientation	Single-Seg. / Parallel
Baffle No.	34
Spacing (Frt/C-C/Rear) (in)	22.562 / 16.000 / 22.562
Baffle Cut (% Dia.)	35.41 %
Longitudinal Baffle / Seal	n/a

TUBE DETAILS

Matl.	SA-179 rm(5)
Tube No.	440
OD (in)	0.750
Thickness (in)	0.083
Length (ft)	48.00
Pitch (in)	0.9688
Layout Ang.	30 deg
	n/a

CHANNEL DETAILS

Front Ch. Cylinder	SA-333-6	
Frt. Ch.Cyl. ID / OD (in)	23.0000	24.0000
Rear Ch. Cylinder	SA-333-6	
Rr. Ch. Cyl. ID / OD (in)	23.0000	24.0000
Front Ch. G.Flg./ Cvr.	SA-350-LF2	SA-350-LF2
Rear Ch. G.Flg./ Cvr.	N/A	N/A
Channel Nozz. Flg.	SA-350-LF2	
Channle Nozz. Neck	SA-333-6	

GASKET & BOLTING DETAILS

Shell Side Girth:	n/a	N/A	
Tube Side Girth:	Spiral Wnd T-304SS "CG"	Supplied	
Floating head:	n/a	n/a	
Shell side nozzles:	Spiral Wnd T-316SS "CG"	Supplied by customer	
Tube side nozzles:	Spiral Wnd T-316SS "CG"	Supplied by customer	
Girth Bolting:	SA-193-B7 ²	Floating Hd. Bolting: ---	²
SS Nozz. Bolting:	SA-193-B7 ²	TS Nozz. Bolting: SA-193-B7	²

1- Bare bolt and nut, 2- Painted Bolt and nut, 3- Electro Galvanized, 4- Hot Dipped Galvanized

Impingement Protection: None - Not Required — **Tube to Tubesheet Joint:** Dbl. Ring Grooved - Rolled Expanded
Est. Wgts per shell: Wet: 32,719 lbs Dry: 24,709 lbs Bundle : Fixed lbs
Rho-V-Sqrd (lb/ft-sec²) : **Shell Inlet/Outlet:** 936 / 857 **Tube Inlet/Outlet:** 2477 / 2862
Code Requirements: ASME Sec VIII, Div.1 — **Registered In:** AB & BC — **TEMA Type:** 'R'

Remarks: Thermal Rating By Shell and Tube Software HTRI.

1. Design includes 10.99% excess surface area.
2. Case 2 winter datasheet for performance above, Summer case governs
3. Sweet service both sides
4. Anti-vibration baffles required under shell nozzles
5. Lo-finned tubing 19 fins per inch, 16 ga (.065"thick) under the fins, 14 ga at bare ends
6.
7.
8.
9.
10.

CALHEX INDUSTRIES LIMITED

9515-48th Street SE Calgary, Alberta

Rev. No.: 2

Cust. Ref. #: 3244

SHELL and TUBE HEAT EXCHANGER SPECIFICATION SHEET - Metric Unit

Customer: EXCELSIOR ENGINEERING
Address: Calgary, Alberta
Plant Location: Husky Oil Operations LTD.: Ansell Gas Plant
Service of Unit: Inlet Gas Heat Exchanger (Case 2 Winter)

Prop. No.: Q-12-2218
Date: September 14, 2012
Ref. No.: Q-12-2218 E-102B C2W R1
Item No.: E-102B

TEMA type & Size (mm): NEN 584 x 14630 Connected In: 1-serie / 1-parallel

Surface Area (m²) ---> Per Unit (eff.) / Per Shell (gross) / Per Shell (eff.): 982 / 385.2 / 982

PERFORMANCE OF ONE UNIT

		SHELL SIDE						TUBE SIDE					
Fluid Allocation		Discharge Gas						Inlet Gas					
Fluid Name													
Fluid Quantity (Total)	kg/hr	16,729.0						16,128.0					
Vapor (In/Out)	kg/hr	16,729.0			16,716.5			16,128.0			16,128.0		
Liquid	kg/hr	--			12.5			--			--		
Steam	kg/hr	--			--			--			--		
Water	kg/hr	--			--			--			--		
Non-Condensables	kg/hr	--			--			--			--		
Temperature (In/Out)	°C	30.0			5.0			0.0			27.4		
Density	Kg/m³	17.87	V/L	--	19.50	V/L	671.6	6.27	V/L	--	5.43	V/L	--
Viscosity	cP	0.0110	V/L	--	0.0110	V/L	0.306	0.0100	V/L	--	0.0201	V/L	--
Molecular Weight, Vapor		--			--			--			--		
Molecular Weight, Non-Condensables		--			--			--			--		
Specific Heat	kJ/kg-°C	2.207	V/L	--	2.173	V/L	2.066	2.034	V/L	--	2.094	V/L	--
Thermal Conductivity	W/m-°C	0.033	V/L	--	0.030	V/L	0.120	0.028	V/L	--	0.032	V/L	--
Latent Heat	kJ/kg												
Inlet Pressure	kPa (abs)	2120.1						696.4					
Velocity, Average	m/sec	2.92						14.08					
Pressure Drop, Allow./Calc.	kPa	30.0			24.2			70.0			18.0		
Fouling Resistance (min)	m²-°C/W	0.000176						0.000176					

Total Heat Exchanged: 252.5 kW MTD (Corrected): 3.6 °C

Transfer Rate (W/m²-°C) --> Service / Clean: 72.05 / 85.85

CONSTRUCTION OF ONE SHELL

Sketch:

		Shell Side			Tube Side		
Design/Vac./Test Pressure	kPa	2,758	FV	Code	2,758	FV	Code
Design Temperature (Max/Min)	°C	73	/	-45	70	/	-45
No Passes per Shell		1			1		
Corrosion Allowance	mm	1.6			1.6		
Connections	Inlet:	(1) 8 300# RFWN			(1) 8 300# RFWN		
Nominal Size &	Outlet:	(1) 8 300# RFWN			(1) 8 300# RFWN		
Rating (Inches)	Intermediate:	(--) — —			(--) — —		

SHELL DETAILS

Shell Cylinder / Head	SA-333-6	
Shell Cyl. ID / OD (mm)	584.2	609.6
Kettle Cyl. ID / OD (mm)	n/a	n/a
Shell Girth Flange(s)	n/a	
Aux.Shell Cyl./OD (mm)	n/a	n/a
Expansion Jt. / Mat.	n/a	
Shell Nozz. Flg.	SA-350-LF2	
Shell Nozz. Neck	SA-333-6	

CHANNEL DETAILS

Front Ch. Cylinder	SA-333-6	
Frt. Ch.Cyl. ID / OD (mm)	584.2	609.6
Rear Ch. Cylinder	SA-333-6	
Rr. Ch. Cyl. ID / OD (mm)	584.2	609.6
Front Ch. G.Flg./ Cvr.	SA-350-LF2	SA-350-LF2
Rear Ch. G.Flg./ Cvr.	N/A	N/A
Channel Nozz. Flg.	SA-350-LF2	
Channle Nozz. Neck	SA-333-6	

BAFFLE & BUNDLE INTERNAL DETAILS

Stationary Tubesheet(s)	SA-516-70N
Floating Tubesheet	N/A
Baffle Material	G-44W (SA-36)
Baffle Type / Orientation	Single-Seg. / Parallel
Baffle No.	34
Spacing (Frt/C-C/Rear) (mm)	573 / 406 / 573
Baffle Cut (% Dia.)	35.41 %
Longitudinal Baffle / Seal	n/a

TUBE DETAILS

Matl.	SA-179 m(5)
Tube No.	440
OD (mm)	19.05
Thickness (mm)	2.1082
Length (mm)	14,630
Pitch (mm)	24.61
Layout Ang.	30 deg
	n/a

GASKET & BOLTING DETAILS

Shell Side Girth:	n/a	N/A
Tube Side Girth:	Spiral Wnd T-304SS "CG"	Supplied
Floating head:	n/a	n/a
Shell side nozzles:	Spiral Wnd T-316SS "CG"	Supplied by customer
Tube side nozzles:	Spiral Wnd T-316SS "CG"	Supplied by customer

Girth Bolting: SA-193-B7 [2] Floating Hd. Bolting: — [2]

SS Nozz. Bolting: SA-193-B7 [2] TS Nozz. Bolting: SA-193-B7 [2]

1- Bare bolt and nut, 2- Painted Bolt and nut, 3- Electro Galvanized, 4- Hot Dipped Galvanized

Impingement Protection: None - Not Required Tube to Tubesheet Joint: Dbl. Ring Grooved - Rolled Expanded

Est. Wgts per shell: Wet: 14,841 Kg Dry: 11,208 Kg Bundle : Fixed Kg

Rho-V-Sqrd (kg/m-sec²) : Shell Inlet/Outlet: 1393 / 1275 Tube Inlet/Outlet: 3686 / 4259

Code Requirements: ASME Sec VIII, Div.1 Registered In: AB & BC TEMA Type: 'R'

Remarks: Thermal Rating By Shell and Tube Software HTRI.

1. Design includes 10.99% excess surface area.
2. Case 2 winter datasheet for performance above, Summer case governs
3. Sweet service both sides
4. Anti-vibration baffles required under shell nozzles
5. Lo-finned tubing 19 fins per inch, 16 ga (.065"thick) under the fins, 14 ga at bare ends
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NEN CALCULATION VERSION 2.0, JAN. 26, 2011 (NOV. 26, 2001)

CALCULATION COVER SHEET

DESIGN CALCULATIONS INDEX

Calculation Description	Applicable Yes	Applicable No	Pages	Rev. Level
Primary Membrane Stress Calcs. (Spread sheet pgm.)	✔		2-14	0
Lifting Lug Calculations	✔		15	0
Horizontal Vessel Saddle Calculations	✔		16	0
Vertical Vessel skirt Calculations		✔		0
Other UG-22 Specified Loadings		✔		0
Vessel Impact Testing Exemption Summary	✔		1	0

REVISION LOG

REV.#: 0 Initial issue
1 Radiography

JOB INFORMATION

Job #:	12-0779	Type:	NEN 23x576	Size: 10570.3	FT²
Customer:	EXCELSIOR ENGINEERING	Owner:	HUSKY OIL OPERATIONS		
Date:	December 13, 2012	By:	Jim Gregory		
		Checked:	Martin Sojka		
		Approved:	DK Dec 12/12.		

SHELL & TUBE EXCHANGER DESIGN CONDITIONS

	Shell side					Tube side				
Design Pressure:	400	psi	~	2758	Kpa	400	psi	~	2758	Kpa
Vacuum Pressure:	15	psi	~	103	Kpa	15	psi	~	103	Kpa
Design Temperature:	163	°F	~	72.8	°C	158	°F	~	70.0	°C
Corrosion Allowance:	0.0625	in	~	1.6	mm	0.0625	in	~	1.6	mm
Radiography:	sopt per UW-11(a)5(b)					sopt per UW-11(a)5(b)				
Efficiency- LS / CS:	0.85		/	1.00		N/R		/	1.00	
Minimum Design Temp.:	-49					-49				
Post Weld Heat Treat:	NO					NO				

ALL MATERIAL STRESSES VALUES PER ASME SEC. II, PART D, 2010 EDITION 2011ADD.

VESSEL C.I.T. NOTES

1) Vessel C.I.T. exemption per *UCS-66(a)(c)(d)(g), FIG UCS-66 NOTE(e), UCS-67(a)2*

NOTES

1) NOZZLES 2" & UNDER EXEMPT PER UG-36-(c)3(a)

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CYLINDER THICKNESSES

Job number: 12-0779
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CODES:

Thickness of shell under internal pressure per : ASME SEC. VIII, DIV. 1 2010ED. 2011ADD. UG-27
Thickness of shell under external pressure per : ASME SEC. VIII, DIV. 1 2010ED. 2011ADD. UG-28

Shell side:

Material :	SA-333-6	S or W:	S	Allow. Amb. Stress:	17100		psi
Pipe~ 1 / Plate~ 2 :		1		Allow. Design Stress:	17100		psi
Pipe OD:		24	in	Is Corrosion Allowance applicable to material:			Y
Design Pressure:	400	psi		Design Temp.:	163 °F	Corrosion Allowance:	0.0625 in
Efficiency:	1.00			*Thickness Calculation includes 12.5% pipe tolerance*			

Minimum Thickness (including CA) — Actual Thickness

$$t = \frac{DP * OD/2}{S\,E + (DP * 0.4)} + CA = 0.3893 \text{ IN}$$

0.5000 IN

MAWP ambient and uncorroded = 632.7 psi
MAWP hot and corroded = 541.1 psi

Tube side:

Material :	SA-333-6	S or W:	S	Allow. Amb. Stress:	17100		psi
Pipe~ 1 / Plate~ 2 :		1		Allow. Design Stress:	17100		psi
Pipe OD:		24	in	Is Corrosion Allowance applicable to material:			Y
Design Pressure:	400	psi		Design Temp.:	158 °F	Corrosion Allowance:	0.0625 in
Efficiency:	1.00			*Thickness Calculation includes 12.5% pipe tolerance*			

Minimum Thickness (including CA) — Actual Thickness

$$t = \frac{DP * OD/2}{S\,E + (DP * 0.4)} + CA = 0.3893 \text{ IN}$$

0.5000 IN

MAWP ambient and uncorroded = 632.7 psi
MAWP hot and corroded = 541.1 psi

Tubing:

Material :	SA-179	S or W:	S	Allow. Amb. Stress:	13400		psi
Tube OD:		0.750	in	Allow. Design Stress:	13400		psi
Tube Length:		576	in	Is Corrosion Allowance applicable to material:			N
Design Pressure:	400	psi		Design Temp.:	163 °F	Corrosion Allowance:	0 in
Efficiency:	1.00						

Minimum Thickness Internal Pressure — Actual Min. Thickness

$$t = \frac{DP * OD/2}{S\,E + (DP * 0.4)} + CA = 0.0111 \text{ IN}$$

0.0830 IN

Maximum External Pressure for Tube thickness

Do / t =	9.0361	EXTERNAL PRESSURE CHART # :			CS-1
L / Do =	50.000	A =	0.01414	Ext.Yield Stress:	27600
		B =	13800	S :	24840

Pa = - Pa1 = 2159.9
Pa2 = 4889.5

Maximum Allowable external Pressure : 2159.9 Existing external Pressure : 415.0

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TUBESHEET THICKNESS CALCULATION

Job number: 12-0779
Revison number: 0 | Page number: 3 of 21

CODES:
ASME SEC VIII, DIV. 1 2010 ED,2011ADD. UHX-13, & FIG UHX-13.1 (a)

DIMENSIONS & PROPERTIES

	Tubes	Channel	Shell	Tubesheet
Material :	SA-179	SA-333-6	SA-333-6	SA-516-70N
Design Pressure, P_t, P_s :	415		415	see EFF. DP.
Design Temperature T_t, T_c, T_s, T :	163	158	163	163
Mean Oper. Temp.'s, $T_{t,m}$, $T_{s,m}$, T_r :	65.24	-	66.36	83.7
Inlet / Outlet temp. at hot end, T'_c, T'_s :	-	81.3	86	-
Ambient Allowable Stress :	13400 *	17100	17100	20000
Design temp Allowable Stress :	13400 *	17100	17100	20000
Operating temp Allowable stress :	13400 *		17100	20000
Diameters, d_t, D_c, D_s :	0.75	23	23	-
Thicknesses , t_t, t_s, h :	0.0830	0.5000	0.5000	**1.5625**
Corrosion Allow., C_t, C_s, $C_{t,s}$:	-	0.0625	0.0625	0.1250
Poisson's ratio ν_t, ν_c, ν_s, ν :	0.28	0.3	0.3	0.3
Elas. Mod @ ds. Temp., E_t, E_c, E_s, E:	2.779E+07	2.879E+07	2.879E+07	2.879E+07
Elas. Mod @ op. Temp., E_t, E_s, E :	2.833E+07	2.930E+07	2.930E+07	2.920E+07
Coeff. of Thermal Exp. at op. temp, $\alpha_{t,m}$, $\alpha_{s,m}$, α' :		6.396E-06	6.399E-06	6.451E-06
Coeff. of Thermal Exp. at In/out. temp, α_c', α_s' :		6.444E-06	6.458E-06	-

NOTE: Pt & Ps are adjusted for vacuum pressure on opposite side when noted on pg 1. if both sides have vacuum both Ps & Pt are adjusted at the same time for a single conservative calculation, rather than running 2 calcs adjusting Ps and Pt individulally.
* Tube stresses are for seamless tubing per note UHX-11.3 and UHX-13.3

Tube characteristics:

Tube joint Expanded (Y/N):	y	No. of Tubes, N_t :	440	Tube Length, L_L	576
Tube joint Welded (Y/N):	n	No. Of Grooves(2/1/0):	2	Expansion length, l_x :	1.5625
Tube Pitch, p :	0.96875	Weld throat length, a :	0	Tube testing (Y/N):	N
Outer tube limit, Do:	22.3902	Pattern :	30	Tube Projection :	0.125
		Tube Jt., Lmax:	1631.39	Pass plate (Y or N) :	N
Total Area of untubed lanes , A_L =$\Sigma(U_{Li}{}^*L_{Li})$:			0		
Unsupported span TS to Baffle:		38.5625		Unsupported span Baff to Baff:	32.000
Tube layout perimeter if required, Cp:		--		Area enclosed by Cp, if required, Ap:	--

Errors:

EXPANSION JOINT DIMENSIONS AND PROPERTIES

Is an Expansion Joint required ? (Y or N) : N Joint Material :
Axial Rigidity, K_j = 0 Joint Inside Diameter, D_j = 0
Is Corrosion applicable to joint Material ? (Y or N) : N

IS THE UNIT TO EXPERIENCE CYCLICAL SERVICE OR DYNAMIC LOADING (Y or N) : N

CALCULATIONS

GEOMETRY VALUES

μ =	0.225806452	d^* (Load cases 1 to 3) $_{NEW}$ =	0.6426
ρ new =	1.0000	d^* (Load cases 4 to 7) $_{NEW}$ =	0.6421
ρ corr =	1.0000	d^* (Load cases 1 to 3) $_{CORR}$ =	0.6426
p^* =	0.9688	d^* (Load cases 4 to 7) $_{CORR}$ =	0.6421
h_g =	0.0000	μ^* (Load cases 1 to 3) $_{NEW}$ =	0.3366
a_o =	11.1951	μ^* (Load cases 4 to 7) $_{NEW}$ =	0.3372
h_g' (1 to 3) new =	0.0000	μ^* (Load cases 1 to 3) $_{CORR}$ =	0.3366
hg' (1 to 3) corr =	0.0000	μ^* (Load cases 4 to 7) $_{CORR}$ =	0.3372
hg' (4 to 7) both =	0.0000		

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TUBE-SHEET THICKNESS CALCULATION cont.'d

Job number: 12-0779
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ρs_{NEW} =	1.0272	ρs_{CORR} =	1.0328	ρc_{NEW} =	1.0272	ρc_{CORR} =	1.0328
L_{NEW} =	572.6250	L_{CORR} =	572.7500				
Xs =	0.5063	Xt =	0.7007				

STIFFNESS FACTORS

$K_{s\ NEW}$ (Case 1 to 3) =	1855597.0	$K_{t\ NEW}$ (Case 1 to 3) =	8439.1
$K_{s\ NEW}$ (Case 4 to 7) =	1888914.6	$K_{t\ NEW}$ (Case 4 to 7) =	8604.4
$K_{s\ CORR}$ (Case 1 to 3) =	1627610.3	$K_{t\ CORR}$ (Case 1 to 3) =	8437.2
$K_{s\ CORR}$ (Case 4 to 7) =	1656834.4	$K_{t\ CORR}$ (Case 4 to 7) =	8602.5
$K_{s,t\ NEW}$ (Case 1 to 3) =	0.4997	$K_{s,t\ NEW}$ (Case 4 to 7) =	0.4989
$K_{s,t\ CORR}$ (Case 1 to 3) =	0.4384	$K_{s,t\ CORR}$ (Case 4 to 7) =	0.4377
J_{NEW} (Case 1 to 3) =	1.0000	J_{NEW} (Case 4 to 7) =	1.0000
J_{CORR} (Case 1 to 3) =	1.0000	J_{CORR} (Case 4 to 7) =	1.0000

SHELL COEFFICIENTS

$B_{s\ NEW}$ =	0.5303	$B_{s\ CORR}$ =	0.5662
$k_{s\ NEW}$ (Case 1 to 3) =	349478.4	$k_{s\ CORR}$ (Case 1 to 3) =	249956.1
$k_{s\ NEW}$ (Case 4 to 7) =	355753.3	$k_{s\ CORR}$ (Case 4 to 7) =	254444.1
$\lambda_{s\ NEW}$ (Case 1 to 3) =	27459031.1	$\lambda_{s\ CORR}$ (Case 1 to 3) =	25044886.0
$\lambda_{s\ NEW}$ (Case 4 to 7) =	27952063.1	$\lambda_{s\ CORR}$ (Case 4 to 7) =	25494571.5
$\delta_{s\ NEW}$ (Case 1 to 3) =	0.00000781	$\delta_{s\ CORR}$ (Case 1 to 3) =	0.00000902
$\delta_{s\ NEW}$ (Case 4 to 7) =	0.00000767	$\delta_{s\ CORR}$ (Case 4 to 7) =	0.00000886

CHANNEL COEFFICIENTS

$B_{c\ NEW}$ =	0.5303	$B_{c\ CORR}$ =	0.5662
$k_{c\ NEW}$ (Case 1 to 3) =	349478.4	$k_{c\ CORR}$ (Case 1 to 3) =	249956.1
$k_{c\ NEW}$ (Case 4 to 7) =	355753.3	$k_{c\ CORR}$ (Case 4 to 7) =	254444.1
$\lambda_{c\ NEW}$ (Case 1 to 3) =	27459031.1	$\lambda_{c\ CORR}$ (Case 1 to 3) =	25044886.0
$\lambda_{c\ NEW}$ (Case 4 to 7) =	27952063.1	$\lambda_{c\ CORR}$ (Case 4 to 7) =	25494571.5
$\delta_{c\ NEW}$ (Case 1 to 3) =	0.00000781	$\delta_{c\ CORR}$ (Case 1 to 3) =	0.00000902
$\delta_{c\ NEW}$ (Case 4 to 7) =	0.00000767	$\delta_{c\ CORR}$ (Case 4 to 7) =	0.00000886

TUBELAYOUT GEOMETRY COEFFICIENTS

h/p $_{NEW}$ =	1.613	E^*/E_{NEW} (Case 1 to 3)=	0.3442	E^*/E_{CORR} (Case 1 to 3)=	0.3492
h/p $_{CORR}$ =	1.484	E^*/E_{NEW} (Case 4 to 7) =	0.3450	E^*/E_{CORR} (Case 4 to 7)=	0.3499
		ν^*_{NEW} (Case 1 to 3)=	0.3207	ν^*_{CORR} (Case 1 to 3)=	0.3167
		ν^*_{NEW} (Case 4 to 7) =	0.3204	ν^*_{CORR} (Case 4 to 7) =	0.3165
		$X_{a\ NEW}$ (Case 1 to 3)=	3.0309	$X_{a\ CORR}$ (Case 1 to 3)=	3.2171
		$X_{a\ NEW}$ (Case 4 to 7) =	3.0332	$X_{a\ CORR}$ (Case 4 to 7) =	3.2196
$Z_{d\ NEW}$ (1 -3) =	0.0538	$Z_{v\ NEW}$ (1 -3) =	0.1063	$Z_{m\ NEW}$ (1 -3) =	0.5058
$Z_{d\ NEW}$ (4 -7) =	0.0537	$Z_{v\ NEW}$ (4 -7) =	0.1062	$Z_{m\ NEW}$ (4 -7) =	0.5055
$Z_{d\ CORR}$ (1 -3) =	0.0456	$Z_{v\ CORR}$ (1 -3) =	0.0966	$Z_{m\ CORR}$ (1 -3) =	0.4765
$Z_{d\ CORR}$ (4 -7) =	0.0455	$Z_{v\ CORR}$ (4 -7) =	0.0965	$Z_{m\ CORR}$ (4 -7) =	0.4762
$Z_{w\ NEW}$ (1 -3) =	0.1063	$Z_{w\ CORR}$ (1 -3) =	0.0966		
$Z_{w\ NEW}$ (4 -7) =	0.1062	$Z_{w\ CORR}$ (4 -7) =	0.0965		

TUBESHEET GEOMETRY COEFFICIENTS

K =	1.0719	F_{NEW} (Case 1 to 3) =	3.9023
		F_{NEW} (Case 4 to 7) =	3.9084
Φ_{NEW} (Case 1 to 3) =	5.1536	F_{CORR} (Case 1 to 3) =	3.5414
Φ_{NEW} (Case 4 to 7) =	5.1606	F_{CORR} (Case 4 to 7) =	3.5469
Φ_{CORR} (Case 1 to 3) =	4.6630		
Φ_{CORR} (Case 4 to 7) =	4.6694		

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TUBE-SHEET THICKNESS CALCULATION cont.'d

Job number: 12-0779
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TUBESHEET LOADING FACTORS

$Q_{1\ NEW}$ (Case 1 to 3) =	-0.1443	$Q_{Z1\ NEW}$ (Case 1 to 3) =	1.6232
$Q_{1\ NEW}$ (Case 4 to 7) =	-0.1443	$Q_{Z1\ NEW}$ (Case 4 to 7) =	1.6243
$Q_{1\ CORR}$ (Case 1 to 3) =	-0.1297	$Q_{Z1\ CORR}$ (Case 1 to 3) =	1.7695
$Q_{1\ CORR}$ (Case 4 to 7) =	-0.1296	$Q_{Z1\ CORR}$ (Case 4 to 7) =	1.7708
$Q_{Z2\ NEW}$ (Case 1 to 3) =	1.40446	U_{NEW} (Case 1 to 3) =	2.80892
$Q_{Z2\ NEW}$ (Case 4 to 7) =	1.40664	U_{NEW} (Case 4 to 7) =	2.81328
$Q_{Z2\ CORR}$ (Case 1 to 3) =	1.86646	U_{CORR} (Case 1 to 3) =	3.73292
$Q_{Z2\ CORR}$ (Case 4 to 7) =	1.86930	U_{CORR} (Case 4 to 7) =	3.73860

THERMAL EXPANSION LOADING FACTORS

γ_{NEW} (Case 1 to 3) =	0		
γ_{NEW} (Case 4 to 7) =	-0.004095	γ_b =	0
γ_{CORR} (Case 1 to 3) =	0		
γ_{CORR} (Case 4 to 7) =	-0.004096		
$\omega_{s\ NEW}$ (Case 1 to 3) =	2.71913	$\omega_{c\ NEW}$ (Case 1 to 3) =	2.71913
$\omega_{s\ NEW}$ (Case 4 to 7) =	2.71913	$\omega_{c\ NEW}$ (Case 4 to 7) =	2.71913
$\omega_{s\ CORR}$ (Case 1 to 3) =	2.39239	$\omega_{c\ CORR}$ (Case 1 to 3) =	2.39239
$\omega_{s\ CORR}$ (Case 4 to 7) =	2.39239	$\omega_{c\ CORR}$ (Case 4 to 7) =	2.39239
$\omega^*_{s\ NEW}$ (Case 1 to 3) =	-2.67201	$\omega^*_{c\ NEW}$ (Case 1 to 3) =	-2.67201
$\omega^*_{s\ NEW}$ (Case 4 to 7) =	-2.67201	$\omega^*_{c\ NEW}$ (Case 4 to 7) =	-2.67201
$\omega^*_{s\ CORR}$ (Case 1 to 3) =	-2.32379	$\omega^*_{c\ CORR}$ (Case 1 to 3) =	-2.32379
$\omega^*_{s\ CORR}$ (Case 4 to 7) =	-2.32379	$\omega^*_{c\ CORR}$ (Case 4 to 7) =	-2.32379

PRESSURE LOADING DUE TO THERMAL EXPANSION UHX-13.8 (for cyclical type service only)

$P_s^{*}{}_{NEW\ \&\ CORR}$ (Case 1 to 3) =	0	$P_c^{*}{}_{NEW\ \&\ CORR}$ (Case 1 to 3) =	0
$P_s^{*}{}_{NEW}$ (Case 4 to 7) =	0.0	$P_c^{*}{}_{NEW}$ (Case 4 to 7) =	0.0
$P_s^{*}{}_{CORR}$ (Case 4 to 7) =	0.0	$P_c^{*}{}_{CORR}$ (Case 4 to 7) =	0.0
T_s^* =	84.825	T_c^* =	82.475

PRESSURE LOADING ON TUBESHEET

$P'_{s\ NEW}$ (Case 1 to 3) =	804.8	$P'_{s\ CORR}$ (Case 1 to 3) =	867.5
$P'_{s\ NEW}$ (Case 4 to 7) =	805.6	$P'_{s\ CORR}$ (Case 4 to 7) =	868.4
$P'_{t\ NEW}$ (Case 1 to 3) =	1190.8	$P'_{t\ CORR}$ (Case 1 to 3) =	1306.9
$P'_{t\ NEW}$ (Case 4 to 7) =	1192.1	$P'_{t\ CORR}$ (Case 4 to 7) =	1308.4
$P_{\gamma\ NEW}$ (Case 1 to 3) =	0.0	$P_{\gamma\ CORR}$ (Case 1 to 3) =	0.0
$P_{\gamma\ NEW}$ (Case 4 to 7) =	-39.4	$P_{\gamma\ CORR}$ (Case 4 to 7) =	-39.4
$P_{w\ NEW}$ (Case 1 to 3) =	0	$P_{w\ CORR}$ (Case 1 to 3) =	0
$P_{w\ NEW}$ (Case 4 to 7) =	0	$P_{w\ CORR}$ (Case 4 to 7) =	0

TUBE BUCKLING FACTORS

			NEW	CORR
Tubesheet to Baffle span, l_t :	30.85			
Tubesheet to Baffle span, l_t :	30.9	F_t =	129.8188	130.0292
Baffle to Baffle span, l_t:	32	F_t =	134.6581	134.6581
r_t =	0.2376	F_t (max) =	134.6581	134.6581
Tube Yield stress , Sy,t =	26000	C_t =	146.7	146.7

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TUBE-SHEET THICKNESS CALCULATION cont.'d

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SUMMARY OF LOADS, CO-EFFICIENTS, & STRESSES FOR NEW TUBESHEET

Case	P_s	P_t	γ	$P_{s\gamma}$	$P_{C\gamma}$	P'_s
1	0	415.0	0	0.0	0.0	0
2	415.0	0.00	0	0.0	0.0	804.8
3	415.0	415.0	0	0.0	0.0	804.8
4	0	0	-0.0041	0.0	0.0	0.0
5	0	415.0	-0.0041	0.0	0.0	0.0
6	415.0	0	-0.0041	0.0	0.0	805.6
7	415.0	415.0	-0.0041	0.0	0.0	805.6

Case	P'_t	P_γ	P_ω	P_w	P_{rim}	P_e
1	1190.8	0	0.0	0.0	-24.9	-331.9
2	0.0	0	0.0	0.0	24.9	226.5
3	1190.8	0	0.0	0.0	0.0	-105.4
4	0	-39.4	0.0	0.0	0.0	-10.7
5	1192.1	-39.4	0.0	0.0	-24.9	-342.6
6	0.0	-39.4	0.0	0.0	24.9	215.7
7	1192.1	-39.4	0.0	0.0	0.0	-116.2

Case	Q_2	Q_3	F_m	$\lvert\sigma\rvert$	$\sigma_{allowable}$
1	307.4	-0.1591	0.0795	24157.5	30000
2	-307.4	-0.1660	0.0830	17199.4	30000
3	0.0	-0.1443	0.0722	6958.2	30000
4	0.0	-0.1443	0.0721	707.5	70932
5	307.3	-0.1586	0.0793	24816.7	70932
6	-307.3	-0.1670	0.0835	16455.0	70932
7	0.0	-0.1443	0.0721	7654.2	70932

Case	$\lvert\tau\rvert$	$\tau_{allowable}$		$F_{t\,min}$	$F_{t\,max}$
1	5265.8	16000		0.2224	1.5569
2	3593.7	16000		0.2457	1.5261
3	1672.1	16000		0.1724	1.6232
4	170.4	16000		0.1711	1.6243
5	5435.8	16000		0.2195	1.5600
6	3422.6	16000		0.2480	1.5222
7	1842.9	16000		0.1711	1.6243

Case	$\sigma_{t,1}$	$\sigma_{t,2}$	$\sigma_{t,\ allowable}$	F_s	S_{tb}
1	-1116.2567	1162.7608	13400	2.00	...
2	794.7648	-697.5403	13400	1.25	11250.8
3	-321.4919	465.2205	13400	2.00	...
4	9.4520	89.7375	26800	1.25	...
5	-1109.0706	1254.0275	26800	2.00	...
6	805.7756	-608.5018	26800	1.25	11250.8
7	-312.7471	555.7882	26800	2.00	...

