

HISTORY DOCKET

CUSTOMER : ULTRAFAB INDUSTRIES LTD.,
WO. NO. : 1176PQ
A.W.C. SERIAL NO. : 7469
ITEM : 60" I.D. VERTICAL H2S CONTACTOR TAG # 772-VECO-202

CONTENTS OF BOOKLET

- 1) CERTIFICATE OF COMPLIANCE
- 2) FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS C/W FORM U-4
MANUFACTURER'S DATA REPORT SUPPLEMENTARY SHEET
- 3) TRAVELLER SHEETS 1&2
- 4) HYDROSTATIC TEST REPORTS/GAUGE CALIBRATION CERTIFICATE & WATER ANALYSIS
REPORT
- 5) NAME PLATES (PHOTO IN IMPERIAL & METRIC) (STAMPED BY ABS)
- 6) HEAT TREAT CHART COMPLETE WITH CALIBRATION CERTIFICATE
- 7) KVI NDE REPORTS RT, UT, MT & HT C/W MAPS, RADIOGRAPH REVIEW FORM & NDE
PERSONNEL CERTIFICATE
- 8) WPS/ PQR/ WELDING CONSUMABLES & WELDERS' QUALIFICATION RECORD C/W
WELD MAP
- 9) HEAT NUMBER MAP AND MATERIAL TEST REPORTS
- 10) DESIGN CALCULATIONS AND AS BUILT DWGS C/W ABS APPROVED DWGS

CERTIFICATE OF COMPLIANCE

I, THE UNDERSIGNED, DECLARE THAT YOUR VESSELS, IDENTIFIED AS

CUSTOMER: ULTRAFAB INDUSTRIES LTD.
AWC W.O. NO: 1176 PQ
SERIAL NO'S: 7469
ITEM: 60" I.D. VERTICAL H2S CONTACTOR TAG # 772-VECO-202

COMPLIES AND EXCEEDS THE QUALITY CONTROL LEVEL OF THE TECHNICAL STANDARDS AND SAFETY AUTHORITY OF ONTARIO AND THE CODES AND STANDARDS OF ASME CODES: SEC. VIII, DIV. 1 UW- 12(a) 2010 EDITION. 2011ADDEENDA

SIGNATURE


ROBERT C. BENTLEY, C.E.T.
QUALITY ASSURANCE MANAGER

DATE

SEP 30 2013

ALL-WELD

COMPANY LIMITED
Engineers Since 1920
A TRADITION OF QUALITY

49 PASSMORE AVE., SCARBOROUGH, ONT., M1V 4T1 TEL (416) 299-3311 FAX (416) 299-3387

1. Manufactured and certified by ALL-WELD COMPANY LIMITED., 49 PASSMORE AVE., SCARBOROUGH, ONT. M1V 4T1 CANADA
(Name and address of Manufacturer)

2. Manufactured for ULTRA FAB INDUSTRIES LTD., 261088 WAGON WHEEL CRES., ROCKY VIEW, ALBERTA, T4A 0E2 CANADA

3. Location of Installation OFF THE COAST OF ANGOLA
(Name and address)

4. Type VERTICAL 7469 M10137.5 1176-1 REV. 6 907 2013
(Horizontal or vertical tank) (Manufacturer's serial number) (CRN) (Drawing number) (National Board number) (Year built)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section VIII, Division 1.
 to 2011a N/A 2010
[Addenda, if applicable (date)] (Code Case numbers) (Year)

6. Shell: SA-516 70N 2.5" 0.125" 5'-0" 8'-0"
(Material spec. number, grade) (Nominal thickness) (Corr. allow.) (Inner diameter) (Length (overall))

7. Seams: TYPE 1 FULL 100% 1100°F 2.25 TYPE 1 FULL 100% 1
[Long (welded, dbl., sngl., lap, buttl)] [R T (spot or full)] [Eff. %] (H T temp) (Time, hr) [Girth (welded, dbl., sngl., lap, buttl)] [R T (spot or full)] [Eff. %] (No. of courses)

8. Heads: (a) Material SA-516-70N (b) Material SA-516-70N
(Spec. no., grade) (Spec. no., grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	TOP	2.491"	0.125"	--	--	2:1	--	--	--	CONCAVE
(b)	BOTTOM	2.491"	0.125"	--	--	2:1	--	--	--	CONCAVE

If removable, bolts used (describe other fastenings) N/A
(Material spec. number, grade, size, number)

9. MAWP 1378 PSI 15 PSI at max. temp. 140°F 140°F
(Internal) (External) (Internal) (External)

Min. design metal temp -20° F at 1378 PSI Hydro., pneu., or comb. test pressure HYDRO 1792 PSI

Proof test N/A

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain etc.)	No.	Diameter or Size	Type	Material		Nominal Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
VENT (N7)	1	2" ID	Cl.900 LWN	SA-350-LF2	SA-350-LF2	1.06"	0.125"	N/A	UW-16.1 (e)	N/A	N/A
OUTLET (N10)	1	8" ID	Cl.900 LWN	SA-350-LF2	SA-350-LF2	1.875"	0.125"	N/A	UW-16.1 (e)	N/A	N/A
CORR. (N9)	1	2" ID	Cl.900 LWN	SA-350-LF2	SA-350-LF2	1.06"	0.125"	N/A	UW-16.1 (e)	N/A	N/A
PURGE (N2)	1	2" ID	Cl.900 LWN	SA-350-LF2	SA-350-LF2	1.06"	0.125"	N/A	UW-16.1 (e)	N/A	N/A

11. Supports: Skirt YES Lugs N/A Legs N/A Other N/A Attached BOTTOM HEAD & WELDED
(Yes or no) (Number) (Number) (Describe) (Where and how)

12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report: N/A

(1) SHOP TEST PERFORMED IN THE VERTICAL POSITION (2) IMPACT TESTED PER UG-20 (f) (3) SEE ATTACHED U-4 FORM
(Name of part, item number, Manufacturer's name and identifying stamp)

CERTIFICATE OF SHOP/FIELD 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 21226
 expires MAY 07, 2016
 Date 16 Sept 2013 Co. name ALL-WELD COMPANY LIMITED. Signed [Signature]
(Manufacturer) (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by ALL-WELD COMPANY LIMITED at 49 PASSMORE AVE. TORONTO, ONT.

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 ONTARIO and employed by T.S.S.A. OF ONTARIO
 have inspected the component described in this Manufacturer's Data Report on SEP 13, 2013, 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 SEP 16, 2013 Signed [Signature] Commissions NB 13106A, ONT 915
(Authorized Inspector) [National Board (incl. endorsements), State, Province and number]

FORM U-4 MANUFACTURER'S DATA REPORT SUPPLEMENTARY SHEET

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

1. Manufactured and certified by ALL-WELD COMPANY LIMITED, 49 PASSMORE AVE., SCARBOROUGH, ONTARIO, M1V 4T1
(Name and address of Manufacturer)

2. Manufactured for ULTRA FAB INDUSTRIES LTD., 281088 WAGON WHEEL CRES., ROCKY VIEW, ALBERTA, T4A 0E2 CANADA
(Name and address of Purchaser)

3. Location of installation OFF THE COAST OF ANGOLA
(Name and address)

4. Type VERTICAL TANK 7469
(Horizontal, vertical, or sphere) (Tank, separator, heat exch, etc) (Manufacturer's serial number)

M10137.5 1176-1 REV. 6 907 2013
(CRN) (Drawing number) (National Board number) (Year built)

DATA REPORT ITEM NUMBER

REMARKS

ITEM 10:

Purpose (Inlet, Outlet, Drain etc.)	No.	Diameter or Size	Type	Material		Nominal Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
LEVEL BRIDAL LOW (N3)	1	2" ID	Cl.900 LWN	SA-350 LF2	SA-350 LF2	1.06"	0.125"	N/A	UW.16 1(e)	N/A	N/A
DIFF PRESS HIGH (N4)	1	2" ID	Cl.900 LWN	SA-350 LF2	SA-350 LF2	1.06"	0.125"	N/A	UW.16 1(e)	N/A	N/A
LEVEL BRIDAL HIGH (N5)	1	2" ID	Cl.900 LWN	SA-350 LF2	SA-350 LF2	1.06"	0.125"	N/A	UW.16 1(e)	N/A	N/A
FILL/WATER FLUSH (N6)	1	2" ID	Cl.900 LWN	SA-350 LF2	SA-350 LF2	1.06"	0.125"	N/A	UW.16 1(e)	N/A	N/A
DIFF PRESS LOW (N8)	1	2" ID	Cl.900 LWN	SA-350 LF2	SA-350 LF2	1.06"	0.125"	N/A	UW.16 1(e)	N/A	N/A
INSPECTION NOZZLE (N11)	1	8" ID	Cl.900 LWN	SA-350 LF2	SA-350 LF2	1.875"	0.125"	N/A	UW.16 1(e)	N/A	SHELL
INLET NOZZLE (N12)	1	8" ID	Cl.900 LWN	SA-350 LF2	SA-350 LF2	1.875"	0.125"	N/A	UW.16 1(e)	N/A	N/A
MANWAY (N13)	1	24" ID	Cl.900 V2/12	SA-350 LF2	SA-350 LF2	5.5"	0.125"	N/A	UW.16 1(e)	N/A	SHELL
BOTTOM DRAIN (N1)	1	NPS 2"	Cl.900 WN	SA-333 6	SA-350 LF2	0.344"	0.125"	N/A	UW.16 1(e)	UW.16.1 (f2)	N/A

Certificate of Authorization: Type: U No.: 21226 Expires MAY 07,2016

Date: 16 Sept 2013 Name: ALL-WELD COMPANY LIMITED Signed: [Signature]
(Manufacturer) (Representative)

Date: SEP 16, 2013 Name: [Signature] Commission: NB13106A, ONT915
(Authorized Inspector) (National Board (incl. endorsements), State, Province, and number)

ALL-WELD CO. LTD.

TRAVELLER

(SUMMARY REPORT) Pg. 1 of 2

DATE 2013-02-06	WORK ORDER 1176Q	CUSTOMER PO 11112	REVIEWED <i>[Signature]</i>	BY A.I. <i>[Signature]</i>
SERIAL NO. 7469	C.R.N. M10137.5	DATE 2013-02-06		SIGN FEB 07 13
NATIONAL BOARD NO. 907				
CUSTOMER ULTRAFAB		ULTIMATE OWNER		
FOR DRAWINGS & DOCUMENTS/REV./DATE ISSUED TO Q.C.		ASME CODE 2010		
SEE Q.C. DOCUMENT CONTROL FORM		SECTION VIII DIV 1		
VESSEL TYPE/JOB DESCRIPTION 60" ID VERTICAL H2S CONTRACTOR OPERATIONS, INSPECTIONS & TEST POINTS		ADD 2011 H = HOLD R = REVIEW		
		H	H	H
		R	R	R
		AWC QC	CUSTOMER	AI
REVIEW APPVD DRWGS, CALCS,		H 10/9/13		R 10/9/13
REVIEW TRAVELLER AND REVIEW INSPECTION AND TEST PLAN		H 15/03/13		R 15/03/13
REVIEW MATERIAL LIST		H 23/07/13		R 23/07/13
REVIEW W.P.S., P.Q.R		H 10/03/13		R 10/03/13
INCOMING MATERIAL INSPECTION REPORT		H 23 July 13		R 23 JUL 23, 13
CHECK ROUNDNESS OF VESSEL		H 29 July 13		
FIT-UP INSPECTION		H 28 July 13		
PRODUCTION IMPACT TEST		H 10/9/13		
MAG PARTICLE / LIQUID PEN TEST		H 10/9/13		
APPROVAL OF RADIOGRAPH MAP BY AI		H 15/03/13		R 15/03/13
RADIOGRAPHIC TESTS - FULL		H 10/9/13		R 10/9/13
ULTRASONIC TEST		H 10/9/13		
HARDNESS TESTS		H 10/9/13		
REVIEW WELDERS QUALIFICATION		H 10/9/13		R 10/9/13
WELD MAP REPORT		H 10/9/13		R 10/9/13
FINAL INTERNAL INSPECTION		H 27/08/13		H 27/08/13
POST WELD HEAT TREATMENT		H 10/9/13		R 10/9/13
FINAL (ALL NCR'S HAVE BEEN CLEARED)		H 16/9/13		R 16/9/13
FINAL COMPLETED VESSEL INSPECTION		H 16/9/13		H 16/9/13
FINAL HYDROSTATIC TEST		H 13/09/13		H 13/09/13
FINAL HYDROSTATIC TEST JACKET		N/A		
FINAL HYDROSTATIC TEST TUBE SIDE		N/A		
APPLICATION OF CODE STAMP + ATTACH NAMEPLATE		H 13/09/13		H 13/09/13
DATA REPORT SIGN OFF		H 16/09/13		H 16/09/13
GLASS BEAD BLASTING		N/A		
DATA PACKAGE SENT TO CUSTOMER		H 16/12/13		

ALL-WELD HYDROSTATIC TEST REPORT

JOB NUMBER 1176 PQ		DATE SEPTEMBER 13, 2013	
CUSTOMER ULTRA FAB INDUSTRIES LTD.		SERIAL NO. 7469	
VESSEL DESCRIPTION 60" I.D. VERTICAL H2S CONTACTOR TAG # 772-VECO-202			
TEST PRESSURE	SHELL 1792 PSIG	TUBE NA	JACKET NA
TEST METAL TEMPERATURE	50° F	HOLDING TIME 1 HOUR MIN	
GAUGE # 122 & 123	LAST CALI. DATE 12-Jun-13	GAUGE #	LAST CALI. DATE

REMARKS

- 1) HYDROSTATIC TESTING SHALL BE PERFORMED IN ACCORDANCE WITH PARA UG-99 OF THE ASME CODE SECTION VIII, DIVISION 1.

- 2) THE METAL TEMPERATURE DURING HYDROSTATIC TEST IS RECOMMENDED TO BE HELD AT LEAST 30°F ABOVE THE MINIMUM DESIGN METAL TEMPERATURE TO A MAXIMUM OF 120°F BUT IN NO CASE LESS THAN THE MDMT.

COMMENTS: ACCEPTED

WITNESSED BY QAS
 DAN COOPER
 FOR MICHAEL S.

Q.A. SIGNATURE *R Bentley*
DATE: SEPTEMBER 13, 2013

Excel - QA - Hydrostatic Test Report

MIKE KAMYAB REVIEWED <input type="checkbox"/> WITNESSED <input checked="" type="checkbox"/> FOR SBM DATE: 9/13/13
--

046
ACCEPTED/REVIEWED/RELEASED for and on behalf of: <u>SBM OFFSHORE</u>
Print Name: <u>GAMBESII SAHA</u>
Signature: <u>[Signature]</u>
Date: <u>SEP 13/13</u>
Applus® VELOSI Velosi America LLC



Winters Instruments
 121 Rainside Road
 Toronto, ON M3A 1B2
 Canada

Tel: 416-444-2345
 Fax: 416-444-8979
 1-800-WINTERS
 www.winters.com

CALIBRATION TEST CERTIFICATE

Calibration Date: JUNE/27/13 Interval: 1 Year

Expiration: JUNE 27, 2014

CUSTOMER: ALL WELD		Winters Asset (Pressure)	ADT672
PURCHASE ORDER: 13-0563		Winters Serial # (Pressure)	27312420003
DATE: JUNE 27, 2013		Asset Accuracy (% FS): +/- 0.1%	
TEST NUMBER: G13-0776		Winters Asset (Vacuum)	
Customer Asset ID Number		Winters Serial # (Vacuum)	
Gauge Part Number	MARSH GAUGE	Asset Accuracy (% FS): +/-	
Gauge Serial Number	#45		
Gauge Range: 0-3000 PSI		Gauge Accuracy (% FS): N/A	Gauge Tolerance: N/A

Upscale		Downscale	
Above Gauge Reading	Reference Gauge Reading	Above Gauge Reading	Reference Gauge Reading
505	500		
1001	1000		
1498	1500		
2000	2000		
2497	2500		

Engineering Unit Used for Test: PSI
 Ambient Temp at Test: 29°C Relative Humidity: 56% Barometric Pressure: 99.3 KPA

Register Your Certificate at www.winters.com/tc

Technician: *[Signature]* Approved: *[Signature]*

NOTE: This instrument has been tested in accordance to ANSI/NC SL Z540-1 and complies with the relevant specifications/drawings of the above purchase order. All test equipment used in this certification is traceable to the National Institute of Standards and Technology.