Wt = 218.1

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TUBE-SHEET THICKNESS CALCULATION cont.'d

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Case	$\sigma_{s,m}$	$\sigma_{s,b}$	σ_s	$\sigma_{c,m}$	$\sigma_{c,b}$	σ_c
1	867.8	-20768.5	21636.3	4573.6	34723.5	39297.1
2	2605.1	25019.0	27624.0	0.0	-11990.1	11990.1
3	3472.9	4250.5	7723.4	4573.6	22733.4	27307.0
4	-112.1	-787.4	899.5	0.0	847.2	847.2
5	755.9	-21550.8	22306.7	4573.6	35565.5	40139.2
6	2492.4	24225.0	26717.5	0.0	-11136.1	11136.1
7	3360.5	3461.6	6822.0	4573.6	23582.3	28155.9

Case	$\sigma_{s,\ Allowable}$		$\sigma_{c,\ Allowable}$	
1	25650.0		25650.0	*
2	25650.0	*	25650.0	
3	25650.0		25650.0	*
4	65384.0		65544.0	
5	65384.0		65544.0	
6	65384.0		65544.0	
7	65384.0		65544.0	

Elastic-Plastic calculation at shell to tubesheet junction requires check

Elastic-Plastic calculation at channel to tubesheet junction requires check

ELASTIC - PLASTIC CALCULATION FOR TUBESHEET TO SHELL & / OR CHANNEL (UHX-13.7 if required)

	Shell to Tubesheet			Channel to Tubesheet		
Case:	1	2	3	1	2	3
$S^*_{s/c}$	-	25650.0	-	25650.0	-	25650.0
$Fact_{s/c}$	-	1.0000	-	0.858503235	-	1
$k_{s,c}$	-	-	-	300028.3	-	-
$\lambda_{s,c}$	-	-	-	23573667.0	-	-
F	-	-	-	3.6359	-	-
Φ	-	-	-	4.8018	-	-
Q_1	-	-	-	-0.1409	-	-
Q_{Z1}	-	-	-	1.6385	-	-
Q_{Z2}	-	-	-	1.47735	-	-
U	-	-	-	2.95470	-	-
P_w	-	-	-	0	-	-
P_W	-	-	-	0	-	-
P_{rim}	-	-	-	-26.1	-	-
P_e	-	-	-	-330.7	-	-
Q_2	-	-	-	323.4	-	-
Q_3	-	-	-	-0.1565	-	-
F_m	-	-	-	0.078249238	-	-
$\lvert\sigma\rvert$	-	-	-	23677.4	-	-
$\lvert\sigma\rvert$ all	-	-	-	30000	-	-

Channel to Tubesheet stress is Okay

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TUBE-SHEET THICKNESS CALCULATION cont.'d

Job number: 12-0779
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SUMMARY OF LOADS, CO-EFFICIENTS, & STRESSES FOR CORRODED TUBESHEET

Case	P_s	P_t	γ	$P_{S\gamma}$	$P_{C\gamma}$	P'_s
1	0	415.0	0	0.0	0.0	0
2	415.0	0	0	0.0	0.0	867.5
3	415.0	415.0	0	0.0	0.0	867.5
4	0	0	-0.0041	0.0	0.0	0.0
5	0	415.0	-0.0041	0.0	0.0	0.0
6	415.0	0	-0.0041	0.0	0.0	868.4
7	415.0	415.0	-0.0041	0.0	0.0	868.4

Case	P'_t	P_γ	P_ω	P_w	P_{rim}	P_e
1	1306.9	0	0.0	0.0	-28.7	-324.8
2	0	0	0.0	0.0	28.7	218.0
3	1306.9	0	0.0	0.0	0.0	-106.9
4	0	-39.4	0.0	0.0	0.0	-9.6
5	1308.4	-39.4	0.0	0.0	-28.8	-334.4
6	0	-39.4	0.0	0.0	28.8	208.4
7	1308.4	-39.4	0.0	0.0	0.0	-116.5

Case	Q_2	Q_3	F_m	$\lvert\sigma\rvert$	$\sigma_{allowable}$
1	299.3	-0.1444	0.0722	25351.2	30000
2	-299.3	-0.1516	0.0758	17860.9	30000
3	0.0	-0.1297	0.0648	7490.3	30000
4	0.0	-0.1296	0.0648	669.1	70932
5	299.2	-0.1439	0.0720	25968.7	70932
6	-299.2	-0.1526	0.0763	17153.0	70932
7	0.0	-0.1296	0.0648	8146.6	70932

Case	$\lvert\tau\rvert$	$\tau_{allowable}$		$F_{t\,min}$	$F_{t\,max}$
1	5601.8	16000		0.2813	1.4072
2	3759.0	16000		0.3175	1.3556
3	1842.8	16000		0.2073	1.5124
4	164.9	16000		0.0254	1.7708
5	5766.4	16000		0.0773	1.6967
6	3593.3	16000		0.1088	1.6519
7	2008.2	16000		0.0254	1.7708

Case	$\sigma_{t,1}$	$\sigma_{t,2}$	$\sigma_{t,O\ allowable}$	F_s	S_{tb}
1	-1025.9799	855.8073	13400	2.00	...
2	724.9756	-439.2467	13400	1.25	11250.8
3	-301.0043	416.5606	13400	2.00	...
4	1.2489	87.1401	26800	2.00	...
5	-1363.0283	1423.1054	26800	2.00	...
6	964.4835	-689.9777	26800	1.25	11250.8
7	-399.7937	645.9876	26800	2.00	...

Wt = 247.5

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TUBE-SHEET THICKNESS CALCULATION cont.'d

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Case	$\sigma_{s,m}$	$\sigma_{s,b}$	σ_s	$\sigma_{c,m}$	$\sigma_{c,b}$	σ_c
1	1076.2	-25870.4	26946.6	5284.0	41907.9	47191.9
2	2932.3	29925.0	32857.3	0.0	-14879.9	14879.9
3	4008.5	4054.6	8063.0	5284.0	27028.0	32312.0
4	-114.2	-871.1	985.3	0.0	932.1	932.1
5	962.2	-26735.2	27697.4	5284.0	42833.6	48117.6
6	2817.6	29046.0	31863.7	0.0	-13939.6	13939.6
7	3894.0	3181.9	7075.9	5284.0	27961.9	33245.9

Case	$\sigma_{s,\ Allowable}$		$\sigma_{c,\ Allowable}$		
1	25650.0	*	25650.0	*	0
2	25650.0	*	25650.0		0
3	25650.0		25650.0	*	0
4	65384.0		65544.0		0
5	65384.0		65544.0		0
6	65384.0		65544.0		0
7	65384.0		65544.0		0
					0

Elastic-Plastic calculation at shell to tubesheet junction requires check

Elastic-Plastic calculation at channel to tubesheet junction requires check

ELASTIC - PLASTIC CALCULATION FOR TUBESHEET TO SHELL & / OR CHANNEL (UHX-13.7 if required)

	Shell to Tubesheet			Channel to Tubesheet		
Case:	1	2	3	1	2	3
$S^*_{s/c}$	25650.0	25650.0	-	25650.0	-	25650.0
$Fact_{s/c}$	0.996562304	0.9333	-	0.746465934	-	0.978510805
$k_{s,c}$	249096.8	233292.3	-	186583.7	-	244584.7
$\lambda_{s,c}$	24958789.3	23375221.2	-	18695154.2	-	24506691.5
F	3.5356	3.4279	-	3.1097	-	3.5049
Φ	4.6553	4.5135	-	4.0945	-	4.6278
Q_1	-0.1296	-0.1280	-	-0.1230	-	-0.1293
Q_{Z1}	1.7699	1.7781	-	1.8042	-	1.7715
Q_{Z2}	1.86859	1.90865	-	2.03777	-	1.87621
U	3.73718	3.81730	-	4.07554	-	3.75242
P_w	0	0	-	0	-	0
P_W	0	0	-	0	-	0
P_{rim}	-28.8	29.4	-	-31.4	-	0.0
P_e	-324.8	217.6	-	-322.3	-	-106.8
Q_2	299.7	-306.1	-	326.8	-	0.0
Q_3	-0.1443	-0.1505	-	-0.1391	-	-0.1293
F_m	0.072158408	0.075235219	-	0.06957245	-	0.064648099
$\lvert\sigma\rvert$	25337.3	17699.0	-	24241.9	-	7464.1
$\lvert\sigma\rvert$ all	30000	30000	-	30000	-	30000

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TUBESHEET WELD SIZING

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ASME SEC. VIII, DIV. 1 2010 ED. 2011ADD.: FIG. UW-13.2 (d)

	Tube Side	Shell Side
Channel and Shell Outside Diameters:	24	24
Channel and Shell Thicknesses:	0.5	0.5
Tube Sheet Facing Thickness:	0.1875	0.1875
Facing Outside Diameters:	22.9375	22.9375
Channel & Shell ID's - Facing OD's:	0.0625	0.0625
Corrosion Allowances:	0.0625	0.0625
Is the tubesheet **S**upported or **U**nsupported :	S	
Tube Sheet weld groove angle (°) :	30	30

CALCULATIONS

	Tube Side	Shell Side
Actual corroded thicknesses, t_s :	0.4375	0.4375
Facing Edge to Channel & Shell OD, a :	0.53125	0.53125
Minimum dimension b for supported Tubesheet [$2t_s$-a]:	0.34375	0.34375
Minimum dimension b for unsupported Tubesheet [$3t_s$-a]:	0.78125	0.78125
Flat Land dimension of groove weld (1/16" of RF in Shell):	0.1250	0.1250
Minimum TS Groove angle, supported Tubesheet (°):	22.4	22.4
Minimum TS Groove angle, unsupported Tubesheet (°):	51.009	51.00901
Actual b dimension :	0.4317	0.4317
Minimum T_p dimension :	0.25	0.25

ACTUAL MINIMUM TUBESHEET THICKNESS

$T =$ 0.4317 + 0.4317 + 0.25 = **1.1134**

ACTUAL MINIMUM TUBESHEET THICKNESS INCLUDING CORROSION ALLOWANCE

$T_c =$ 1.1134 + 0.125 = **1.2384**

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SHELL ALLOWABLE COMPRESSIVE STRESS

Job number: 12-0779
Revison number: 0 | Page number: 11 of 21

CODES:
ASME SEC. VIII, DIV. 1 2010 ED., per UG-23 (b)

Shell

Material :	SA-333-6	S or W:	S	Allow. Amb. Stress:	17100	psi
Pipe~ 1 / Plate~ 2 :		1		Allow. Design Stress:	17100	psi
Shell OD :	24		in	Corrosion Allowance :	0.0625	in
Design Pressure :		400	psi	Design Temperature :	163	°F

CALCULATIONS

New uncorroded thickness : 0.5 in
Thickness reduced for pipe tolerance of 12.5%
EXTERNAL PRESSURE CHART # : CS-2
Minimum thickness, t : 0.3750 in
Outside radius, Ro : 12 in

$$\text{Factor A} = \frac{0.125}{(Ro / t)} = 0.0039063$$

Maximum Shell Compressive Stress, B ($S_{B,S}$) = **16744** psi

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NOZZLE REINFORCEMENT IN SHELL CALC. VERSION 3.0, JAN 08, 2007, (Dec. 21, 2002)

NOZZLE REINFORCEMENT CALCULATION

Job number: 12-0779
Revison number: 0 | Page number: 12 of 21

CODES:
ASME SEC. VIII, DIV. I , 2010 ED., 2011 ADD. UG-36,37,40,41,45 ; UW-15,16; Appedix 1-7

DIMENSIONS & PROPERTIES

Operating Conditions	
Design Pressure :	400
Design Temperature :	163
Corrosion Allowance :	0.0625
Nozzle nom. Size :	8
Nozzle Rating :	300 #
Shell or Tube side :	s

Repad	
Material :	sa-516-70n
Ambient Allow. Stress :	20000
Operating Allow. Stress :	20000
Outside Diameter :	12.6250
Thickness :	0.2500
Weld size, L_2 :	0.2500

Is the Nozzle Saddled on (*Y* or *N*): N

	Shell	Nozzle
Material :	SA-333-6	SA-106-B
Seamless or Welded :	S	S
Ambient Allowable Stress :	17100	17100
Operating Allowable Stress :	17100	17100
Pipe or PLate :	Pl	Pl
Efficiency, E :	1.000	1.000
Outside Diameter :	24.0000	8.625
Thickness :	0.500	0.500
Radial Reinforcement Limit, D* :	0.0000	-
Hillside Offset, L :	-	0.0000
Inward Nozz. Projection :	-	0.0000
Nozz. Fillet Weld size, L_1 / L_3 :	0.3750	0.0000

CALCULATIONS (corroded condition)

t_r :	0.27580	f_{r1} :	1.000	Parall. :	15.5000
t :	0.37500	f_{r2} :	1.000	Norm. :	0.9375
t_m :	0.09193	f_{r3} :	1.000	D_p :	12.6250
t_n :	0.43750	f_{r4} :	1.000		12.6250
t_e :	0.25000	F :	1.000	d :	7.7500
t_i :	0.00000		0.500	d* :	7.7500
				d (circ.) :	7.7500

Min. Weld leg sizes		Per
L_1 :	0.3571	UW-16
L_2 :	0.1786	UW-16
L_3 :	0.3571	UW-16
Minimum Nozz. thickness (UG-45)		
t_n min =	0.3383	

			Longitudinal Rein
AREA REQUIRED, $A = d\,t_r F + 2\,t_n\,t_r F(1-f_{r1})$ =			2.1375
Area Available in Shell, A1 (use larger value of) :		Long.	
$d^*(E_1\,t - F\,t_r) - 2\,t_n(E_1\,t - F\,t_r)(1 - f_{r1})$ =		0.7688	
$2\,(t + t_n)(E_1\,t - F\,t_r) - 2\,t_n(E_1\,t - F\,t_r)(1 - f_{r1})$ =		0.1612	0.7688
Area Available in Nozzle Outward, A2 (use smaller value of) :			
	$5^*(t_n - t_m)\,f_{r2}\,t$ =	0.6479	
<no-repad>	$5^*(t_n - t_m)\,f_{r2}\,t_n$ =	0.7559	
<with repad>	$2^*(t_n - t_m)(2.5\,t_n + t_e)\,f_{r2}$ =	0.9287	0.6479
Area Available in Nozzle Inward, A3 (use smaller value of) :			
$5\,t\,t_i\,f_{r2}$ = 0	$5\,t\,t_i\,f_{r2}$ =	0	
	$5\,h\,t_i\,f_{r2}$ =	0	0.0000
Area Available in outward nozzle weld, A_{41} =			0.1406
Area Available in repad weld, A_{42} =			0.0625
Area Available in inward nozzle weld, A_{43} =			0.0000
Area Available in repad, $A_5 = (D_p - d - 2\,t_n)\,t_e\,f_{r4}$ =			1.0000
TOTAL AVAILABLE AREA =			2.6199
Opening is adequately reinforced by :			**0.4824**

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NOZZLE REINFORCEMENT IN SHELL CALC. VERSION 3.0, JAN 08, 2007, (Dec. 21, 2002)

NOZZLE REINFORCEMENT CALCULATION

Job number: 12-0779
Revison number: 0 | Page number: 13 of 21

CODES:
ASME SEC. VIII, DIV. I , 2010 ED., 2011 ADD. UG-36,37,40,41,45 ; UW-15,16; Appedix 1-7

DIMENSIONS & PROPERTIES

Operating Conditions	
Design Pressure :	400
Design Temperature :	158
Corrosion Allowance :	0.0625
Nozzle nom. Size :	8
Nozzle Rating :	300 #
*S*hell or *T*ube side :	T

Repad	
Material :	sa-516-70n
Ambient Allow. Stress :	20000
Operating Allow. Stress :	20000
Outside Diameter :	12.6250
Thickness :	0.2500
Weld size, L_2 :	0.2500

Is the Nozzle Saddled on (*Y* or *N*): N

	Shell	Nozzle
Material :	SA-333-6	SA-106-B
*S*eamless or *W*elded :	S	S
Ambient Allowable Stress :	17100	17100
Operating Allowable Stress :	17100	17100
*PI*pe or *PL*ate :	PI	PI
Efficiency, E :	1.000	1.000
Outside Diameter :	24.0000	8.625
Thickness :	0.500	0.500
Radial Reinforcement Limit, D* :	0.0000	-
Hillside Offset, L :	-	0.0000
Inward Nozz. Projection :	-	0.0000
Nozz. Fillet Weld size, L_1 / L_3 :	0.3750	0.0000

CALCULATIONS (corroded condition)

t_r :	0.27580	f_{r1} :	1.000	Parall. :	15.5000			
t :	0.37500	f_{r2} :	1.000	Norm. :	0.9375	Min. Weld leg sizes		Per
t_m :	0.09193	f_{r3} :	1.000	D_p :	12.6250	L_1 :	0.3571	UW-16
t_n :	0.43750	f_{r4} :	1.000		12.6250	L_2 :	0.1786	UW-16
t_e :	0.25000	F :	1.000	d :	7.7500	L_3 :	0.3571	UW-16
t_i :	0.00000		0.500	d* :	7.7500	Minimum Nozz. thickness (UG-45)		
				d (circ.) :	7.7500	t_n min =		0.3383

			Longitudinal Rein
AREA REQUIRED, A = d t_r F + 2 t_n t_r F(1-f_{r1}) =			2.1375
Area Available in Shell, A1 (use larger value of) :		Long.	
d* (E_1 t - F t_r)- 2 t_n(E_1 t - F t_r) (1 - f_{r1}) =		0.7688	
2 (t + t_n) (E_1 t - F t_r) - 2 t_n(E_1 t - F t_r) (1 - f_{r1}) =		0.1612	0.7688
Area Available in Nozzle Outward, A2 (use smaller value of) :			
	5* (t_n - t_m) f_{r2} t =	0.6479	
<no-repad>	5* (t_n - t_m) f_{r2} t_n =	0.7559	
<with repad>	2* (t_n - t_m) (2.5 t_n + t_e) f_{r2} =	0.9287	0.6479
Area Available in Nozzle Inward, A3 (use smaller value of) :			
5 t t_i f_{r2} = 0	5 t t_i f_{r2} =	0	
	5 h t_i f_{r2} =	0	0.0000
Area Available in outward nozzle weld, A_{41} =			0.1406
Area Available in repad weld, A_{42} =			0.0625
Area Available in inward nozzle weld, A_{43} =			0.0000
Area Available in repad, A_5 = (D_p - d - 2 t_n) t_e f_{r4} =			1.0000
TOTAL AVAILABLE AREA =			2.6199
Opening is adequately reinforced by :			**0.4824**

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EXTERNAL PRESSURE ON CYLINDER STRESS CALCULATION

Job number: 12-0779
Revison number: 0 | Page number: 14 of 21

CODES:
ASME SEC. VIII, DIV. 1 2010 ED., 2011ADD. per UG-23 (b)

SHELL-CHANNEL-NOZZLE CYLINDER

Material :	SA-333-6	S or W:	S	Allow. Ambient Stress:	17100	psi
Pipe~ 1 / Plate~ 2 :		1		Allow. Design Stress:	17100	psi
Description:		SHELL		Corrosion Allowance :	0.0625	in
External Design Press. :		15	psi	Design Temperature :	163	°F
Cylinder OD, Do:		24	in			
Cylinder thickness:		0.5	in			
Cylinder Length:		572.75	in			

CALCULATIONS

Do / t : 64.0000
L / Do : 23.8646

EXTERNAL PRESSURE CHART # : CS-2

Shell Compressive Stress Factor, B = 4060

Maximum Allowable External Pressure, Pa: **84.58** PSI

Minimum thickness at 15 PSI = 0.2413 in
(Excluding C/A)

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EXTERNAL PRESSURE ON CYLINDER STRESS CALCULATION

Job number: 12-0799
Revison number: 0 | Page number: 15 of 21

CODES:
ASME SEC. VIII, DIV. 1 2010 ED., 2011ADD. per UG-23 (b)

SHELL-CHANNEL-NOZZLE CYLINDER

Material :	SA-333-6	S or W:	S	Allow. Ambient Stress:	17100	psi
Pipe~ 1 / Plate~ 2 :		1		Allow. Design Stress:	17100	psi
Description:		CHANNEL		Corrosion Allowance :	0.0625	in
External Design Press. :		15	psi	Design Temperature :	158	°F
Cylinder OD, Do:		24	in			
Cylinder thickness:		0.5	in			
Cylinder Length:		17	in			

CALCULATIONS

Do / t : 64.0000
L / Do : 0.7083

EXTERNAL PRESSURE CHART # : CS-2

Shell Compressive Stress Factor, B = 16815

Maximum Allowable External Pressure, Pa: **350.31** PSI

Minimum thickness at 15 PSI = 0.0750 in
(Excluding C/A)

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EXTERNAL PRESSURE ON CYLINDER STRESS CALCULATION

Job number: 12-0799
Revison number: 0

CODES:
ASME SEC. VIII, DIV. 1 2010 ED., 2011ADD. per UG-23 (b)

SHELL-CHANNEL-NOZZLE CYLINDER

Material :	SA-333-6	S or W: S	Allow. Ambient Stress:	17100	psi
Pipe~ 1 / Plate~ 2 :		1	Allow. Design Stress:	17100	psi
Description:		8" NOZZLE SHELL	Corrosion Allowance :	0.0625	in
External Design Press. :		15 psi	Design Temperature :	163	°F
Cylinder OD, Do:		8.625 in			
Cylinder thickness:		0.5 in			
Cylinder Length:		12 in			

CALCULATIONS

Do / t : 23.0000
L / Do : 1.3913

EXTERNAL PRESSURE CHART # : CS-2

Shell Compressive Stress Factor, B = 17288

Maximum Allowable External Pressure, Pa: **1002.20** PSI

Minimum thickness at 15 PSI = 0.0346 in
(Excluding C/A)

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EXTERNAL PRESSURE ON CYLINDER STRESS CALCULATION

Job number: 12-0799
Revison number: 0 | Page number: 17 of 21

CODES:
ASME SEC. VIII, DIV. 1 2010 ED., 2011ADD. per UG-23 (b)

SHELL-CHANNEL-NOZZLE CYLINDER

Material :	SA-333-6	S or W: S	Allow. Ambient Stress:	17100	psi
Pipe~ 1 / Plate~ 2 :	1		Allow. Design Stress:	17100	psi
Description:	8" NOZZLE channel		Corrosion Allowance :	0.0625	in
External Design Press. :	15	psi	Design Temperature :	158	°F
Cylinder OD, Do:	8.625	in			
Cylinder thickness:	0.5	in			
Cylinder Length:	12	in			

CALCULATIONS

Do / t : 23.0000
L / Do : 1.3913

EXTERNAL PRESSURE CHART # : CS-2

Shell Compressive Stress Factor, B = 17288

Maximum Allowable External Pressure, Pa: **1002.20** PSI

Minimum thickness at 15 PSI = 0.0306 in
(Excluding C/A)

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EXT PRESS NOZZLE REINFORCEMENT IN SHELL CALC. VERSION 1.1, Jan 06,2006 (Sept.30, 2002)

EXTERNAL PRESSURE NOZZLE REINFORCEMENT CALCULATION

Job number: 12-0799
Revison number: 0 | Page number: 18 of 21

CODES:

ASME SEC. VIII, DIV. I , 2010ed., 2011ADD. UG-28,36,37,40,41,45 ; UW-15,16

DIMENSIONS & PROPERTIES

Operating Conditions	
Design Pressure :	15
Design Temperature :	163
Corrosion Allowance :	0.0625
Nozzle nom. Size :	8
Nozzle Rating :	300 #
Shell or Tube side :	S

Repad	
Material :	SA-516-70N
Ambient Allow. Stress :	20000
Operating Allow. Stress :	20000
Outside Diameter :	12.6250
Thickness :	0.2500
Weld size, L_2 :	0.2500

Is the Nozzle Saddled on (Y or N): N

	Shell	Nozzle
Material :	SA-333-6	SA-333-6
Seamless or Welded :	S	S
Ambient Allowable Stress :	17100	17100
Operating Allowable Stress :	17100	17100
Pipe or PLate :	PI	PI
Efficiency, E :	1.000	1.000
Outside Diameter :	24.0000	8.625
Thickness :	0.500	0.500
Radial Reinforcement Limit, d* :	0.0000	-
Hillside Offset, L :	-	0.0000
Inward Nozz. Projection :	-	0.0000
Nozz. Fillet Weld size, L_1 / L_3 :	0.3750	0.0000

CALCULATIONS (corroded condition)

t_r :	0.24130	f_{r1} :	1.000	Parall. :	15.5000
t :	0.37500	f_{r2} :	1.000	Norm. :	0.9375
t_m :	0.03460	f_{r3} :	1.000	D_p :	12.6250
t_n :	0.43750	f_{r4} :	1.000		12.6250
t_e :	0.25000	F :	1.000	d :	7.7500
t_i :	0.00000		0.500	d* :	7.7500
				d (circ.) :	7.7500

Min. Weld leg sizes		Per
L_1 :	0.3571	UW-16
L_2 :	0.1786	UW-16
L_3 :	0.3571	UW-16
Minimum Nozz. thickness (UG-45)		
t_n min =	0.3038	

		Longitudinal Rein
AREA REQUIRED, $A = 0.5 *(d\ t_r F + 2\ t_n\ t_r F(1-f_{r1}))$ =		0.9350
Area Available in Shell, A1 (use larger value of) :	Long.	
$d^* (E_1\ t - F\ t_r) - 2\ t_n(E_1\ t - F\ t_r)(1 - f_{r1})$ =	1.0362	
$2\ (t + t_n)(E_1\ t - F\ t_r) - 2\ t_n(E_1\ t - F\ t_r)(1 - f_{r1})$ =	0.2173	1.0362
Area Available in Nozzle Outward, A2 (use smaller value of) :		
$5^* (t_n - t_m)\ f_{r2}\ t$ =	0.7554	
<no-repad> $5^* (t_n - t_m)\ f_{r2}\ t_n$ =	0.8813	
<with repad> $2^* (t_n - t_m)(2.5\ t_n + t_e)\ f_{r2}$ =	1.0828	0.7554
Area Available in Nozzle Inward, A3 (use smaller value of) :		
$5\ t\ t_i\ f_{r2}$ = 0	$5\ t\ t_i\ f_{r2}$ = 0	
	$5\ h\ t_i\ f_{r2}$ = 0	0.0000
Area Available in outward nozzle weld, A_{41} =		0.1406
Area Available in repad weld, A_{42} =		0.0625
Area Available in inward nozzle weld, A_{43} =		0.0000
Area Available in repad, $A_5 = (D_p - d - 2\ t_n)\ t_e\ f_{r4}$ =		1.0000
TOTAL AVAILABLE AREA =		2.9947
Opening is adequately reinforced by :		**2.0597**

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EXT PRESS NOZZLE REINFORCEMENT IN SHELL CALC. VERSION 1.1, Jan 06,2006 (Sept.30, 2002)

EXTERNAL PRESSURE NOZZLE REINFORCEMENT CALCULATION

Job number: 12-0799
Revison number: 0 | Page number: 19 of 21

CODES:
ASME SEC. VIII, DIV. I , 2010ed., 2011ADD. UG-28,36,37,40,41,45 ; UW-15,16

DIMENSIONS & PROPERTIES

Operating Conditions	
Design Pressure :	15
Design Temperature :	158
Corrosion Allowance :	0.0625
Nozzle nom. Size :	8
Nozzle Rating :	300 #
Shell or Tube side :	T

Repad	
Material :	SA-516-70N
Ambient Allow. Stress :	20000
Operating Allow. Stress :	20000
Outside Diameter :	12.6250
Thickness :	0.2500
Weld size, L_2 :	0.2500

Is the Nozzle Saddled on (*Y* or *N*): N

	Shell	Nozzle
Material :	SA-333-6	SA-333-6
Seamless or Welded :	S	S
Ambient Allowable Stress :	17100	17100
Operating Allowable Stress :	17100	17100
Pipe or PLate :	Pl	Pl
Efficiency, E :	1.000	1.000
Outside Diameter :	24.0000	8.625
Thickness :	0.500	0.500
Radial Reinforcement Limit, d* :	0.0000	-
Hillside Offset, L :	-	0.0000
Inward Nozz. Projection :	-	0.0000
Nozz. Fillet Weld size, L_1 / L_3 :	0.5000	0.0000

CALCULATIONS (corroded condition)

t_r :	0.07500	f_{r1} :	1.000	Parall. :	15.5000			
t :	0.37500	f_{r2} :	1.000	Norm. :	0.9375	Min. Weld leg sizes		Per
t_m :	0.03460	f_{r3} :	1.000	D_p :	12.6250	L_1 :	0.3571	UW-16
t_n :	0.43750	f_{r4} :	1.000		12.6250	L_2 :	0.1786	UW-16
t_e :	0.25000	F :	1.000	d :	7.7500	L_3 :	0.3571	UW-16
t_i :	0.00000		0.500	d* :	7.7500	Minimum Nozz. thickness (UG-45)		
				d (circ.) :	7.7500	t_n min =		0.1375

			Longitudinal Rein
AREA REQUIRED, A = 0.5 *(d t_r F + 2 t_n t_r F(1-f_{r1})) =			0.2906
Area Available in Shell, A1 (use larger value of) :		Long.	
d* (E_1 t - F t_r)- 2 t_n(E_1 t - F t_r) (1 - f_{r1}) =		2.3250	
2 (t + t_n) (E_1 t - F t_r) - 2 t_n(E_1 t - F t_r) (1 - f_{r1}) =		0.4875	2.3250
Area Available in Nozzle Outward, A2 (use smaller value of) :			
	5* (t_n - t_m) f_{r2} t =	0.7554	
<no-repad>	5* (t_n - t_m) f_{r2} t_n =	0.8813	
<with repad>	2* (t_n - t_m) (2.5 t_n + t_e) f_{r2} =	1.0828	0.7554
Area Available in Nozzle Inward, A3 (use smaller value of) :			
5 t t_i f_{r2} = 0	5 t t_i f_{r2} = 0		
	5 h t_i f_{r2} = 0		0.0000
Area Available in outward nozzle weld, A_{41} =			0.2500
Area Available in repad weld, A_{42} =			0.0625
Area Available in inward nozzle weld, A_{43} =			0.0000
Area Available in repad, A_5 = (D_p - d - 2 t_n) t_e f_{r4} =			1.0000
TOTAL AVAILABLE AREA =			4.3929
Opening is adequately reinforced by :			**4.1023**

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LIFTING LUG CALCULATION VERSION 2.0 May 27, 2008

LIFTING LUG CALCULATION

Job number: 12-0799
Revison number: 0 Page number: 20 of 21

CODES:

ASME SEC. VIII, DIV. I , 2010 ed.,2011ADD.:	UG-22
TEMA Ninth Edition, 2007 :	RGP-G-7.24
Pressure Vessel Design Manual :	Pg. 171 - 189

LIFTING-LUG GEOMETRY

Lug Material SA-516-70N

Allowable Stress	20000	psi
Design Load	19125	lbs/lug
Shackle Pin	1.625	in
Actual Hole	1.75	in
Lug Base Length	10	in
Lug Thickness	1.5	in
Fillet Weld Leg	0.5	in
Insulation Thk.	2	in
Lug Height	7	in
Pin offset	4.5	in

SHELL GEOMETRY:

Shell Material	SA-333-6	
Allowable Stress	17100	psi
Shell Type	0	Pipe
Shell Thickness	0.5	in
Corrosion	0.0625	in
Inside Diameter	23	in
Repad Thickness	0.375	in
Mill Tolerance	0.875	
Effective Shell Thickness	0.5557	in
Shackle clearance	0.43	in

Maximum Load / Lug:

Vertical Load =	19125	lb
Longitudinal Load =	14312	lb
Cross Load =	4130	lb

Shell Stress:	Shell Actual Stresses:	Code Allowable Stresses:
Radial stress =	13995 psi	17100 psi (Sa)
Longitudinal stress =	9348 psi	25650 psi combined (1.5 x Sa)

Lifting Details:

Minimum Sling or Chain Rating: **24000 lbs (12.0 ton)**

Maximum Off Vertical Angle for L: **36.8 deg (for each lifting-lug)**

NOTE: If this angle is less then 30 degree, two crane or a spreader bar shall be used for the lift.

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HORIZONTAL SUPPORT SADDLE CALCULATION VERSION 3.0, JAN. 03, 2005 (JAN. 08, 2002)

HORIZONTAL SUPPORT SADDLE STRESSES

Job number: 12-0779
Revison number: | Page number: 21 of 21

CODES:
Recommended Good practice : L.P. Zick analysis- Pressure Vessel Handbook latest

DIMENSIONS & PROPERTIES

Tema type unit (ie. NEN):	NEN		Length between shell seams, (L):	575.75
Total Dry Weight:	25500	Lbs	Maximum Seam to Ctr. Of Saddle, (A):	36
Total Wet Weight:	33200	Lbs	Saddle Support Width (SSW):	22
Design Pressure	400	psi	Saddle Gusset Width (SGW):	4
Shell Material:	SA-333-6		Support and Gusset thickness (tsg):	0.5000
Allow. Stress in Tension:	17100	psi	Is a Wear Plate used (Y or N):	Y
Allow. Stress in Comp.:	16744	psi	Wear Plate Thickness (twp):	0.2500
Shell *PI*pe or *PL*ate:	PI		Wear Plate Width (WPW):	8
Shell OD:	24.000	IN		
Shell Thickness:	0.5000	IN		
Corrosion Allowance:	0.0625	IN		
Efficiency:	1.0000			

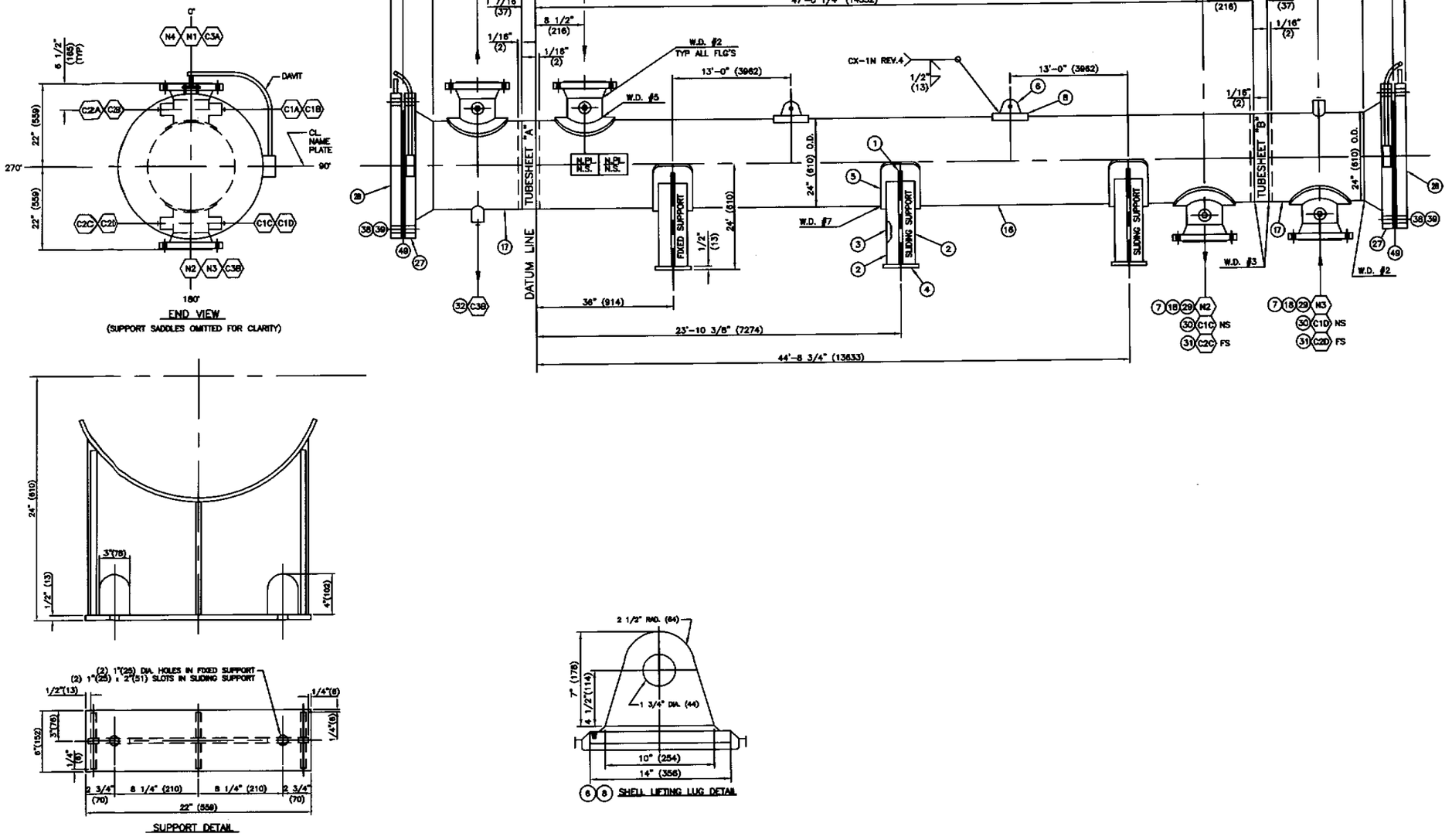
Tube Sheet Thickness : 1.5625

CALCULATIONS

Weight of unit full of water:	33200.0	Lbs		Contact Angle, θ :		127.8
Load per Saddle, Q:	11066.66667	IN	K_1:	0.3749	K_5:	0.3699
Minimum Shell thickness, t_s:	0.3750		K_2:	1.0530	K_6:	0.0468
Shell Outside Radius, R:	12		K_3:	0.3190	K_7:	0.7328
Head or TS Length, H:	1.5625		K_4:	0.7543	K_8:	0.6670
Min. Equiv. Head Thickness, t_h:	0.375					

	ALLOWABLE	ACTUAL
LONGITUDINAL BENDING STRESSES:		
Tension (at the saddles):	17100	7630.0
Compression (at the saddles):	16744	5708.7
Tension (at midspan):	17100	13415.3
Compression (at the midspan):	16744	615.3
TANGENTIAL SHEAR STRESSES		
Shell:	13680	1354.6
CIRCUMFERENTIAL STRESS		
At Horn of Saddle:	25650	6530.8
At Bottom of Shell	8372	1568.5

IMPERIAL DIMENSIONS ARE IN BRACKETS



SUPPORT DETAIL

6 8 SHELL LIFTING LUG DETAIL

BILL OF MATERIAL

ITEM	QTY.	DESCRIPTION	MATERIAL	P.O.#
		PLATE / STRUCTURAL		
1	2	1/2" PL. x 21 1/2" x 17 3/8" LG. – SUPPORT WEB	G-40W	
2	12	1/2" PL. x 2 1/2" x 16 1/4" – OUTER SUPPORT GUSSETS	G-40W	
3	6	1/2" PL. x 2 1/2" x 11 1/8" – MIDDLE SUPPORT GUSSETS	G-40W	
4	3	1/2" PL. x 6" x 22" – SHOE PLATES	G-40W	
5	3	3/8" PL. x 8" x 30" LG. ROLLED TO 24" I.D. – SUPPORT WEAR PLATE	SA-516-70N	
6	2	1 1/2" THK. PLATE x 7" x 16" – SHELL LIFTING LUGS	SA-516-70N	
7	4	1/4" PL. x 12 5/8" O.D." x 8 5/8" I.D. ROLLED TO 24" I.D. – N1-4 REPADS	SA-516-70N	
8	2	3/8" PL. x 6" x 14" LG. ROLLED HARDWAY TO 24" I.D. – LIFT LUG REPAD	SA-516-70N	
9				
10				
11				
12				
13				
14				
15				
		PIPE / FITTINGS		
16	1	24" – SCH. X.H. (0.500") SEAMLESS PIPE x 47'-6 3/4" LG – SHELL	SA-333-6	
17	2	24" – SCH. X.H. (0.500") SEAMLESS PIPE x 17" LG – CHANNELS	SA-333-6	
18	4	8" – SCH. XH (0.500") SMLS PIPE x 7 1/2" LG – N1, N2, N3, N4	SA-333-6	
19				
20				
21				
22				
23				
24				
25				
		FORGINGS		
26				
		ANSI FLANGES / CPLG'S		
27	2	24" – CLASS 300 RFWN (SCH X.H. BORE) – CHANNEL FLANGES — CLASS 1	SA-350-LF2	
28	2	24" – CLASS 300 RF BLIND FLANGE – CHANNEL COVER — CLASS 1	SA-350-LF2	
29	4	8" – CLASS 300 RFWN (SCH XH BORE) – N1, N2, N3, N4 — CLASS 1	SA-350-LF2	
30	4	1" – CLASS 6000 SCRTD FULL CPLG – C1A-D — CLASS 1	SA-350-LF2	
31	4	3/4" – CLASS 6000 SCRTD FULL CPLG – C2A-D — CLASS 1	SA-350-LF2	
32	2	1" – CLASS 6000 SCRTD FULL CPLG C/W PLUG – C3A/B — CLASS 1	SA-350-LF2	
33				
34				
35				
36				
37				
		STUD BOLTS & NUTS		
38	48	1 1/2" DIA. x 9 1/4" LG STUD BOLTS	SA-193-B7	
39	96	1 1/2" DIA. H. HEX NUTS	SA-194-2H	
40				
41				
42				
43				
44				
45				
46				
47				
48				
		GASKETS		
49	4	24" – CLASS 300 RF. FLEXITALIC STYLE C.G. GASKET (SEE DETAIL)	T-3168.S.	
50				
51				
52				
53				
54				
		NAME PLATES		
55	1	12" LG. x 6" T-BAR STYLE NAME PLATE BRACKETS C/W S.S. NAMEPLATE PLATE (SEE DETAIL)	SA-516-70N	

QUANTITIES

QUANTITIES LISTED ARE FOR ONE UNIT, ONE UNIT REQ'D

SPECIAL CHEMISTRY

CERTIFIED AS BUILT

CONSTRUCTION / GENERAL NOTES

1. SURFACE PREP: SSPC-SP6 (COMMERCIAL BLAST)
   PRIM: ONE COAT OF RUSTOLEUM 7088 (WHW) PRIMER (1.5–2.0 mils DFT)
   FINISH: ONE COAT OF RUSTOLEUM 808 (SILVER GRAY) INDUSTRIAL HIGH GLOSS ENAMEL (1.5–2.0 mils DFT)
   COLOR: WARM GREY
2. EXTERNAL DIMENSIONS, NOZZLE, SUPPORT LOCATIONS AND FABRICATION TOLERANCES SEE TEMA 2007 EDITION, SECTION 2, FIGURES F-1 AND F-2

REV.	BY	DESCRIPTION	CALC. PACKAGE REV. LEVEL	REVISED CALCS. REQUIRED	APPROVAL	DATE
1	JG	RADIOGRAPHY	1	YES	MB	DEC.14/12
0	JG	ISSUED FOR APPROVAL	0	ORIGINAL ISSUE	MB	SEPT.13/12

NOZZLE / CONNECTION SCHEDULE

REF.	QTY.	SIZE	RATING	TYPE	SERVICE	WELD SIZE A	WELD SIZE B	WELD DETAIL #	EXTERNAL PROJECT.	REPAD
N1	1	8"	300	RFWN	SHELL SIDE INLET	3/8"	1/4"	2,5	10"	YES
N2	1	8"	300	RFWN	SHELL SIDE OUTLET	3/8"	1/4"	2,5	10"	YES
N3	1	8"	300	RFWN	TUBE SIDE INLET	3/8"	1/4"	2,5	10"	YES
N4	1	8"	300	RFWN	TUBE SIDE OUTLET	3/8"	1/4"	2,5	10"	YES
C1A-D	4	1"	6000	SCRTD	T.A.'S	3/8"	------	6	------	NO
C2A-D	4	3/4"	6000	SCRTD	P.I.'S	3/8"	------	6	------	NO
C3A/B	2	1"	6000	SCRTD	VENT / DRAIN C/W PLUG	3/8"	------	8	------	NO

DESIGN DATA

	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE:	400 PSIG + F.V. / 2758 kPa + F.V.	400 PSIG + F.V. / 2758 kPa + F.V.
DESIGN TEMPERATURE:	163 °F / 73 °C	158 °F / 70 °C
MIN. DESIGN METAL TEMPERATURE:	-40 °F / -40 °C	-40 °F / -40 °C
RADIOGRAPHY:	SPOT PER UW-11(a)(5)b	SPOT PER UW-11(a)(5)b
STRESS RELIEVING:	N/R	N/R
CORROSION ALLOWANCE:	0.0625" / 1.6 mm	0.0625" / 1.6 mm
TEST PRESSURE:	520 PSIG / 3585 kPa	520 PSIG / 3585 kPa
WELDING PROCEDURES:	CS-1S EDA, CS-2S EDA (SEE'D TUBE SHEET)	CS-1S EDA, CS-2S EDA (SEE'D TUBE SHEET)
MEAN DESIGN TEMP.:	SHELL: 68.3ºF	TUBES: 68.3ºF / TUBESHEET "A":63.8ºF / TUBESHEET "B": 36.5ºF

EXPECT TESTING: ALL MATERIAL C.S.T. EXEMPT PER UCS-66(d)(3)(b)(1), PER UCS-66 NOTE (d), UCS-67-(a)(2)

MWP EQUAL TO DESIGN PRESSURE.

NO CORROSION ALLOWANCE APPLICABLE TO TUBING MATERIAL.

CODE: ASME SECTION VIII, DIV. 1, 2010 ED., 2011 ADD. — DESIGN: TEMA "R", API-660

FABRICATION ALBERTA & BRANCH COLUMBIA — C.R.N. #:

WEIGHT OF BUNDLE: 14000 LBS / 6577 KGS — VOLUME: 123.04 CU.FT./ 3.484 CU.M.

SHIPPING WEIGHT (DRY): 38000 LBS / 17867 KGS — TEST WEIGHT : 33900 LBS/ 15099 KGS

HEATING SURFACE: (4148.9 SQ. FT. / 385.35 SQ.M GROSS) – (10570.3 SQ.FT. / 982.02 SQ.M. EFF.)

REGISTERED QUALITY CONTROL PROCEDURES ACP 1386 — REGISTERED WELDING PROCEDURES WP 2380.2

CALHEX INDUSTRIES LTD.
9515 – 48th STREET S.E.
CALGARY, ALBERTA T2C 2R1

CUSTOMER: EXCELSIOR ENGINEERING FOR HUSKY OIL OPERATIONS

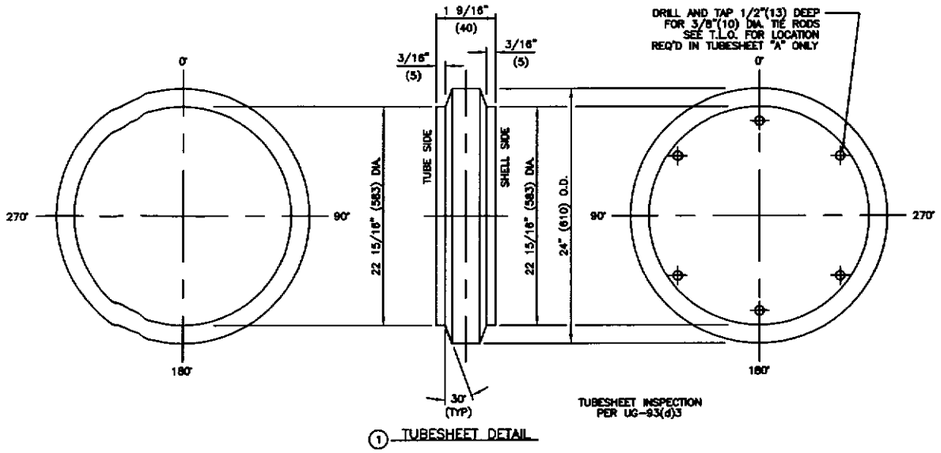
PROJECT: INLET GAS HEAT EXCHANGER
(1) MEN 23 x 576 ITEM#: E-1028
P.O. #: 8400547876
HUSKY OIL ANSELL GAS PLANT

ENGINEERING RECORDS

	NAME	DATE
DRAWING BY:	A.GREGORY	OCT.12/12
CHECKED BY:	D.KUJANEK	OCT.13/12
APPROVED BY:	M.SOUKA	

SCALE: N.T.S. — L.S.D. NO.: — DWG. NO.: 12-0779-S — REV.: 1

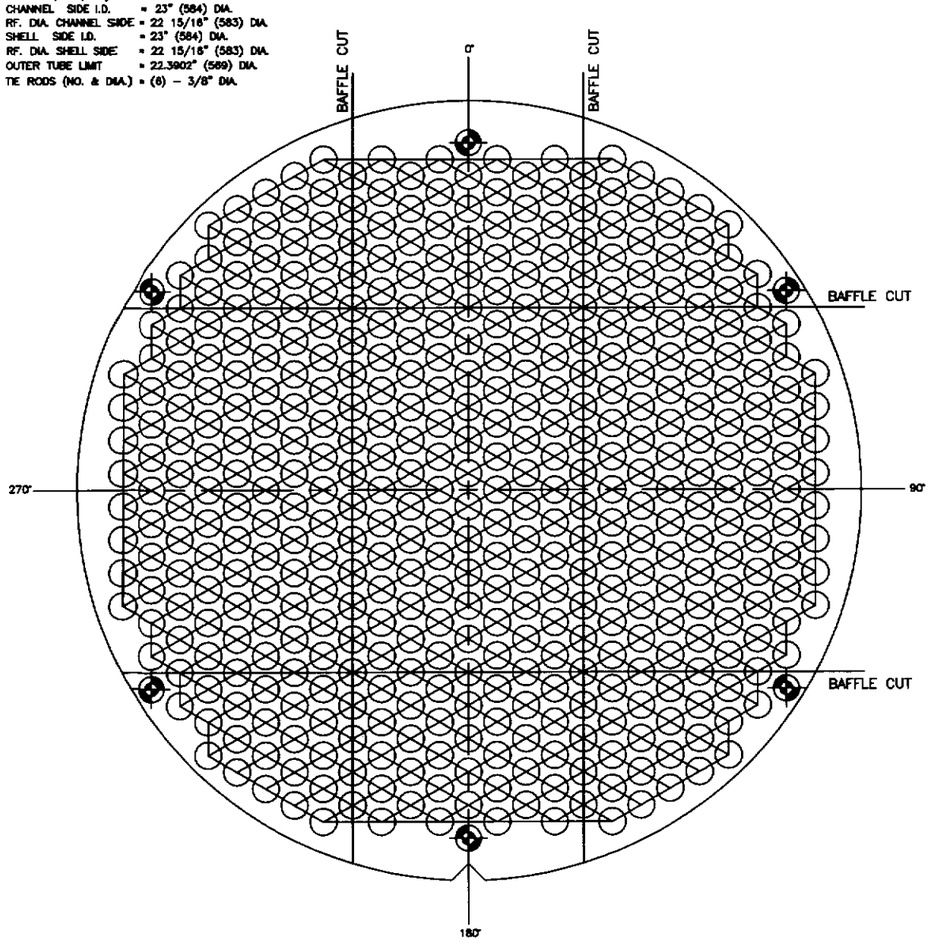
METRIC DIMENSIONS ARE IN BRACKETS

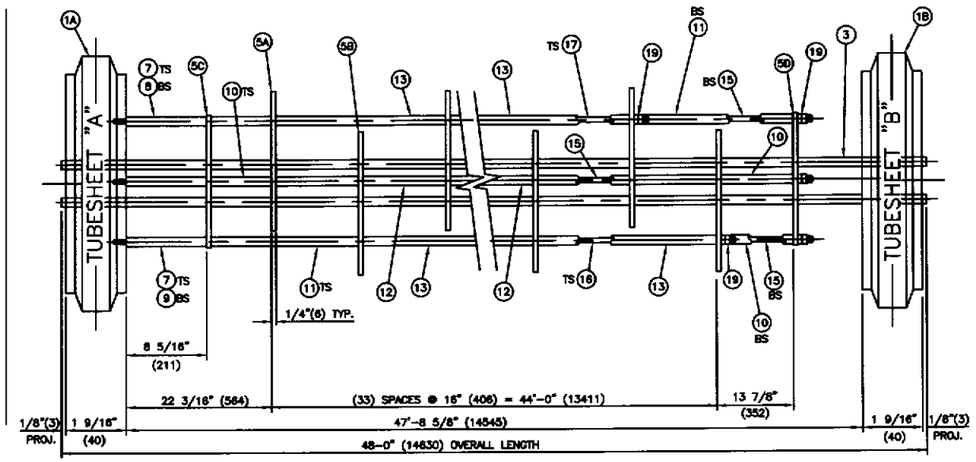


① TUBESHEET DETAIL

TUBE LAYOUT

(440) 3/4"(19) O.D. x #14 BWG x 48'-0" (14630) LG.
ON A 31/32"(24.6) 30° TRI. PITCH
CHANNEL SIDE I.D. = 23" (584) DIA.
RF. DIA. CHANNEL SIDE = 22 15/16" (583) DIA.
SHELL SIDE I.D. = 23" (584) DIA.
RF. DIA. SHELL SIDE = 22 15/16" (583) DIA.
OUTER TUBE LIMIT = 22.3902" (569) DIA.
TIE RODS (NO. & DIA.) = (6) – 3/8" DIA.





BUNDLE ASSEMBLY
(TOP VIEW)

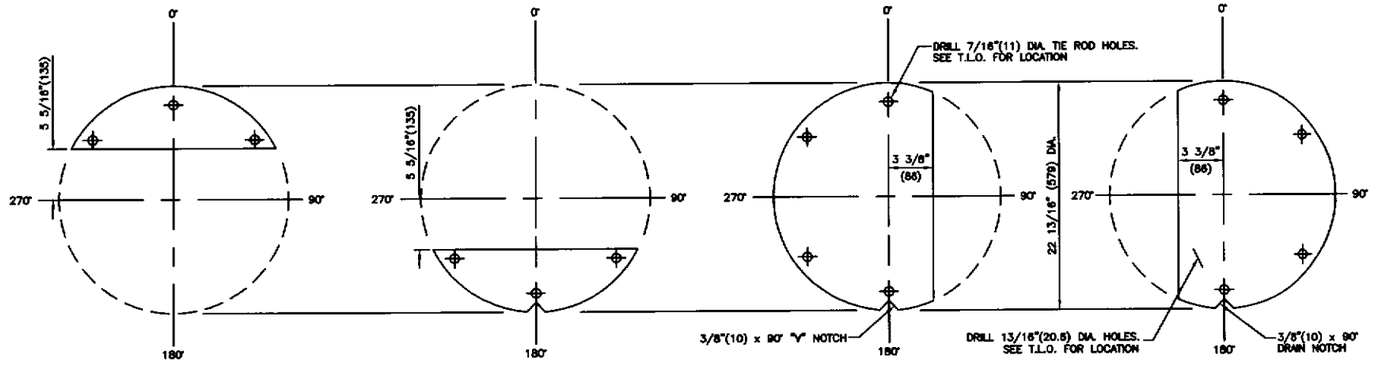
BILL OF MATERIAL

ITEM	QTY.	DESCRIPTION	MATERIAL	P.O.#
		PLATE		
1	2	1 9/16" PL. x 24" DIA. TUBESHEET	SA-516-70N	
2				
		TUBES		
3	440	3/4" DIA. x #14 BWG (0.078) BARE ENDS (19 FPI 16 GA. UNDER FINS) x 48'-0" SEAMLESS TUBES	SA-179	
4				
		BAFFLES		
5	36	1/4" PL. x 22 13/16" O.D. BAFFLES	SA-516	
6				
		SPACERS		
7	3	3/4" DIA. x #14 BWG x 8 5/16" LG. SPACER	SA-179/SA-214	
8	2	3/4" DIA. x #14 BWG x 22 3/16" LG. SPACER	SA-179/SA-214	
9	1	3/4" DIA. x #14 BWG x 38 3/16" LG. SPACER	SA-179/SA-214	
10	4	3/4" DIA. x #14 BWG x 13 5/8" LG. SPACER	SA-179/SA-214	
11	2	3/4" DIA. x #14 BWG x 39 5/8" LG. SPACER	SA-179/SA-214	
12	88	3/4" DIA. x #14 BWG x 15 3/4" LG. SPACER	SA-179/SA-214	
13	64	3/4" DIA. x #14 BWG x 31 3/4" LG. SPACER	SA-179/SA-214	
14				
		TIE RODS		
15	3	3/8" DIA. R.B. x 47'-3" LG. TIE ROD	N.R. SRL.	
16	1	3/8" DIA. R.B. x 46'-1" LG. TIE ROD	N.R. SRL.	
17	2	3/8" DIA. R.B. x 44'-8" LG. TIE ROD	N.R. SRL.	
18				
		NUTS		
19	12	3/8" DIA. HEX NUTS	SA-320	
20				
		IMPACT PLATE		
21				
22				

QUANTITIES

MATERIAL LISTED IS FOR ONE BUNDLE, ONE BUNDLE REQUIRED

SPECIAL CHEMISTRY NOTES



5C BAFFLE DETAIL (1 REQ'D)

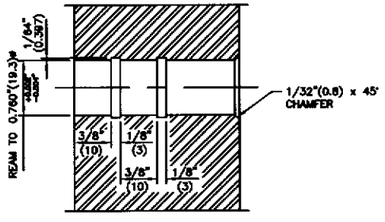
5D BAFFLE DETAIL (1 REQ'D)

5A BAFFLE DETAIL (17 REQ'D)

5B BAFFLE DETAIL (17 REQ'D)

CERTIFIED AS BUILT

TUBE EXPANSION LENGTH = 1 9/16" (40)



TUBE HOLE GROOVING DETAIL

CONSTRUCTION / GENERAL NOTES

NO.	
1	-
2	-
3	-
4	-
5	-
6	-
7	-

REV.	BY	DESCRIPTION	SIZE "B" DWG. CALC. PACKAGE REV. LEVEL	SIZE "E" DWG. REVISED CALCS. REQUIRED	MS APPROVAL	SEPT.5/12 DATE
0	JG	ISSUED FOR APPROVAL				

REVISION RECORD

CALHEX INDUSTRIES LTD.
9515 – 48th STREET S.E.
CALGARY, ALBERTA T2C 2R1

CUSTOMER: EXCELSIOR ENGINEERING FOR HUSKY OIL OPERATIONS

PROJECT: INLET GAS HEAT EXCHANGER (1) MEH 23 x 576 ITEM#: E-102B
P.O. #: 8400547676
HUSKY OIL ANSELL GAS PLANT

ENGINEERING RECORDS	NAME	DATE
DRAWING BY:	J.GREGORY	OCT.12/12
CHECKED BY:	B.HLADNIK	OCT.12/12
APPROVED BY:		

SCALE: N.T.S. | I.S.D. NO.: - | DWG. NO.: 12-0779-T | REV.: 0

INSTALLATION, OPERATION AND MAINTENANCE

E-1 PERFORMANCE OF HEAT EXCHANGERS

Satisfactory operation of heat exchangers can be obtained only from units which are properly designed and have built-in quality. Correct installation and preventive maintenance are user responsibilities.

E-1.1 PERFORMANCE FAILURES

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

(1) Excessive fouling.

(2) Air or gas binding resulting from improper piping installation or lack of suitable vents.

(3) Operating conditions differing from design conditions.

(4) Maldistribution of flow in the unit.

(5) Excessive clearances between the baffles and shell and/or tubes, due to corrosion.

(6) Improper thermal design.

The user's best assurance of satisfactory performance lies in dependence upon manufacturers competent in the design and fabrication of heat transfer equipment.

E-2 INSTALLATION OF HEAT EXCHANGERS

E-2.1 HEAT EXCHANGER SETTINGS

E-2.11 CLEARANCE FOR DISMANTLING

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

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

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

E-2.12 FOUNDATIONS

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

E-2.13 FOUNDATION BOLTS

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

E-2.14 LEVELING

Exchangers must be set level and square so that pipe connections may be made without forcing.

E-2.2 CLEANLINESS PROVISIONS

E-2.21 CONNECTION PROTECTORS

All exchanger openings should be inspected for foreign material. Protective plugs and covers should not be removed until just prior to installation.

E-2.22 DIRT REMOVAL

The entire system should be clean before starting operation. Under some conditions, the use of strainers in the piping may be required.

E-2.23 CLEANING FACILITIES

Convenient means should be provided for cleaning the unit as suggested under "Maintenance of Heat Exchangers," Paragraph E-4.