F750-05 Rev 4 - Calibration Test Certificate-Gauges.doc / Last Revision: June 3, 2010

JUL 03 2013



Report For: All-Weld Company Limited
49 Passmore Avenue,
SCARBOROUGH, Ontario
M1V 4T1
Phone: 416-299-3311
Fax: 416-299-3387
Email: mail@allweld.com

Laboratory #: 608638-12

Report Date: May 14, 2012

Received Date: May 9, 2012

Customer P.O. #: N860-9764Q

Specimen: Water Sample

TEST REPORT

RE: ANALYSIS OF WATER SAMPLE FOR HALOGEN AND SULPHUR RADICALS

On May 9, 2012, CMTL received a water sample to determine the presence and relative concentration of halogen and sulphur radicals.

The submitted sample was analyzed using a DX-120 Ion Chromatogram as per ASTM D4327-11 and the following results were obtained:

HALOGEN RADICALS	CONCENTRATION (ppm)
Fluoride (F ⁻)	0.5
Chloride (Cl ⁻)	47.4
Bromide (Br ⁻)	<0.5

SULPHUR RADICALS	CONCENTRATION (ppm)
Sulphate (SO ₄ ²⁻)	27.7

This report is subject to the following terms and conditions: 1. This report relates only to the specimen provided and there is no representation or warranty that it applies to similar substances or materials or the bulk of which the specimen is a part. 2. The content of this report is for the information of the customer identified above only and it shall not be reprinted, published or disclosed to any other party except in full. Prior written consent from Cambridge Materials Testing Limited is required. 3. The name Cambridge Materials Testing Limited shall not be used in connection with the specimen reported on or any substances or materials similar to that specimen without the prior written consent of Cambridge Materials Testing Limited. 4. Neither Cambridge Materials Testing Limited nor any of its employees shall be responsible or held liable for any claims, loss or damages arising in consequence of reliance on this report or any default, error or omission in its preparation or the tests conducted. 5. Specimens are retained 6 months, test reports and test data are retained 7 years from date of final test report and then disposed of, unless instructed otherwise in writing.

* Cambridge Materials Testing Limited is accredited for tests listed on the scope of accreditation available for review at www.cambridgematerials.com.
Test Report Template Revision March 2010

Cambridge Materials Testing Limited

Per Steve Brown

QUALITY ASSURANCE

Per Rupinder Singh

TECHNICIAN

907

CERTIFIED

L-WELD

COMPANY LIMITED
THOROUGH CHECKERS SINCE

MAY	18	PSI	W	1401	°F
MAY	15	PSI	W	1401	°F
MAY	10	°F	W	1378	PSI
MAY	10	PSI	W	N/A	°F
MAY	10	PSI	W	N/A	°F
MAY	12	PSI	W	N/A	°F
MAY	12	°F	W	N/A	PSI

SERIAL NO. 10157.5 YEAR BUILT 2013

772-350-202

CERTIFIED BY
ALL-WELD

COMPANY LIMITED
SCARBOROUGH, ONTARIO
ENGINEERS SINCE 1920

W L
R T
H T

1/3

SHELL MAWP	9501	kPa AT	60	°C
SHELL MAEWP	103.5	kPa AT	60	°C
SHELL MDMT	-28.9	°C AT	9501	kPa
CHANNEL MAWP	N/A	kPa AT	N/A	°C
JACKET MAWP	N/A	kPa AT	N/A	°C
MAEWP	N/A	kPa AT	N/A	°C
MDMT	N/A	°C AT	N/A	kPa
SERIAL NO.	7469	YEAR BUILT	2013	

C.R.N. M10157.5 10-296008

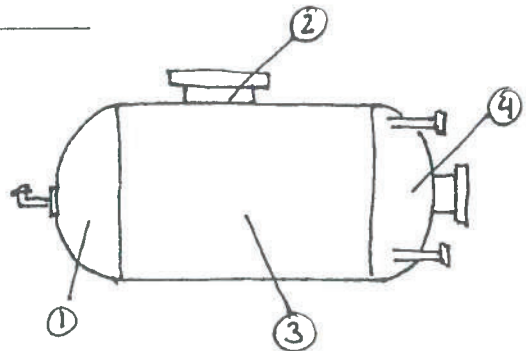
TAG# 772-VECO-202

QCM
 Sept 09 / 2013

CONREX STEEL LIMITED
 50 TABER ROAD
 REXDALE, ONTARIO M9W 3A9
 HEAT TRACING RECORD

CSL WO#	QTY	DESCRIPTION	CUSTOMER	CUST PO#
75165	1	vessel 60" dia x 155 7/16" lg	All Weld Company	13-0781
		(1 st of 2) job # 1176.36		
		# Serial # 7469		

HEAT TREATMENT SPECIFICATION: All weld PWHT Proc. No PWHT-PI Rev No 0
 HEAT AT max 160°F PER HOUR FROM 800°F
 HOLD 125 to 150 MINUTES AT 1175°F ± 25°F
 COOL AT max 200°F PER HOUR TO 800°F



THERMOCOUPLES: # 1 2 4 3

NOTES:

All temperatures in degees Fahrenheit unless noted

SIGNED FOR CSL *[Signature]*

DATE Sept 3/13

TIME	STEP	SETPT	CHART TEMPERATURES					
			TC#1	TC#2	TC#3	TC#4	TC#5	TC#6
16:49	1	113	122	121	122	123	0	0
16:59	1	177	200	198	200	200	0	0
17:09	1	257	290	288	290	290	0	0
17:19	1	337	375	374	375	375	0	0
17:29	1	417	461	461	461	462	0	0
17:39	1	496	540	541	539	541	0	0
17:49	1	576	617	619	617	619	0	0
17:59	1	656	690	694	691	692	0	0
18:09	1	736	772	775	772	776	0	0
18:19	2	803	826	830	827	828	0	0
18:29	2	820	837	842	838	842	0	0
18:39	2	837	851	856	852	854	0	0



CHART TEMPERATURES

TIME	STEP	SETPT	TC#1	TC#2	TC#3	TC#4	TC#5	TC#6
18:49	2	853	866	871	867	870	0	0
18:59	2	870	879	885	880	883	0	0
19:10	2	887	899	903	899	902	0	0
19:20	2	903	911	917	912	916	0	0
19:30	2	920	925	929	926	928	0	0
19:40	2	937	942	947	942	945	0	0
19:50	2	953	957	963	958	961	0	0
20:00	2	970	973	978	974	976	0	0
20:10	2	987	990	996	992	994	0	0
20:20	2	1003	1007	1013	1008	1011	0	0
20:30	2	1020	1023	1028	1024	1026	0	0
20:40	2	1037	1039	1046	1040	1043	0	0
20:50	2	1053	1055	1061	1056	1059	0	0
21:00	2	1070	1073	1079	1075	1077	0	0
21:10	2	1087	1087	1094	1089	1091	0	0
21:20	2	1103	1103	1111	1105	1108	0	0
21:30	2	1120	1123	1130	1125	1128	0	0
21:40	2	1137	1138	1144	1139	1142	0	0
21:50	2	1153	1154	1160	1155	1157	0	0
22:00	2	1170	1171	1178	1173	1176	0	0
22:10	3	1175	1176	1185	1180	1183	0	0
22:20	3	1175	1174	1181	1175	1178	0	0
22:30	3	1175	1174	1181	1175	1178	0	0
22:40	3	1175	1176	1182	1177	1180	0	0
22:50	3	1175	1174	1181	1176	1178	0	0
23:00	3	1175	1175	1181	1177	1178	0	0
23:10	3	1175	1174	1181	1175	1177	0	0
23:20	3	1175	1174	1180	1175	1176	0	0
23:30	3	1175	1172	1179	1173	1173	0	0
23:40	3	1175	1176	1181	1176	1178	0	0
23:50	3	1175	1174	1180	1175	1177	0	0
00:00	3	1175	1173	1179	1174	1175	0	0
00:09	3	1175	1179	1183	1179	1180	0	0
00:19	3	1175	1175	1181	1176	1177	0	0
00:29	3	1175	1172	1178	1173	1173	0	0
00:39	4	1165	1160	1165	1160	1161	0	0
00:49	4	1148	1140	1145	1141	1141	0	0
00:59	4	1132	1126	1131	1127	1127	0	0
01:09	4	1115	1107	1112	1107	1108	0	0
01:19	4	1098	1089	1095	1091	1090	0	0
01:29	4	1082	1070	1076	1070	1070	0	0
01:39	4	1065	1049	1057	1049	1050	0	0
01:49	4	1048	1032	1040	1031	1033	0	0
01:59	4	1032	1018	1026	1017	1019	0	0
02:09	4	1015	1006	1015	1005	1007	0	0
02:19	4	998	996	1004	994	997	0	0
02:29	4	982	986	995	985	988	0	0
02:39	4	965	978	987	977	979	0	0
02:49	4	948	970	978	968	971	0	0
02:59	4	932	959	967	957	960	0	0
03:09	4	916	942	952	941	944	0	0
03:19	4	900	925	937	925	928	0	0
03:29	4	884	910	920	910	912	0	0

2 hrs / 20 minutes



CHART TEMPERATURES

TIME	STEP	SETPT	TC#1	TC#2	TC#3	TC#4	TC#5	TC#6
03:39	4	868	893	905	894	896	0	0
03:49	4	852	876	890	878	880	0	0
03:59	4	836	861	873	863	864	0	0
04:09	4	820	844	858	847	848	0	0
04:19	4	804	827	843	831	832	0	0
04:29	4	788	812	826	816	816	0	0
04:39	4	772	795	811	800	800	0	0
04:49	4	756	778	796	784	784	0	0
04:59	4	740	763	779	769	768	0	0
05:09	4	724	746	764	753	752	0	0
05:19	4	708	729	749	737	736	0	0
05:29	4	692	714	732	722	720	0	0
05:39	4	676	697	717	706	704	0	0
05:49	4	660	680	702	690	688	0	0
05:59	4	644	665	685	675	672	0	0
06:09	4	628	648	670	659	656	0	0
06:19	4	612	631	655	643	640	0	0
06:29	4	596	616	638	628	624	0	0
06:39	4	580	599	623	612	608	0	0
06:49	4	564	582	608	596	592	0	0
06:59	4	548	567	591	581	576	0	0

REF#1598

ACCEPTED/REVIEWED/RELEASED 046
for and on behalf of: SBM OFFSHORE
Print Name: CAVRESII SAH
Signature: [Signature] **Applus®**
Date: sep 10 13 **VELOSI**
Velosi America LLC

CONREX STEEL LTD.

50 Taber Road. Rexdale. Ontario, M9W 3A9 Phone (416)-747-4665 Fax (416)-747-4667

CALIBRATION CERTIFICATE

INSTRUMENT: STRESS RELIEF FURNACE # 2
 MANUFACTURER: NORTH AMERICAN
 SERIAL NUMBER: CONREX # 2

Standard	As Found	Calibrated	Standard	As Found	Calibrated
LOAD#1			ADDITIONAL TEMPERATURE CONTROLS		
1125°F	1127°F	Aug 19, 2013	1#: 1125°F	1127°F	— " —
1650°F	1652°F	— " —	1650°F	1652°F	— " —
			2#: 1125°F	1126°F	— " —
LOAD#2			1650°F	1651°F	— " —
1125°F	1127°F	— " —	3#: 1125°F	1126°F	— " —
1650°F	1652°F	— " —	1650°F	1651°F	— " —
			4#: 1125°F	1127°F	— " —
LOAD#3			1650°F	1651°F	— " —
1125°F	1128°F	— " —	5#: 1125°F	1127°F	— " —
1650°F	1652°F	— " —	1650°F	1651°F	— " —
			6#: 1125°F	1127°F	— " —
			1650°F	1652°F	— " —
			7#: 1125°F	1126°F	— " —
			1650°F	1650°F	— " —
			8#: 1125°F	1126°F	— " —
			1650°F	1650°F	— " —

CORRECTLY REVIEWED/RELEASED
 for and on behalf of: S BMO PPS SHORE
 Print Name: CHAMBERLAIN SAHA
 Signature: [Signature]
 Date: OCT 21 13
 APPLIED VELOCITY
 Velocity America LLC

If 'calibrated' column is blank. No adjustments were necessary

COMMENTS: STANDARD: PPS MINITEMP MODEL 1062, SER# B67568
 QC INSPECTOR: [Signature] QC MANAGER: Ling Tang DATE: Aug 19, 2013

CERTIFICATE OF CALIBRATION

REPORT NUMBER 13116913

This certificate attests that the equipment and/or standards used in the calibration are calibrated to recognized standards which are traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or National Research Council of Canada (NRCC). The calibration was performed in accordance with the applicable portions of ISO/IEC 17025:2005, ISO 9001:2008, ANSI/NCSL Z540-1-1994 and technical requirements of the customer's order.

The instrument described below has been calibrated in our lab on date noted. Data not accredited will be identified by an asterisk (*). Copyright of this Certificate is owned by the issuing laboratory and may not be reproduced other than in full.

Equipment	Mini-Temp Calibrator	Calibration Date	22-Apr-2013
Model	1062	Calibration Expiry Date	22-Apr-2014
Serial	B67568	Property of	Conrex Steel Limited
Accessories	None	Address	50 Taber Road
Asset	N/A		Rexdale
Manufacturer	Transmation		Ontario
Date Received	19-Apr-2013		M9W 3A9
Date of Last Calibration	12-Apr-2012	Procedure	CPR #0713
Condition When Received	Good	Method	Comparison
Humidity	42.5%		ISO/IEC 17025:2005 &
Temperature	22.8°C	Conformance Standards	ISO 9001:2008
Purchase Order	3027	Other Standards	N/A

Calibration Standard(s) Used

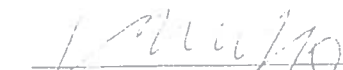
Asset Number	Traceability	Calibration Date	Calibration Expiry Date
AVO 381	ST3104386	23-Jun-2011	23-Jun-2014

The reported data is valid only at the time of the calibration and is related only to the instrument/equipment being calibrated.

The Calibration Expiry Date appearing on this Certificate of Calibration and the Calibration Label is determined by the client or by the appropriate ASTM Standard/Manufacturer and does not imply continued conformance to specifications.

The instrument/equipment was inspected, cleaned, and tested using manufacturer's specifications and procedures, client's procedures, or national/international standards and procedures.

Reported uncertainties are expressed as expanded uncertainty values at approximately the 95% confidence level assuming a normal distribution, with a coverage factor of k=2.


 Francis Foo (Technician)


 K. F. Lok (Authorized)

RADIOGRAPH REVIEW FORM

W.O. NO. 1176 PQ
SERIAL NO. 7469

- 1) THE X-RAY MAP ATTACHED SHOWS THE LOCATION OF THE RADIOGRAPHS.
- 2) THE INFORMATION REQUIRED IN ASME SECTION V T-291 IS FOUND ON THE WELDING INSPECTION REPORT MADE OUT BY KV INSPECTION SERVICES.
- 3) EVALUATION AND DISPOSITION OF MATERIAL AND WELDS EXAMINED IS FOUND ON THE X-RAY MAP ATTACHED.
- 4) THE IDENTIFICATION OF THE MANUFACTURER'S REPRESENTATIVE WHO PERFORMED THE FINAL ACCEPTANCE OF THE RADIOGRAPHS IS IDENTIFIED BY HIS STAMP FOUND ON THE WELDING INSPECTION REPORT MADE OUT BY KV INSPECTION SERVICES ON THE LINE "MANUFACTURES REPRESENTATIVE".
- 5) THE DATE OF THE MANUFACTURES EVALUATION IS FOUND ON THE WELDING INSPECTION REPORTS MADE OUT BY KV INSPECTION SERVICES ON THE LINE "MANUFACTURES REPRESENTATIVE".