E-2.3 FITTINGS AND PIPING

E-2.31 BY-PASS VALVES

It may be desirable for purchaser to provide valves and by-passes in the piping system to permit inspection and repairs.

E-2.32 TEST CONNECTIONS

When not integral with the exchanger nozzles, thermometer well and pressure gage connections should be installed close to the exchanger in the inlet and outlet piping.

E-2.33 VENTS

Vent valves should be provided by purchaser so units can be purged to prevent vapor or gas binding. Special consideration must be given to discharge of hazardous or toxic fluids.

E-2.34 DRAINS

Drains may discharge to atmosphere, if permissible, or into a vessel at lower pressure. They should not be piped to a common closed manifold.

E-2.35 PULSATION AND VIBRATION

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

E-2.36 SAFETY RELIEF DEVICES

The ASME Code defines the requirements for safety relief devices. When specified by the purchaser, the manufacturer will provide the necessary connections for the safety relief devices. The size and type of the required connections will be specified by the purchaser. The purchaser will provide and install the required relief devices.

E-3 OPERATION OF HEAT EXCHANGERS

E-3.1 DESIGN AND OPERATING CONDITIONS

Equipment must not be operated at conditions which exceed those specified on the name plate(s).

E-3.2 OPERATING PROCEDURES

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

E-3.21 START-UP OPERATION

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

E-3.22 SHUT-DOWN OPERATION

For exchangers with removable bundles, the units may be shut down by first gradually stopping the flow of the hot medium and then stopping the flow of the cold medium. If it is necessary to stop the flow of cold medium, the circulation of hot medium through the exchanger should also be stopped. For fixed tubesheet exchangers, the unit must be shut down in a manner to minimize differential expansion between shell and tubes. When shutting down the system, all units should be drained completely when there is the possibility of freezing or corrosion damage. To guard against water hammer, condensate should be

drained from steam heaters and similar apparatus during start-up or shut-down. To reduce water retention after drainage, the tube side of water cooled exchangers should be blown out with air.

E-3.23 TEMPERATURE SHOCKS

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

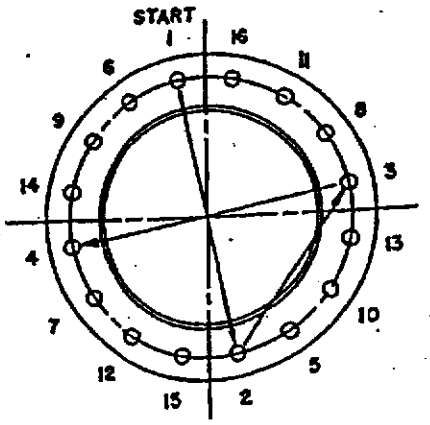
E-3.24 BOLTED JOINTS

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

E-3.25 RECOMMENDED BOLT TIGHTENING PROCEDURE

It is important that all bolted joints be tightened uniformly and in a diametrically staggered pattern, as illustrated in Figure E-3.25, except for special high pressure closures when the instructions of the manufacturer should be followed.

FIGURE E-3.25



E-4 MAINTENANCE OF HEAT EXCHANGERS

E-4.1 INSPECTION OF UNIT

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

E-4.11 INDICATIONS OF FOULING

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

E-4.12 DISASSEMBLY FOR INSPECTION OR CLEANING

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

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

(1) Stationary Head End

(a) Type A, C, D & N, remove cover only

(b) Type B, remove bonnet

(2) Rear Head End

(a) Type L, N & P, remove cover only

(b) Type M, remove bonnet

(c) Type S & T, remove shell cover and floating head cover

(d) Type W, remove channel cover or bonnet

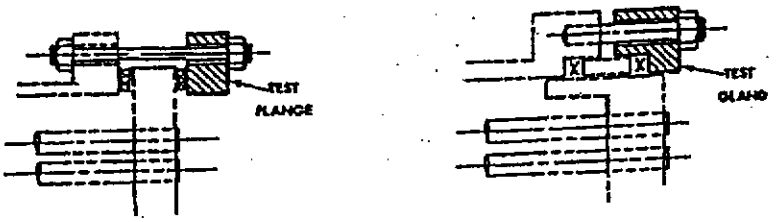
E-4.13 LOCATING TUBE LEAKS

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

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

(2) Units with bonnet type head: For fixed tubesheet units where tubesheets are an integral part of the shell, remove bonnet and apply hydraulic pressure in the shell. For fixed tubesheet units where tubesheets are not an integral part of the shell and for units with removable bundles, remove bonnet, re-bolt tubesheet to shell or install test flange or gland, whichever is applicable, and apply hydraulic pressure in the shell. See Figure E-4.13-1 for typical test flange and test gland.

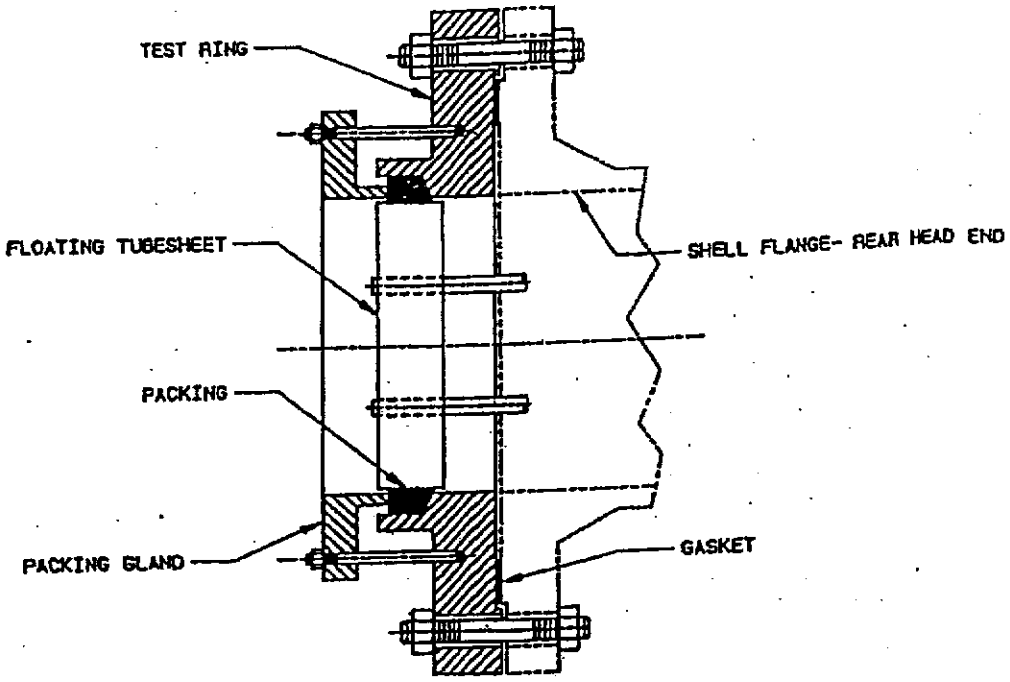
FIGURE E-4.13-1



(3) Units with Type S or T floating head: Remove channel cover or bonnet, shell cover and floating head cover. Install test ring and bolt in place with gasket and packing. Apply hydraulic pressure in the shell. A typical test ring is shown in Figure E-4.13-2. When a test ring is not available it is possible to locate leaks in the floating head end by removing the shell cover and applying hydraulic pressure in the tubes. Leaking tube joints may then be located by sighting through the tube lanes. Care must be exercised when testing partially assembled exchangers to prevent over extension of expansion joints or overloading of tubes and/or tube-to-tubesheet joints.

(4) Hydrostatic test should be performed so that the temperature of the metal is over 60° F (16° C) unless the materials of construction have a lower nil-ductility transition temperature.

FIGURE E-4.13-2



E-4.2 TUBE BUNDLE REMOVAL AND HANDLING

To avoid possible damage during removal of a tube bundle from a shell, a pulling device should be attached to eyebolts screwed into the tubesheet. If the tubesheet does not have tapped holes for eyebolts, steel rods or cables inserted through tubes and attached to bearing plates may be used. The bundle should be supported on the tube baffles, supports or tubesheets to prevent damage to the tubes.

Gasket and packing contact surfaces should be protected.

E-4.3 CLEANING TUBE BUNDLES

E-4.31 CLEANING METHODS

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

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

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

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

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

(4) High pressure water jet cleaning.

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

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

E-4.32 CLEANING PRECAUTIONS

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

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

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

E-4.4 TUBE EXPANDING

A suitable tube expander should be used to tighten a leaking tube joint. Care should be taken to ensure that tubes are not over expanded.

E-4.5 GASKET REPLACEMENT

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

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

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

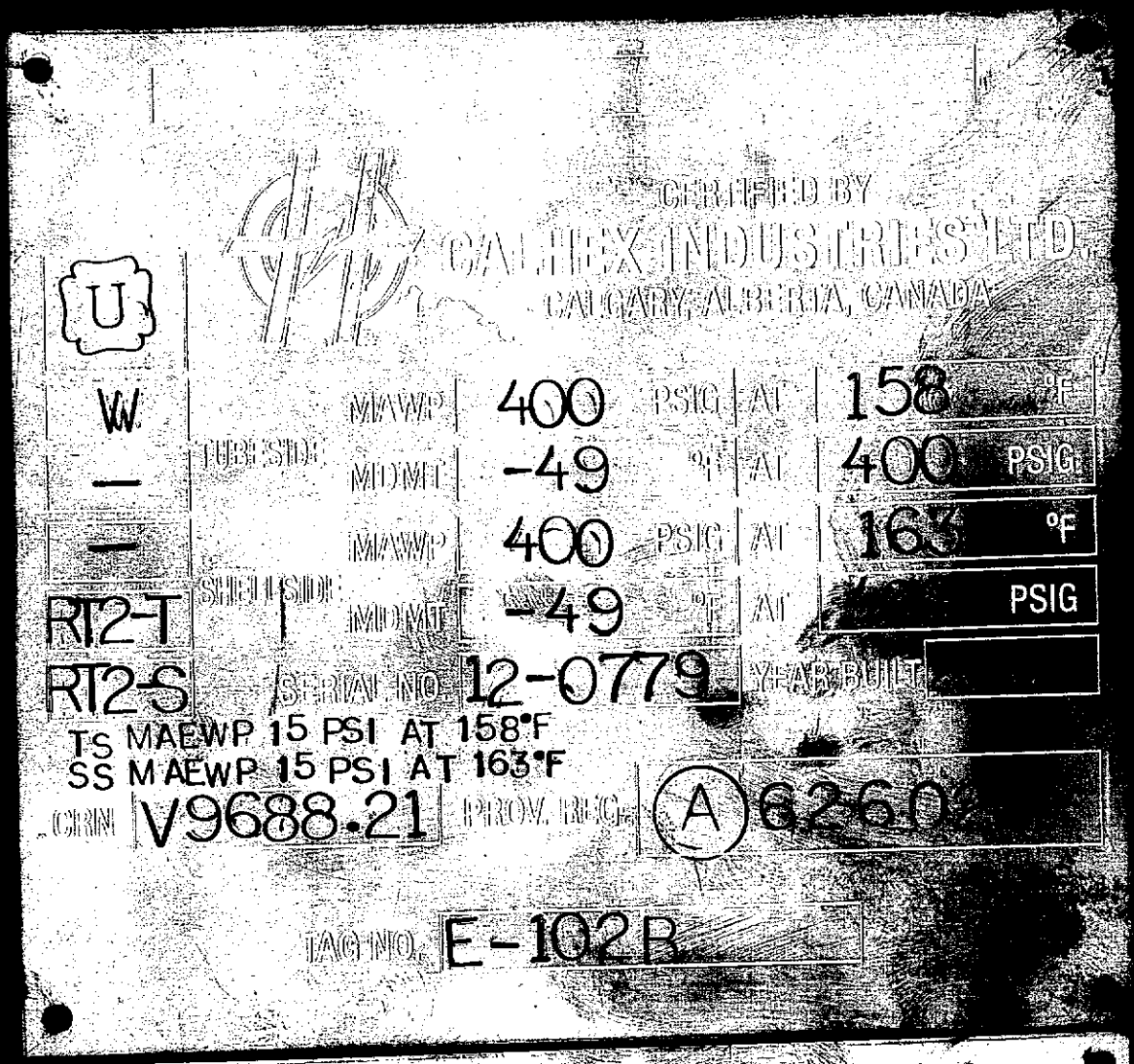
Metal jacketed type gaskets are widely used. When these are used with a tongue and groove joint without a nubbin, the gasket should be installed so that the tongue bears on the seamless side of the gasket jacket. When a nubbin is used, the nubbin should bear on the seamless side.

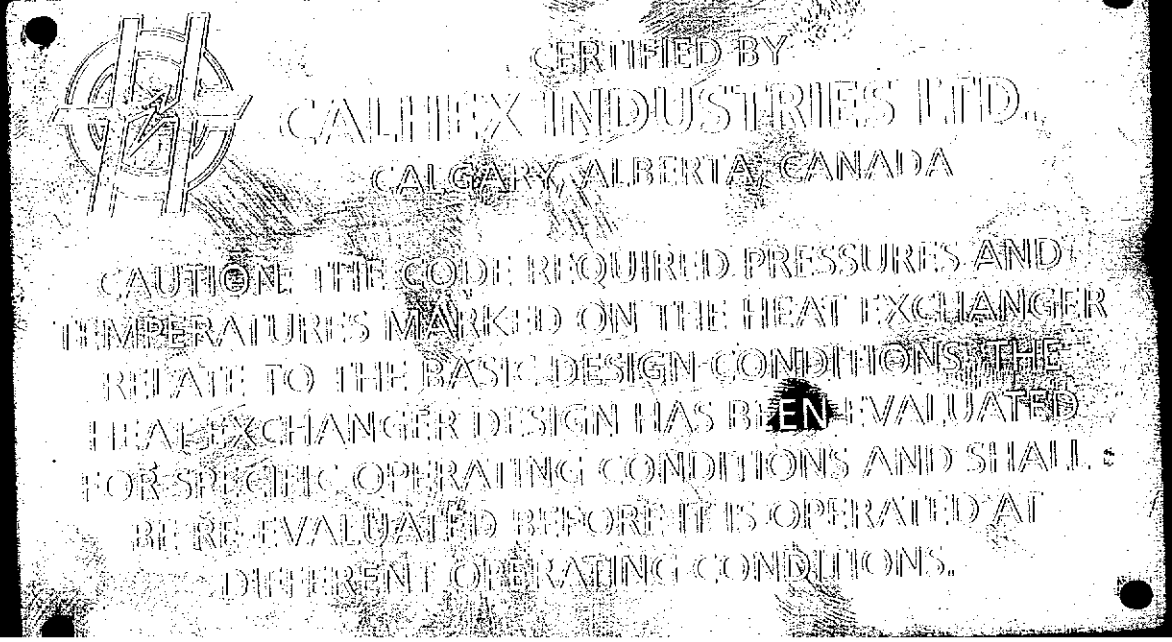
E-4.6 SPARE AND REPLACEMENT PARTS

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

E-4.7 PLUGGING OF TUBES

In U-tube heat exchangers, and other exchangers of special design, it may not be feasible to remove and replace defective tubes. Defective tubes may be plugged using commercially available tapered plugs with ferrules or tapered only plugs which may or may not be seal welded. Excessive tube plugging may result in reduced thermal performance, higher pressure drop, and/or mechanical damage. It is the user's responsibility to remove plugs and neutralize the bundle prior to sending it to a shop for repairs.


CERTIFIED BY
CALHEX INDUSTRIES LTD.
CALGARY, ALBERTA, CANADA
U
W
—
—
RT2-T
RT2-S
TUBE SIDE
SHELL SIDE
MAWP 400 PSIG AT 158 °F
MDMT -49 °F AT 400 PSIG
MAWP 400 PSIG AT 163 °F
MDMT -49 °F AT PSIG
SERIAL NO. 12-0779
YEAR BUILT
TS MAEWP 15 PSI AT 158°F
SS MAEWP 15 PSI AT 163°F
CRN V9688.21
PROV. REG. (A) 8260.2
TAG NO. E-102B


CERTIFIED BY
CALHEX INDUSTRIES LTD.
CALGARY, ALBERTA, CANADA
CAUTION: THE CODE REQUIRED PRESSURES AND TEMPERATURES MARKED ON THE 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.

CALHEX INDUSTRIES LTD.
9515 – 48th Street S.E., Calgary, Alberta, T2C 2R1

Bus: (403) 225 - 4395 {CALHEX5}
Fax: (403) 261 - 2761

MATERIAL CONTROL SHEET

Job #: 12-0779

Item #: E-102B

Part Description	Material Specification	Material Tracking # / Heat # - Plate Identifier	Part Description	Material Specification	Material Tracking # / Heat # - Plate Identifier
TUBES	SA179	193106	NOZZLE RFWN	SA350-LF2 CL.1	12/30011
"	"	213254			
			NOZZLE PIPE	SA333-6	B368 (268216)
TUBESHEETS	SA516-70N	B663 (344655-30841)			
			NOZZLE REPADS	SA516-70N	B998 (W2H505-D01)
SHELL CYLINDERS	SA333-6	B959 (MA3971)			
CHANNEL RFWN	SA350-LF2 CL.1	H0742/3			
CHANNEL CYLINDERS	SA333-6	B959 (MA3971)			
CHANNEL COVERS	SA350-LF2 CL.1	198658			
SUPPORT/WEAR PADS	SA516-70N	B947 (SB99M-01115)			
LIFT LUG REPADS	SA516-70N	B947 (SB99M-01115)			

Above materials meet the requirements of ASME Section II Part A

Quality Control Signature: [signature]

Date: DEC 12 2012

CA-TIS 008

RONCONI SpA
COLD DRAWN STEEL TUBES
20090 OPERA (Mi) - Via Lambro,9-ITALY
www.ronconi.com - quality@ronconi.com

CERTIFICATO PROVE MATERIALI

Mod. MDCQ01 B7
Test Certificate-Abnahmeprüfzeugnis
EN 10204 3.1

REPARTO COLLAUDO C.
Inspectione Dept. - Abnahmeabteilung

um. Cert. **11893**
Data 05/06/2012
Date - Datum

Foglio 1/1
Sheet - Blatt

Cliente **HEAT TRANSFER TUBULAR PRODUCTS LLC**
Customer - Kunde

Ordine num. PST 221
Order - Bestellung

Data 23/04/2012
Date - Datum

Ns. Commessa 32 13 12 405/2
Our order - Unsere Bestellung

Data 21/05/2012
Date - Datum

Descrizione COLD DRAWN SEAMLESS TUBES
Description - Beschreibung

Trattamento termico **Normalized**
Heat treatment - Wärmebehandlung

Norma e Acciaio **ASME SA179**
Norm and Steel Grade - Norm und Stahlgüte

In accordo a **YOUR REF. ST221**
Acc.to - Gemäss

Pezzi 200+500+520
Quantity - Anzahl

Peso kg. 18865
Weight - Gewicht

Dimensioni **19,05 x 2,11MW x 12217/13437/14656 mm**
Sizes - Abmessungen

Valori richiesti Requirements Anforderungen	Rs min	Rm min	Rm max	$A_{2"}$ min	A_{p5} min	HRB min	HRB max	Resilienza min	Resilienza med	Prova a caldo min
							72			
Provino Specimen Probestab	Snervamento Yield point Streckgrenze	Rottura Tensile strength Zugfestigkeit		Allungamento Elongation Bruchdehnung		Durezza Hardness Haerte		Resilienza Notch impact Kerbschlagarbeit		Prova a caldo Hot test Waermepruefung

N	Sez mm²	Lo mm	Risultati ottenuti (Results - Ergebnisse) N/mm2	N/mm2	%	%		J	J	N/mm2
1							65 ✓			
2							66 ✓			
3							66 ✓			
4							67 ✓			
5	Prova di Schiacciamento eseguita con esito positivo - Flattening test satifactory - Aufweitversuch zufriedenstellend durchgeführt									OK
6	Prova di Allargamento eseguita con esito positivo - Flaring test satisfactory - Ringfaltversuch zufriedenstellend durchgeführt									OK
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										

MATERIAL CHECKED TO ASME SECTION II BY CALHEX INDUSTRIES LTD.
DATE: DEC 11/12
SIGNATURE:
MIN. THK.:

CONFORMS TO 2010 EDITION: 2011 ADDENDA

Si certifica che è stato eseguito con esito positivo il:
We here by certify that we succesfully run:
Wir garantieren, dass folgendan Prüfungen zufriedenstellend durchgeführt wurden:

- ☑ Controllo (100%) Eddy current secondo norma **ASME SA450 24.8.2.1**
  Eddy current test (100%) acc.to - Wirbelstromprüfung (100%) gemäss
- ☐ Controllo (100%) Ultrasuoni secondo norma
  Ultrasonic test (100%) acc.to - Ultraschallprüfung (100%) gemäss
- ☐ Controllo PMI (100%)
  PMI test (100%) - PMI (100%)

Il controllo visivo e dimensionale dei tubi è stato eseguito con esito positivo
The visual and dimensional test has been performed with satisfactory result - Die visuellen und dimensionalen Kontrollen wurden mit zufriedenstellenden Ergebnissen durchgeführt

Analisi chimica
Chemical analysis - Chemische Analyse

Acciaio calmato ed elaborato al forno elettrico, degasato a vuoto
Steel elaborated in electric furnace, fully killed and vacuum degassed - Beruhigter Elektro Vakuum entgaßt Stahl

Colata N. Heat No -Schmelze Nr	C %	Si %	Mn %	P %	S %	Cr %	Mo %	Ni %	Cu %	V %	Nb %	Al %	N %	Sn %	Ti %	As %	Sb %
193106	0,100 ✓		0,46 ✓	0,009 ✓	0,003 ✓												
213254	0,095 ✓		0,46 ✓	0,007 ✓	0,002 ✓												

Marcatura (Marking - Markierung) RONCONI/ITALY/SA179/HEATNO/19,05X2,11/MW

Note Notes - Anmerkungen
ORIGIN OF RAW MATERIAL: GERMANY
MANUFACTURER: RONCONI SPA - ITALY
Tests n° 1-2-5-6 heat n° 193106: 1020 tubes
Tests n° 3-4-5-6 heat n° 213254: 500 tubes

Il Capo reparto
Chief of Dept. - Abteilungschef
CND II Lev. ET-UT Cert. n. FG1746
RONCONI SpA CONTROLLO QUALITA' QUALITY CONTROL

Ente collaudatore
Inspected by - Abnahmebeamter

CERTIFICATE OF COMPLIANCE

edmonton exchanger
& manufacturing ltd.

5545-89 Street Edmonton, Alberta Canada T6E 5W9 www.edmontonexchanger.com tel 780.468.6722 • QC fax 780.466.4668 • sales fax 780.466.5155

Customer CALHEX INDUSTRIES LTD. PO CX-07737 Work Order C89057 Date 2011/04/18 CofC# 24156 Page 1 of 1

Item#	Description	Qty	Heat#
P89057-1	PLATE(S) - 2.0000" NOM X 121" X 72" (Material Spec: SA 516-70 Normalized) **Conforms to NACE MR0175 / ISO 15156-2 2009 Annex A**	1	350925-23140
P89057-2	PLATE(S) - 1.7500" NOM X 121" X 72" (Material Spec: SA 516-70 Normalized) **Conforms to NACE MR0175 / ISO 15156-2 2009 Annex A**	1	344655-30841 B663
P89057-3	PLATE(S) - 1.5000" NOM X 121" X 72" (Material Spec: SA 516-70 Normalized) **Conforms to NACE MR0175 / ISO 15156-2 2009 Annex A**	1	350924-23519
P89057-4	PLATE(S) - 1.0000" NOM X 121" X 60" (Material Spec: SA 516-70 Normalized) **Conforms to NACE MR0175 / ISO 15156-2 2009 Annex A**	1	G7492-879270448

Brinell Equipment: Newage Calibrated Pin
Brinell Hardness Tester

Material being supplied conforms to the latest ASME Code Section II, Part A, 2010 Edition. All welders and procedures are qualified to ASME Code Section IX.

Supplementary Examination - Items

CE=0.39
NACE-OK
-50-OK
S≤0.006

CA-TIS00 84

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: 360093-14.05.10

A08/ Manufacturer's order/ A03 Certificate No.: 354135-003

Sheet: 1/9.

A05 Established inspecting body: DH

A06 Purchaser: EDMONTON STEEL, EDMON — A07.1 No.: ED10548-J1010-ER

Final receiver: EDMONTON STEEL, EDMON — A07.2 No.:

B01 Product: HOT ROLLED PLATES

15530

B02/ Steel design.: SA516-70 SA20-S5

B03 Any suppl. requirements: ASME-II-A:07+A09
DIL-HUE-3:R29-2010-01-31

A01-A99 Further commercial information - Concession requests

B14 Item No.	B07.2 Heat No.	B07.1 Rol.plate / Test No.	B16 Concession request no.	Date
03	344653	30842-01	1-CK2WP	06.04.10
03	344653	30843-01	1-CJVK2	06.04.10

CONFORMS TO ZG10 EDITION: 2011 ADDENDA

B01-B99 Description of the product

B14 Item No.	B08 Number of pieces	B09 Thickness	B10 Width	B11 Length	B12 Theoretical mass KG	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate No./ Test No.
			INCH					
01	1	1,5000 x	121,00000 x	480,00000	11207	N	344653	32210-01
01	1	1,5000 x	121,00000 x	480,00000	11207	N	344653	32210-02
**	2				22414			
02	1	1,6250 x	97,00000 x	480,00000	9733	N	344653	30848-01
02	1	1,6250 x	97,00000 x	480,00000	9733	N	344653	30848-02
**	2				19466			
03	1	1,7500 x	121,00000 x	480,00000	13075	N	344652	32216-01
03	1	1,7500 x	121,00000 x	480,00000	13075	N	344653	30842-01
03	1	1,7500 x	121,00000 x	480,00000	13075	N	344653	30843-01
03	1	1,7500 x	121,00000 x	480,00000	13075	N	344655	28436-01
03	1	1,7500 x	121,00000 x	480,00000	13075	N	344655	30836-01
03	1	1,7500 x	121,00000 x	480,00000	13075	N	344655	30837-01
03	1	1,7500 x	121,00000 x	480,00000	13075	N	344655	30841-01
**	7				91525			
05	1	2,0000 x	121,00000 x	480,00000	14943	N	344657	28426-01
05	1	2,0000 x	121,00000 x	480,00000	14943	N	344657	28428-01
05	1	2,0000 x	121,00000 x	480,00000	14943	N	344657	28429-01
05	1	2,0000 x	121,00000 x	480,00000	14943	N	344657	28430-01

A09 Purchaser article number

MATERIAL CHECKED TO
ASME SECTION II BY
CALHEX INDUSTRIES LTD.

DATE: MAY 15, 2011

SIGNATURE:

MIN. THK.: 1.772"

CONFORMS TO 2010 EDITION: ADDENDA

JOB # STOCK
HEAT CODE # 3663
(344655-30841)

A04 Manufacturer's mark: D H

Z01/Z02/Z03 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

B. MUELLER
Test House Manager

Inspector's stamp: AHB

Date 14.05.10 BM 1

A01

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

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: 360093-14.05.10

A08/ Manufacturer's order/ A03 Certificate No.: 354135-003 Sheet: 2/...

A05 Established inspecting body: DH

A06 Purchaser: EDMONTON STEEL,EDMON A07.1 No. ED10548-J1010-ER

Final receiver: EDMONTON STEEL,EDMON A07.2 No.

B01 Product: HOT ROLLED PLATES

B02/ Steel design.: SA516-70 SA20-S5

B03 Any suppl. requirements: ASME-II-A:07+A09
DIL-HUE-3:R29-2010-01-31

B01-B99 Description of the product

B14 Item No.	B08 Number of pieces	B09 Thickness	B10 Width	B11 Length	B12 Theoretical mass KG	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate No./ Test No.	A09 Purchaser article number
			INCH						
05	1	2,0000 x	121,00000 x	480,00000	14943	N	344657	28431-01	
05	1	2,0000 x	121,00000 x	480,00000	14943	N	344657	28432-01	
05	1	2,0000 x	121,00000 x	480,00000	14943	N	344657	28433-01	
**	7				104601				
06	1	2,2500 x	121,00000 x	480,00000	16810	N	344659	22452-01	
06	1	2,2500 x	121,00000 x	480,00000	16810	N	344659	23550-01	
**	2				33620				
***	20				271626				

B04 Product delivery condition

ITEM NO.: 01-06
N: HT: 1670 GR.F +36 -27 GR.F
SOAKING TIME TO ATTAIN THE TARGET TEMPERATURE OVER THE WHOLE SECTION: 1-1,75 MIN/MM (25-45 MIN/INCH)
COOLING IN STILL AIR

B06 Marking of the product

ITEM NO.: 01-06
STEEL DESIGNATION SA516 70 MTLTV SA516 60 MTLTV
HEAT NO. / TRADEMARK / ROLLED PLATE NO.-TEST NO. / INSPECTOR'S STAMP

B07-B99 Further information about the product

ITEM NO.: 01-06
THICKNESS REDUCTION RATIO >= 3,0 IS FULFILLED (CF. A/SA20 PAR. 5.3)

A04 D H Manufacturer's mark

Z01/Z02/Z03 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

B. MUELLER
Test House Manager

AHB Inspector's stamp

A01 AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

Date 14.05.10 BM 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)

A10 Advice of dispatch No./ Date of dispatch: 360093-14.05.10

A08/ Manufacturer's order/ A03 Certificate No.: 354135-003 Sheet: 3/...

A05 Established inspecting body: DH

A06 Purchaser: EDMONTON STEEL,EDMON A07.1 No. ED10548-J1010-ER

Final receiver: EDMONTON STEEL,EDMON A07.2 No.

B01 Product: HOT ROLLED PLATES

B02/ Steel design.: SA516-70 SA20-S5

B03 Any suppl. requirements: ASME-II-A:07+A09
DIL-HUE-3:R29-2010-01-31

C10-C29 Tensile test

B14 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01	C02/ C01	C03 Temp. GR.F	C10 C11 KSI RP02	C12 RM	C13	C14-C15 A % L0=2IN
01	344653	32210		K1	QV	RT	48,1	75,0		41
02	344653	30848		K1	QV	RT	48,1	74,5		36
03	344652	32216		K1	QV	RT	47,9	74,7		37
03	344653	30842		K1	QV	RT	48,3	74,1		40
03	344653	30843		K1	QV	RT	48,0	74,4		38
03	344655	28436		K1	QV	RT	45,8	73,1		40
03	344655	30836		K1	QV	RT	47,9	74,0		39
03	344655	30837		K1	QV	RT	47,4	73,8		37
03	344655	30841		K1	QV	RT	48,0 ✓	73,5 ✓		39 ✓
05	344657	28426		K1	QV	RT	47,0	73,4		40
05	344657	28428		K1	QV	RT	48,9	74,1		38
05	344657	28429		K1	QV	RT	47,7	74,0		39
05	344657	28430		K1	QV	RT	47,1	72,8		41
05	344657	28431		K1	QV	RT	46,7	73,7		40
05	344657	28432		K1	QV	RT	47,7	73,7		42
05	344657	28433		K1	QV	RT	48,3	73,7		39
06	344659	22452		K1	QV	RT	44,7	74,5		39
06	344659	23550		K1	QV	RT	44,4	73,7		37

A04 Manufacturer's mark: D H

Z01/Z02/Z03 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

B. MUELLER
Test House Manager

Inspector's stamp: A H B

A01 AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

Date 14.05.10 BM 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)

A10 Advice of dispatch No./ Date of dispatch: 360093-14.05.10

A08/ A03 Manufacturer's order/ Certificate No.: 354135-003

Sheet: 4/...

A05 Established inspecting body: DH.

A06 Purchaser: EDMONTON STEEL, EDMON A07.1 No. ED10548-J1010-ER

Final receiver: EDMONTON STEEL, EDMON A07.2 No.

B01 Product: HOT ROLLED PLATES

B02/ Steel design. SA516-70 SA20-S5

B03 Any suppl. requirements ASME-II-A:07+A09
DIL-HUE-3:R29-2010-01-31

C30-C39 Hardness test

B14 Rem. No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01	C02/C01	C03 Temp. GR.F	C33 Testing method	C35 C31 Individual values			C32 Mean value
01	344653	32210		K1	O	RT	HBW 10/3000	HB	143	142	144	143
02	344653	30848		K1	O	RT	HBW 10/3000	HB	146	142	145	144
03	344652	32216		K1	O	RT	HBW 10/3000	HB	139	138	138	138
03	344653	30842		K1	O	RT	HBW 10/3000	HB	141	142	141	141
03	344653	30843		K1	O	RT	HBW 10/3000	HB	140	141	140	140
03	344655	28436		K1	O	RT	HBW 10/3000	HB	138	138	136	137
03	344655	30836		K1	O	RT	HBW 10/3000	HB	138	137	136	137
03	344655	30837		K1	O	RT	HBW 10/3000	HB	140	145	140	142
03	344655	30841		K1	O	RT	HBW 10/3000	HB	139	138	138	138
05	344657	28426		K1	O	RT	HBW 10/3000	HB	138	138	138	138
05	344657	28428		K1	O	RT	HBW 10/3000	HB	142	140	139	140
05	344657	28429		K1	O	RT	HBW 10/3000	HB	138	137	138	138
05	344657	28430		K1	O	RT	HBW 10/3000	HB	141	140	141	141
05	344657	28431		K1	O	RT	HBW 10/3000	HB	135	136	136	136
05	344657	28432		K1	O	RT	HBW 10/3000	HB	139	138	137	138
05	344657	28433		K1	O	RT	HBW 10/3000	HB	142	140	139	140
06	344659	22452		K1	O	RT	HBW 10/3000	HB	144	141	144	143
06	344659	23550		K1	O	RT	HBW 10/3000	HB	138	138	138	138

A04 D H Manufacturer's mark

Z01/Z02/Z03 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

B. MUELLER
Test House Manager

AHB Inspector's stamp

Date 14.05.10 BM 1

A01 AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

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: 360093-14.05.10

A08/ Manufacturer's order/ A03 Certificate No.: 354135-003 Sheet: 5/...

A05 Established inspecting body: DH

A06 Purchaser: EDMONTON STEEL, EDMON A07.1 No.: ED10548-J1010-ER

Final receiver: EDMONTON STEEL, EDMON A07.2 No.:

B01 Product: HOT ROLLED PLATES

B02/ Steel design.: SA516-70 SA20-S5

B03 Any suppl. requirements: ASME-II-A:07+A09
DIL-HUE-3:R29-2010-01-31

C40-C49 Impact test

B14 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01	C02/ C01	C03 Temp. GR.F	C41 Width of test piece	C40 Type of test piece	C44 Testing method	C46 Energy	C45	C42 Individual values AV=FT.LBF			C43 Mean value
01	344653	32210		K1	LV	-51		CHP-V			AV	80	82	96	86
02	344653	30848		K1	LV	-51		CHP-V			AV	122	111	97	110
03	344652	32216		K1	LV	-51		CHP-V			AV	83	103	128	105
03	344653	30842		K1	LV	-51		CHP-V			AV	96	97	72	88
03	344653	30843		K1	LV	-51		CHP-V			AV	55	108	96	86
03	344655	28436		K1	LV	-51		CHP-V			AV	108	55	104	89
03	344655	30836		K1	LV	-51		CHP-V			AV	78	102	83	88
03	344655	30837		K1	LV	-51		CHP-V			AV	105	72	117	98
03	344655	30841		K1	LV	-51		CHP-V			AV	97	75	116	96
05	344657	28426		K1	LV	-51		CHP-V			AV	75	101	97	91
05	344657	28428		K1	LV	-51		CHP-V			AV	83	82	91	85
05	344657	28429		K1	LV	-51		CHP-V			AV	72	119	81	91
05	344657	28430		K1	LV	-51		CHP-V			AV	89	82	120	97
05	344657	28431		K1	LV	-51		CHP-V			AV	97	109	94	100
05	344657	28432		K1	LV	-51		CHP-V			AV	66	17	21	35
05	344657	28433		K1	LV	-51		CHP-V			AV	90	59	71	73
06	344659	22452		K1	LV	-51		CHP-V			AV	92	97	90	93
06	344659	23550		K1	LV	-51		CHP-V			AV	94	105	96	98

A04 D H Manufacturer's mark

Z01/Z02/Z03 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

B. MUELLER
Test House Manager

A H B Inspector's stamp

Date 14.05.10 BM 1

A01 **AG der Dillinger Hüttenwerke**
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

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: 360093-14.05.10

A08/ Manufacturer's order/ A03 Certificate No.: 354135-003 Sheet: 6/...

A05 Established inspecting body: DH

A06 Purchaser: EDMONTON STEEL,EDMON A07.1 No. ED10548-J1010-ER

Final receiver: EDMONTON STEEL,EDMON A07.2 No.

B01 Product: HOT ROLLED PLATES

B02/ Steel design. SA516-70 SA20-85

B03 Any suppl. requirements: ASME-II-A:07+A09
DIL-HUE-3:R29-2010-01-31

C70-C99 Chemical composition % - Heat analysis

B07.2 Heat	C70	C	SI	MN	P	S	N	CU	MO	NI	CR	V	NB	SN	TI
344652	Y	0,184	0,359	1,18	0,011	0,0008	0,0057	0,019	0,011	0,025	0,030	0,000	0,000	0,001	0,002
344653	Y	0,173	0,361	1,17	0,010	0,0009	0,0078	0,025	0,014	0,031	0,024	0,000	0,000	0,000	0,002
344655	Y	0,178	0,301	1,18	0,010	0,0007	0,0074	0,023	0,009	0,035	0,030	0,000	0,000	0,001	0,002
344657	Y	0,174	0,338	1,19	0,011	0,0009	0,0059	0,028	0,015	0,035	0,029	0,000	0,000	0,000	0,002
344659	Y	0,170	0,365	1,18	0,009	0,0009	0,0063	0,016	0,004	0,025	0,222	0,001	0,000	0,001	0,002

B07.2 Heat	C70	B	CA	AL-T
344652	Y	0,0000	0,0016	0,031
344653	Y	0,0001	0,0016	0,034
344655	Y	0,0001	0,0012	0,031
344657	Y	0,0001	0,0016	0,027
344659	Y	0,0001	0,0012	0,045

<0.32 ✓
<1.00 ✓

C94 Heat analysis Carbon equivalent / Alloying restrictions

B07.2 Heat										
344652	FO-02=	0,39	FO-51=	0,000	FO-55=	0,09	FO-78=	0,04	FO-91=	6,4
344653	FO-02=	0,38	FO-51=	0,000	FO-55=	0,09	FO-78=	0,04	FO-91=	6,8
344655	FO-02=	0,39	FO-51=	0,000	FO-55=	0,10	FO-78=	0,04	FO-91=	6,6
344657	FO-02=	0,39	FO-51=	0,000	FO-55=	0,11	FO-78=	0,04	FO-91=	6,8
344659	FO-02=	0,41	FO-51=	0,001	FO-55=	0,27	FO-78=	0,23	FO-91=	6,9

C95 Ladle treatment

ITEM NO.: 01-06
HEAT OF THE INDICATED ITEM: VACUUM DEGASSED / SULPHIDE SHAPE CONTROL

A04 Manufacturer's mark

Z01/Z02/Z03 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

B. MUELLER
Test House Manager

Inspector's stamp

A01 AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

Date 14.05.10 BM 1

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

DILLINGER HÜTTE

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: 360093-14.05.10

A06/ Manufacturer's order/ A03 Certificate No.: 354135-003 Sheet: 7/...

A05 Established inspecting body: DH

A06 Purchaser: EDMONTON STEEL,EDMON A07.1 No.: ED10548-J1010-ER

Final receiver: EDMONTON STEEL,EDMON A07.2 No.:

B01 Product: HOT ROLLED PLATES

B02/ Steel design.: SA516-70 SA20-S5

B03 Any suppl. requirements: ASME-II-A:07+A09
DIL-HUE-3:R29-2010-01-31

C95 Further information about ladle treatment

ITEM NO.: 01-06
CALCIUM TREATED

C70-C99 Chemical composition % - Product analysis

B07.2 Heat	B07.1 Test No.	C01	C	SI	MN	P	S	N	CU	MO	NI	CR	V	NB	SN	TI
344652	32213	K1	0,182	0,353	1,16	0,011	0,0008	0,0056	0,018	0,010	0,023	0,030	0,001	0,000	0,000	0,002
344652	32216	K1	0,178	0,361	1,16	0,010	0,0010	0,0061	0,014	0,012	0,030	0,030	0,000	0,000	0,001	0,002
344653	30844	K1	0,178	0,358	1,16	0,009	0,0009	0,0067	0,025	0,014	0,029	0,023	0,001	0,000	0,000	0,002
344653	30846	K1	0,175	0,354	1,16	0,009	0,0010	0,0069	0,025	0,015	0,031	0,024	0,001	0,000	0,001	0,002
344653	32208	K1	0,180	0,366	1,16	0,010	0,0011	0,0061	0,020	0,012	0,025	0,027	0,000	0,000	0,001	0,002
344653	32209	K1	0,178	0,358	1,16	0,009	0,0011	0,0068	0,023	0,013	0,029	0,025	0,000	0,000	0,000	0,002
344655	28434	K1	0,178	0,291	1,16	0,009	0,0009	0,0066	0,022	0,009	0,035	0,029	0,000	0,000	0,001	0,002
344655	28435	K1	0,178	0,292	1,16	0,009	0,0009	0,0066	0,022	0,007	0,034	0,030	0,000	0,001	0,000	0,002
344655	30836	K1	0,175	0,302	1,16	0,010	0,0011	0,0067	0,022	0,009	0,035	0,029	0,000	0,000	0,001	0,002
344657	28431	K1	0,174	0,327	1,16	0,010	0,0009	0,0053	0,026	0,013	0,032	0,029	0,000	0,000	0,000	0,002
344659	23555	K1	0,169	0,361	1,16	0,008	0,0009	0,0063	0,012	0,004	0,019	0,210	0,001	0,000	0,000	0,002

B07.2 Heat	B07.1 Test No.	C01	B	CA	AL-T
344652	32213	K1	0,0001	0,0017	0,032
344652	32216	K1	0,0002	0,0013	0,032
344653	30844	K1	0,0000	0,0015	0,034
344653	30846	K1	0,0002	0,0016	0,035
344653	32208	K1	0,0000	0,0016	0,032
344653	32209	K1	0,0001	0,0016	0,033
344655	28434	K1	0,0000	0,0010	0,030
344655	28435	K1	0,0001	0,0012	0,031

A04 D H Manufacturer's mark

Z01/Z02/Z03 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

B. MUELLER
Test House Manager

A H B Inspector's stamp

A01 AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

Date 14.05.10 BM 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)

A10 Advice of dispatch No./ Date of dispatch: 360093-14.05.10

A08/ Manufacturer's order/ A03 Certificate No.: 354135-003 Sheet: 8/...

A05 Established inspecting body: DH

A06 Purchaser: EDMONTON STEEL,EDMON A07.1 No. ED10548-J1010-ER

Final receiver: EDMONTON STEEL,EDMON A07.2 No.

B01 Product: HOT ROLLED PLATES

B02/ Steel design. SA516-70 SA20-S5

B03 Any suppl. requirements: ASME-II-A:07+A09
DIL-HUE-3:R29-2010-01-31

C70-C99 Chemical composition % - Product analysis

B07.2 Heat	B07.1 Test No.	C01	B	CA	AL-T
344655	30836	K1	0,0001	0,0014	0,030
344657	28431	K1	0,0000	0,0014	0,027
344659	23555	K1	0,0001	0,0012	0,034

C94 Product analysis Carbon equivalent / Alloying restrictions

B07.2 Heat	B07.1 Test No.	C01						
344652	32213	K1	FO-02=	0,39	FO-51=	0,001	FO-55=	0,08
344652	32216	K1	FO-02=	0,38	FO-51=	0,000	FO-55=	0,09
344653	30844	K1	FO-02=	0,38	FO-51=	0,001	FO-55=	0,09
344653	30846	K1	FO-02=	0,38	FO-51=	0,001	FO-55=	0,10
344653	32208	K1	FO-02=	0,38	FO-51=	0,000	FO-55=	0,08
344653	32209	K1	FO-02=	0,38	FO-51=	0,000	FO-55=	0,09
344655	28434	K1	FO-02=	0,38	FO-51=	0,000	FO-55=	0,10
344655	28435	K1	FO-02=	0,38	FO-51=	0,001	FO-55=	0,09
344655	30836	K1	FO-02=	0,38	FO-51=	0,000	FO-55=	0,10
344657	28431	K1	FO-02=	0,38	FO-51=	0,000	FO-55=	0,10
344659	23555	K1	FO-02=	0,41	FO-51=	0,001	FO-55=	0,25

C94 Carbon equivalent formula / Alloying restrictions

FO-02 = C+(MN/6)+(CR+MO+V)/5+(NI+CU)/15
FO-51 = V +NB
FO-55 = CU+MO+NI+CR
FO-78 = CR+MO
FO-91 = MN/C

A04 Manufacturer's mark: D H

Z01/Z02/Z03 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

B. MUELLER
Test House Manager

Inspector's stamp: A H B

A01 AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

Date 14.05.10 BM 1

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

DILLINGER HÜTTE

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: 360093-14.05.10

A08/ Manufacturer's order/ A03 Certificate No.: 354135-003 Sheet: 9

A05 Established inspecting body: DH

A06 Purchaser: EDMONTON STEEL,EDMON A07.1 No. ED10548-J1010-ER

Final receiver: EDMONTON STEEL,EDMON A07.2 No.

B01 Product: HOT ROLLED PLATES

B02/ Steel design. SA516-70 SA20-S5

B03 Any suppl. requirements ASME-II-A:07+A09
DIL-HUE-3:R29-2010-01-31

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

ITEM NO.: 01-06
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

MTR APPROVED EDMONTON EXCHANGER

A04 Manufacturer's mark

Z01/Z02/Z03 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

B. MUELLER
Test House Manager

Inspector's stamp

A01 AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

Date 14.05.10 BM 1

UNITED STATES STEEL

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

DATE: 06/01/12
TIME: 04:13:55
SERIAL NO: L0041424

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	VEHICLE ID
DR04533 01		118913-00	

SOLD TO ADDRESS
FEDERAL STEEL SUPPLY, INC.
THESE TEST REPORTS APPLY TO.
YOUR P.O. # LX-0939

MAIL TO ADDRESS

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

SPECIFICATION AND GRADE

PRESSURE PIPE CARBON SMLS BF ASTM A333-*11 GRADE 1 ASTM A333-*11 GRADE 6 ASME SA333-*2010 EDITION GRADE 1 ASME SA333-*2010 EDITION GRADE 6 ASTM A106-*10 ASME SA106-*2010 EDITION GRADE B DUAL STENCIL 58000 PSI MAX YIELD BLK REG MILL COAT PE BEV 30 DEG MEETING ALL THE APPLICABLE REQUIREMENTS OF MACK STANDARD MR-01-75 *:ISO 15156-2 2009 ED AND MR-0103-2009_ED

JOB # 12-0779
HEAT CODE # B959
(MA3971)

MATERIAL COND: FULL BODY NORMALIZED

O.D.: 24.000 (609.600) in (mm)

WALL: 0.500 (12.700) in (mm)

PRODUCT IDENTIFICATION	TENSILE TEST TYPE/ ORIENTATION	TEST COND.	GAUGE WIDTH IN	YIELD PSI	EXT % .50	TENSILE PSI	Y/T	ELONG % (IN 2")	HARDNESS SCALE: HRB	MIN HYDRO PSI	DWELL(SEC)
				MIN: 35000 MAX: 58000		MIN: 60000 MAX:	MAX:	MIN: 35.0	MIN: 66.0 MAX: 99.5	1000	5
MA3971 X138NA	STRIP/L/B	NM	1.500	47100	.50	68000	0.69	46.8	B 74.1	1000	5
MA3971 X138NA	STRIP/L/B	NM	1.500	46500	.50	68000	0.68	48.9			
		**	END OF DATA THIS SHEET **								

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

PRODUCT IDENTIFICATION	TYPE	C	MN	P	S	SI	CU	NI	CR	MO	AL	N	V	B	TI	CB	CO				C.E.*
																					MAX .50
MA3971	HEAT		14	111	010	001	24	09	04	03	02	031		02	0003	001	001				.35
MA3971 X138NA	PROD		14	110	011	001	21	10	03	02	01	022		02	0003	003	001				.34
MA3971 X138NA	PROD		15	110	012	001	22	11	03	03	01	025		02	0004	003	001				.35
			** END OF DATA THIS SHEET **																		

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

DECIMAL POSITIONS FOR ELEMENTS ARE INDICATED BY THE LEFT MARGIN. VERTICAL DOTTED LINE OR DECIMAL POINT. ELEMENTS REPORTED IN MASS FRACTION (%)

CONFORMS TO 2010 EDITION: 2011 ADDENDA

MATERIAL CHECKED TO ASME SECTION II BY CALHEX INDUSTRIES LTD.
DATE: DEC. 11/12
SIGNATURE:
MIN. THK.: .514", .520"

UNITED STATES STEEL

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

DATE: 06/01/12
TIME: 04:13:55
SERIAL NO: L0041424

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER
DR04533 01		118913-00

MATERIAL COND: FULL BODY NORMALIZED

O.D.: 24.000(609.600) in (mm)

WALL: 0.500 (12.700) in (mm)

PRODUCT IDENTIFICATION	FLAT	BEND	GRAIN SIZE	SSH COLLAPSE	CHARPY V-NOTCH IMPACT TESTING											
					DIR	TEST LOC.	TEMP DEG F	SIZE	TEST COND.	FT-LBS 1	FT-LBS 2	FT-LBS 3	FT-LBS AVG	% SHEAR 1	% SHEAR 2	% SHEAR 3	% SHEAR AVG
MA3971 X138NA	OK				L	B	- 50	FULL	NM	166	211	153	176	80	100	80	86
			**	END OF DATA THIS SHEET **													

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

TESTING / INSPECTION INFORMATION

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

ADDITIONAL NOTES/COMMENTS

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

FEDERAL STEEL SUPPLY
QA APPROVED
BY MB
DATE 10/23/12

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

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

DATE 06/01/12

PO# CX-09676 Item# 1
Heat Number: H0742/3
Trans Am Piping Products Ltd. - Rev'd By: SB
Shipment/Seq #: S 12 - 1760 11

24" CL 300 W/N FLANGE RF XH
BORE A350-LF2 CL 1

12-0779 2 FLANGES

TÜV CERT
EN ISO 9001 : 2008
Zertifikat-Registrier-Nr. 44 100 071888

BEBITZ

Bereich Flansche / Flange Division

Flanschenwerk Bebitz GmbH - Lebendorfer Str. 1 - 06420 Bebitz / GERMANY (A01)
Tel. +49 34691 40 0 - Fax +49 3469140 329 - Email: flanges@bebitz.de

Abnahmeprüfzeugnis 3.1 / Inspection certificate 3.1 / Certificat de reception 3.1

nach (A02) / acc. DIN EN 10204 : 2005 Nr. (A03) / No. 12-18377 **Datum (Z02) / Date** 21.08.2012

Zeichen des Herstellers (A04) / Manufacturer's brand: B

Stempel des Abnehmers (Z03) / Stamp of the testing engineer: TKO B

Überprüft als Hersteller nach AD-Merkblatt W0 / TRD100 und VdTÜV Werkstoffblätter 350/3, 354, 399. / Approved as manufacturer acc. AD-Merkblatt W0 / TRD100 and VdTÜV Material Sheets 350/3, 354, 399.
Zertifiziert nach DGR 97/23/EG durch TÜV CERT Zertifzierungsst. für Druckgeräte der TÜV NORD GmbH Co KG, Benannte Stelle Nr. 0045. / Certified acc. to PED 97/23/EC, certifying body for pressure equipment TÜV NORD GmbH Co KG, registration no. 0045.

Besteller (A06) Customer
TRANS AM Piping Products Ltd.
9335 Endeavor Drive S.E.
CALGARY, ALBERTA T3S 0A1

Bestell-Nr (A07) / Order-No. CI-12-302
Auftrag (A08) / Order 3220838
Lieferschein / Delivery No. 3233736
Position (B07.1) / Item 6

Stck (B08) Quantity	Bezeichnung (B01; B09 - B11) Product	Schmelze/Prüflos (B07) Heat no./Test no.
5	24 inch Welding Neck Flange 300 lbs XS raised face	H0742/3

Material (B02; B05) LF2 Class 1 - ASTM A 350M-07 / ASME SA-350M
forged 1050 - 1150°C / normalized 898 - 925°C, still air

Anford. (B03) Requirements
ASME B 16.5-2009
NACE MR0175-2011 / MR0103-2010 - DIN EN ISO 15156-2 : 2009
2011a ASME Boiler & Pressure Vessel Code - Section II Part A

Schmelzenanalyse (C71 - C92) / Ladle analysis **Erschmelzung (C70) / Melting process** E

≤0.32 ✓
≤1.00 ✓

C	Si	Mn	P	S	Cr	Ni	Ti	Mo	Nb	V	N	Cu	Al	CEV
0,180	0,23	1,12	0,010	0,004	0,15	0,08	0,001	0,02	0,003	0,015		0,11	0,024	0,42

$CEV = C + \frac{Mn}{6} + \frac{V + Mo + Cr}{5} + \frac{Ni + Cu}{15}$ $PREN = Cr + 3{,}3 \times Mo + 16 \times N$

Mechanische Prüfungen / Mechanical tests

Probenlage (C02): q/t / Position of Specimen: q/t
Zugversuch / Tensile Test - ASTM A 370 $l_0 = 4\,d_0$

Temp (C03) °C	Streckgr. (C11) / Yield strength 0,2% MPa (N/mm²)	1,0% MPa (N/mm²)	Zugfestigk. (C12) Tensile strength MPa (N/mm²)	Dehng. (C13) Elongation %	Einschnürg. Red. of area %	KBV / Charpy Impact Test DIN EN ISO 148-1 Temp. (C03) °C	Einzelwerte (C42) Single values J	MW (C43) Average J	Härte (C32) Hardness ISO 6506-1 HBW 2,5/187,5
20	min 250 max		485 655	22,0	30	-46	20	27	137 187
20	326 ✓		509 ✓	33,7 ✓	73 ✓	-50 ✓	140 ✓ 121 ✓ 110	123,7 ✓	153
20	323 ✓		507 ✓	34,2 ✓	74 ✓	-50 ✓	114 ✓ 143 ✓ 126	127,7 ✓	150

CONFORMS TO 2010 EDITION: 2011 ADDENDA

MATERIAL CHECKED TO ASME SECTION II BY CALHEX INDUSTRIES LTD.
DATE: DEC. 11/12
SIGNATURE:
MIN. THK.:

CA-TIS 0494

Besichtigung und Ausmessung ohne Beanstandungen. (D01) / Results of inspection and dimension without objections.
Die gestellten Anforderungen sind erfüllt. (Z01) / The product meets the requirements.

APZ wurde mit EDV erstellt und ist ohne Unterschrift gültig. /
This MTR was electronically generated and is valid without a signature.

R. Sparing,
Abnahmebeauftragter des Herstellers (Z02)
Inspection Representative of the Manufacturer

Angaben in Klammern entsprechen den Vorgaben der DIN EN 10168 /
Data in parentheses refer to EN 10168.

2 BLINDS 12-0779

PO# CX-09676 Item#4
Heat Number: 198658
Trans Am Piping Products Ltd. - Rev'd By: SB
Shipment/Seq #: S 12 - 1778 29

24" CL 300 BLIND FLANGE RF
A350-LF2 CL 1

SAN ENG STEEL FORGING CO LTD
311, Jen Hsin Road, Jen Wu District
Kaohsiung, Taiwan, R.O.C.
TEL:07-3724249 ; FAX:07-3712923
URL: www.saneng.com.tw
e-mail: saneng@ksts.seed.net.tw

MILL TEST CERTIFICATE

EN10204-3.1.B(DIN50049/3.1.B)

Customer: TRANS AM PIPING PRODUCTS LTD.

Order No.: 7005689(1)-T/A

Certificate No.: SE-5689A
Date: 08/31/2012
Page: 1 OF 1

PRODUCT	MATERIAL SPECIFICATIONS	DIMENSIONAL SPECIFICATIONS
FORGED CARBON STEEL FLANGES	ASTM A350 LF2-11 CL.1/ASME SA350 LF2-11 CL.1	ASME B16.5-09 CSA Z245.12

CHEMICAL COMPOSITION (%)

Item No.	CODE NO	DESCRIPTION	QUANTITY	C	Si	Mn	P	S	Cu	Cr	Ni	Mo	V	Nb	N			CE(*3)
			Min	-	0.150	0.600	-	-	-	-	-	-	-	-	-			
			Max	0.300	0.300	1.350	0.035	0.040	0.400	0.300	0.400	0.120	0.080	0.020	-			
1		150 BLRF 20" LF2	12 PCE	0.200	0.210	1.130	0.019	0.006	0.120	0.110	0.060	0.030	0.010	0.002	0.008			0.430
2		150 BLRF 24" LF2	5 PCE	0.200	0.210	1.130	0.016	0.007	0.160	0.120	0.100	0.020	0.010	0.001	0.008			0.436
3		300 BLRF 24" LF2 ←	15 PCE	0.210✓	0.190✓	1.140✓	0.015✓	0.006✓	0.136✓	0.098✓	0.060✓	0.010✓	0.002✓	0.002✓	0.005✓			0.433

≤0.32✓
≤1.00✓

Item No.	Heat No.	T.S.(*1) (MPA)	Y.S.(*1) (MPA)	E.L.(*1) (%)	Hardness (HB)	R.A.(*1) (%)	Impact Test Temp: -46°C✓ Minimum: 20.0 Joule 1	2	3	Material Supplier
	Min	485.0	250.0	22.0	-	30.0				
	Max	655.0	-	-	197	-				
1	292444	539.4	389.3	35.6	156/154	71.3	33.0	61.0	95.0	SEAH BESTEEL
2	B00530	547.0	400.0	33.8	155/152	68.6	101.0✓	63.0✓	75.0✓	SEAH BESTEEL
3	198658	525.6✓	361.9✓	34.4✓	154/151	70.4✓	74.0✓	81.0✓	60.0✓	SEAH BESTEEL ←

HEAT TREATMENT(*2)
☒ N

REMARKS
690°CX3HRS
CONFORMS WITH NACE MR0103-10 AND NACE MR0175/ISO15156.2-09
CONFORMS WITH Z245.12 CAT II GR.248 SOUR SERVICE-09(FOR USE AS WELDING NECK AND BLIND FLANGES ONLY)
TEST SPECIMEN SIZE: 10X10
TEST SPECIMEN ORIENTATION: TRANSVERSE
IMPACT TEST TEMP.: -46°C

SAN ENG STEEL FORGING CO., LTD. QUALITY ASSURANCE DEPT.

Manager of Quality Assurance Dep't

*1: T.S. = Tensile Strength, Y.S.=Yield Strength, E.L.=Elongation, R.A.=Reduction of Area.

*2: N=Normalized, A=Annealed, Q=Quenched, T=Tempered, S.T=Solution Treated, S.R=Stress Relieved, A.C=Air Cooled, F.C=Furance Cooled, W.C=Water Cooled, O.C=Oil Cooled.

*3: C.E. Value = C + (Mn /6) + (Cr + Mo +V) / 5 + (Ni + Cu) / 15

We hereby certify that the material has been tested in accordance with the above specification and also with the requirements called for by the above order.

CONFORMS TO 2010 EDITION: 2011 ADDENDA JAR

MATERIAL CHECKED TO
ASME SECTION II BY
CALHEX INDUSTRIES LTD.
DATE: DEC.11/12
SIGNATURE: JAR
MIN. THK.:

CA-TIS

520904AH006-1 ENSTEEL INDUSTR - Cert#: P20420CT002.5699M.01116 - P.O.#: 40079 A

ESSAR Steel Algoma Inc.

105 West Street, Sault Ste. Marie, Ontario Canada P6A 7B4

CUSTOMER PURCHASE ORDER NUMBER	ENTRY DATE	CREATE DATE	TALLY NUMBER	SHIPPER'S NO.	CARRIER	MILL ORDER
P20420CT002E	2012/04/24	2012/06/27	284093	-	CP -317404	19992

SHIP TO CUSTOMER NAME AND ADDRESS

WILKINSON STEEL AND METALS INC.
9525-60TH AVENUE
EDMONTON ALBERTA
T6E 0C3

SHIP TO CUSTOMER NAME AND ADDRESS

WILKINSON STEEL AND METALS INC.
C/O BATES EQUIPMENT
9525 60TH AVENUE
EDMONTON, ALBERTA T6E 0C3

MILL TEST REPORTS

ESSAR STEEL ALGOMA INC. HEREBY CERTIFIES THAT THE MATERIAL HEREIN DESCRIBED WAS MADE AND TESTED IN ACCORDANCE WITH THE RULES OF THE SPECIFICATION SHOWN. ALL RESULTS ARE RETAINED IN ACCORDANCE WITH THE COMPANY'S STANDARD RECORD KEEPING PRACTICES.

K. UGHADPAGA
MANAGER METALLURGICAL SERVICES

THIS MILL TEST REPORT MAY NOT BE REPRODUCED EXCEPT IN FULL WITHOUT WRITTEN APPROVAL OF ESSAR STEEL ALGOMA INC. IF YOU RECEIVE THIS DOCUMENT AND ARE NOT THE INTENDED RECEIVER, PLEASE CALL (705)945-2424 COLLECT FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.