PREPARED BY: ROBERT C. BENTLEY
Q.A. MANAGER

DATE: SEP 09 2013



KV INSPECTION SERVICES LTD

Established 1980


1486 Wallace Road, Oakville, Ontario L6L 2Y2

Office: (905) 844-9448 Fax: (905) 844-6697

www.kvinspection.com

Email: kvinsp1@aol.com

CHRIS VEENEMAN

Natural Resources Canada		Ressources naturelles Canada	
	Name Nom	Christopher Veeneman	
	Rec. No No matricule	6651	
	Issue Date Date d'emission	2011/02/14	
	Corrective lenses for [X] near [X] far vision Verres correctifs pour la vision de [X] pres [X] distance		
	Signature		

Natural Resources Canada		Ressources naturelles Canada			
Qualified to / Qualifié(e) en	CAN 1058 48 9710	6651			
1997/2007 Qualifié(e) en					
Method Méthode	Level Niveau	Sector Secteur	Cert. Date Date cert.	Date recert. Date recert.	Expires Expiration
MT	2	EMC	1997/05/08		2013/12/31
PT	2	EMC	1997/11/07		2013/12/31
RT	2	EMC	2000/01/06		2013/12/31
LT	2	EMC	2010/06/03		2013/12/31

KV INSPECTION SERVICES LTD

Established 1980

1486 Wallace Road, Oakville, Ontario L6L 2Y2

Office: (905) 844-9448 Fax: (905) 844-6697

www.kvinspection.com

Email: kvinsp1@aol.com

FRANK MARUNDE



Natural Resources
Canada

Ressources naturelles
Canada



Name: **Frank Marunde**
Nom
Reg. No. **8885**
No. matricule
Issue Date/ **2012/11/29**
Date d'émission

This card does not identify the named individual to be an employee or representative of Natural Resources Canada, Government of Canada.
Cette carte n'identifie pas l'individu d'être un employé ou un représentant de Ressources naturelles Canada, Gouvernement du Canada.

Corrective lenses for || near || far vision.
Verres correctifs pour la vision de || près || distance.

Signature:  C. 113 246 52



Natural Resources
Canada

Ressources naturelles
Canada

Registered to Cerbha selon CAN CGSB 48 9712

8885

Method Méthode	Level Niveau	Sector Secteur	Cert. Date Date cert.	Date recert. Date recert.	Expires Expiration
MT	2	EMC	1998/10/26		2015/12/31
PT	2	EMC	1998/10/26		2015/12/31
UT	2	EMC	2005/10/31		2015/12/31

For verification of certification status, policies and definitions, visit website:
<http://nrc.nrcan.gc.ca/> Pour la vérification de la certification, les politiques, et les définitions,
visitez le site web <http://nrc.nrcan.gc.ca/>

Manager: Certifying Agency
Gestionnaire: Ordre/organisme de certification

SCH 160
.344" THK

C2 OK
AMC
D.N.

C3 OK
AMC
D.N.

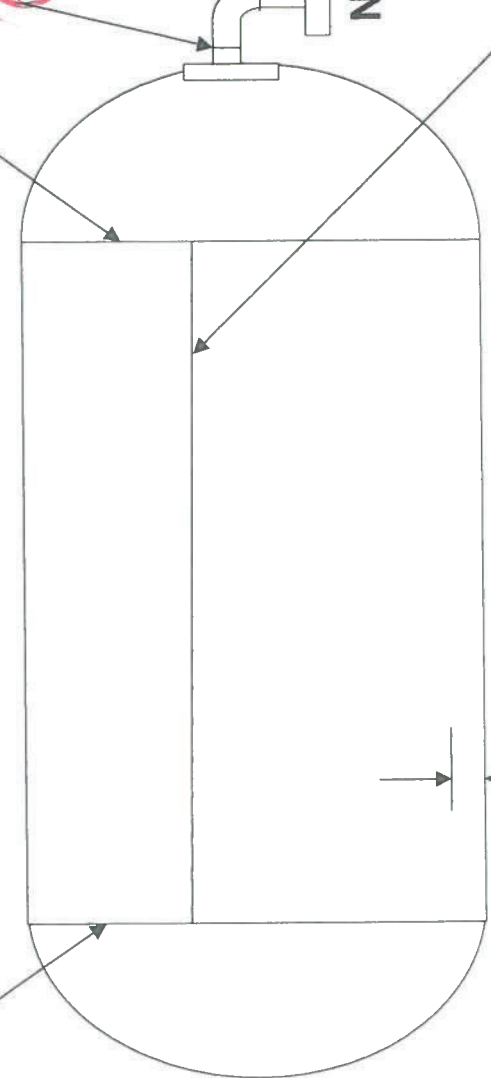
C2 OK
AMC
D.N.

C1 OK
AMC
D.N.

L1 OK
AMC
D.N.

N1

2 1/2" THK



AI  Date MAR 15 2013

ALL-WELD CO. LTD. - RT MAP

CLIENT: ULTRAFAB

WORK ORDER #: 1176PQ SN 7469

JOB DESCRIPTION: 60" I.D. VERTICAL CONTACTOR

DRAWING #: 1176-1

PREPARED BY: D.NESCI

DATE: FEB. 28/13

AFTER PWHT

RT MAP - 1176PQ

ASME SECTION VIII. DIV. 1

100% (RT-1)

MATERIAL SA-516 70N, SA-350 LF2, SA-333 6, SA-420 WPLG

P.O. 13-0170-1176PQ

1486 Wallace Road
 Oakville, Ontario L6L 2Y2
 Phone: 905-844-9448
 Fax: 905-844-6697

Radiographic Examination Report RT

Specification - Acceptance Criteria

ASME UW-51 UW-52 B31.1 B31.3NS CSA Other

General Data

Customer	ALL-WORLD	Date	SEPT. 7/13
Location	SCARBOROUGH	P. O. #	
Project	ULTRAFAS	Shop Order #	1176 PQ- 7469
Procedure	KV 5 Rev 2	Worksheet #	37600
Technician	C. Veeneeman	CGSB Reg #	6651
		ASNT/SNT-TC-1A Level	II

Technical Data 660

Material Type	Carbon	Alloys	Isotope	IR 192	Other	Physical/Focal Size	.199"
Base Material Thickness	2 1/2"		Exposure	Single Wall	Double Wall	Film per Cassette	1
Weld Thickness	1/4"		View	Single Wall	Double Wall	PWHT	Yes No
Reinforcement	1/4"		Number of Exposures				7
Film Mfg.	KODAK		Minimum Source to Object Distance				30"
Film Type	AA		Maximum Distance from Source Side of Object to Film				23/4"

UNIT No.	SIZE/LOC	SLAG	L.O.P.	L.O.F.	CRACK	POROSITY	U.C.	OTHERS	ACC	REJ
L1	0-1								-	
	1-2								-	
	2-3								-	
	3-4								-	
	4-5								-	
	5-6								-	
	6-END								-	

ACCEPTED/REVIEWED/RELEASED 046
 for and on behalf of: SBM OFFSHORE
 Print Name: GANESH SAHAY
 Signature: *[Signature]*
 Date: Sep 11/13
Applus[®] VELOSI
 Velosi America LLC

CHRIS VEENEMAN
 CGSB LEVEL II, REG.# 6651
 MT/PT/RT/UT
 SNT-TC-1A LEVEL II
 MT/PT/RT/UT

KV Inspection Technician	<i>[Signature]</i>	Date	SEPT. 7/13
Customer Representative	<i>[Signature]</i>	Date	SEP 09 2013



1486 Wallace Road
 Oakville, Ontario L6L 2Y2
 Phone: 905-844-9448
 Fax: 905-844-6697

Radiographic Examination Report RT

Specification - Acceptance Criteria

ASME UW-51 UW-52 B31.1 B31.3NS CSA Other

General Data

Customer	ALL-WORLD	Date	SEPT. 7/13
Location	SCARBOROUGH	P. O. #	
Project	ULTRAFAB	Shop Order #	117600-7469
Procedure	C. Veeneman	Worksheet #	37600
Technician	KV5 RON	CGSB Reg #	0651 ASNT/SNT-TC-1A Level II

Technical Data 660

Material Type	Carbon	Alloys	Isotope	OTHER	Physical/Focal Size	.199"	
Base Material Thickness	2 1/2"		Exposure	Single Wall	Double Wall	Film per Cassette	1
Weld Thickness	"		View	Single Wall	Double Wall	PWHT	Yes No
Reinforcement	1/4"		Number of Exposures				1
Film Mfg.	KODAK		Minimum Source to Object Distance	PANORAMIC (60°)			
Film Type	AA		Maximum Distance from Source Side of Object to Film				2 3/4"

UNIT No.	SIZE/LOC	SLAG	L.O.P.	L.O.F.	CRACK	POROSITY	U.C.	OTHERS	ACC	REJ
C1	0-1								/	
	1-2								/	
	2-3								/	
	3-4								/	
	4-5								/	
	5-6								/	
	6-7								/	
	7-8								/	
	8-9								/	
	9-10								/	
	10-11								/	
	11-12								/	
	12-13								/	
	13-14								/	
	14-0								/	

ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SBM OFFSHORE 046
 Print Name: GAMESH SAHA
 Signature: [Signature]
 Date: SEP 11 2013
Applus
VELOSI
 Velosi America LLC

CHRIS VEENEMAN
 CGSB LEVEL II, REG.# 6651
 MT/PT/RT/UT
 SNT-TC-1A LEVEL II
 MT/PT/RT/UT

KV Inspection Technician	<u>[Signature]</u>	Date	SEPT. 7/13
Customer Representative	<u>[Signature]</u>	Date	SEP 09 2013



1486 Wallace Road
 Oakville, Ontario L6L 2Y2
 Phone: 905-844-9448
 Fax: 905-844-6697

**Radiographic Examination Report
 RT**

Specification - Acceptance Criteria

ASME UW-51 UW-52 B31.1 B31.3NS CSA Other

General Data

Customer	ALL-WORD	Date	SEPT. 7/13
Location	SCARBOROUGH	P. O. #	
Project	ULTRAFAB	Shop Order #	1176 PQ-7469
Procedure	Kv 5 ROV 3	Worksheet #	37600
Technician	C. Veeman	CGSB Reg #	6651 ASNT/SNT-TC-1A Level II

Technical Data Co 60

Material Type	Carbon Alloys	Isotope	IR 192 Other	Physical/Focal Size	.13"
Base Material Thickness	2 1/2"	Exposure	Single Wall	Double Wall	Film per Cassette 1
Weld Thickness	"	View	Single Wall	Double Wall	PWHT Yes No
Reinforcement	1/4"	Number of Exposures	1		
Film Mfg.	KODAK	Minimum Source to Object Distance	PANORAMIC (60")		
Film Type	AA	Maximum Distance from Source Side of Object to Film	2 3/4"		

UNIT No.	SIZE/LOC	SLAG	L.O.P.	L.O.F.	CRACK	POROSITY	U.C.	OTHERS	ACC	REJ
C2	0-1								/	
	1-2								/	
	2-3								/	
	3-4								/	
	4-5								/	
	5-6								/	
	6-7								/	
	7-8								/	
	8-9								/	
	9-10								/	
	10-11								/	
	11-12								/	
	12-13								/	
	13-14								/	
	19-0								/	

ACCEPTED/REVIEWED/RELEASED 046
 for and on behalf of: SPM OFFSHORE
 Print Name: CHRIS VEEMAN
 Signature: [Signature]
 Date: SEP 10/13

Applus
VELOSI
 Velosi America LLC

CHRIS VEEMAN
 CGSB LEVEL II, REG.# 6651
 MT/PT/RT/UT
 SNT-TC-1A LEVEL II
 MT/PT/RT/UT

KV Inspection Technician	<u>[Signature]</u>	Date	SEPT. 7/13
Customer Representative	<u>[Signature]</u>	Date	SEP 09 2013



Radiographic Examination Report RT

Specification - Acceptance Criteria

ASME UW-51 UW-52 B31.1 B31.3NS CSA Other

General Data

Customer	ALL-WORLD	Date	SEPT. 7/13
Location	SCARBOROUGH	P. O. #	
Project	ULTRAFAB	Shop Order #	1176-7469
Procedure	KV 6 RvZ	Worksheet #	37600
Technician	C. Veeman	CGSB Reg #	6651 ASNT/SNT-TC-1A Level II

Technical Data

Material Type	Carbon	Alloys	Isotope	IR 192	Other	Physical/Focal Size	.13"
Base Material Thickness	5/60		Exposure	Single Wall	Double Wall	Film per Cassette	
Weld Thickness	"		View	Single Wall	Double Wall	PWHT	Yes No
Reinforcement	2/8"		Number of Exposures				3 per
Film Mfg.	KODAK		Minimum Source to Object Distance				18"
Film Type	MA		Maximum Distance from Source Side of Object to Film				2"

UNIT No.	SIZE/LOC	SLAG	L.O.P.	L.O.F.	CRACK	POROSITY	U.C.	OTHERS	ACC	REJ
N1-C1	A								-	
	B								-	
	C								-	
N1-C2	A								-	
	B								-	
	C								-	
N1-C3	A								-	
	B								-	
	C								-	

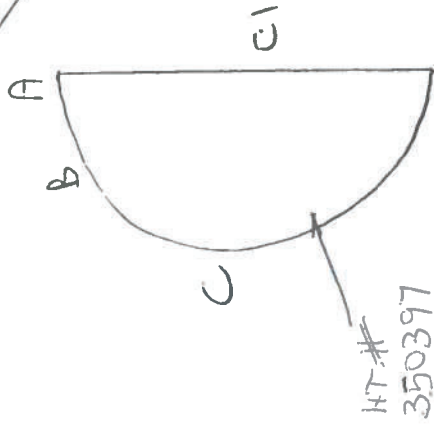
ACCEPTED/REVIEWED/RELEASED
for and on behalf of: SAM OFF SHORE
Print Name: CLARETT SAHA
Signature: [Signature]
Date: SEP 10 2013
046
Applus® VELOSI
Velosi America LLC

KV Inspection Technician	[Signature]	Date	SEPT. 7/13
Customer Representative	[Signature]	Date	SEP 09 2013

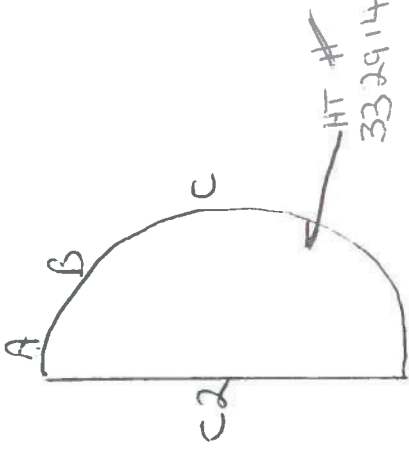
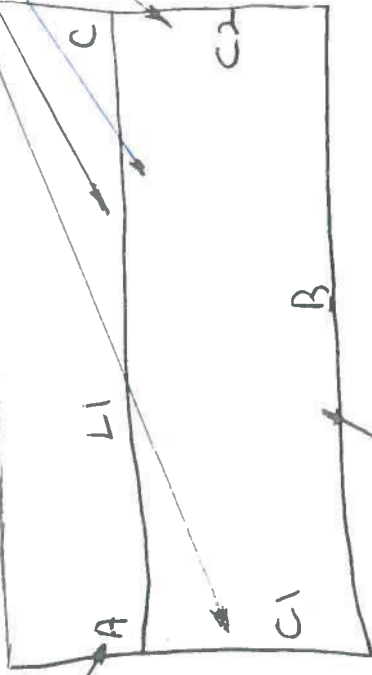


Thk Readings + 3 spots (A,B,C)

Scan for laminations
3" to Seams TYP
L1, C1, C2



THK C1 (A,B,C)



THK C2 (A,B,C)

ALL-WELD CO. LTD. -

CLIENT: Ultrafab

WORK ORDER #: 1176 PQ SN 7469

JOB DESCRIPTION:

DRAWING #:

PREPARED BY: D.NESCI

DATE: FEB 27 2013

UT MAP - Thk/Seams

ASME SECTION VIII. DIV. 1

Material SA 516 Gr 70

P.O. 13-0154 - 1176 PQ

1486 Wallace Road
 Oakville, Ontario L6L 2Y2
 Phone: 905-844-9448
 Fax: 905-844-6697

Ultrasonic Examination Report UT

General Data

Customer	All-Weld Company	Date	February 26, 2013
Shop Order	1176 PQ Serial # 7469	Project	
Component		P.O. #	Worksheet #: 36451
Drawing	Rev.	Technician	Frank Marunde SNT-TC-1A Level III
NDT Specification	ASTM E 797	Appendix	NDT Procedure KV-UT# 1 R.02

Technical Data – Ultrasonic Examination (UT)

Material Type	Carbon Steel	Technique	<input checked="" type="radio"/> Pulse Echo-Contact <input type="radio"/> Immersion <input type="radio"/> Dual
Material Thickness		Instrument Brand	<input checked="" type="radio"/> Olympus Epoch 1000i <input type="radio"/> Serial # 090054812
Weld Type	<input type="radio"/> Butt <input type="radio"/> T Joint <input type="radio"/> Fillet	Surface	<input checked="" type="radio"/> As Rolled <input type="radio"/> Ground <input type="radio"/> Machined <input type="radio"/> Shot Blasted
Weld Thickness	N/A	Couplant	<input checked="" type="radio"/> UT-X <input type="radio"/> Oil <input type="radio"/> Other <input type="radio"/> Temperature
Heat Treated	<input checked="" type="radio"/> YES <input type="radio"/> NO	Sensitivity (PRL)	50 dB
Heat Treatment		Surface Conditions	

Transducers/Calibration Blocks

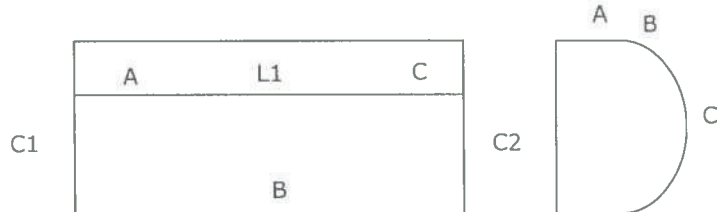
Diameter		Size	Beam Angle	Frequency	Manufacturer	Blocks
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<input type="radio"/> 3/8"	<input type="radio"/> 1"	<input type="radio"/> 1/2" x 1"	<input type="radio"/> 60°	<input type="radio"/> 2.25 MHz	<input checked="" type="radio"/> Panametrics	<input type="radio"/> ASTM E164 MAB
<input checked="" type="radio"/> 1/2"	<input type="radio"/> 1 1/8"	<input type="radio"/> 1" x 1"	<input type="radio"/> 70°	<input checked="" type="radio"/> 5.00 MHz	<input type="radio"/> Krautkramer	<input type="radio"/> Back Reflection
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/> Normal	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/> Micrometer Shell

Scope of Testing

Thickness Examinations

	Shell	Head to C1	Head to C2
A	2.541	2.612	2.620
B	2.549	2.532	2.536
C	2.558	2.510	2.512

All Dimensions are in inches



AWC
 FEB 28 2013

Scanning

Test Area	Disposition	From	Length	Depth	Amplitude

ACCEPTED/REVIEWED/REJECTED

for and on behalf of: SRM OFFSHORE

Print Name: GARRITH SAHILL

Signature: [Signature]

Date: Apr 17 13

Applus[®]
VELOSI
 Velosi America LLC

Evaluation – Acceptance

<input checked="" type="radio"/> Accepted	KV Inspection Services – Technician	<u>[Signature]</u>	Date	February 26, 2013
<input type="radio"/> Rejected	CGSB No. 48.9712-2000 Reg. No.	8885	Place	Scarborough, ON.

General Data

Customer	All-Weld Company		Date	February 26, 2013	
Shop Order	1176 PQ Serial # 7469		Project		
Component			P.O. #	Worksheet #:	36451
Drawing	Rev.		Technician	Frank Marunde	SNT-TC-1A Level III
NDT Specification	ASME SA 578		Appendix	NDT Procedure	KV-UT# 1 R.02

Technical Data - Ultrasonic Examination (UT)

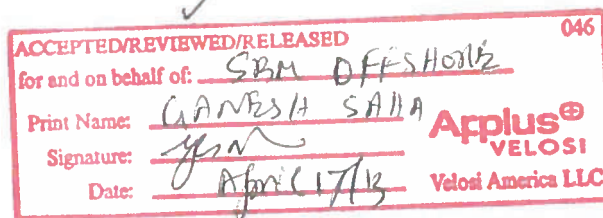
Material Type	Carbon Steel	Technique	<input checked="" type="radio"/> Pulse Echo-Contact <input type="radio"/> Immersion <input type="radio"/> Dual		
Material Thickness	2 1/2"	Instrument Brand	<input checked="" type="radio"/> Olympus Epoch 1000i	Serial #	090054812
Weld Type	<input type="radio"/> Butt <input type="radio"/> T Joint <input type="radio"/> Fillet	Surface	<input checked="" type="radio"/> As Rolled <input type="radio"/> Ground <input type="radio"/> Machined <input type="radio"/> Shot Blasted		
Weld Thickness	N/A	Couplant	<input checked="" type="radio"/> UT-X <input type="radio"/> Oil <input type="radio"/> Other	Temperature	
Heat Treated	<input checked="" type="radio"/> YES <input type="radio"/> NO	Sensitivity (PRL)	56 dB		
Heat Treatment		Surface Conditions			

Transducers/Calibration Blocks

Diameter		Size	Beam Angle	Frequency	Manufacturer	Blocks
<input type="radio"/> 1/4"	<input type="radio"/> 3/4"	<input type="radio"/> 5/8" x 5/8"	<input type="radio"/> 45°	<input type="radio"/> 1.00 MHz	<input type="radio"/> Techsonic	<input type="radio"/> IIW A2
<input type="radio"/> 3/8"	<input checked="" type="radio"/> 1"	<input type="radio"/> 1/2" x 1"	<input type="radio"/> 60°	<input checked="" type="radio"/> 2.25 MHz	<input checked="" type="radio"/> Panametrics	<input type="radio"/> ASTM E164 MAB
<input type="radio"/> 1/2"	<input type="radio"/> 1 1/8"	<input type="radio"/> 1" x 1"	<input type="radio"/> 70°	<input type="radio"/> 5.00 MHz	<input type="radio"/> Krautkramer	<input checked="" type="radio"/> Back Reflection
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/> Normal	<input type="radio"/>	<input type="radio"/>	<input type="radio"/> ASME

Scope of Testing

Lamination scan 3" both sides of joints C1, C2 & L1

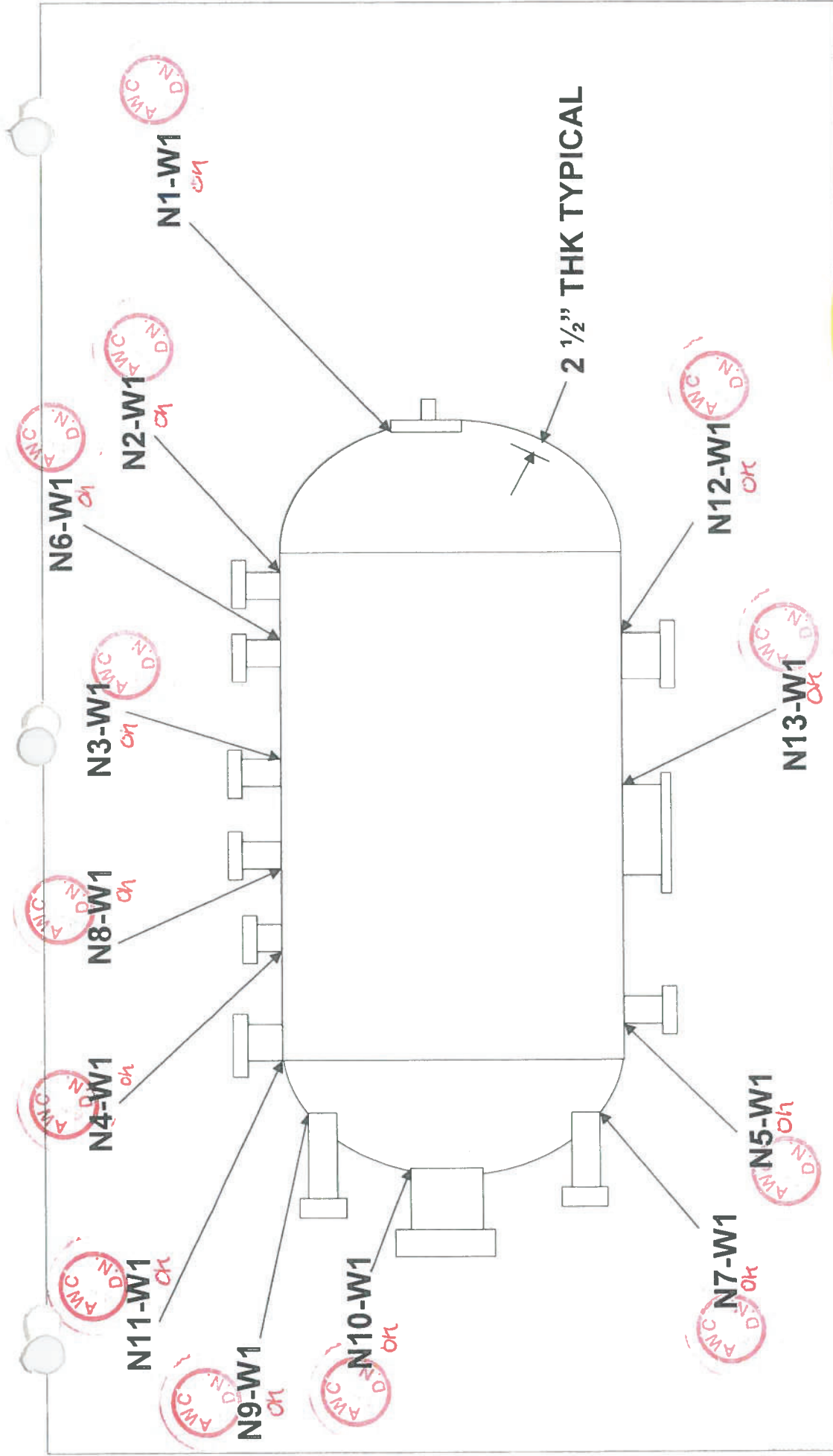


Scanning

Test Area	Disposition	From	Length	Depth	Amplitude

Evaluation - Acceptance

<input checked="" type="radio"/> Accepted	KV Inspection Services - Technician		Date	February 26, 2013
<input type="radio"/> Rejected	CGSB No. 48.9712-2000 Reg. No.	8885	Place	Scarborough, ON.



AFTER PWHT

ALL-WELD CO. LTD. - UT MAP

UT MAP - 1176PQ

CLIENT: ULTRAFAB
 WORK ORDER #: 1176PQ SN 7469

ASME SECTION VIII. DIV. 1

JOB DESCRIPTION: 60" I.D. VERTICAL CONTACTOR

MATERIAL SA-516 70N, SA-350 LF2, SA-333 6, SA-420 WPLG

DRAWING #: 1176-1
 PREPARED BY: D.NESCI

P.O. 13-0224

DATE: March 4, 2013

1486 Wallace Road
 Oakville, Ontario L6L 2Y2
 Phone: 905-844-9448
 Fax: 905-844-6697

Ultrasonic Examination Report UT

General Data

Customer	All-Weld Company		Date	September 05, 2013		
Shop Order	1176 PQ		Project			
Component			P.O. #		Worksheet #:	37497
Drawing		Rev.	Technician	Frank Marunde	SNT-TC-1A Level	III
NDT Specification	ASME Sec. VIII		Appendix	12	NDT Procedure	KV-UT# 1 R.02

Technical Data - Ultrasonic Examination (UT)

Material Type	Carbon Steel	Technique	<input checked="" type="radio"/> Pulse Echo-Contact <input type="radio"/> Immersion <input type="radio"/> Dual			
Material Thickness	2 1/2"	Instrument Brand	<input checked="" type="radio"/> Olympus Epoch 1000i	Serial #	090054812	
Weld Type	<input type="radio"/> Butt <input checked="" type="radio"/> T Joint <input type="radio"/> Fillet	Surface	<input checked="" type="radio"/> As Rolled <input type="radio"/> Ground <input type="radio"/> Machined <input type="radio"/> Shot Blasted			
Weld Thickness	2 1/2"	Couplant	<input checked="" type="radio"/> UT-X <input type="radio"/> Oil <input type="radio"/> Other	Temperature		
Heat Treated	<input type="radio"/> YES <input type="radio"/> NO	Sensitivity (PRL)	48 dB / 54 dB / 63 dB			
Heat Treatment		Surface Conditions				

Transducers/Calibration Blocks

Diameter		Size	Beam Angle	Frequency	Manufacturer	Blocks
<input type="radio"/> 1/4"	<input type="radio"/> 3/4"	<input checked="" type="radio"/> 5/8" x 3/4"	<input checked="" type="radio"/> 45°	<input type="radio"/> 1.00 MHz	<input type="radio"/> Techsonic	<input type="radio"/> IIW A2
<input type="radio"/> 3/8"	<input type="radio"/> 1"	<input type="radio"/> 1/2" x 1"	<input checked="" type="radio"/> 60°	<input checked="" type="radio"/> 2.25 MHz	<input checked="" type="radio"/> Panametrics	<input type="radio"/> ASTM E164 MAB
<input type="radio"/> 1/2"	<input type="radio"/> 1 1/8"	<input type="radio"/> 1" x 1"	<input checked="" type="radio"/> 70°	<input type="radio"/> 5.00 MHz	<input type="radio"/> Krautkramer	<input type="radio"/> Back Reflection
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/> Normal	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/> ASME

Scope of Testing

Ser# 7469: Examination of category D attachment welds (After PWHT)

- | | |
|-------|--------|
| N1-W1 | N8-W1 |
| N2-W1 | N9-W1 |
| N3-W1 | N10-W1 |
| N4-W1 | N11-W1 |
| N5-W1 | N12-W1 |
| N6-W1 | N13-W1 |
| N7-W1 | |


 SEP 16 2013

Scanning

Test Area	Disposition	From	Length	Depth	Amplitude

ACCEPTED/REVIEWED/RELEASED

for and on behalf of: SBA off site

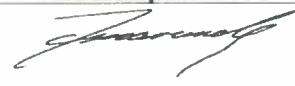
Print Name: ANISH SANA

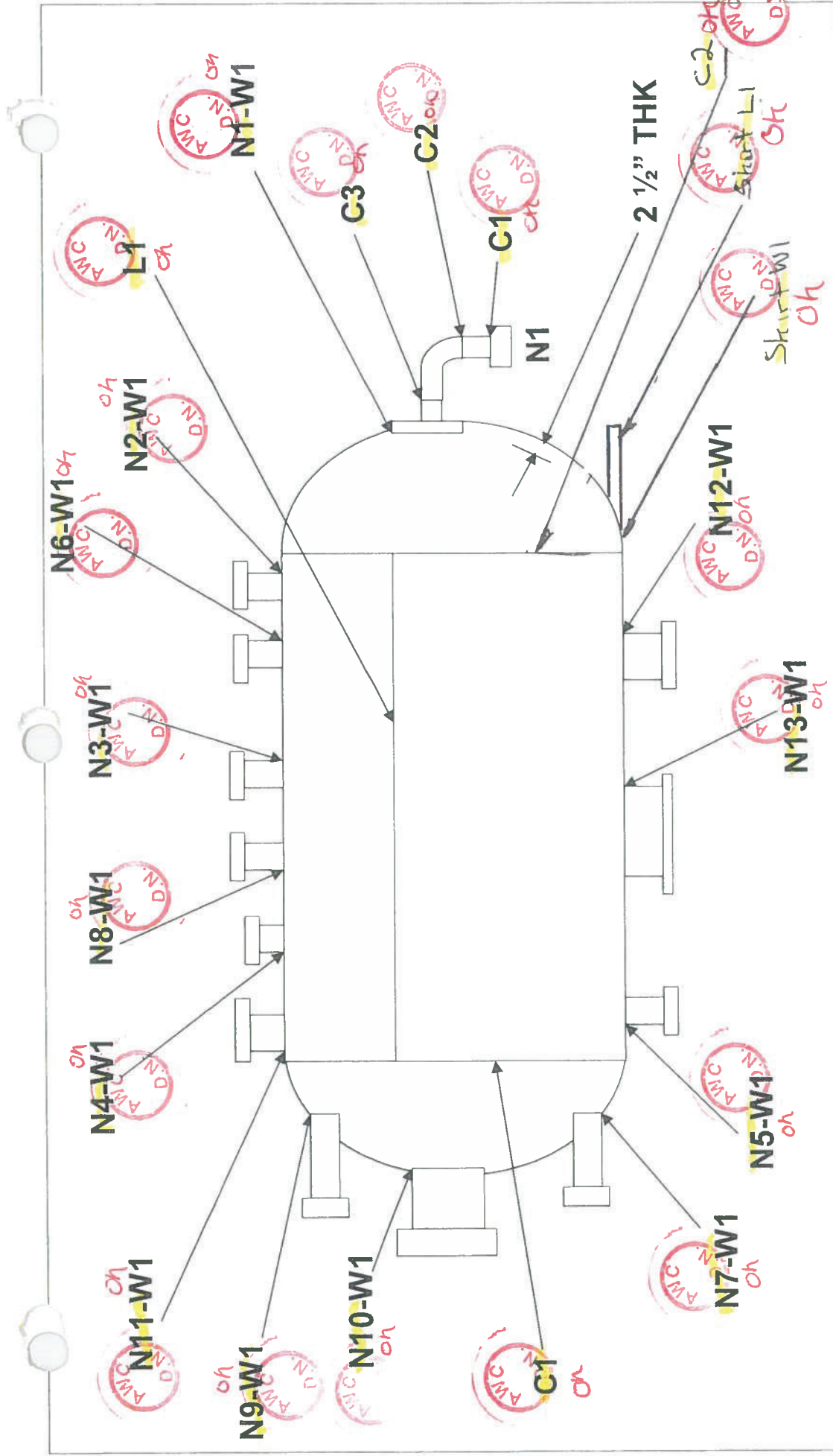
Signature: [Signature]