CUSTOMER SPECIFICATION

HR MULTIPLE CERTIFIED PLATE - CARBON - ASTM A516 GR 70/ASME SA516 GR 70 (10) (11A) - CVNL 20/16 FT LBS AT -50 F - FULLY KILLED - FINE GRAIN - PVQ - NORMALIZED - FLATNESS 1/2 A-20 - NACE MR0175 - BHN 200 MAX NORMALIZED FOR 12 MINUTES MIN @ 1670 F

3/8" SA 516 70N HT # 5699M PL # 01115 W1123 Sept '12

SUPPLEMENTARY INSTRUCTIONS

TEST CERT 1: CSTEPANIUK@WILKINSONSTEEL.COM TEST CERT 2: MEL ELI AS 604-301-3244 PLATE TEST COUPON:

INSP TA TEST REPORTS REQUIRED

CUST USE RESALE

2000229923 PF
2012/07/01 12:55

MEETS EN 10204:2004 TYPE 3.1
ISO QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM
ALL HEATS FULLY KILLED
HEATS INDICATED WITH (*) FINE GRAINED
HEATS INDICATED WITH (+) MADE IN CANADA WITH DOMESTIC AND NORTH AMERICAN MATERIALS

* PRODUCT SHIPPED *

CUSTOMER ITEM 00003 OUR ITEM 008 DIMENSIONS .375 X 120 X 480 "

CONFORMS TO 2010 EDITION: 2011 ADDENDA

PLATE NUMBER	HEAT-MS	NO. PIECES	WEIGHT
01115	5699M-05	2	12251
01116	5699M-08	2	12251

* MECHANICAL PROPERTIES *

TENSILE TESTS:

HEAT	PLATE NUMBER	SAMPLE SRCE	SAMPLE GAUGE	TEST COND	TEST METH	TEST DIR	YIELD KSI	TENSILE KSI	% ELONG	
5699M	01115	166"	.3750	N	.2	T	53.1	74.0	25(8")	LAB
5699M	01116	166"	.3750	N	.2	T	52.1	74.0	24(8")	ALG

HARDNESS TESTS:

HEAT	PLATE NUMBER	SRCE	GAUGE IN	TEST COND	TEST METH	HARDNESS	
5699M	01115	166"	.3750	N	HBW	152	LAB
5699M	01116	166"	.3750	N	HBW	152	ALG

MATERIAL CHECKED TO ASME SECTION II BY CALIEX INDUSTRIES LTD.
DATE: DEC. 11/12
SIGNATURE:
MIN. THK.: .390"; .391"; .390" ALG

JOB # 12-0779
HEAT CODE # B947
(5699M-01115)

WARNING THE TEST RESULTS AND VALUES REPORTED HEREIN INDICATE ONLY THAT (1) THE PARTICULAR STEEL FOR WHICH THIS CERTIFICATE IS ISSUED MEETS THE MINIMUM SPECIFIED YIELD STRENGTH AND (2) THE CHEMICAL ANALYSIS AND PHYSICAL PROPERTIES OF SUCH STEEL ARE IN CONFORMANCE WITH THE REQUIREMENTS OF THE SPECIFICATION INDICATED. THE RESULTS OR VALUES REPORTED HEREIN CAN NOT BE USED TO QUALIFY THE STEEL FOR ANY SPECIFICATION OTHER THAN THE ONE INDICATED AND CAN NOT BE RELIED UPON FOR ANY PURPOSE (INCLUDING DESIGN OR CALCULATIONS) AS REPRESENTING THE ACTUAL STRENGTH OF SUCH STEEL.

CA-IIS 0088

S20904AH006-1 ENSTEEL INDUSTR - Cert#: P20420CT002.5699M.01116 - P.O.#: 40079 A

ESSAR Steel Algoma Inc.

105 West Street, Sault Ste. Marie, Ontario Canada P6A 7B4

CUSTOMER PURCHASE ORDER NUMBER	ENTRY DATE	CREATE DATE	TALLY NUMBER	SHIPPER'S NO.	CARRIER	MILL ORDER
P20420CT002E	2012/04/24	2012/06/27	284093	-	CP -317404	19992

SHIP TO CUSTOMER NAME AND ADDRESS

WILKINSON STEEL AND METALS INC.
9525-60TH AVENUE
EDMONTON ALBERTA
T6E 0C3

SHIP TO CUSTOMER NAME AND ADDRESS

WILKINSON STEEL AND METALS INC.
C/O BATES EQUIPMENT
9525 60TH AVENUE
EDMONTON, ALBERTA T6E 0C3

CUSTOMER SPECIFICATION

HR MULTIPLE CERTIFIED PLATE - CARBON - ASTM A516 GR 70/ASME SA516 GR 70 (10) (11A) - CVNL 20/16 FT LBS AT -50 F - FULLY KILLED - FINE GRAIN - PVQ - NORMALIZED - FLATNESS 1/2 A-20 - NACE MR0175 - BHN 200 MAX NORMALIZED FOR 12 MINUTES MIN @ 1670 F

SUPPLEMENTARY INSTRUCTIONS

TEST CERT 1: CSTEPANIUK@WILKINSONSTEEL.COM TEST CERT 2: MEL ELI AS 604-301-3244 PLATE TEST COUPON:

SHIP VIA TEST REPORTS REQUIRED

COST USE RESALE

2000229923 PF

2012/07/01 12:55

MILL TEST REPORTS

ESSAR STEEL ALGOMA INC. HEREBY CERTIFIES THAT THE MATERIAL HEREIN DESCRIBED WAS MADE AND TESTED IN ACCORDANCE WITH THE RULES OF THE SPECIFICATION SHOWN. ALL RESULTS ARE RETAINED IN ACCORDANCE WITH THE COMPANY'S STANDARD RECORD KEEPING PRACTICES.

K. UCHADPAGA
MANAGER METALLURGICAL SERVICES

THIS MILL TEST REPORT MAY NOT BE REPRODUCED EXCEPT IN FULL WITHOUT WRITTEN APPROVAL OF ESSAR STEEL ALGOMA INC. IF YOU RECEIVE THIS DOCUMENT AND ARE NOT THE INTENDED RECEIVER, PLEASE CALL (705)945-2424 COLLECT FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.

MECHANICAL PROPERTIES

IMPACT TESTS:

HEAT	PLATE NUMBER	SRCE	GAUGE IN	COND	METH	DIR	SIZE	TEMP	FULLSIZE ENERGY * FTLB			* AVG*	SPEC	LAB
5699M	01115	166"	.3750	N	CVN	L	3/4	-50F	101	92	84	92	ASTM	ALG
5699M	01116	166"	.3750	N	CVN	L	3/4	-50F	85	101	102	96	ASTM	ALG

CHEMICAL PROPERTIES

HEAT	(WT %)	C	MN	P	S	SI	CR	NI	CU	MO	AL	CB	V	B	DO
		TI	SN	N	AS	ZR	PB	SB							
5699M*+		.21	1.06	.011	.007	.29	.02	.02	.04	.00	.032	.000	.001	.0002	.40
		.003													

≤0.32
≤1.00

WARNING THE TEST RESULTS AND VALUES REPORTED HEREIN INDICATE ONLY THAT (1) THE PARTICULAR STEEL FOR WHICH THIS CERTIFICATE IS ISSUED MEETS THE MINIMUM SPECIFIED YIELD STRENGTH AND (2) THE CHEMICAL ANALYSIS AND PHYSICAL PROPERTIES OF SUCH STEEL ARE IN CONFORMANCE WITH THE REQUIREMENTS OF THE SPECIFICATION INDICATED. THE RESULTS OR VALUES REPORTED HEREIN CAN NOT BE USED TO QUALIFY THE STEEL FOR ANY SPECIFICATION OTHER THAN THE ONE INDICATED AND CAN NOT BE RELIED UPON FOR ANY PURPOSE (INCLUDING DESIGN OR CALCULATIONS) AS REPRESENTING THE ACTUAL STRENGTH OF SUCH STEEL.

4PCS 8" FLANGES 12-0779

8" CL 300 W/N FLANGE RF XH
BORE A350-LF2 CL 1

PO# CX-09676 Item# 3
Heat Number: 12/30011
TransAm Piping Products Ltd. - Rev'd By: SB
Shipment/Seq #: 5112 - 1425 14

METALFAR
PRODOTTI INDUSTRIALI S.P.A.
STAMPAGGIO A CALDO DI ACCIAI COMUNI - LEGATI E INOSSIDABILI

SEDE AMMINISTRATIVA E STABILIMENTO
23861 CESANA BRIANZA (LC) - Italy
Via G. Parini, 29
Tel. +39 031.655441
Fax +39 031.655149
quality.mfi@tiammes.com

COMPANY WITH QUALITY MANAGEMENT SYSTEM CERTIFIED BY DNV = ISO 9001:2008 =

SALA PROVE E ANALISI MATERIALI / MATERIAL TEST DEPARTMENT

CERTIFICATO DI COLLAUDO SECONDO EN 10204 - 3.1 INSPECTION CERTIFICATE

Certif. N. 2226	Del/Dated 08.05.2012	Fattura / Invoice N. 1541	Del/Dated 07.05.2012
DDT / Del Note N. 1792	Del/Dated 07.05.2012	Ns.Ord. / Our ref. N.	Del/Dated

TRANS AM PIPING PRODUCTS LTD
9335 ENDEAVOR DRIVE S.E.
T3S 0A1 CALGARY, ALBERTA CA

Dest.: TRANS AM "PROJECTS" Warehouse
9335 - Endeavor Drive S.E.
T3S 0A1 Calgary, ALBERTA CA

COD. COL. COLATA / HEAT CODE HEAT: 12/39812 | POS. ITEM: 030 | VS.ORDINE / YOUR REFERENCE: CI-12-311 | Q.TA' / Q.TY: 520,00 | DESCRIZIONE / DESCRIPTION: W/N 300 RF 2" XS LF2CL1

DIM.IN ACC. A / DIM. ACCORDANCE TO: ASME/ANSI B16.5 -2009

VISIVO E DIMENS. / VIS. & DIMENS.: SATISFACTORY

MATERIALE / MATERIAL: ASTM A350 LF2 CL1/2 (LADLE)

C%	Si%	Mn%	S%	P%	Cr%	Ni%	Mo%	Ti%	Cu%	V%	Nb%	N%	Al%	C.E.%
0,195	0,230	0,960	0,008	0,011	0,190	0,060	0,020	0,018	0,130	0,002	0,002	0,000	0,025	0,410

PROVETTA / TEST SPECIMEN SEZ. mm2 / SECT. mm2	LUNG. mm / LENGHT mm	FORMA / SHAPE 1=○ 2=□	SNERVAMENTO / YIELD POINT N/mm2 >=0,2%	ROTTURA / TENSILE STRENGHT N/mm2 >=	ALLUNGAMENTO / ELONGATION %>=	CONTRAZIONE / REDUCTION OF AREA %>=	DUREZZA / HARDNESS HBW
126,60	50,80	1	353,0	525,0	31,0	59,0	159,0 - 163,0

RESILIENZA / IMPACT TEST - JOULE/mm2

TIPO / TYPE 10x10mm	°C	1	2	3
KV	-50	66	64	68

SNERVAMENTO / YIELD POINT N/mm2 >=1,0% Ns.Rif. / OUR REF.: 0,0

MATERIALE IN ACCORDO A / MATERIAL IN ACC. TO: ASTM/ASME A 350/SA 350 M - 11 ASME CODE SECT. II, PART A, ED. 2010
CSA Z245.12 GRADE 248 CAT.II

TRATTAMENTO TERMICO / HEAT TREATMENT: NORMALIZED AT 930 C - COOLED IN STILL AIR

FORNO / FURNACE: ELECTRIC FURNACE

ORIGINE / ORIGIN: EUROPE

COD. COL. COLATA / HEAT CODE HEAT: 12/30011 | POS. ITEM: 033 | VS.ORDINE / YOUR REFERENCE: CI-12-311 | Q.TA' / Q.TY: 48,00 | DESCRIZIONE / DESCRIPTION: W/N 300 RF 8" XS LF2CL1

≤0.32 ✓
≤1.00 ✓

DIM.IN ACC. A / DIM. ACCORDANCE TO: ASME/ANSI B16.5 -2009

VISIVO E DIMENS. / VIS. & DIMENS.: SATISFACTORY

MATERIALE / MATERIAL: ASTM A350 LF2 CL1/2 (LADLE)

C%	Si%	Mn%	S%	P%	Cr%	Ni%	Mo%	Ti%	Cu%	V%	Nb%	N%	Al%	C.E.%
0,190 ✓	0,240 ✓	0,950 ✓	0,010 ✓	0,010 ✓	0,100 ✓	0,060 ✓	0,020 ✓	0,020	0,130 ✓	0,002 ✓	0,000 ✓	0,000	0,028	0,385

PROVETTA / TEST SPECIMEN SEZ. mm2 / SECT. mm2	LUNG. mm / LENGHT mm	FORMA / SHAPE 1=○ 2=□	SNERVAMENTO / YIELD POINT N/mm2 >=0,2%	ROTTURA / TENSILE STRENGHT N/mm2 >=	ALLUNGAMENTO / ELONGATION %>=	CONTRAZIONE / REDUCTION OF AREA %>=	DUREZZA / HARDNESS HBW
126,60	50,80	1	346,0 ✓	514,0 ✓	30,0 ✓	59,0 ✓	156,0 - 159,0

RESILIENZA / IMPACT TEST - JOULE/mm2

TIPO / TYPE 10x10mm	°C	1	2	3
KV	-50 ✓	66 ✓	68 ✓	64 ✓

SNERVAMENTO / YIELD POINT N/mm2 >=1,0% Ns.Rif. / OUR REF.: 0,0

MATERIALE IN ACCORDO A / MATERIAL IN ACC. TO: ASTM/ASME A 350/SA 350 M - 11 ASME CODE SECT. II, PART A, ED. 2010
CSA Z245.12 GRADE 248 CAT.II

TRATTAMENTO TERMICO / HEAT TREATMENT: NORMALIZED AT 930 C - COOLED IN STILL AIR

FORNO / FURNACE: ELECTRIC FURNACE

ORIGINE / ORIGIN: EUROPE

CONFORMS TO 2010 EDITION: 2011 ADDENDA

MATERIAL CHECKED TO
ASME SECTION II BY
CALHEX INDUSTRIES LTD.
DATE: DEC 11/12
SIGNATURE:
MIN. THK.:

NOTE MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION
NOTES MATERIAL IN ACCORDANCE WITH NACE MR-0175/2003 ISO 15156-2009
MATERIAL IN ACCORDANCE WITH NACE MR-0103/2010

UFFICIO CONTROLLO QUALITA' / QUALITY CONTROL DEPARTEMENT	ENTE UFFICIALE DI COLLAUDO / INSPECTION AUTHORITY	MARCHIO PRODUZIONE / MANUFACTURER'S SYMBOL
S. Corti		MFF

PO# CX. 06313. J-b# 10.0528/stock
19'.6" log.

Auestraße 25, 52249 Eschweiler
Telefon 0 24 03 / 7 92 - 181 Verkauf -275 Qualitätsstelle
Telefax 0 24 03 / 7 92 - 180 Verkauf -270 Qualitätsstelle

ESW Röhrenwerke GmbH

Abnahmeprüfzeugnis 3.1
Inspection certificate 3.1
Certificat de reception 3.1
nach EN 10204

Besteller/Purchaser/Acheteur:

FIRMA
SEAMLESS STEEL PIPE LTD.

6771 84 STREET S.E.

CDN CALGARY, AB T2C 4T6

Werks-Nr./Our Order-No./N° Cde Usine: 354721 002 0 01

Werkstoff/Quality/nuance d'acier: Grade290:CATII/Gr.6

Bestell-Nr./Order-No./N° Cde Acheteur: 1143037 KN:06-5618/I-6078

H.-Zeichen:

Gegenstand/Product/Produit:

SEAMLESS, HOT ROLLED STEEL TUBES

Prüfbedingungen/Technical requirements/Specifications techniques:
ASTM A/ASME SA 333/999 HF 04+ASME Sect.II Pt.A/ 04 ADD.05+CSA Z245.1-02 Cat.II+NACE MR 0175/03

Lieferbedingungen/Terms of Delivery/Conditions de livraison:
see technical requirements + ASME B 36.10M/04

Kennzeichnung/Marking/Marquage:
ESW ASTM A/ASME SA 333 Grade 290 Cat II/Gr.6 268216 M 45 C S HN 8" NPS x Sched 80 AS US Germany P.O. I-6078

Pos./Pos./Pos.	Stück/Quantity/Nombre	Abmessungen/Dimensions	Masse/Weight/Masse kg x lbs	Meter/Mètre	Prüfdruck/Test Pressure/Pression hydraulique bar
2	18	8" NPS x Sched 80 8,626" X 0,500" 18 FT - 22 FT	15565	350,02	207

Schmelzen-Nr./Cast-N° coulée	Erschm.-Art/Mode Melting-Furn. d'elabor	Schmelzenanalyse/Heat Analysis/Analyse sur coulée
268216	Y	CONFORMS TO 2007 EDITION: 2009 ADDENDA

% C	% SI	% MN	% P	% S	% CU	% CR	% NI	% MO	% V
0,1600	0,2400	0,8500	0,0200	0,0020	0,0200	0,0500	0,0300	0,0100	0,0010
% CAE	**% N**	**% AL**	**% NB**	**% AS**	**% SN**	**% TI**			
0,3200	0,0040	0,0280	0,0010	0,0020	0,0010	0,0050			

MATERIAL CHECKED TO ASME SECTION II BY CALTEX INDUSTRIES LTD.

DATE: Mar 18, 2010

SIGNATURE:

MIN. THK.: 0.527"

Ultraschall-Prüfung gem./Ultrasonic Test acc. to/Contrôle par ultrasons suivant

acc. to ASTM E 213 o.k

Es wird bestätigt, daß die Lieferung geprüft wurde und den oben angeführten Prüf- und Lieferbedingungen entspricht.
Hereby it is certified that the material has been tested and complies with the above mentioned technical requirements and terms of delivery.
Nous certifions que les produits livrés étaient vérifiés et sont conformes aux stipulations de la commande.

Die gestellten Anforderun
Les conditions requises s
Sämtliche Rohre haben d
The tubes/pipes have pas
Tous les tubes ont subi av

freien Durchgang.
sage.
il étanches.

Der Rohrwerkstoff entspri
The material of the tubes/
Le matériau des tubes répond à la norme ci-dessus, au degré spécifié de la norme indiquée.

CONFORMS TO 2010 EDITION: 2011 ADDENDA

JOB # 10-0528
HEAT CODE # B368
268216

Die Rohre befinden sich über ihre ganze Länge in sachgemäßem Wärmebehandlungszustand.
The tubes/pipes are in a relevant heat-treated condition./Sur toute leur longueur, les tubes sont dans un bon état thermique.
Lieferzustand/Condition of Delivery/Etat de livraison: normalisiert/normalized/normalisé - vergütet/hardened and tempered/trempé et revenu - geglüht/annealed/recuit

Die Vorbehandlung des Vormaterials wurde entsprechend Gütestufe III durchgeführt.
The preparatory treatment of the material complies with grade III.
La préparation des matières premières répond au degré de qualité III.

Die Prüfung auf Werkstoffverwechslung wurde an allen Rohren durchgeführt./Each tube/pipe is tested for exchange of material.
Vérification de la nuance (chaque tube).

CuNiMoV
.02+.03+.02+.024+.008 = .094% < 0.60%

ESW Röhrenwerke GmbH
Eschweiler

CE: .39%
Nichts NACE MR0175

ESCHWEILER, DEN 20.10.2006
ZERTIFIZIERTER WERKSTOFFHERSTELLER GEM. DGRL/PED 97/23/EG,
ANHANG 1, ABSCHNITT 4.3, TUEV-ANLAGENTECHNIK GMBH,
1 Anlage(n)/Enclosure(s)/Annexe(s) KENN-NR. 0035.
DIESES ZEUGNIS IST MASCHINELL ERSTELLT UND WIRD NICHT UNTERSCHRIEBEN

GEZ. DREXLER
Der Abnahmebeauftragte
Inspection Inspector
L'expert d'usine

8" SCH 80 ASTM A/SA 333 Gr 6 HT. 268216

ESW Röhrenwerke GmbH

Auestraße 25, 52249 Eschweiler
Telefon 02403/792-181 Verkauf -275 Qualitätsstelle
Telefax 02403/792-180 Verkauf -270 Qualitätsstelle

Anlage/Enclosure/Annexe N°: 1
Werks-Nr./Our Order No./
N° Cde Usine:
354721 002 0 01

Prüfergebnis/Test results/Résultat des essais

Besichtigung und Ausmessung/
results of inspection an measurement/
Contrôle aspect et dimensions: O.B./OK/SATISFAISANT

Ringaufdornversuch/Ring expanding test/
Essai d'anneau (traction):

Ringzugversuch/Ring tensile test/
Essai d'anneau (évasement):

Ringfaltversuch/Flattening test/
Essai d'aplatissement: O.B./OK/SATISFAISANT

Aufweitversuch/Flaring test/
Essai d'évasement:

Drifttest:/Drifttest:/Contrôle de Mandrin:

Schmelzen-Nr./ Cast-No. N° Coulée	Rohr-Nr. Test-No. N° d'essai	Streckgrenze/ Yield stress/ Limit élastique R_e N/mm²	Zugfestigkeit/ Tensile strength/ Résistance R_m N/mm²	Bruchdehnung/ Elongation/ Allongement A_2 %	Kerbschlagarbeit/Impact Value/ Essai de flexion par choc Joule					
					bei/at/.. °C	1.	2.	3.	Mittel/ Average/ Moyen	Probe/Type/ Type:
		290-495	415-625	MIN. 30	-45				27	ISO-V
268216		302 307	440 447	34 36	- 45 - 45	147 140	139 142	155 152	147 145	

Technical requirements: * + ISO 15156-1/03 + ISO 15156-2/03*. The material conforms with NACE MR 0103. Hardness acc. to NACE MR 0175/03 max. 22 HRC.
Test Pressure 207 bar is äquivalent to 20,7 mpa.

ESW Röhrenwerke GmbH
Eschweiler

ESCHWEILER, DEN 20.10.2006

Eschweiler, den

GEZ. DREXLER

DIESES ZEUGNIS IST MASCHINELL ERSTELLT UND WIRD NICHT UNTERSCHRIEBEN

Der Abnahmebeauftragte
Work's Inspector
L'expert d'usine

Anlage zum Abnahmezeugnis des Auftrags/Enclosure to inspection certificate by Order-No.: 354721 002

Stahlsorte: Gr.6/Gr.290 Cat II

Schmelzen-Nr.: 268216

Schmelzenanalyse / Heat analysis / Analyse sur coulée [%]

	C	Si	Mn	P	S	Al	Cu	Cr	Ni	Mo	V	As	Sn	Nb	Ti	N					
268216	0,16	0,24	0,82	0,020	0,002	0,028	0,02	0,05	0,03	0,01	0,001	0,002	0,001	0,001	0,005	0,0040					
Check 1	0,17	0,22	0,85	0,017	0,001	0,030	0,02	0,040	0,03	0,02	0,002	0,002	0,004	0,002	0,003	0,0050					

ESW Röhrenwerke GmbH
Qualitätsstelle

Q_A erstellt am 29.08.2006

SSP
SEAMLESS STEEL PIPE LTD

CERTIFICATE OF COMPLIANCE

BRINNEL HARDNESS TEST RESULTS
PIN BRINNEL TESTER TO NACE MR0175

Heat	Description		BHN
268216	8" S/80 (.500") GR 6	SMLS ASTM /ASME A/SA-333	125

Operator RALPH GPETZ
Date: November 18, 2008

6771 - 84 STREET S.E.
CALGARY, ALBERTA T2C 4T6
TEL 403-236-9305
FAX 403-236-8879

SSAB

1/4" SA516 70N HT # W2H505 PL # D01 4571 Oct '12

Test Certificate

12400 Highway 43 North, Axis, Alabama 36505

Form TC1: Revision 1: Date 31 Oct 2000

Customer:
SAMUEL & SON LIMITED
(A DIVISION OF SAMUEL SALES)
2360 DIXIE ROAD
MISSISSAUGA
ON L4Y1Z7

Customer P.O. No.: U01205 & 41-337110 | Mill Order No.: 41-337111-01 | Shipping Manifest: AR145797

Product Description: ASTM A516-70(10)/ASME SA516-70(11A)
NACE MR0175 ANNEX A2.1.2 COMPLIANT
LCVN 20 FT-LBS @ -50F/A673-P
NORMALIZED

Ship Date: 04 Sep 12
Cert Date: 04 Sep 12

Cert No: 081348938
(Page 1 of 1)

Size: 0.250 X 120.0 X 480.0 (IN)

Heat Id	Piece Id	Tested Thickness	Tst Loc	YS (KSI)	UTS (KSI)	%RA	Elong % 2in 8in	Tst Dir	Average Hardness	Charpy Impact Tests: Abs. Energy(FTLB) 1 2 3 Avg	% Shear 1 2 3 Avg	Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
E2H127	B08	0.246 (DISCRT)	T	56	77		29	T	165 HBW	36 38 37 37		-50F	L	5.0	
W2H505	D01	0.251 (DISCRT)	T	54	75		23	T	159 HBW	32 47 34 38		-50F	L	5.0	

Heat Id	C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	B	CEV	ORGN
						Chemical Analysis										≤0.32 ✓ ≤1.00 ✓	
E2H127	.18	1.12	.010	.001	.20	.025	.024	.29	.14	.07	.07	.002	.006	.007	.0000	.42	USA
W2H505	.18	1.12	.008	.002	.20	.027	.026	.26	.13	.10	.03	.003	.006	.008	.0000	.42	USA

MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED
DURING THE MANUFACTURE OF THIS PRODUCT
KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE
CEV (IIW) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15
MTR EN 10204:2004 INSPECTION CERTIFICATE 3.1 COMPLIANT
CHARPY FULL SIZE EQUIVALENT = ABSORBED ENERGY AVG X 10 / TEST SIZE IN MM
NORMALIZED PLATES. HEATED AT 1665F FOR 15 MINUTES.
TEST COUPONS TAKEN FROM HEAT TREATED PLATE.
PRODUCTS SHIPPED:

W2H505	D01	6366524	PCES:	1,	WGT:	4178	W2H505	D01	6366523	PCES:	1,	WGT:	4178
W2H505	D01	6366521	PCES:	1,	WGT:	4177	W2H505	D01	6366519	PCES:	1,	WGT:	4177
W2H505	D01	6366518	PCES:	1,	WGT:	4177	W2H505	D01	6366517	PCES:	1,	WGT:	4178
E2H127	B08	6368185	PCES:	1,	WGT:	4084	E2H127	B08	6368184	PCES:	1,	WGT:	4080
E2H127	B08	6368186	PCES:	1,	WGT:	4080	E2H127	B08	6368182	PCES:	1,	WGT:	4082

MATERIAL CHECKED TO
ASME SECTION II BY
CALHEX INDUSTRIES LTD.
DATE: DEC. 6/12
SIGNATURE:
MIN. THK.: .247"; .245"; .245"; .245"

JOB # 12-0779
HEAT CODE # B998
(W2H505-D01)

CONFORMS TO 2010 EDITION: 2011 ADDENDA

CA-TISCO

(P) Cust Part # :

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

Justin Ward
SENIOR METALLURGIST - PRODUCT

SPECTRUM N.D.T. LTD

MAGNETIC PARTICLE TEST REPORT

Client CALHEX INDUSTRIES	**Job #**	12-0779	**Report #**	**150340**
	Req # or PO #		Work Sheet #	47139
Address CALGARY, ALBERTA	Requested by MR. ANDREW BENNS		Demo #	1013
			Procedure #	MP2 REV4

Work Description INSPECTION OF TUBE SHEET BEVELED EDGES BEFORE WELDING		Material CARBON STEEL	Surface EXTERNAL
Code ASME V ART. 7	Acceptance Criteria ASME VIII DIV. 1 APP.6	Ambient Temp ≥16°C	Background / Batch WCP 2 / 11B12K / 01879
Technique CONTINUOUS MAGNETISM	Equipment/Serial # B300 YOKE / 50860	Power AC 110 V	Lifting Capability Check 10 LBS OK
Particle type RED	Batch # 16595	Particle Size 20 Um AVG.	Particle Manufacture CIRCLE SYSTEMS INCORPORATED
Light Source GE 12V BULB	Light intensity 1100 LUX	Inspection surface GOOD	Inspector D ULMER

IDENTIFICATION	DESCRIPTION	COMMENTS
VESSLE ID# 12-0779	TUBESHEET "A" BEVELED EDGES BEFOREWELDING	NO REJECTABLE INDICATIONS NOTED ~ACCEPTABLE~
VESSLE ID# 12-0779	TUBESHEET "B" BEVELED EDGES BEFOREWELDING	NO REJECTABLE INDICATIONS NOTED ~ACCEPTABLE~

Ind No	Position	Length	Remarks

Reg Hrs: 1.0	**OT1 Hrs:**	**OT2 Hrs**	**Consumables ()**

CHANGES, MODIFICATIONS, ALTERATIONS OR ADDITIONAL WELDING WITHOUT RE-INSPECTION VOIDS REPORT.

CLIENT	INSPECTOR	LEVEL CGSB LEVEL II # 16069 SNT LEVEL II	DATE NOVEMBER 30, 2011

CA-TIS0084

SPECTRUM N.D.T. LTD

MAGNETIC PARTICLE TEST REPORT

Client CALHEX INDUSTRIES	**Job #**	**12-0779**	**Report #**	**150367**
	Req # or PO #		Work Sheet #	47151
Address CALGARY, ALBERTA	Requested by MR. ANDREW BENNS		Demo #	1014
			Procedure #	MP2 REV4

Work Description INSPECTION OF VARIOUS VESSEL WELDMENTS		Material CARBON STEEL	Surface EXTERNAL
Code ASME V ART. 7	Acceptance Criteria ASME VIII DIV. 1 APP.6	Ambient Temp ≥16°C	Background / Batch EXTERNAL SURFACE WCP 2 / 11B12K / 01874
Technique CONTINUOUS MAGNETISM	Equipment/Serial # B300 YOKE / 50860	Power AC 110 V	Lifting Capability Check 10 LBS OK
Particle type 7C	Batch # 08GO91	Particle Size < 20 Um AVG.	Particle Manufacture MAGNAFLUX
Light Source GE 12V BULB	Light intensity 1100 LUX	Inspection surface AS WELDED	Inspector D ULMER

IDENTIFICATION	DESCRIPTION	COMMENTS
	SHELL SIDE	
VESSLE ID# 12-0779	EXPOSED EDGES OF TUBESHEET "A" AFTER WELDING	NO REJECTABLE INDICATIONS NOTED ~ACCEPTABLE~
VESSLE ID# 12-0779	EXPOSED EDGES OF TUBESHEET "B" AFTER WELDING	NO REJECTABLE INDICATIONS NOTED ~ACCEPTABLE~
VESSLE ID# 12-0779	ALL ATTACHMENT WELDS TO SHELL	NO REJECTABLE INDICATIONS NOTED ~ACCEPTABLE~
VESSLE ID# 12-0779	TEMPORARY ATTACHMENT LOCATIONS ON SHELL	NO REJECTABLE INDICATIONS NOTED ~ACCEPTABLE~
VESSLE ID# 12-0779	LIFT LUG TO REPAD/ REPAD TO SHELL FILLET WELDS (X2)	NO REJECTABLE INDICATIONS NOTED ~ACCEPTABLE~
VESSLE ID# 12-0779	SADDLE TO SHELL FILLET WELDS (X3)	NO REJECTABLE INDICATIONS NOTED ~ACCEPTABLE~
VESSLE ID# 12-0779	CAT "D" NOZZLES (N1, N2)	NO REJECTABLE INDICATIONS NOTED ~ACCEPTABLE~
VESSLE ID# 12-0779	NAMEPLATE BRACKET FILLET WELDS	NO REJECTABLE INDICATIONS NOTED ~ACCEPTABLE~
	TUBE SIDE	
VESSLE ID# 12-0779	ALL ATTACHMENT WELDS	NO REJECTABLE INDICATIONS NOTED ~ACCEPTABLE~
VESSLE ID# 12-0779	TEMPORARY ATTACHMENT LOCATIONS ON SHELL	NO REJECTABLE INDICATIONS NOTED ~ACCEPTABLE~
VESSLE ID# 12-0779	CAT "D" NOZZLES (N3, N4, C3a, C3b)	NO REJECTABLE INDICATIONS NOTED ~ACCEPTABLE~
VESSLE ID# 12-0779	DAVIT ARM POCKET TO FLANGE FILLET WELDS (X2)	NO REJECTABLE INDICATIONS NOTED ~ACCEPTABLE~
VESSLE ID# 12-0779	CHANNEL COVER LIFT LUG FILLET WELDS (X2)	NO REJECTABLE INDICATIONS NOTED ~ACCEPTABLE~

Ind No	Position	Length	Remarks

Reg Hrs: 1.5	**OT1 Hrs:**	**OT2 Hrs:**	**Consumables (1.0 can)**

CHANGES, MODIFICATIONS, ALTERATIONS OR ADDITIONAL WELDING WITHOUT RE-INSPECTION VOIDS REPORT.