Date: SEP 18 2013

Applus[®]
VELOSI
Veloci America LLC

Evaluation - Acceptance

<input checked="" type="radio"/> Accepted	KV Inspection Services - Technician		Date	September 05, 2013
<input type="radio"/> Rejected	CGSB No. 48.9712-2000 Reg. No.	8885	Place	Scarborough, ON



ALL-WELD CO. LTD. - MAG PARTICLE MAP

CLIENT: ULTRAFAB

WORK ORDER #: 1176PQ

SN 7469

JOB DESCRIPTION: 60" I.D. VERTICAL CONTACTOR

DRAWING #: 1176-1

PREPARED BY: D.NESCI

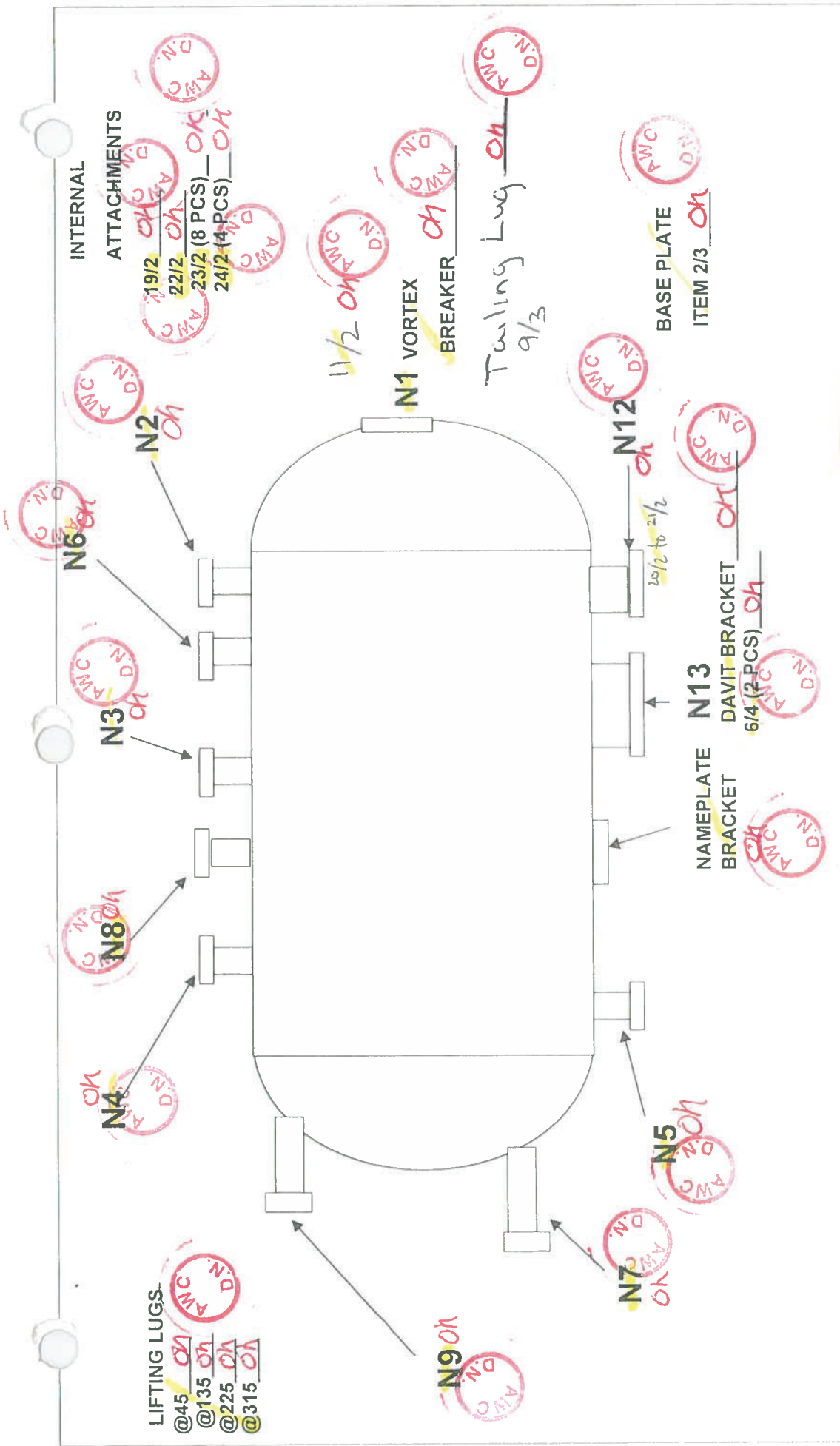
DATE: March 4, 2013

AFTER PWHT

**MAG PARTICLE MAP - 1176PQ
INSIDE / OUTSIDE WHERE APPLICABLE
ASME SECTION VIII. DIV. 1**

MATERIAL SA-516 70N, SA-350 LF2, SA-333 6, SA-420 WPLG

P.O. 13-0198



ALL-WELD CO. LTD.

MT SUPPORTS / ATTACHMENTS MAP

CLIENT: ULTRAFAB
 WORK ORDER #: 1176PQ SN 7469
 JOB DESCRIPTION: 60" I.D. VERTICAL CONTACTOR
 DRAWING #: 1176-1
 PREPARED BY: D.NESCI
 DATE: March 4, 2013

AFTER PWHT

MT SUPPORTS/ ATTACHMENTS MAP - 1176PQ
 INSIDE / OUTSIDE WHERE APPLICABLE
 ASME SECTION VIII. DIV. 1

MATERIAL SA-516 70N
 P.O. 13-0198

1486 Wallace Road
 Oakville, Ontario L6L 2Y2
 Phone: 905-844-9448
 Fax: 905-844-6697

Magnetic Particle Inspection Report MT

Specification – Acceptance Criteria

As per ASME Sec. VIII, Appx. 6, Div. 1

General Data

Customer	All-Weld Company	Date	September 6, 2013		
Location	Scarborough, Ontario	P. O. #			
Project	Vessel	Shop Order #	1176 PQ S/N 7469		
Procedure	KV NDT# 3 Rev. 02	Worksheet #	37498		
Technician	Frank Marunde	CGSB Reg #	8885	ASNT/SNT-TC-1A Level	II

Technical Data – Magnetic Particle (MT)

Material Type	<input checked="" type="radio"/> Carbon Steel	<input type="radio"/> Other	Material Thickness	
---------------	---	-----------------------------	--------------------	--

Test Method

<input checked="" type="radio"/> Dry	<input type="radio"/> Wet	<input type="radio"/> Wet Fluorescent
--------------------------------------	---------------------------	---------------------------------------

Test Equipment

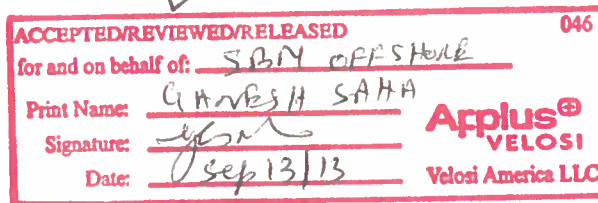
Indicators	<input checked="" type="radio"/> 825 R - Red	<input type="radio"/> 66 - Yellow	<input type="radio"/> Magnaglow 20B Fluorescent
	<input type="radio"/> 3A - Black	<input type="radio"/> 803/1- Black Ink	<input type="radio"/> 8800A Fluorescent
Background	<input checked="" type="radio"/> 8901W Contrast Aid	<input type="radio"/> None	
Equipment	<input checked="" type="radio"/> AC Yoke	<input type="radio"/> Calibrated Blacklight	<input type="radio"/> Other
Method	<input checked="" type="radio"/> Continuous	<input type="radio"/> Residual	
Light Meter	Type EA31	Serial # 07076802	Intensity 1400 Lx

Lighting Equipment Description: Flashlight

Inspection

Description: After P.W.H.T

Item #	Description of Weld/Test Area	Technique	Defect Location	Interpretation
1)	C1,C2 & L1 (Interior and Exterior)	L & T		Acceptable to specifications
2)	N1- C1, C2, & C3	L & T		Acceptable to specifications



KV Inspection Technician		Date	September 6, 2013
Customer Representative		Date	SEP 11 2013

1486 Wallace Road
 Oakville, Ontario L6L 2Y2
 Phone: 905-844-9448
 Fax: 905-844-6697

Magnetic Particle Inspection Report MT

Specification – Acceptance Criteria

As per ASME Sec. VIII, Appx. 6, Div. 1

General Data

Customer	All-Weld Company	Date	September 10, 2013		
Location	Scarborough, Ontario	P. O. #			
Project		Shop Order #	1176 PQ S/N 7469		
Procedure	KV #3 Rev. 02	Worksheet #	37500		
Technician	Frank Marunde	CGSB Reg #	8885	ASNT/SNT-TC-1A Level	II

Technical Data – Magnetic Particle (MT)

Material Type	<input checked="" type="radio"/> Carbon Steel	<input type="radio"/> Other	Material Thickness	
---------------	---	-----------------------------	--------------------	--

Test Method

<input checked="" type="radio"/> Dry	<input type="radio"/> Wet	<input type="radio"/> Wet Fluorescent
--------------------------------------	---------------------------	---------------------------------------

Test Equipment

Indicators	<input checked="" type="radio"/> 825 R - Red	<input type="radio"/> 66 - Yellow	<input type="radio"/> Magnaglow 20B Fluorescent
	<input type="radio"/> 3A - Black	<input type="radio"/> 803/1- Black Ink	<input type="radio"/> 8800A Fluorescent
Background	<input checked="" type="radio"/> 8901W Contrast Aid	<input type="radio"/> None	
Equipment	<input checked="" type="radio"/> AC Yoke	<input type="radio"/> Calibrated Blacklight	<input type="radio"/> Other
Method	<input checked="" type="radio"/> Continuous	<input type="radio"/> Residual	
Light Meter	Type EA31	Serial # 07076802	Intensity 1400 Lx

Lighting Equipment Description: Flashlight

Inspection

Description: After P.W.H.T

Item #	Description of Weld/Test Area	Technique	Defect Location	Interpretation
1)	Skirt - W1, Skirt - L1, baseplate item 2/3 welds	L & T		Acceptable to specifications
2)	Davit bracket weld	L & T		Acceptable to specifications
3)	Name plate bracket	L & T		Acceptable to specifications
4)	Item 6/4 attachment welds	L & T		Acceptable to specifications
5)	Item 20/2 to 21/2 weld	L & T		Acceptable to specifications

046



ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: IBM OFFSHORE

Print Name: CHRISTIE SAH

Signature: [Signature]

Date: sep 13/13

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 VELOSI
 Velosi America LLC

Inspection Technician		Date	September 10, 2013
Customer Representative		Date	SEP 11 2013

1486 Wallace Road
 Oakville, Ontario L6L 2Y2
 Phone: 905-844-9448
 Fax: 905-844-6697

Specification - Acceptance Criteria

As per ASME Sec. VIII, Appx. 6, Div. 1

General Data

Customer	All-Weld Company	Date	September 10, 2013		
Location	Scarborough, Ontario	P. O. #			
Project		Shop Order #	1176 PQ S/N 7469		
Procedure	KV #3 Rev. 02	Worksheet #	37500		
Technician	Frank Marunde	CGSB Reg #	8885	ASNT/SNT-TC-1A Level	II

Technical Data - Magnetic Particle (MT)

Material Type	<input checked="" type="radio"/> Carbon Steel	<input type="radio"/> Other	Material Thickness	
---------------	---	-----------------------------	--------------------	--

Test Method

<input checked="" type="radio"/> Dry	<input type="radio"/> Wet	<input type="radio"/> Wet Fluorescent
--------------------------------------	---------------------------	---------------------------------------

Test Equipment

Indicators	<input checked="" type="radio"/> 825 R - Red	<input type="radio"/> 66 - Yellow	<input type="radio"/> Magnaglow 20B Fluorescent
	<input type="radio"/> 3A - Black	<input type="radio"/> 803/1- Black Ink	<input type="radio"/> 8800A Fluorescent
Background	<input checked="" type="radio"/> 8901W Contrast Aid	<input type="radio"/> None	
Equipment	<input checked="" type="radio"/> AC Yoke	<input type="radio"/> Calibrated Blacklight	<input type="radio"/> Other
Method	<input checked="" type="radio"/> Continuous	<input type="radio"/> Residual	
Light Meter	Type EA31	Serial # 07076802	Intensity 1400 Lx

Lighting Equipment Description: Flashlight

Inspection

Description: After P.W.H.T

Item #	Description of Weld/Test Area	Technique	Defect Location	Interpretation
1)	Nozzle attachment welds N1-W1, N2-W1, N3-W1, N4-W1, N5-W1, N6-W1, N7-W1, N8-W1, N9-W1, N10-W1, N11-W1, N12-W1, N13-W1 (interior & exterior)	L & T		Acceptable to specifications
2)	4 lifting lug attachment welds and 1 tailing lug attachment weld	L & T		Acceptable to specifications

046

ACCEPTED/REVIEWED/RELEASED



for and on behalf of: SBM OFFSHORE

Print Name: GANESH SAHII

Signature: [Signature]

Due: SEP 13/13

Applus[®]
VELOSI
 Velosi America LLC

KV Inspection Technician		Date	September 10, 2013
Customer Representative		Date	SEP 19 2013

1486 Wallace Road
 Oakville, Ontario L6L 2Y2
 Phone: 905-844-9448
 Fax: 905-844-6697

Magnetic Particle Inspection Report MT

Specification - Acceptance Criteria

As per ASME Sec. VIII, Appx. 6, Div. 1

General Data

Customer	All-Weld Company	Date	September 10, 2013		
Location	Scarborough, Ontario	P. O. #			
Project		Shop Order #	1176 PQ S/N 7469		
Procedure	KV #3 Rev. 02	Worksheet #	37500		
Technician	Frank Marunde	CGSB Reg #	8885	ASNT/SNT-TC-1A Level	II

Technical Data - Magnetic Particle (MT)

Material Type	<input checked="" type="radio"/> Carbon Steel	<input type="radio"/> Other	Material Thickness	
---------------	---	-----------------------------	--------------------	--

Test Method

<input checked="" type="radio"/> Dry	<input type="radio"/> Wet	<input type="radio"/> Wet Fluorescent
--------------------------------------	---------------------------	---------------------------------------

Test Equipment

Indicators	<input checked="" type="radio"/> 825 R - Red	<input type="radio"/> 66 - Yellow	<input type="radio"/> Magnaglow 20B Fluorescent
	<input type="radio"/> 3A - Black	<input type="radio"/> 803/1- Black Ink	<input type="radio"/> 8800A Fluorescent
Background	<input checked="" type="radio"/> 8901W Contrast Aid	<input type="radio"/> None	
Equipment	<input checked="" type="radio"/> AC Yoke	<input type="radio"/> Calibrated Blacklight	<input type="radio"/> Other
Method	<input checked="" type="radio"/> Continuous	<input type="radio"/> Residual	
Light Meter	Type EA31	Serial # 07076802	Intensity 1400 Lx

Lighting Equipment Description: Flashlight

Inspection

Description: After P.W.H.T

Item #	Description of Weld/Test Area	Technique	Defect Location	Interpretation
1)	Welds of nozzle supports N1, N2, N3, N4, N5, N6, N7, N8, N9	L & T		Acceptable to specifications
2)	Attachment welds of item 19/2, 22/2, 23/2 (x8), 24/2 (x4)	L & T		Acceptable to specifications
3)	Vortex breaker attachment weld	L & T		Acceptable to specifications

046

ACCEPTED/REVIEWED/RELEASED



for and on behalf of: SBM OFFSHORE

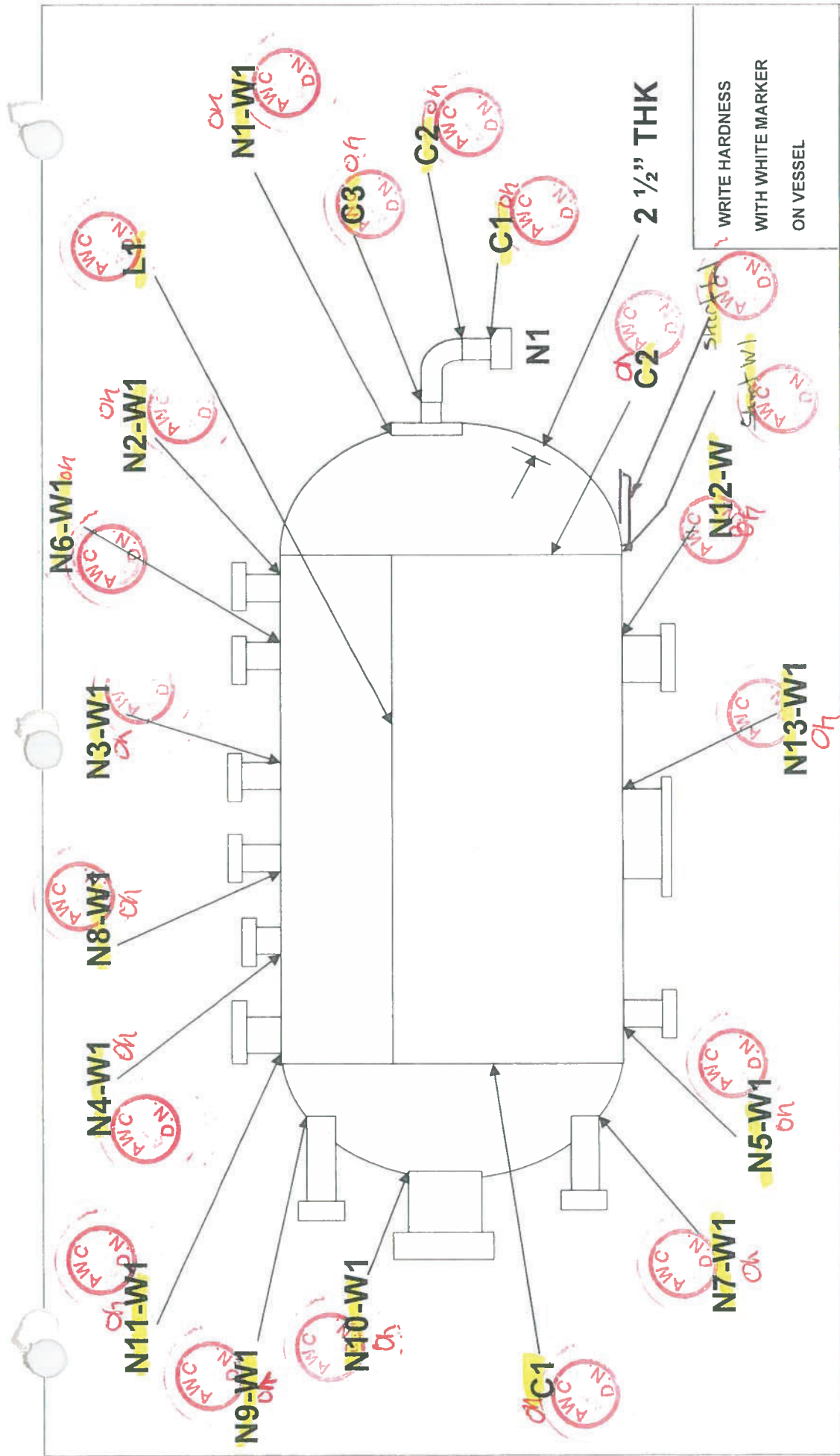
Print Name: CLARENCE SAHA

Signature: [Signature]

Date: SEP 13/13

Applus[®]
VELOSI
 Velosi America LLC

KV Inspection Technician		Date	September 10, 2013
Customer Representative		Date	SEP 11 2013

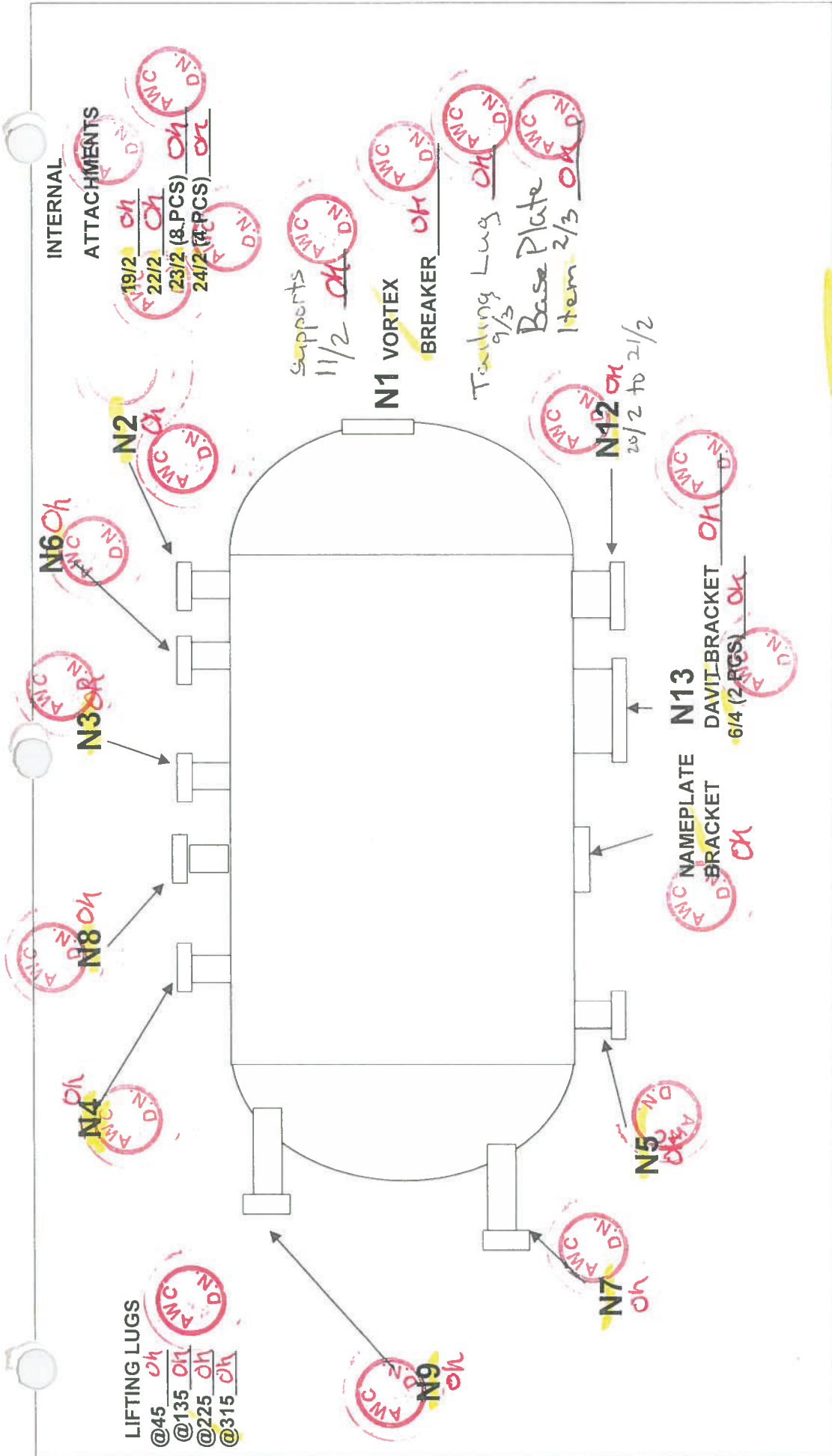


AFTER PWHT
HT MAP - 1176PQ
OUTSIDE

ASME SECTION VIII. DIV. 1
 MATERIAL SA-516 70N, SA-350 LF2, SA-333 6, SA-420 WPLG
 1 SET OF READINGS PER WELD
 (BM, HAZ, W, HAZ, BM) 248 HV10 MAX
 P.O. 13-0229

ALL-WELDED CO. LTD. - HT MAP

CLIENT: ULTRAFAB
 WORK ORDER #: 1176PQ SN 7469
 JOB DESCRIPTION: 60" I.D. VERTICAL CONTACTOR
 DRAWING #: 1176-1
 PREPARED BY: D.NESCI
 DATE: March 4, 2013



ALL-WELD CO. LTD.
HT SUPPORTS / ATTACHMENTS MAP

CLIENT: ULTRAFAB
 WORK ORDER #: 1176PQ SN 7469
 JOB DESCRIPTION: 60" I.D. VERTICAL CONTACTOR
 DRAWING #: 1176-1
 PREPARED BY: D.NESCI
 DATE: March 4, 2013

AFTER PWHT
HT SUPPORTS/ ATTACHMENTS MAP - 1176PQ
 INSIDE / OUTSIDE WHERE APPLICABLE
 ASME SECTION VIII. DIV. 1

MATERIAL SA-516 70N
 P.O. 13-0198

**Hardness Testing Report
HT**

Specification – Acceptance Criteria

General Data

Customer	All-Weld Company	Date	September 6, 2013
Location	Scarborough, ON	P. O. #	
Project		Shop Order #	1176 PQ S/N 7469
Procedure	KV HT# 35 Rev.00	Worksheet #	37498
Technician	Frank Marunde	HT Certified	<input checked="" type="checkbox"/> CGSB Reg # 8885

Technical Data – Hardness Testing (HT)

Material	Carbon Steel
----------	--------------

Test Method & Equipment


Technique	<input checked="" type="radio"/> Impact Load – Digital Readout <input type="radio"/> Impact Load – Ocular Viewing
Equipment	<input checked="" type="radio"/> Equotip D Impact Device
Readings Taken	<input type="radio"/> Average of 5 readings <input checked="" type="radio"/> Average of 3 readings <input type="radio"/> Other
Scale	<input type="radio"/> Brinell Hardness <input checked="" type="radio"/> HV Unit Setting: Steel

Inspection

Description: After P.W.H.T

Item #	Description of Test Area	Parent Material	HAZ	Weld	HAZ	Parent Material
Ser# 7469	C1	110	147	185	128	120
	C2	133	165	205	136	100
	L1	154	148	204	141	170
	Lifting lugs 0°	133	124	159	188	191
	Lifting lugs 90°	104	123	150	141	141
	Lifting lugs 180°	141	147	175	192	197
	Lifting lugs 270°	115	127	132	142	136
	Skirt W1	155	141	142	114	108
	Skirt L1	119	155	165	136	129

046
 ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SAM OFF SHORE
 Print Name: S.A. MESH SAHA
 Signature: *[Signature]*
 Date: Sep 12/13
APPJUS®
VELOSI
 Velosi America LLC

KV Inspection Technician	<i>[Signature]</i>	Date	September 6, 2013
Customer Representative		Date	SEP 11 2013

1486 Wallace Road
 Oakville, Ontario L6L 2Y6
 Phone: 905-844-9448
 Fax: 905-844-6697

**Hardness Testing Report
 HT**

Specification – Acceptance Criteria

General Data

Customer	All-Weld Company	Date	September 6, 2013
Location	Scarborough, ON	P. O. #	
Project		Shop Order #	1176 PQ S/N 7469
Procedure	KV HT# 35 Rev.00	Worksheet #	37498
Technician	Frank Marunde	HT Certified	<input checked="" type="checkbox"/> CGSB Reg # 8885

Technical Data – Hardness Testing (HT)

Material	Carbon Steel
----------	--------------

Test Method & Equipment



Technique	<input checked="" type="radio"/> Impact Load – Digital Readout	<input type="radio"/> Impact Load – Ocular Viewing	
Equipment	<input checked="" type="radio"/> Equotip D Impact Device		
Readings Taken	<input type="radio"/> Average of 5 readings	<input checked="" type="radio"/> Average of 3 readings	<input type="radio"/> Other
Scale	<input type="radio"/> Brinell Hardness	<input checked="" type="radio"/> HV	Unit Setting: Steel

Inspection

Description: After P.W.H.T

Item #	Description of Test Area	Parent Material	HAZ	Weld	HAZ	Parent Material
Ser# 7469	N1-C1	144	150	195	161	143
	N1-C2	145	158	223	164	148
	N1-C3	136	140	213	164	130
	N1 support weld # 1	114	140	156	132	147
	N1 support weld # 2	119	139	167	139	139
	N1 support weld # 3	130	127	141	141	150
	N1 support weld # 4	127	141	152	147	161

046
 ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SAM OF SHORE
 Print Name: G. MARUNDE
 Signature: [Signature]
 Date: SEP 13/13
Applus®
VELOSI
 Velosi America LLC

KV Inspection Technician		Date	September 6, 2013
Customer Representative		Date	SEP 11 2013

**Hardness Testing Report
HT**

Specification – Acceptance Criteria

General Data

Customer	All-Weld Company	Date	September 9, 2013
Location	Scarborough, ON	P. O. #	
Project		Shop Order #	1176 PQ S/N 7469
Procedure	KV HT# 35 Rev.00	Worksheet #	37499
Technician	Frank Marunde	HT Certified	<input checked="" type="checkbox"/> CGSB Reg # 8885

Technical Data – Hardness Testing (HT)

Material	Carbon Steel
----------	--------------

Test Method & Equipment

Technique	<input checked="" type="radio"/> Impact Load – Digital Readout <input type="radio"/> Impact Load – Ocular Viewing
Equipment	<input checked="" type="radio"/> Equotip D Impact Device
Readings Taken	<input type="radio"/> Average of 5 readings <input checked="" type="radio"/> Average of 3 readings <input type="radio"/> Other
Scale	<input type="radio"/> Brinell Hardness <input checked="" type="radio"/> HV Unit Setting: Steel

Inspection

Description: After P.W.H.T DWG. 1176-1 Rev.7

Item #	Description of Test Area	Parent Material	HAZ	Weld	HAZ	Parent Material
Ser# 7469	N1	121	178	192	183	133
	N2	134	161	181	167	111
	N3	124	172	157	161	131
	N4	128	134	114	207	134
	N5	117	124	164	140	154
	N6	118	139	156	182	160
	N7	123	134	175	143	118
	N8	123	131	114	209	140
	N9	109	181	130	133	143
	N10	109	110	135	176	155
	N11	119	164	140	163	128

046
 ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SJM OFFSHORE
APPLUS
VELOSI
 Velosi America LLC
 Print Name: GARESH SAHA
 Signature: [Signature]
 Date: Sept 12/13

KV Inspection Technician	<u>[Signature]</u>	Date	September 9, 2013
Customer Representative	<u>[Signature]</u>	Date	SEP 11 2013