CLIENT	INSPECTOR	LEVEL CGSB LEVEL II # 16069 SNT LEVEL II	DATE DECEMBER 10, 2012

CA-TIS 00847

SPECTRUM N.D.T. LTD

ULTRASONIC TEST REPORT

Client CALHEX Industries	**JOB #**	**12-0779**	**Report #**	**140469**
	SER #	**N/A**	Work Sheet #	31434
Address Calgary, Alberta	Requested by Mr. A. Benns		Demo #	1018
			Procedure#	UP4 Rev. 1
Work Description Inspection of Repad Splices weldments		Code ASME V Art.4	Acceptance criteria ASME VIII Div.1, App.12	
Material / Thickness Carbon Steel, 1/4" Thk.	Surface Condition As Ground	Temperature 18 °C	Surface Preparation Grinding	
Instrument GE	Model USN 58L	Serial # 020L7T	Calibration Std IIW Block-A14827	
Sensitivity 3/32" Diameter SDH set at 80% FSH DAC		Couplant UT-X	Inspector K. Han	

Search Unit	Serial Number	Size	Ref Sensitivity	Scan Sensitivity
0 Deg. 2.25 Mhz GAMMA	022877	1.0" Diameter	BWE 80%	+6 dB
70 Deg. 4 Mhz Phoenix	B8304	10mm Diameter	80% FSH DAC	+ 6 dB
60 Deg. 4 Mhz Phoenix	C3932	10mm Diameter	80% FSH DAC	+ 6 dB
45 Deg. 4 Mhz Phoenix	C4883	10mm Diameter	80% FSH DAC	+ 6 dB

Identification	Description	Result
12-0779	Inspected Repad Splices welds L1 & L2 on nozzles: N1, N2, N3, N4	- ACCEPTABLE -

Ind #	Depth (inch)	Length (inch)	Amplitude (dB)	Probe(s)	Remarks	Classification

A = Acceptable minor non reportable indication B = Acceptable reportable indication C = Rejectable indication

Reg Hrs 2.0	**OT1 Hrs**	**OT2 Hrs**	**Consumables**

CHANGES, MODIFICATIONS, ALTERATIONS OR ADDITIONAL WELDING WITHOUT RE-INSPECTION VOIDS REPORT.

CLIENT	INSPECTOR	LEVEL	DATE
	K. D. Han	CGSB L2 #16012 / ASNT L3 #148347	Dec 12, 2012

CA-TIS 0084

RR #: 54558

SPECTRUM NDT LTD.

Radiographic Inspection Report

CLIENT: Calhex

JOB LOCATION: Calgary, AB

JOB #: 12-0779

P.O. #: _____ DATE: Nov 28/12

ISOTOPE: IR^{192} FILM: GAVERT D4 ☐

FILM/CASS: 1 D5 ☑

TECH #1 D7 ☐

EFSS: 3.5mm± OTHER:

CODE: UW51 ☐ UW52 ☑ B31.3 ☐ NS ☐ SC OTHER ☐

MATERIAL: ☑ CS ☐ SS

VEIWING ☑ SW ☑ EXPOSURE ☐ DW

ABBREVIATIONS: (LEGEND)

IF - INCOMPLETE FUSION
IP - INCOMPLETE PENETRATION
S - SLAG
P - POROSITY
I - ICICLES
UC - UNDERCUT
BT - BURN THROUGH
C - CRATER
HL - HIGH-LOW
LC - LOW COVER
CR - CRACK

FILM NO.	LOCATION	IF	IP	S	P	I	UC	BT	C	LC	CR	OK	REJ	REMARKS	SFD	DIA.	SOD	MSSOFD	THICK	# EXP	WS
C15	0-8											✓			12	24	11.5		XH	1	B
C75	0-8				1							✓			12	24	11.5		XH	1	A

INSPECTOR: Steve Wolfe

CLIENT REPRESENTATIVE:

FINAL INTERPRETATION OF RADIOGRAPHS SHALL BE THE RESPONSIBILITY OF THE CLIENT OR THEIR REPRESENTATIVE.

ASNT II ☑
ASNT III ☐
CGSB II ☐ 13808

COMMENTS:

CA-TIS

RR #: 54530

SPECTRUM NDT LTD.

Radiographic Inspection Report

CLIENT: Calhex **JOB LOCATION:** Calgary, AB

JOB #: 12-0779 **P.O. #:** _____ **DATE:** Nov 20/12

ISOTOPE: IR^{192} FILM: GAVERT D4 ☐
FILM/CASS: 1 D5 ☑
TECH #1 D7 ☐
EFSS: 3.5mm± OTHER:

CODE: UW51 ☐
UW52 ☑
B31.3 NS ☐ SC ☐
OTHER ☐

MATERIAL: ☑ CS ☐ SS

VEIWING ☑ SW ☑ EXPOSURE
☐ DW ☑

ABBREVIATIONS: (LEGEND)
IF - INCOMPLETE FUSION
IP - INCOMPLETE PENETRATION
S - SLAG
P - POROSITY
I - ICICLES
UC - UNDERCUT
BT - BURN THROUGH
C - CRATER
HL - HIGH-LOW
LC - LOW COVER
CR - CRACK

FILM NO.	LOCATION	IF	IP	S	P	I	UC	BT	C	LC	CR	OK	REJ	REMARKS	SFD	DIA.	SOD	MSSOFD	THICK	# EXP	WS
C45	0-8											✓			12"	24"	11.5		0.5	1	G
N1S	0-8				1							✓			9	8	8.5		0.5	1	A
N2S	0-8											✓			↓	↓	↓		↓	↓	A
N4S	0-8								2			✓									A

INSPECTOR: Steve Wolfe

CLIENT REPRESENTATIVE:

FINAL INTERPRETATION OF RADIOGRAPHS SHALL BE THE RESPONSIBILITY OF THE CLIENT OR THEIR REPRESENTATIVE.

ASNT II ☑
ASNT III ☐
CGSB II ☐ 13808

COMMENTS:

CA-TIS: 00847

RR #: 54561

SPECTRUM NDT LTD.

Radiographic Inspection Report

CLIENT: Calhex **JOB LOCATION:** Calgary, AB

JOB #: 12-0779- **P.O. #:** _____ **DATE:** Nov 28/12

ISOTOPE: IR^{192} FILM: GAVERT D4 ☐
FILM/CASS: 1 D5 ☐
TECH #1 D7 ☑
EFSS: 3.5mm± OTHER:

CODE: UW51 ☑ UW52 ☑ B31.3 ☐ NS ☐ SC OTHER ☐

MATERIAL: ☑ CS ☐ SS

VEIWING ☑ SW ☑ EXPOSURE ☐ DW

ABBREVIATIONS: (LEGEND)
IF - INCOMPLETE FUSION
IP - INCOMPLETE PENETRATION
S - SLAG
P - POROSITY
I - ICICLES
UC - UNDERCUT
BT - BURN THROUGH
C - CRATER
HL - HIGH-LOW
LC - LOW COVER
CR - CRACK

FILM NO.	LOCATION	IF	IP	S	P	I	UC	BT	C	LC	CR	OK	REJ	REMARKS	SFD	DIA.	SOD	MSSOFD	THICK	# EXP	WS
N35												✓			8	8	7.5		XH	1	A

INSPECTOR: Steve Wolfe

CLIENT REPRESENTATIVE: _____

FINAL INTERPRETATION OF RADIOGRAPHS SHALL BE THE RESPONSIBILITY OF THE CLIENT OR THEIR REPRESENTATIVE.

ASNT II ☐
ASNT III ☐
CGSB II ☑ 13908

COMMENTS:

CA-TIS 00824

Lincoln Electric of Canada LP
179 Wicksteed Ave.
Toronto, ON M4G 2B9

CERTIFIED MATERIAL TEST REPORT

Product:	SUPERARC L-56	Size:	0.035" (0.9 mm)
Classification:	ER 70S-6	Q3 Lot No.:	12829712
Specification:	AWS A5.18	Heat No.:	C88620
Date Completed:	MARCH 23, 2012	Stock No.:	ED561006PIPE (44 lb. fibre spool)

This is to certify that SUPERARC L-56, Q3 Lot number 12829712, was tested using the GMAW process in accordance with the specification named above and concluded on the date shown, the results of which are shown below. The welding procedures and gas used are shown below. Mechanical properties and chemical results are taken from weld deposits in the as welded condition. This material was manufactured and supplied according to the Quality System Program of Lincoln Electric Company of Canada, Toronto, Ontario, which meets the requirements of ISO 9001:2008 and other specifications applicable. This material was manufactured under one lot control number and meets the requirements of AWS A5.01 Lot Classification Class S3.

Shielding Gas: 75% Ar/25% CO_2, 45 CFH

Operating Settings:

Wire Feed Speed (in/min)	600
Voltage, DC+ (volts)	27
Travel Speed (in/min)	12 – 14
Electrical Stickout (in)	¾
Layers/Passes	6/16
Interpass Temperature (°F)	325

Tensile Properties:

Tensile Strength (psi)	87 890
Yield Strength (psi)	74 060
Elongation (%)	29

Impact properties, Charpy V-notch:

Average ft-lbs at –55°F	77 (79, 76, 75)

Electrode Analysis:

% C	0.07
% Mn	1.46
% Si	0.85
% S	0.006
% P	0.005
% Cu (Total)	0.11

Weld Deposit Analysis:

% C	0.07
% Mn	1.25
% Si	0.69
% S	0.009
% P	0.004
% Cu	0.19

Technologist – Production Testing and Certification

Quality Assurance Manager, Consumables Division

ABSA
the pressure equipment safety authority

9410 - 20 Ave N.W.
Edmonton, Alberta, Canada T6N 0A4
Tel: (780) 437-9100 / Fax: (780) 437-7787

October 30, 2012

Attention: Document Control
CALHEX INDUSTRIES LTD
9515-48 STREET SE
CALGARY, AB T2C 2R1

The design submission, tracking number 2012-07234, originally received on October 19, 2012 was surveyed and accepted for registration as follows:

CRN : V9688.2 **Accepted on:** October 30, 2012

Reg Type: New Design

Drawing No. : 12-0779-S/T Rev 0 As Noted

Description	MAWP	Design Temperature	MDMT
TS Internal Pressure	2758 kPa	70°C	-45°C
TS External Pressure	103 kPa	70°C	-45°C
SS Internal Pressure	2758 kPa	70°C	-45°C
SS External Pressure	103 kPa	70°C	-45°C

An invoice covering survey and registration fees will be forwarded from our Revenue Accounts.

If you have any question don't hesitate to contact me by phone at (780) 433-0281 ext 3335 or fax (780) 437-7787 or e-mail dedovic@absa.ca.

Sincerely,

DEDOVIC, BLAZO

Safety Authority

New Westminster, BC V3L 0E1
Toll Free: 1-866-566-SAFE
Fax: (778) 396 - 2064
www.safetyauthority.ca

CALHEX INDUSTRIES LTD
9515 48TH STREET SE
CALGARY AB T2C 2R1

Date: November 28, 2012
Account #: 39806
Journal #: 56001
Our File #: 5309600

Attn: DARREN KLADNIK

Re: Application for Design Registration

The design, as detailed in your, Ref: 12-0779, for a Heat Exchanger is accepted for registration as follows:

Registered To: CALHEX INDUSTRIES LTD **CRN:** V9688.21

Shell Side	**MDMT:** -49 deg F	**MAWT:**	158 deg F	**MAWP:**	400 psig
Tube Side	**MDMT:** -49 deg F	**MAWT:**	158 deg F	**MAWP:**	400 psig

Drawing #: 12-0779-S, 12-0779-T **Drawing Revision:** 0 / 0

Conditions Of Registration:

1- Shell Side and Tube Side also designed for Full Vacuum @ 158 deg F.

	Amount	HST	Total
Fee for reviewing your design:	$148.00	$17.76	$165.76
Total:	$148.00	$17.76	$165.76
Less amount received with submission:			$0.00
			$165.76

An invoice for $165.76 will follow.

Contact me if you have any questions.

ALIREZA BONAKDAR
(778) 396-2032
Alireza.Bonakdar@safetyauthority.ca
Design Engineer

cc:

Calhex Industries

Ltd.

Welding Procedures

Welding Procedure:

CX-1N

Rev. 4

original.

ABSA
pressure equipment safety authority

9410 - 20 Ave N.W.
Edmonton, Alberta, Canada T6N 0A4
Tel: (780) 437-9100 / Fax: (780) 437-7787

March 26, 2008

Sheldon Alcock
CALHEX INDUSTRIES LTD
9515-48 STREET SE
CALGARY, AB T2C 2R1

Dear Sheldon Alcock,

The welding procedures received on March 17, 2008 are accepted for registration as follows:

Reg. No. : WP-2380.2 **Accepted on:** March 26, 2008

Tracking No. : 2008-01881

Reg Type : Revision To Acc. Design

Spec. No. : CX-1N REV 4

Registered under owner / manufacturer name CALHEX INDUSTRIES LTD

Please note the acceptance of the registration does not allow the use of this welding procedure in the construction, modification, or repair of any boiler, pressure vessel, pressure piping system or fitting in Alberta unless the contractor/manufacturer has registered a Quality Control system for such work with ABSA.

Welding procedures, which specify impact testing, have been accepted in accordance with A.S.M.E. Section IX only. Other A.S.M.E. Code Sections may have additional requirements respecting impact testing.

An invoice covering survey and registration fees will be forwarded from our Revenue Accounts.

Enclosed is a stamped welding procedure for your reference.

Sincerely,

R. Roseberg

ROSEBERG, BOB, P. Eng.
Design Survey Engineer

original

WELDING PROCEDURE SPECIFICATION NO.: CX-1N (Rev. 4)

WELDING PROCEDURE QUALIFICATION RECORD NO.(S): PQ1, PQ3, PQ16, PQ31, PQ32

QUALIFIED FOR

Base Metal (Typical): 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 **Weld Types:** GROOVE & FILLET

Position: ALL POSITIONS **Diameter:** ALL DIAMETERS

Filler Metal: GMAW: ER70S-2 or 6 SMAW: E7018-1

BASE METAL CONDITIONS & GROOVE THICKNESS RANGE QUALIFIED:

NOTCH TOUGHNESS APPLICATIONS TO -46°C AS WELDED

BASE METAL THICKNESS RANGE 3.0 to 203 mm (0.119 to 8.00 in.) inclusive

COMBINED DEPOSITED WELD METAL THICKNESS

ASME B31.1	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

ALBERTA BOILERS SAFETY ASSOCIATION
PROVINCE OF ALBERTA
SAFETY CODES ACT
WELDING PROCEDURE
Reg. No. WP 2380.2
Spec No. CX-1N (REV 4)
Weld Process GMAW / SMAW
Matl. Gr. P No. 1 Gr 1+2 to P No. 1 Gr 1+2
Elec. Gr. F No. 6+4 A No. 1
Th. Qual. For 3 to 203 mm PWHT NO
CVN -46°C
Yr. 08 Mo 03 Day 26 Signed
R. ROSEBERG, P.ENG.
WELDING SPECIALIST

PROVINCIAL REGISTRATION

Calhex Industries

Ltd.

Welding Procedures

Welding Procedure:

CX-2N

Rev. 1

ABSA
the pressure equipment safety authority

#200, 4208 - 97 Street
Edmonton, Alberta, Canada T6E 5Z9
Tel: (780) 437-9100 / Fax: (780) 437-7787

September 01, 2005

Sheldon Alcock
CALHEX INDUSTRIES LTD
9515 48 STREET SE
CALGARY, AB T2C 2R1

Dear Sheldon Alcock,

The welding procedures received on August 18, 2005 are accepted for registration as follows:

Reg. No. : WP-2380.2 **Accepted on:** September 01, 2005

Tracking No. : 2005-06606

Reg Type : Revision To Acc. Design

Spec. No. : CX-2N REV 1

Registered under owner / manufacturer name CALHEX INDUSTRIES LTD

Please note the acceptance of the registration does not allow the use of this welding procedure in the construction, modification, or repair of any boiler, pressure vessel, pressure piping system or fitting in Alberta unless the contractor/manufacturer has registered a Quality Control system for such work with ABSA.

Welding procedures, which specify impact testing, have been accepted in accordance with A.S.M.E. Section IX only. Other A.S.M.E. Code Sections may have additional requirements respecting impact testing.

An invoice covering survey and registration fees will be forwarded from our Revenue Accounts.

Enclosed is a stamped welding procedure for your reference.

Sincerely,

R. Roseberg

ROSEBERG, BOB, P. Eng.
Design Survey Engineer

CALHEX INDUSTRIES LTD.
9515-48TH STREET S.E., Calgary, Alberta, T2C 2R1
Bus: (403) 225 - 4395 {CALHEX 5}
Fax: (403) 261 - 2761

WELDING PROCEDURE SPECIFICATION NO.: CX-2N (Rev.1)

WELDING PROCEDURE QUALIFICATION RECORD NO. (S): PQ4, PQ5, PQ16

QUALIFIED FOR

Base Metal (Typical): 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): SMAW **Weld Types:** GROOVE & FILLET
Position: ALL POSITIONS **Diameter:** ALL DIAMETERS
Filler Metal: E6010, E7018-1

BASE METAL CONDITIONS & GROOVE THICKNESS RANGE QUALIFIED:

BASE METAL THICKNESS RANGE
NOTCH TOUGHNESS APPLICATIONS TO -46°C AS WELDED
3.2 to 203 mm (0.125 to 8.00 in.) inclusive

COMBINED DEPOSITED WELD METAL THICKNESS

ASME B31.1	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

ALBERTA BOILERS SAFETY ASSOCIATION
PROVINCE OF ALBERTA
SAFETY CODES ACT
WELDING PROCEDURE
Reg. No. WP 2380.2
Spec No. CX-2N (REV.1)
Weld Process SMAW
Matl. Gr. P No. 1 Gr.1+2 to P No. 1 Gr.1+2
Elec. Gr. F No. 3+4 A No. 1
Th. Qual. For 3.2 to 203 mm PWHT NO
CVN - 46°C
Yr 05 Mo 09 Day 01 Signed
R. ROSEBERG, P.ENG.
WELDING SPECIALIST

PROVINCIAL REGISTRATION

CALHEX INDUSTRIES LTD.
9515 - 48 th. Street S.E., Calgary, Alberta, T2C 2R1
Bus: (403) 225 - 4395 { CALHEX5 }
Fax: (403) 261 - 2761

WELDERS LOG

WELDERS NAME / FILE NUMBER	SYMBOL	PROCESS	BASE METALS	FILLER METAL "F" NUMBER(S)	BACKING	MINIMUM OD (In)	DEPOSIT THICKNESS (In)	POSITIONS	UPHILL / DOWNHILL	CORED / SOLID	INSERT	BACKING GAS	GTAW CURRENT	GMAW X-FER	EXPIRY DATE P.Q. CD.
Glen Hansen W-12138	A	GMAW	P1	6	Optional	1	0.110"	0-45°, Flat	Vertical Down	N.A.	N.A.	Optional	N.A.	S.C.	May 24, 2014
		SMAW	P1	4	Required	1	0.488"	Flat	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	May 24, 2014
		SMAW	P1	3	Optional	1"	0.250"	All	Uphill	N.A.	N.A.	N.A.	N.A.	N.A.	May 24, 2014
		SMAW	P1	4	Required	1"	MAX	All	Uphill	N.A.	N.A.	N.A.	N.A.	N.A.	May 24, 2014
		GMAW	P8	6	Optional	1	0.110"	0-45°, Flat	Vertical Down	N.A.	N.A.	Optional	N.A.	S.C.	Mar. 24, 2013
		SMAW	P8	5	Required	1	0.672"	Flat	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Mar. 24, 2013
		SAW	P1	F6	Required	WPS	MAX	Flat	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	July 24, 2014

LABOUR

Alberta

Form No. CB-43 (90/07)

Grade "B" Pressure Welder's Certificate of Competency

This is to Certify that: Glen D. Hansen

having complied with provisions of the Boilers and Pressure Vessels Act is hereby granted a Grade "B" Pressure Welder's Certificate of Competency, and, is authorized to engage in pressure welding in accordance with the prescribed Regulations.

Dated at Edmonton, this Second day of April 19 91

W- 12138
ABB File No.

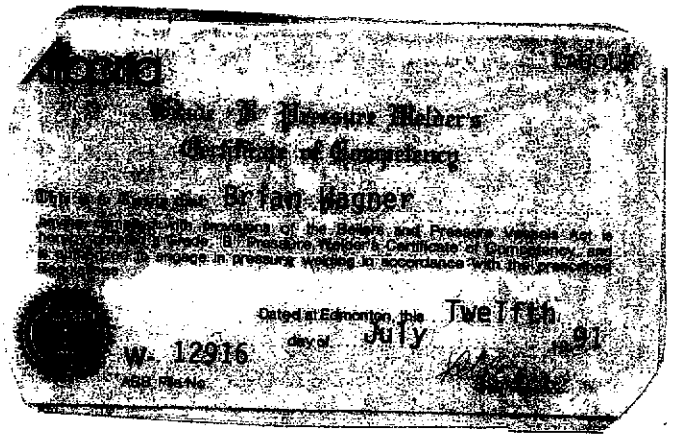
Chief Inspector

№ 7772

CALHEX INDUSTRIES LTD.
9515 - 48 th. Street S.E., Calgary, Alberta, T2C 2R1
Bus: (403) 225 - 4395 { CALHEX5 }
Fax: (403) 261 - 2761

WELDERS LOG

WELDERS NAME / FILE NUMBER	SYMBOL	PROCESS	BASE METALS	FILLER METAL "F" NUMBER(S)	BACKING	MINIMUM OD (In)	DEPOSIT THICKNESS (In)	POSITIONS	UPHILL / DOWNHILL	CORED / SOLID	INSERT	BACKING GAS	GTAW CURRENT	GMAW X-FER	EXPIRY DATE P.Q. CD.
Brian Wagner W-12916	B	GMAW	P1	6	Optional	1	0.110"	0-45°	Vertical Down	N.A.	N.A.	N.A.	N.A.	S.C.	Dec. 2. - 2012
		SMAW	P1	4	Required	2.875"	0.488"	Flat	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Dec. 2. - 2012
		SMAW	P1	3	Optional	1	0.250"	All	Vertical Up	N.A.	N.A.	N.A.	N.A.	N.A.	Dec. 2. - 2012
		SMAW	P1	4	Required	1	MAX	All	Vertical Up	N.A.	N.A.	N.A.	N.A.	N.A.	Dec. 2. - 2012
		GMAW	P8	6	Optional	1	0.110"	0-45°	Vertical Down	N.A.	N.A.	N.A.	N.A.	S.C.	April 28-2013
		SMAW	P8	5	Required	1	0.672"	FLAT	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	April 28-2013



Alberta

Labour

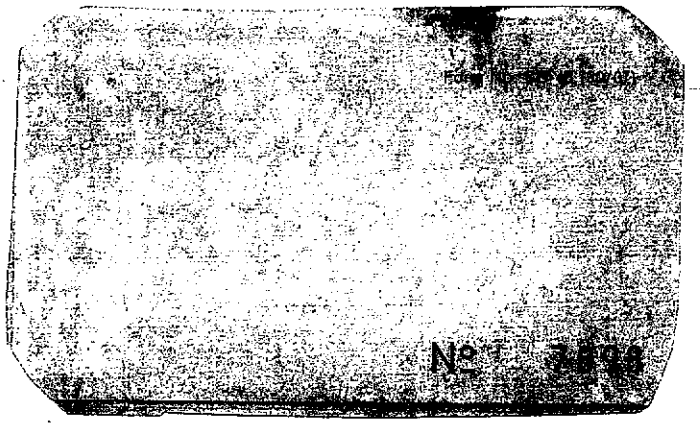
Steam & Pressure Boilers
Certificate of Competency

This is to certify that Brian Wagner

has successfully passed the examinations of the Boilers and Pressure Vessels Act for the purpose of obtaining a grade ... Steam & Pressure Boilers Certificate of Competency, and is hereby authorized to engage in pressure welding in accordance with the provisions of the Act and regulations.

Dated at Edmonton, this Twelfth day of July A.D. 91

W- 12916
ABB File No.



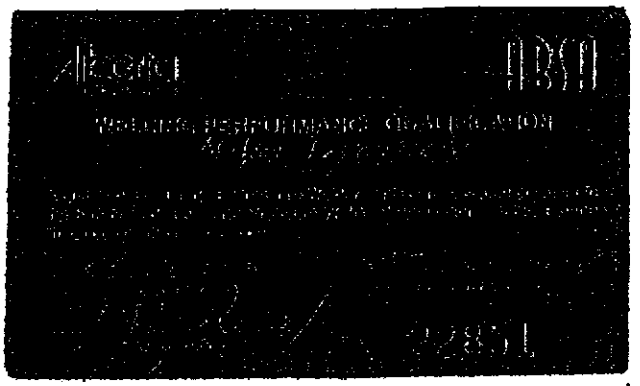
Form [illegible]

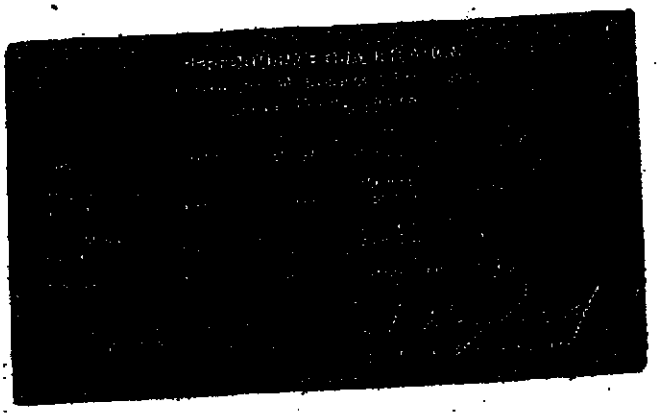
No. 2898

CALHEX INDUSTRIES LTD.
9515 - 48 th. Street S.E., Calgary, Alberta, T2C 2R1
Bus: (403) 225 - 4395 { CALHEX5 }
Fax: (403) 261 - 2761

WELDERS LOG

WELDERS NAME / FILE NUMBER	SYMBOL	PROCESS	BASE METALS	FILLER METAL "F" NUMBER(S)	BACKING	MINIMUM OD (In)	DEPOSIT THICKNESS (In)	POSITIONS	UPHILL / DOWNHILL	CORED / SOLID	INSERT	BACKING GAS	GTAW CURRENT	GMAW X-FER	EXPIRY DATE P.Q. CD.
Mike Taranov W-22851	G	GMAW	P1	6	Optional	1	0.110"	0-45°	Vertical Down	N.A.	N.A.	N.A.	N.A.	S.C.	Dec. 2, - 2012
		SMAW	P1	4	Required	2.875"	0.488"	Flat	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Dec. 2, - 2012
		SMAW	P1	3	Optional	1	0.250"	All	Vertical Up	N.A.	N.A.	N.A.	N.A.	N.A.	Dec. 2, - 2012
		SMAW	P1	4	Required	1	MAX	All	Vertical Up	N.A.	N.A.	N.A.	N.A.	N.A.	Dec. 2, - 2012
		GMAW	P1 or P8 – P8	6	Optional	1	0.110"	0-45°, Flat	Vertical Down	N.A.	N.A	Optional	N.A.	S.C.	Sept. 1, 2011
		SMAW	P1 or P8 – P8	5	Required	1	0.488"	Flat	Uphill	N.A.	N.A	N.A.	N.A	N.A	Sept. 1, 2011
		GTAW	P1	6	Optional	2.875"	0.200"	Flat / Vertical	Uphill	N.A.	N.A.	Optional	DCEN	N.A.	April 15, 2010
		SMAW	P1	4	Required	2.875"	0.800" max	Flat / vertical	Uphill	N.A.	N.A.	N.A.	N.A.	N.A	April 15, 2010
		GTAW	P1	6	Optional	1	0.188"	All	Uphill	N.A.	N.A.	Optional	DCEN	N.A.	May 4, 2012
		SMAW	P1	4	Required	1	0.684"	All	Uphill	N.A.	N.A.	N.A.	DCEN	N.A.	May 4, 2012
		GTAW	P1 or P8 – P8	6	Optional	2.875"	0.500"	Flat	N.A.	N.A.	N.A.	Required	DCEN	N.A.	May 4, 2012
		SMAW	P1 or P8 – P8	5	Required	2.875"	Max.	Flat	N.A.	N.A.	N.A.	Required	DCEN	N.A.	May 4, 2012
		GTAW	P10H to P10H	6	Optional	2.875"	0.200"	Flat	N.A.	N.A.	N.A.	Required	DCEN	N.A.	Aug. 7, 2012
		SMAW	P10H to P10H	5	Required	2.875"	0.274"	Flat	N.A.	N.A.	N.A.	Required	N.A.	N.A.	Aug. 7, 2012
		GMAW (STT)	P10H to P10H	6	Optional	2.875"	0.110"	0-45°, Flat	Vertical Down	N.A.	N.A.	Required	N.A.	N.A.	Aug. 5, 2012
		SMAW	P10H to P10H	5	Required	2.875"	0.664"	Flat	N.A.	N.A.	N.A.	N.A.	N.A.	S.C.	Aug. 5, 2012
		GMAW (STT)	P10H to P10H	6	Optional	2.875"	0.110"	30°-60°, Flat	Vertical Down	N.A.	N.A.	Required	N.A.	N.A.	Aug. 23, 2012
		SMAW	P10H to P10H	5	Required	2.875"	Max.	Flat	N.A.	N.A.	N.A.	N.A.	N.A.	S.C.	Aug. 23, 2012





CALHEX INDUSTRIES LTD.
9515 - 48 th. Street S.E., Calgary, Alberta, T2C 2R1
Bus: (403) 225 - 4395 { CALHEX5 }
Fax: (403) 261 - 2761

WELDERS LOG

WELDERS NAME / FILE NUMBER	SYMBOL	PROCESS	BASE METALS	FILLER METAL "F" NUMBER(S)	BACKING	MINIMUM OD (In)	DEPOSIT THICKNESS (In)	POSITIONS	UPHILL / DOWNHILL	CORED / SOLID	INSERT	BACKING GAS	GTAW CURRENT	GMAW X-FER	EXPIRY DATE P.Q. CD.
Michael Montgomery W-28275	J	GMAW	P1	6	Optional	1	0.110"	0-45°, Flat	Vertical Down	N.A.	N.A.	N.A.	N.A.	S.C.	Jan. 20-2013
		SMAW	P1	4	Required	1	0.488"	Flat	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Jan. 20-2013
		SMAW	P1	3	Optional	1	0.250"	All	Vertical Up	N.A.	N.A.	N.A.	N.A.	N.A.	Mar. 24, 2013
		SMAW	P1	4	Required	1	MAX	All	Vertical Up	N.A.	N.A.	N.A.	N.A.	N.A.	Mar. 24, 2013
		GMAW	P1 or P8 – P8	6	Optional	1	0.110"	0-45°, Flat	Vertical Down	N.A.	N.A	Optional	N.A.	S.C.	Mar. 24, 2013
		SMAW	P1 or P8 – P8	5	Required	1	0.672"	Flat	N.A.	N.A.	N.A	N.A.	N.A	N.A	Mar. 24, 2013
		GTAW	P1	6	Optional	1	0.188"	All	Uphill	N.A.	N.A.	Optional	DCEN	N.A.	Mar. 24, 2013
		SMAW	P1	4	Required	1	0.500"	Flat	N.A.	N.A.	N.A.	N.A.	DCEN	N.A.	Mar. 24, 2013
		SAW	P1	F6	Required	WPS	MAX	Flat	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	May 3, 2013

Alberta
Municipal Affairs and Housing

ABSA
the pressure equipment safety authority

23552

Grade "B" Pressure Welder's Certificate of Competency

This is to certify that **Michael Montgomery**
having complied with provisions of the Safety Codes Act, is authorized to engage in pressure welding in accordance with the prescribed Regulations.