**Hardness Testing Report
HT**

Specification – Acceptance Criteria

General Data

Customer	All-Weld Company	Date	September 9, 2013
Location	Scarborough, ON	P. O. #	
Project		Shop Order #	1176 PQ S/N 7469
Procedure	KV HT# 35 Rev.00	Worksheet #	37499
Technician	Frank Marunde	HT Certified	<input checked="" type="checkbox"/> CGSB Reg # 8885

Technical Data – Hardness Testing (HT)

Material	Carbon Steel		
Test Method & Equipment			
Technique	<input checked="" type="radio"/> Impact Load – Digital Readout <input type="radio"/> Impact Load – Ocular Viewing		
Equipment	<input checked="" type="radio"/> Equotip D Impact Device		
Readings Taken	<input type="radio"/> Average of 5 readings <input checked="" type="radio"/> Average of 3 readings <input type="radio"/> Other		
Scale	<input type="radio"/> Brinell Hardness <input checked="" type="radio"/> HV	Unit Setting:	Steel

Inspection

Description: After P.W.H.T DWG. 1176-1 Rev.7

Item #	Description of Test Area	Parent Material	HAZ	Weld	HAZ	Parent Material
Ser# 7469	N12	148	121	180	150	140
	N13	101	181	140	159	131
	N2 support weld #1	120	125	180	149	142
	N2 support weld #2	109	170	179	142	113
	N2 support weld #3	149	149	199	151	143
	N2 support weld #4	126	127	167	113	101

046
 ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SUN OFFSHORE
 Print Name: GAMBESH SAINI
 Signature: [Signature]
 Date: SEP 15/13
Applus®
VELOSI
 Velosi America LLC

KV Inspection Technician	<u>[Signature]</u>	Date	September 9, 2013
Customer Representative	<u>[Signature]</u>	Date	SEP 19 2013



General Data

Customer	All-Weld Company	Date	September 9, 2013
Location	Scarborough, ON	P. O. #	
Project		Shop Order #	1176 PQ S/N 7469
Procedure	KV HT# 35 Rev.00	Worksheet #	37499
Technician	Frank Marunde	HT Certified	<input checked="" type="checkbox"/> CGSB Reg # 8885

Technical Data – Hardness Testing (HT)

Material	Carbon Steel
----------	--------------

Test Method & Equipment

Technique	<input checked="" type="radio"/> Impact Load – Digital Readout <input type="radio"/> Impact Load – Ocular Viewing
Equipment	<input checked="" type="radio"/> Equotip D Impact Device
Readings Taken	<input type="radio"/> Average of 5 readings <input checked="" type="radio"/> Average of 3 readings <input type="radio"/> Other
Scale	<input type="radio"/> Brinell Hardness <input checked="" type="radio"/> HV Unit Setting: Steel

Inspection

Description: After P.W.H.T

Item #	Description of Test Area	Parent Material	HAZ	Weld	HAZ	Parent Material
Ser# 7469	N3 support weld #1	117	127	146	141	113
	N3 support weld #2	119	121	137	118	109
	N3 support weld #3	106	136	129	139	132
	N3 support weld #4	120	114	154	143	130
	N4 support weld #1	119	160	176	124	129
	N4 support weld #2	114	129	151	122	135
	N4 support weld #3	126	131	143	159	148
	N4 support weld #4	107	133	164	138	143

046
 ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SAM OFFSHORE
 Print Name: GABRIEL SAHA
 Signature: *[Signature]*
 Date: Sep 13/13
Applus®
VELOSI
 Veloci America LLC

KV Inspection Technician	<i>[Signature]</i>	Date	September 9, 2013
Customer Representative	<i>[Signature]</i>	Date	SEP 19 2013



**Hardness Testing Report
HT**

Specification – Acceptance Criteria

General Data

Customer	All-Weld Company	Date	September 9, 2013
Location	Scarborough, ON	P. O. #	
Project		Shop Order #	1176 PQ S/N 7469
Procedure	KV HT# 35 Rev.00	Worksheet #	37499
Technician	Frank Marunde	HT Certified	<input checked="" type="checkbox"/> CGSB Reg # 8885

Technical Data – Hardness Testing (HT)

Material	Carbon Steel
----------	--------------

Test Method & Equipment

Technique	<input checked="" type="radio"/> Impact Load – Digital Readout <input type="radio"/> Impact Load – Ocular Viewing
Equipment	<input checked="" type="radio"/> Equotip D Impact Device
Readings Taken	<input type="radio"/> Average of 5 readings <input checked="" type="radio"/> Average of 3 readings <input type="radio"/> Other
Scale	<input type="radio"/> Brinell Hardness <input checked="" type="radio"/> HV Unit Setting: Steel

Inspection

Description: After P.W.H.T

Item #	Description of Test Area	Parent Material	HAZ	Weld	HAZ	Parent Material
Ser# 7469	N5 support weld # 1	127	141	171	163	131
	N5 support weld # 2	131	143	149	151	143
	N5 support weld # 3	134	121	137	118	129
	N5 support weld # 4	140	167	151	139	126
	N6 support weld # 1	121	149	143	128	117
	N6 support weld # 2	119	127	148	139	141
	N6 support weld # 3	130	138	166	161	137
	N6 support weld # 4	127	150	153	147	111

046
 ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SAM OFCS HOME
 Print Name: GAMBIR SAHA
 Signature: *[Signature]*
 Date: Sep 12/13
Applus®
VELOSI
 Velosi America LLC

KV Inspection Technician	<i>[Signature]</i>	Date	September 9, 2013
Customer Representative	<i>[Signature]</i>	Date	SEP 19 2013



**Hardness Testing Report
HT**

Specification – Acceptance Criteria

General Data

Customer	All-Weld Company	Date	September 9, 2013
Location	Scarborough, ON	P. O. #	
Project		Shop Order #	1176 PQ S/N 7469
Procedure	KV HT# 35 Rev.00	Worksheet #	37499
Technician	Frank Marunde	HT Certified	<input checked="" type="checkbox"/> CGSB Reg # 8885

Technical Data – Hardness Testing (HT)

Material	Carbon Steel
----------	--------------

Test Method & Equipment



Technique	<input checked="" type="radio"/> Impact Load – Digital Readout	<input type="radio"/> Impact Load – Ocular Viewing	
Equipment	<input checked="" type="radio"/> Equotip D Impact Device		
Readings Taken	<input type="radio"/> Average of 5 readings	<input checked="" type="radio"/> Average of 3 readings	<input type="radio"/> Other
Scale	<input type="radio"/> Brinell Hardness	<input checked="" type="radio"/> HV	Unit Setting: Steel

Inspection

Description: After P.W.H.T

Item #	Description of Test Area	Parent Material	HAZ	Weld	HAZ	Parent Material
Ser# 7469	N7 support weld # 1	137	153	177	123	144
	N7 support weld # 2	126	157	164	141	128
	N7 support weld # 3	131	134	143	139	117
	N7 support weld # 4	142	161	147	141	130
	N8 support weld # 1	149	139	143	176	154
	N8 support weld # 2	145	131	123	167	127
	N8 support weld # 3	151	127	117	153	118
	N8 support weld # 4	123	128	124	143	120

046
 ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SPM OFFSHORE
 Print Name: GAMBIT SAHA
 Signature: [Signature]
 Date: SEP 13/13
Applus®
VELOSI
 Velosi America LLC

KV Inspection Technician		Date	September 9, 2013
Customer Representative		Date	SEP 11 2013

**Hardness Testing Report
HT**

Specification – Acceptance Criteria

General Data

Customer	All-Weld Company	Date	September 9, 2013
Location	Scarborough, ON	P. O. #	
Project		Shop Order #	1176 PQ S/N 7469
Procedure	KV HT# 35 Rev.00	Worksheet #	37499
Technician	Frank Marunde	HT Certified	<input checked="" type="checkbox"/> CGSB Reg # 8885

Technical Data – Hardness Testing (HT)

Material	Carbon Steel
----------	--------------

Test Method & Equipment



Technique	<input checked="" type="radio"/> Impact Load – Digital Readout <input type="radio"/> Impact Load – Ocular Viewing
Equipment	<input checked="" type="radio"/> Equotip D Impact Device
Readings Taken	<input type="radio"/> Average of 5 readings <input checked="" type="radio"/> Average of 3 readings <input type="radio"/> Other
Scale	<input type="radio"/> Brinell Hardness <input checked="" type="radio"/> HV Unit Setting: Steel

Inspection

Description: After P.W.H.T

Item #	Description of Test Area	Parent Material	HAZ	Weld	HAZ	Parent Material
Ser# 7469	N9 support weld #	113	137	129	141	129
	N9 support weld #	117	132	156	161	136
	N9 support weld #	128	144	143	128	140
	N9 support weld #	120	151	161	137	131
	Skirt W1	132	141	173	146	129
	Skirt L1	141	163	196	147	131
	Name plate bracket	94	153	143	N/A	163
	Davit bracket	156	167	137	115	143
	Item 2/3 baseplate	123	136	125	133	128

046
 ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SAM OFF SHORE
 GANESH SAHA
Applus®
VELOSI
 Velosi America LLC
 Print Name: _____
 Signature: _____
 Date: Sep 12/13

KV Inspection Technician		Date	September 9, 2013
Customer Representative		Date	SEP 11 2013

**Hardness Testing Report
HT**

Specification – Acceptance Criteria

General Data

Customer	All-Weld Company	Date	September 9, 2013
Location	Scarborough, ON	P. O. #	
Project		Shop Order #	1176 PQ S/N 7469
Procedure	KV HT# 35 Rev.00	Worksheet #	37499
Technician	Frank Marunde	HT Certified	<input checked="" type="checkbox"/> CGSB Reg # 8885

Technical Data – Hardness Testing (HT)

Material	Carbon Steel
----------	--------------

Test Method & Equipment

Technique	<input checked="" type="radio"/> Impact Load – Digital Readout	<input type="radio"/> Impact Load – Ocular Viewing	
Equipment	<input checked="" type="radio"/> Equotip D Impact Device		
Readings Taken	<input type="radio"/> Average of 5 readings	<input checked="" type="radio"/> Average of 3 readings	<input type="radio"/> Other
Scale	<input type="radio"/> Brinell Hardness	<input checked="" type="radio"/> HV	Unit Setting: Steel

Inspection

Description: After P.W.H.T

Item #	Description of Test Area	Parent Material	HAZ	Weld	HAZ	Parent Material
Ser# 7469	Vortex Breaker	125	175	190	127	108
	Item 19/2 Weld #1	151	126	149	122	120
	Item 19/2 weld #2	148	139	164	123	158
	Item 6/4 weld #1	121	140	172	144	150
	Item 6/4 weld #2	129	145	211	139	144
	Item 6/4 weld #3	118	138	170	128	142
	Item 6/4 weld #4	130	141	192	150	147
	Item 20/2 to 21/2	126	152	149	N/A	157
	Item 9/3 tailing lug	161	176	175	140	126

046
 ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: *SBM OFF SHORE*
 Print Name: *SAHA*
 Signature: *[Signature]*
 Date: *SEP 13/13*
Applus®
VELOSI
 Weld America LLC

KV Inspection Technician	<i>[Signature]</i>	Date	September 9, 2013
Customer Representative	<i>[Signature]</i>	Date	SEP 19 2013



1486 Wallace Road
 Oakville, Ontario L6L 2Y6
 Phone: 905-844-9448
 Fax: 905-844-6697

**Hardness Testing Report
 HT**

Specification – Acceptance Criteria

General Data

Customer	All-Weld Company	Date	September 9, 2013
Location	Scarborough, ON	P. O. #	
Project		Shop Order #	1176 PQ S/N 7469
Procedure	KV HT# 35 Rev.00	Worksheet #	37499
Technician	Frank Marunde	HT Certified	<input checked="" type="checkbox"/> CGSB Reg # 8885

Technical Data – Hardness Testing (HT)

Material	Carbon Steel
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Test Method & Equipment

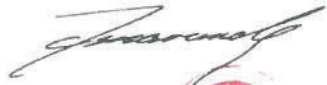

Technique	<input checked="" type="radio"/> Impact Load – Digital Readout	<input type="radio"/> Impact Load – Ocular Viewing	
Equipment	<input checked="" type="radio"/> Equotip D Impact Device		
Readings Taken	<input type="radio"/> Average of 5 readings	<input checked="" type="radio"/> Average of 3 readings	<input type="radio"/> Other
Scale	<input type="radio"/> Brinell Hardness	<input checked="" type="radio"/> HV	Unit Setting: Steel

Inspection

Description: After P.W.H.T

Item #	Description of Test Area	Parent Material	HAZ	Weld	HAZ	Parent Material
Ser# 7469	Item 23/2 Piece #1	153	173	158	176	137
	Item 23/2 Piece #2	148	183	189	153	133
	Item 23/2 Piece #3	139	197	153	140	123
	Item 23/2 Piece #4	141	181	167	152	129
	Item 23/2 Piece #5	124	190	170	160	151
	Item 23/2 Piece #6	144	169	166	196	157
	Item 23/2 Piece #7	145	157	161	163	163
	Item 23/2 Piece #8	140	169	158	167	138

046
 ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SBM OFF SHORE
 Print Name: GONNAST SAHA
 Signature: [Signature]
 Date: 08/13/13
Applus®
VELOSI
 Velosi America LLC

KV Inspection Technician		Date	September 9, 2013
Customer Representative		Date	SEP 11 2013

1486 Wallace Road
 Oakville, Ontario L6L 2Y6
 Phone: 905-844-9448
 Fax: 905-844-6697

**Hardness Testing Report
 HT**

Specification – Acceptance Criteria

General Data

Customer	All-Weld Company	Date	September 9, 2013
Location	Scarborough, ON	P. O. #	
Project		Shop Order #	1176 PQ S/N 7469
Procedure	KV HT# 35 Rev.00	Worksheet #	37499
Technician	Frank Marunde	HT Certified	<input checked="" type="checkbox"/> CGSB Reg # 8885

Technical Data – Hardness Testing (HT)

Material	Carbon Steel
----------	--------------

Test Method & Equipment


Technique	<input checked="" type="radio"/> Impact Load – Digital Readout	<input type="radio"/> Impact Load – Ocular Viewing	
Equipment	<input checked="" type="radio"/> Equotip D Impact Device		
Readings Taken	<input type="radio"/> Average of 5 readings	<input checked="" type="radio"/> Average of 3 readings	<input type="radio"/> Other
Scale	<input type="radio"/> Brinell Hardness	<input checked="" type="radio"/> HV	Unit Setting: Steel

Inspection

Description: After P.W.H.T

Item #	Description of Test Area	Parent Material	HAZ	Weld	HAZ	Parent Material
Ser# 7469	Item 24/2 Piece #1	122	138	171	167	149
	Item 24/2 Piece #2	144	190	181	161	138
	Item 24/2 Piece #3	137	173	168	164	142
	Item 24/2 Piece #4	136	159	173	154	144
	Item 22/2	134	171	163	194	181

046
 ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SRM OFF SHORE
Arplus®
VELOSI
 Velost America LLC
 Print Name: GIANESHI SAHA
 Signature: *[Signature]*
 Date: Sep 12/13

KV Inspection Technician	<i>[Signature]</i>	Date	September 9, 2013
Customer Representative		Date	SEP 11 2013

Welding Procedure Specification (WPS)