Dated at Edmonton
December 01, 2009

W-28875
File no.

Chief Inspector and Administrator

FORM U-1 MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS (2010)

As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

(A) 626024

1. Manufactured and certified by: **CALHEX INDUSTRIES LTD. 9515 48TH STREET S.E., CALGARY, ALBERTA, CANADA T2C 2R1** (Name and address of Manufacturer)

2. Manufactured for: **Husky Oil Operations Ltd. 707 – 8th Avenue S.W. Calgary, AB T2P 1H5** (Name and address of Purchaser)

3. Location of installation: **Husky Oil Ansell Gas Plant Edson, AB LSD# - 07-27-051-19-W5M** (Name and address)

4. Type: **Horizontal** (Horizontal, vertical, or sphere) | **Heat Exchanger** (Tank, separator, jkt. vessel, heat exh.,etc.) | **12-0779** (Manufacturer's serial number)

V9688.21 (CRN) | **12-0779-S Rev. 0 & T Rev. 0** (Drawing No.) | **-** (National Board Number.) | **2012** (Year Built)

5. ASME Code, Section VIII, Div. 1: **2010 & 2011** [Edition and Addenda (date)] | **2714** (Code Case Number) | **-** [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) Number of course(s): **2** (b) Overall length (ft & in.): **47' – 8.750"**

Course(s)			Material	Thickness		Long. Joint (Cat.A)			Circum. Joint (Cat. A,B, & C)			Heat Treatment	
No.	Diameter, in.	Length (ft & in.)	Spec./Grade or Type	Nom.	Corr.	Type	Full,Spot,None	Eff.	Type	Full,Spot,None	Eff.	Temp.	Time
1	23"	39' – 8.750"	SA333-6	0.500"	0.0625"	S	None	0.85	7/1	Spot *	0.70	-	-
1	23"	8' – 0"	SA333-6	0.500"	0.0625"	S	None	0.85	7/1	Spot *	0.70	-	-

7. Heads: (a) (Material spec. number, grade or type) (H.T. - time & temp.) (b) (Material spec. number, grade or type) (H.T. - time & temp.)

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

If removable, bolts used (describe other fastening) (Material spec. number, grade, size, number)

8. Type of jacket: Jacket closure (Describe as ogee and weld, bar, etc)

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

9. MAWP: **400** (Internal) **15** (External) psi at max. temp. **163** (Internal) **163** (External) °F Min. design metal temp. **-49** °F at **400** psi.

10. Impact test: **No, exempt per UCS-66(a)(c)(d)(g), Fig. UCS-66 Note (c) & UCS-67(a)2.** at test temperature of **-** °F. (Indicate yes or no and the component(s) impact tested)

11. Hydro.,pneu.,or comb.test pressure: **520 psi** Proof test: **-**

Items 12 and 13 to be completed for tube sections.

12. Tubesheet: **SA516-70N** [Stationary (material spec. no)] | **23"** [Diameter, (subject to press.)] | **1.5625"** (Nominal thickness) | **0.125"** (Corr. Allow.) | **Welded** [Attachment (welded or bolted)]

- [Floating (material spec. no.)] | **-** (Diameter) | **-** (Nominal thickness) | **-** (Corr. Allow.) | **-** (Attachment)

13. Tubes: **SA179 **** (Material spec. no., grade or type) | **0.750"** (O.D.) | **16 BWG** (Nominal thickness) | **440** (Number) | **Straight** [Type (straight or U)]

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

14. Shell: (a)No. of course(s) **2** (b) Overall length (ft & in.): **2' – 10"**

Course(s)			Material	Thickness		Long. Joint (Cat.A)			Circum. Joint (Cat. A,B, & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full,Spot,None	Eff.	Type	Full,Spot,None	Eff.	Temp.	Time
2	23"	1' – 5"	SA333-6	0.500"	0.0625"	S	None	1.0	1/7	Spot *	0.70	-	-

15. Heads: (a) **SA350-LF2 CL.1** (Material spec. number, grade or type) (H.T. - Time & Temp.) (b) **SA350-LF2 CL.1** (Material spec. number, grade or type) (H.T. - Time & Temp.)

	Location (Top,	Thickness		Radius		Elliptical	Conical	Hemispherical	Flat	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle	Ratio	Apex Angle	Radius	Diameter	Convex	Concave	Type	Full,Spot,None	Eff.
(a)	End	2.75"	0.0625"						36"					
(b)	End	2.75"	0.0625"						36"					

If removable, bolts used (describe other fastening). **(24) 1.50" x 9.250" Lg. SA193-B7 UNC Studs / (48) 1.50" SA194-2H UNC Nuts** (Material spec. number, grade, size, number)

FORM U-1 (Back)

16. MAWP **400** (Internal) **15** (External) psi at max. temp. **158** (Internal) **158** (External) °F Min. design metal temp. **-49** °F at **400** Psi

17. Impact test **No, exempt UCS-66(a)(c)(d)(g), Fig. UCS-66 Note (c) & UCS-67(a)2.** at test temperature of **-** °F.
(Indicate yes or no and the component(s) impact tested)

18. Hydro., pneu., or comb. test press. **520 psi** Proof test **-**

19. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Flange Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Detail		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
Shellside Inlet	1	8" 300 CL	RFWN	SA333-6	SA350-LF2 CL.1	0.344"	0.0625"	SA516-70N	UW16.1c	BW	Shell Top
Shellside Outlet	1	8" 300 CL	RFWN	SA333-6	SA350-LF2 CL.1	0.344"	0.0625"	SA516-70N	UW16.1c	BW	Shell Bottom
Tubeside Inlet	1	8" 300 CL	RFWN	SA333-6	SA350-LF2 CL.1	0.344"	0.0625"	SA516-70N	UW16.1c	BW	Channel Bottom
Tubeside Outlet	1	8" 300 CL	RFWN	SA333-6	SA350-LF2 CL.1	0.344"	0.0625"	SA516-70N	UW16.1c	BW	Channel Top
T.I.	4	1"	CPLG	SA350-LF2 CL.1	-	6000 CL	0.0625"	-	UW16.1a	-	Inlets/Outlets
P.I.	4	¾"	CPLG	SA350-LF2 CL.1	-	6000 CL	0.0625"	-	UW16.1a	-	Inlets/Outlets
Vent	1	1"	CPLG	SA350-LF2 CL.1	-	6000 CL	0.0625"	-	UW16.1a	-	Channel Top
Drain	1	1"	CPLG	SA350-LF2 CL.1	-	6000 CL	0.0625"		UW16.1a	-	Channel Bottom

20. Supports: Skirt **No** (Yes/no) Lugs **4** (Number) Legs **n/a** (Number) Other **Saddles** (Describe) Attached **Welded to Shell & Channel Covers** (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, Manufacturer's name and identifying number):

22. Remarks: **(2) 24" 300 CL RFWN Channel Flanges – SA350-LF2 CL.1**

SAFETY VALVES: **P.S.V. on piping per UG-125 (g) to be installed by owner.** CUBIC CAPACITY: **123.04 cu. ft.**

SURFACE AREA: **4146.9 sq. ft.**

SERVICE: **Inlet Gas Heat Exchanger** *** RT2 – Spot per UW-11(a)5(b). ** Tube Length – 48' – 0" Lg.**

ITEM #: **E-102B** **Constructed to Drawing # 12-0779–S Rev. 1 & T Rev. 0.**

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. **33238** Expires **April 22** ,20 **14**

Date **DEC 14 2012** Name **Calhex Industries Ltd.** (Manufacturer) Signed (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, AB, CANADA** have inspected the pressure vessel described in this Manufacturer's Data Report on ,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 **DEC 14 2012** Signed (Authorized Inspector) Commissions **NB 14678 AB 428** [National Board (incl.endorsements),State,Province,and number]

CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE

We certify that the statements on 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 (Assembler) Signed (Representative)

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

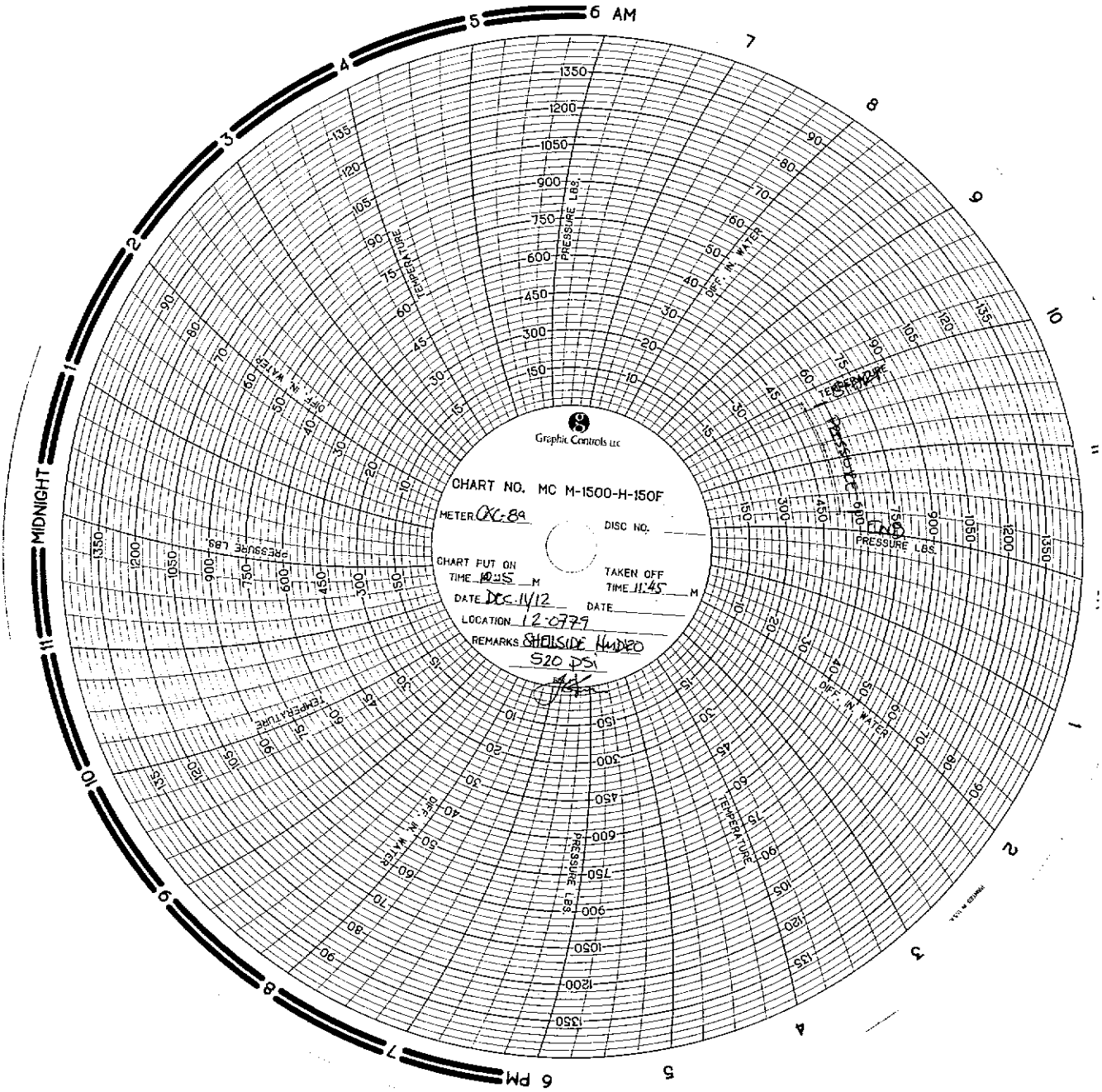
I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of and employed by of , have compared the statements in this Manufacturer's Data Report with the described pressure vessel and state that parts referred to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

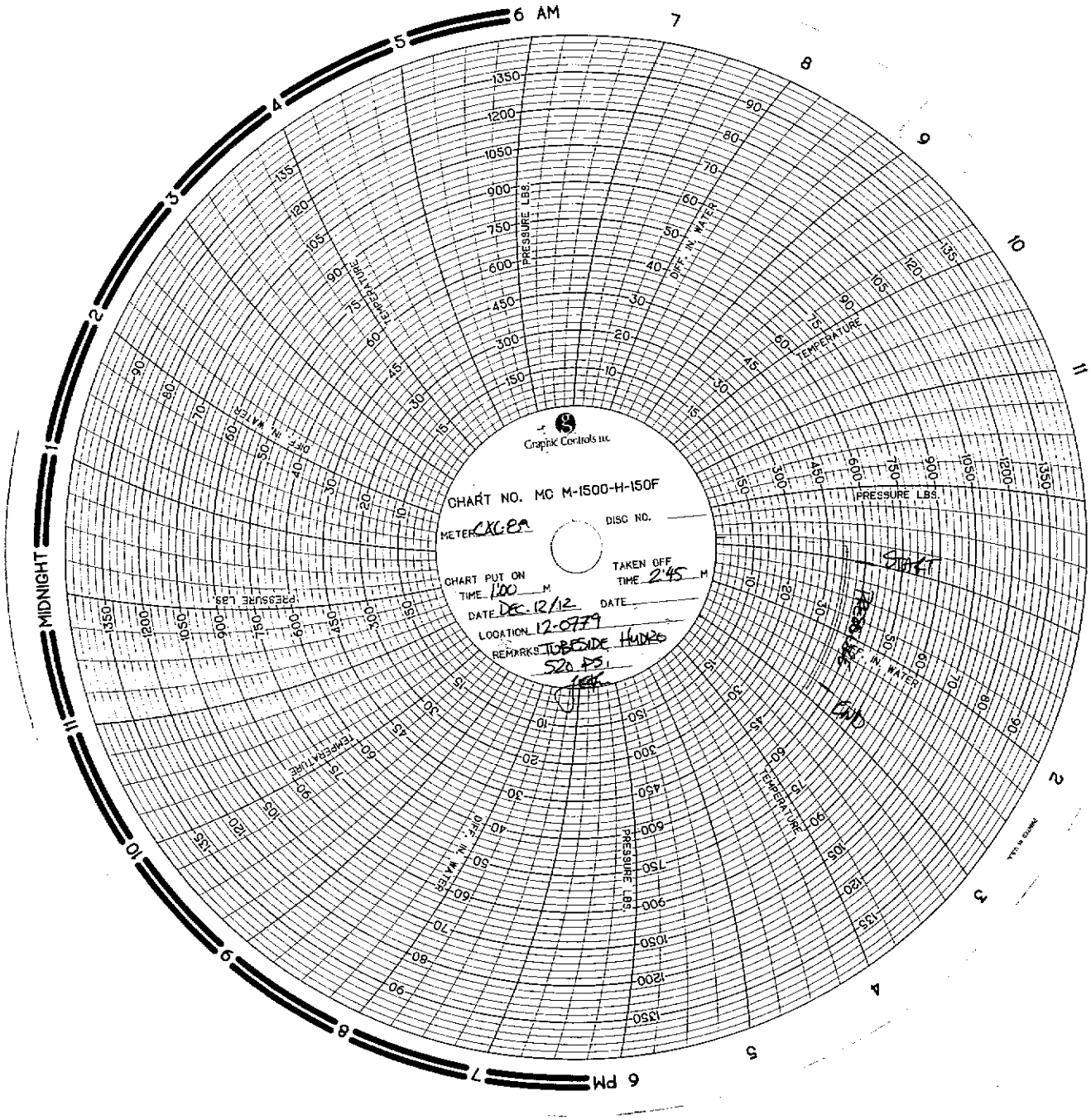
Date Signed (Authorized Inspector) Commissions (National Board (incl. endorsements), State, Province and number.)

CALHEX INDUSTRIES LTD.
9515 - 48 th. Street S.E., Calgary, Alberta, T2C 2R1
Bus: (403) 225 - 4395 { CALHEX5 }
Fax: (403) 261 - 2761

HYDROSTATIC TEST REPORT

CUSTOMER:	**Excelsior Engineering**			
OWNER:	**Husky Oil Operations**			
ITEM #:	**E-102B**			
JOB #:	**12-0779**			
	SHELLSIDE		TUBESIDE	
DESIGN PRESSURE:	**400 psi**		**400 PSI**	
HYDROSTATIC TEST PRESSURE:	**520 PSI**		**520 PSI**	
DATE:	DEC 1 1 2012	**DATE:**	DEC 1 2 2012	
Calhex Representative:		**Calhex Representative:**		
Customer Representative:		**Customer Representative:**		
DATE:	DEC 1 1 2012	**Date:**	DEC 1 2 2012	
Gauges – CXG-2 & CXG-39		**Gauges – CXG-2 & CXG-39**		
Remarks:				
Hydro-tested min. 1 hour. No leaks detected.				


6 AM
MIDNIGHT
6 PM
Graphic Controls LLC
CHART NO. MC M-1500-H-150F
METER QC-89
DISC NO.
CHART PUT ON
TIME 1025 M
DATE DEC 11/12
TAKEN OFF
TIME 11:45 M
DATE
LOCATION 12-0779
REMARKS SHELLSIDE HUDSON
520 PSI
PRESSURE LBS.
TEMPERATURE
DIFF. IN WATER


6 AM
MIDNIGHT
6 PM
Graphic Controls Inc.
CHART NO. MC M-1500-H-150F
METER CXC-89
DISC NO.
CHART PUT ON
TIME 1:00 M
DATE DEC. 12/12
TAKEN OFF
TIME 2:45 M
DATE
LOCATION 12-0779
REMARKS TUBESIDE HUM26
520 PSI
START
END
PRESSURE LBS.
DIFF. IN. WATER
TEMPERATURE

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Fax: (403) 261 - 2761

TRAVEL SHEET (FRONT)

DO NOT START CONSTRUCTION WITHOUT AI REVIEW TRAVEL SHEET REVISION NO.: Ø

AI REVIEW: MM REVIEW DATE: NOV 12 2012

Customer:	Excelsior Engineering	OWNER:	Husky Oil Operations	PROJECT:	Ansell Gas Plant	PO#	8400547676

SERIAL NO.:**12-0779** JOB NO.:**12-0779-S & T** VESSEL TYPE: **Inlet Gas Heat Exchanger** Tag# **E-102B**

DRAWING NO.: **12-0779-S& T** DWG. REVISION NO.: Ø & Ø TRAVEL SHEET INITIATION BY: DR NOV 10 2012

Seq.	Item	Comments	Q.C.I.	Date	A.I. Hold Points	A.I.	Date	Owner / Customer Rep.	Date
1.	Calculations in File	Approved by Customer and ABSA	DR	NOV 10 2012		TD	DEC 14 2012	* HH	03 Dec 2012
2.	Release of App'd Dwg.	Approved by Customer and ABSA	DR	NOV 10 2012		MM	NOV 12 2012	* HH	03 Dec 2012
3.	Heat Numbers Recorded	2010 Edition 2011 add	DR	DEC 11 2012		MM	DEC 11 2012	* HH	12 Dec 2012
4.	MTRs Checked		DR	DEC 11 2012		TD	DEC 14 2012	* HH	12 Dec 2012
5.	Examination of Material (UG-93)		DR	DEC 11 2012					
6.	WPS(s) Checked	(-49 °F) Lot# 1282972	DR	DEC 11 2012				* HH	17 Dec 2012
7.	Welder(s) Qualified		DR	DEC 11 2012				* HH	17 Dec 2012
8.	Thicknesses Verified & Recorded		DR	DEC 11 2012		TD	DEC 14 2012	* HH	12 Dec 2012
9.	Shell(s) & Head(s) Fit-up Inspection		DR	DEC 11 2012		TD	DEC 12 2012	* HH	12 Dec 2012
10.	Nozzles & Fittings Fit-up Inspection		DR	DEC 11 2012					
11.	Nozzle Orientation		DR	DEC 11 2012					
12.	Nozzle & Flange Rating Checked		DR	DEC 11 2012					
13.	Impact Testing	No, exempt per UCS-66(a)(c)(d)(g), Fig. UCS-66 Note (c) & UCS-67(a)3.	N/a	—					—
14.	Internals Checked	N1- plus All Drains to be flush	DR	DEC 11 2012					
15.	Final Internal Inspection	Shellside –	DR	NOV 20 2012**		MM	NOV 28 2012	** HH	11 Dec 2012
		Tubeside –	DR	DEC 11 2012**		MM	DEC 11 2012	HH	11 Dec 2012
16.	Bundle Insertion		DR	DEC 11 2012					
17.	Weld Size Checked	As per weld detail	DR	DEC 11 2012					
18.	Welder I.D. Checked		DR	DEC 11 2012					
19.	Final External Inspection	2-N/P – 2-LL	DR	DEC 11 2012		TD	DEC 12 2012	HH	11 Dec 2012
20.	Radiography	Shellside – N/A PER UW 13.2(d)	N/A	—		TD	DEC 14 2012		—
a).	Radiography	Tubeside- N/A PER UW 13.2(d)	DR	DEC 12 2012		TD	DEC 14 2012	HH	12 Dec 2012
21.	MPI- UG-93 – Tubesheets A & B Beveled Edges before welding		DR	DEC 12 2012		TD	DEC 14 2012	HH	12 Dec 2012
	MPI- UG-93 – Tubesheets A & B Beveled Edges AFTER welding		DR	DEC 12 2012		TD	DEC 14 2012	HH	12 Dec 2012
	UT- Cat. D's -		N/A						
	MPI-S/S Temp's / Fillet Welds-Cat. D's – Saddle to Shell-N/P		DR	DEC 12 2012					
	MPI-T/S- Temp's / Fillet Welds-Cat. D's / Lift lugs		DR	DEC 12 2012					
	HT – <200 BHN- AFTER PWHT –		N/A						
22.	Final Ext. Prior to P.W.H.T. –		N/A	—					—
23.	PWHT Chart Checked		N/A	—					—
24.	Hydrostatic Test – 1 Hr Report & CHART	Shellside: Gauge: 520 psi CXG- 1 & CXG- 89	DR	DEC 11 2012		MM	DEC 11 2012	** HH	11 Dec 2012
24.a	Hydrostatic Test – 1 HR Report & CHART	Tubeside: Gauge: 520 psi CXG- 2 & CXG- 89	DR	DEC 12 2012**		TD	DEC 12 2012	** HH	12 Dec 2012
25.	CRN Drawing: (AB) (BC)	CRN# V9168 .2	DR	DEC 14 2012		TD	DEC 14 2012	HH	17 Dec 2012
26.	N.C.R.	Approved:	DR	DEC 12 2012					—
27.	Nameplate Stamping	Imp. / CAUTION	DR	DEC 12 2012		TD	DEC 14 2012	HH	18 Dec 2012
28.	Manuf. Data Report Completed & Verified	U1 –FULL VACUUM	DR	DEC 12 2012		TD	DEC 14 2012	HH	18 Dec 2012
29.	Nameplate Installation	IMP / Caution	DR	DEC 18 2012				HH	18 Dec 2012
30.	Final Paint – As per Drawing	WOOD Covers / Rust Prev.	DR	DEC 18 2012				HH	18 Dec 2012
31.	INSULATION-		DR	DEC 16 2012					—
32.	Shipping and Release		DR	DEC 16 2012				HH	18 Dec 2012
33.	Final Documentation	Manufacturer's Data Book	DR	DEC 16 2012				HH	19 Dec 2012

The Authorized Inspector shall be presented with the Travel Sheet prior to construction so that he can designate additional inspection points and/or Hold Points. Any revisions shall be marked with a delta symbol with revision number and described at the bottom of this page.

* Denotes an A.I. Inspection Point ** Denotes an A.I. Hold Point

* Low Temp.

CA-TIS 00234

CALHEX INDUSTRIES LTD.
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TRAVEL SHEET (BACK)

MATERIAL THICKNESS VERIFICATION AND IDENTIFICATION				WELD I.D. / WELDER SYMBOLS / FIT-UP						
Description	Thickness	Material Spec. & Grade	Heat & Plate Identifier or Material Tracking Number	Weld I.D.	Welder Symbol	Fit-Up Exam	Weld I.D.	Welder Symbol	Fit-Up Exam	Verify Type 1 Joint
Tubes	0.750" 14 BWG	SA179	193106 / 213254							
Tubesheet A	1.5625" (1.568")	SA516-70N	B663				C3	J		
Tubesheet B	1.5625" (1.570")	SA516-70N	B663				C5	J		
Shell Cylinder	24" XH (.514")	SA333-6	B959				C4	G		
Chan. Cylinder	24" XH (.514")	SA333-6	B959				C2	J		
Channel Cover	24" 300 CL RF BL.	SA350-LF2 CL.1	198658							
Channel RFWN	24" 300 CL RFWN	SA350-LF2 CL.1	H0742/3				C1	B		
Chan. Cylinder	24" XH (.514")	SA333-6	B959				C6	J		
Channel Cover	24" 300 CL RF BL.	SA350-LF2 CL.1	198658							
Channel RFWN	24" 300 CL RFWN	SA350-LF2 CL.1	H0742/3				C7	A		
Saddle Repad	0.375" (.390")	SA516-70N	B947							
Saddle Repad	0.375" (.390")	SA516-70N	B947							
Saddle Repad	0.375" (.390")	SA516-70N	B947							

ATTACHMENT AND / OR NOZZLE MATERIAL THICKNESS VERIFICATION AND IDENTIFICATION						WPS# /WELDER SYMBOLS / FIT-UP			
Mark	Mat. I.D.	Neck	Fitting	Flange	Repad or Attachment	Cat. B	Cat. C	Cat. D	Pad OD
N1 C1b C2b	Spec.-Grd.	SA333-6	SA350-LF2 CL.1	SA350-LF2 CL.1	SA516-70N		^A	^J^J	12.625"
	Thk./Rating	8" XH (.527")	1"&¾" 6000 CL CPLG	8" 300 CL RFWN	0.250"(.245")		CX-1N	^B^B CX-2N	
	Heat# or ID	B368	4038 / 4048	12/30011	B998				
N2 C1c C2c	Spec.-Grd.	SA333-6	SA350-LF2 CL.1	SA350-LF2 CL.1	SA516-70N		^A	^J^J	12.625"
	Thk./Rating	8" XH (.527")	1"&¾" 6000 CL CPLG	8" 300 CL RFWN	0.250"(.245")		CX-1N	^B^B CX-2N	
	Heat# or ID	B368	4038 / 4048	12/30011	B998				
N3 C1d C2d	Spec.-Grd.	SA333-6	SA350-LF2 CL.1	SA350-LF2 CL.1	SA516-70N		^A	^J^J	12.625"
	Thk./Rating	8" XH (.527")	1"&¾" 6000 CL CPLG	8" 300 CL RFWN	0.250"(.245")		CX-1N	^B^B CX-2N	
	Heat# or ID	B368	4038 / 4048	12-30011	B998				
N4 C1a C2a	Spec.-Grd.	SA333-6	SA350-LF2 CL.1	SA350-LF2 CL.1	SA516-70N		^A	^J^J	12.625"
	Thk./Rating	8" XH (.527")	1"&¾" 6000 CL CPLG	8" 300 CL RFWN	0.250"(.245")		CX-1N	^B^B CX-2N	
	Heat# or ID	B368	4038 / 4048	12-30011	B998				
C3a	Spec.-Grd.		SA350-LF2 CL.1					^J	
	Thk./Rating		1" 6000 CL CPLG					CX-2N	
	Heat# or ID		4038						
C3b	Spec.-Grd.		SA350-LF2 CL.1					^J	
	Thk./Rating		1" 6000 CL CPLG					CX-2N	
	Heat# or ID		4038						
	Spec.-Grd.								
	Thk./Rating								
	Heat# or ID								

Procoat Coatings Ltd.
6632 90 Ave SE
Calgary, AB T2C 2T3
(p) 403-236-0988 (f) 403-236-0993
Email procoatc@telus.net

PROCOAT COATINGS LTD
QUALITY CONTROL INSPECTION REPORT

DATE: December 18, 2012

CUSTOMER: Calhex Industries Ltd.

CUSTOMER JOB: 12-0779

PROCOAT WORK ORDER #: 1010-12-12

ITEM DESCRIPTION: (1) Vessel (NEN 23 x 576 – 25500lbs)

CA-TIS 3088

PROCOAT COATINGS LTD
SURFACE PREPARATION INSPECTION REPORT

DATE: December 13, 2012

INSPECTION

SANDBLASTER: James

SURFACE PREP: SSPC-SP6

PROFILE THICKNESS: 2.5 - 3.0mils

ABRASIVE USED: 30/50 Silica

EQUIPMEN: 375 CFM Compressor NOZZLE: #6

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

SURFACE PREP CONDITIONS

AIR TEMP: 2°C SUBSTRATE TEMP: 1.5°C

RELATIVE HUMIDITY: 29% DEW POINT: -13°C

Procoat Coating Inspection Report

Date	13-Dec-12	13-Dec-12		
Coat	1st	2nd		
Avg.	1.8	3.8		
DFT(mil) High	2	4.2		
Low	1.6	3.3		
No. of reads	263	244		
Applicator	Lloyd	Lloyd		
Product	Rust-oleum Industrial Choice	Rust-oleum Enamel		
Color	Grey	Silver Grey		
Batch #	206331	245484		
	P25151	P20242		
Air Temp (C)	23	23		
Steel Temp(C)	23	23		
Humidity (%)	29%	29%		
Dew Point (C)	-13	-13		
Comments:				