STAINLESS TO
CARBON STEEL

**Customer
Work Order #**

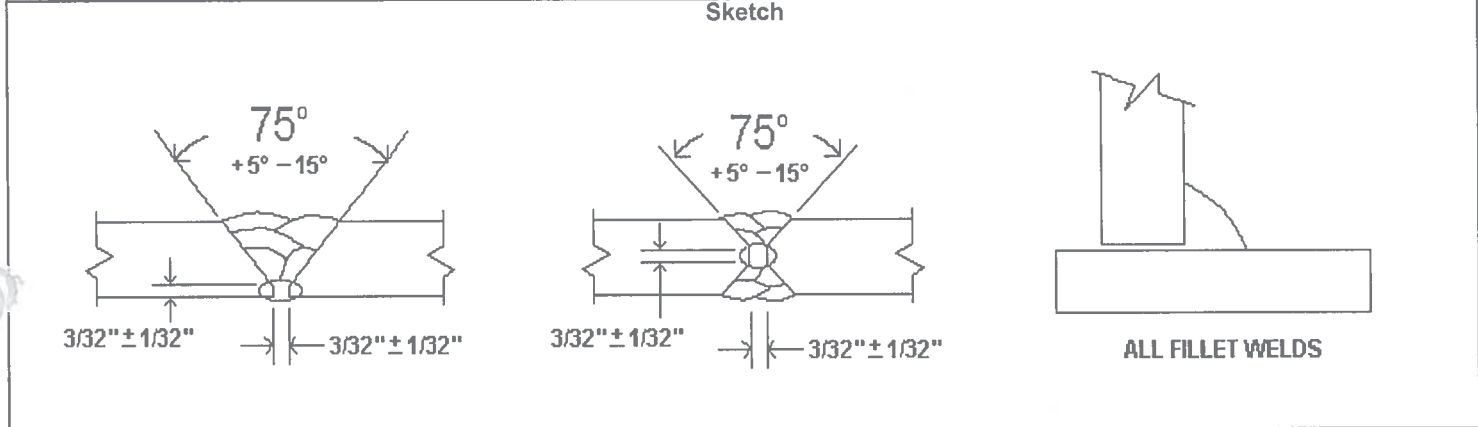
1	Company
Name/	ALL-WELD COMPANY LIMITED
Address /	49 PASSMORE AVE. / 14 PASSMORE AVE. PLANT 1 / PLANT 2
	SCARBOROUGH, ONTARIO
Postal Code (PLANT 1)	Postal Code (PLANT 2)
M1V-4T1	M1V-2R6

2	Provincial Registration	WP G186.5
----------	--------------------------------	-----------

3	Procedure Identification	
WPS NO.	2-1	Revision No. 4
Code Section	IX	Date 14 April, 07
PQR No.	2	

4	Welding Process(es)	1	SMAW	Manual	<input checked="" type="checkbox"/>	Semi-auto.	<input type="checkbox"/>	Auto.	<input type="checkbox"/>
		2		Manual	<input type="checkbox"/>	Semi-auto.	<input type="checkbox"/>	Auto.	<input type="checkbox"/>
		3		Manual	<input type="checkbox"/>	Semi-auto.	<input type="checkbox"/>	Auto.	<input type="checkbox"/>

5	Joints (QW-402)	
Design	SINGLE & DOUBLE V GROOVE	Backing Material WELD METAL
Backing	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> X	Other NONE



6	Base Metals (QW-403)	P. No. 8	Gr. No. 1	to P. No. 1	Gr. No. 1 & 2
or Specifications type and grade SA-240, 304, 304L, 316, 316L & 310 + 321 to SA-36, 53, 105, 106, 181, 234WPB, 285 & 516					
or Chemical Analysis and Mech. Prop. NONE					
Thickness Range Qualified		Total 1) 3/16" to 1 1/2"			
Other 1) NO SINGLE PASS TO BE GREATER THAN 1/2"					

7	Filler Metals (QW-404)				
1. AWS No. E309-16	RETURN ELECTRODES TO THE OVEN EVERY 4 HOURS	SFA 5.4	F-No 5	A-No. 8	Dia. 3/32" & 1/8"
2. AWS No. E309-16		SFA 5.4	F-No 5	A-No. 8	Dia. 5/32" & 3/16"
3. AWS No.		SFA	F-No	A-No.	Dia.
Flux Tradename	NONE	Electrode Flux Classification NONE			
Consumable Insert	NONE	Other MAX DEPOSITED METAL 1 1/2"			

8	Positions (QW-405)
Position(s) of Groove	ALL
Welding Progression	UP
Position(s) of Fillet	ALL
Other	NONE

10	Postweld Heat Treatment (QW-407)
Temperature Range	NONE
Time Range	NONE
Other	NONE

9	Preheat (QW-406)	
Preheat Temperature	Min.	SEE 'OTHER'
Interpass Temperature	Max.	350° F
Preheat Maintenance	SEE 'OTHER'	
Other	NONE	

11	Gas (QW-408)	
Shielding Gas Composition	NONE	
Gas Flow Rate	NONE	
Backing Gas Composition	NONE	
Trailing Shield Gas Composition	NONE	
Other	NONE	

12	Electrical Characteristics and Technique (QW-409)-(QW-410)						
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Weld Layer(s)	Process	Filler Metal		Current				Travel Speed Range
		Classification	Diameter	Type	Polarity	Amp. Range	Volt Range	
ROOT	SMAW	E309-16	3/32"	DC	RP	65-95	N/A	N/A
ROOT	SMAW	E309-16	1/8"	DC	RP	90-120	N/A	N/A
FILL	SMAW	E309-16	5/32"	DC	RP	120-160	N/A	N/A
FILL	SMAW	E309-16	3/16"	DC	RP	155-195	N/A	N/A

Tungsten Electrode Size and Type	NONE						
Mode of Metal Transfer for GMAW	NONE						
String or Weave Bead	STRING						
Method of Back Gouging	GRINDING OR ARC AIR GOUGING AND GRINDING TO SOUND METAL						
Initial and Interpass Cleaning (Brushing, Grinding, etc.)	WIRE BRUSH OR GRINDING						
Orifice or Gas Cup Size	NONE						
Oscillation	NONE	Width	NONE	Frequency	NONE		
Contact Tube to Work Distance	NONE						
Multiple or Single Pass (per side)	SINGLE AND OR MULTIPLE						
Multiple or Single Electrode	SINGLE						
Electrode Wire feed speed range	NONE						
Other	Preheat Requirements: When welding to or together for the thickness noted below the preheat requirements must be followed. For P1 -Thickness and minimum temperature 0 to 3/4" thick preheat to 50° F, 1" thick and up 200° F.						

13	Supplementary Comments	
NONE		

14 Company Representative Signature  Date 14 April, 07
Stephen White Q.I.T

Registration of this Welding Procedure (Specification plus Qualification Record) is required pursuant to the provisions of Section 36 (1) of the Boilers and Pressure Vessels Act of Ontario.
The registration becomes invalid when any essential variable changes, or any requirement of the ASME Code Section IX, affecting this procedure, is altered.



Ministry of
Consumer and
Commercial
Relations

Boilers and
Pressure Vessels
Branch
Technical Standards Division

Tel. (416) 965-4121

400 University Avenue
Toronto, Ontario
M5G 1S5

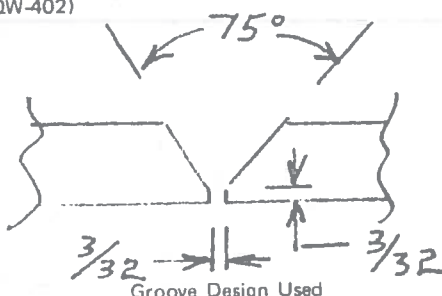
PROCEDURE QUALIFICATION RECORD

PQR-2

Date December 1, 1981

All-Weld Company Limited (Manufacturer) 49 Passmore Avenue, Scarborough, Ontario (Address)

Weld Proc. Spec. No. P8XPlxF5 Weld Process(es) SMAW Types MANUAL (Manual, Automatic)

<p>JOINTS (QW-402)</p>  <p>Groove Design Used</p>	<p>BASE METALS (QW-403)</p> <p>Material Spec. <u>SA240 & SA 285C</u></p> <p>Type or Grade <u>304 & C.S.</u></p> <p>P No. <u>8</u> to P No. <u>1</u></p> <p>Thickness <u>3/4"</u></p> <p>Diameter <u>FLAT</u></p> <p>Other <u>N/A</u> NO WELD PASS GREATER THAN 1/2 INCH THICK. VOID @ 14/3/95</p>
<p>FILLER METALS (QW-404)</p> <p>Weld Metal Analysis A No. <u>A8</u></p> <p>Size of Electrode <u>1/8 x 5/32</u></p> <p>Filler Metal F No. <u>F5</u></p> <p>SFA Specification <u>SFA 5.4</u></p> <p>AWS Classification <u>E308-16</u></p> <p>Other <u>N/A</u></p>	<p>POSITION (QW-405)</p> <p>Position of Groove <u>FLAT</u></p> <p>Weld Progression <u>N/A</u> (Uphill, Downhill)</p> <p>Other _____</p> <p>PREHEAT (QW-406)</p> <p>Preheat Temp. <u>50° F. MIN</u></p> <p>Interpass Temp. <u>350° F. MAX</u></p> <p>Other <u>N/A</u></p>
<p>POSTWELD HEAT TREATMENT (QW-407)</p> <p>Temperature <u>NONE</u></p> <p>Time <u>N/A</u></p> <p>Other <u>N/A</u></p>	<p>GAS (QW-408)</p> <p>Type of Gas or Gases <u>N/A</u></p> <p>Composition of Gas Mixture <u>N/A</u></p> <p>Other <u>N/A</u></p>
<p>ELECTRICAL CHARACTERISTICS (QW-409)</p> <p>Current <u>D.C.</u></p> <p>Polarity <u>REVERSE</u></p> <p>Amps. <u>120</u> Volts <u>25</u></p> <p>Travel Speed <u>7-10</u> <u>1PM</u></p> <p>Other <u>N/A</u></p>	<p>TECHNIQUE (QW-410)</p> <p>String or Weave Bead <u>STRING</u></p> <p>Oscillation <u>N/A</u></p> <p>Multipass or Single Pass <u>MULTIPASS</u> (per side)</p> <p>Single or Multiple Electrodes <u>SINGLE</u></p>

G 186.5

TENSILE TEST (QW-150)

SPECIMEN NO.	WIDTH	THICKNESS	AREA	ULTIMATE TOTAL LOAD LB.	ULTIMATE UNIT STRESS PSI	CHARACTER OF FAILURE & LOCATION
AW-7-5	.755	.370	.280		64,000	PARENT METAL
AW-7-6	.755	.350	.264		63,000	PARENT METAL

GUIDED BEND TESTS (QW-160)

TYPE AND FIGURE NO.	RESULT	TYPE AND FIGURE NO.	RESULT
AW-7-1	SATISFACTORY	AW-7-3	SATISFACTORY
AW-7-2	SATISFACTORY	AW-7-4	SATISFACTORY

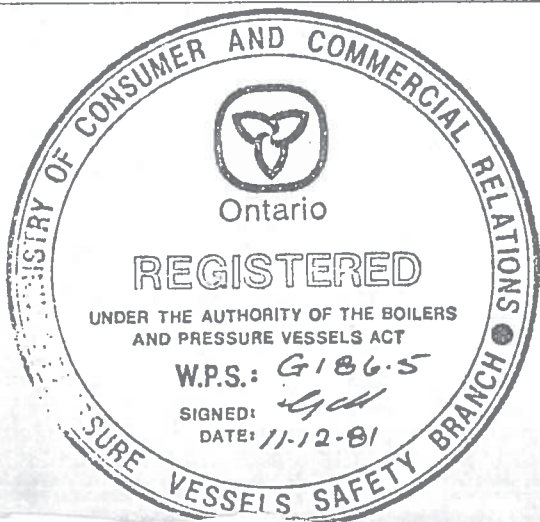
TOUGHNESS TESTS (QW-170)

SPECIMEN NO.	NOTCH LOCATION	NOTCH TYPE	TEST TEMP.	IMPACT VALUES	LATERAL EXP.		DROPWEIGHT	
					% SHEAR	MILS	BREAK	NO BREAK

Type of Test _____
 Deposit Analysis _____
 Other _____

Weld Test Witnessed By Mr. J. Clark
Authorized Inspector

Tensile Test Made By The Warnock Hersey Co. Ltd
 Laboratory Test No. 7735/TP63/TP96



We certify that the Statements in this record are correct and the test welds were prepared, welded and tested in accordance with ASME Boiler and Pressure Vessel Code Section IX.

Signed ALL-WELD COMPANY LIMITED
(Manufacturer)
 By R. J. McIntyre
 R. J. MCINTYRE
 Q.A. SUPERVISOR/

Welding Procedure Specification (WPS)

CARBON STEEL

Customer Work Order #

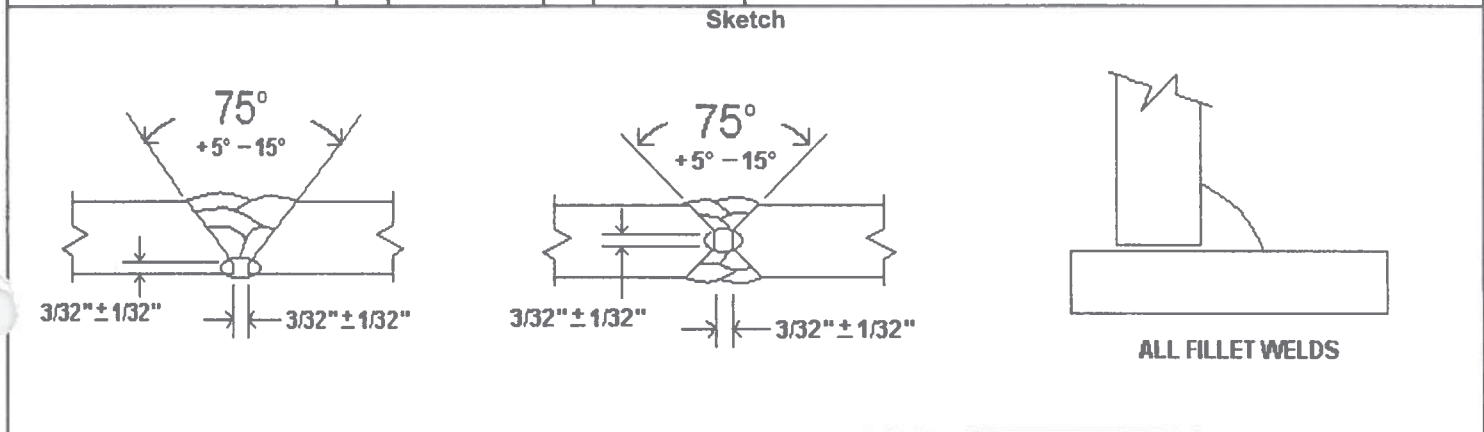
1	Company
Name/	ALL-WELD COMPANY LIMITED
Address /	49 PASSMORE AVE. , 14 PASSMORE AVE. PLANT 1 PLANT 2
	SCARBOROUGH, ONTARIO
Postal Code (PLANT 1)	Postal Code (PLANT 2)
M1V-4T1	M1V-2R6

2	Provincial Registration	WP T4660.5
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3	Procedure Identification	
WPS NO.	29-2	Revision No. 0
Code Section	IX	Date 15 APRIL, 13
PQR No.	29X	

4	Welding Process(es)	1 GTAW	Manual	<input checked="" type="checkbox"/>	Semi-auto.	<input type="checkbox"/>	Auto.	<input type="checkbox"/>
		2	Manual	<input type="checkbox"/>	Semi-auto.	<input type="checkbox"/>	Auto.	<input type="checkbox"/>
		3	Manual	<input type="checkbox"/>	Semi-auto.	<input type="checkbox"/>	Auto.	<input type="checkbox"/>

5	Joints (QW-402)	
Design	SINGLE , DOUBLE V GROOVE & FILLETS	Backing Material WITH OR WITHOUT WELD METAL
Backing	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	Other BACKING FOR SINGLE OR DOUBLE V GROOVE



6	Base Metals (QW-403)	P. No. <u>1</u> Gr. No. <u>1</u> to P. No. <u>1</u> Gr. No. <u>2</u>
	or Specifications type and grade	SA-333-GR 6 to SA-36, 53-B, 105, 106-B, 234 WPB, 350-LF2 & 516-GR70
	or Chemical Analysis and Mech. Prop.	NONE
Thickness Range Qualified	Total 1) 0.300" TO 0.600" FOR IMPACTS 2) 0.062" TO 0.600" NON IMPACT	
Other	1) NO SINGLE PASS TO BE GREATER THAN 1/2"	

7	Filler Metals (QW-404)	
1. AWS No. ER70S-2	PRODUCT FORM - SOLID	SFA 5.18 F-No 6 A-No. 1 Dia. 1/16"
2. AWS No. ER70S-2		SFA 5.18 F-No 6 A-No. 1 Dia. 1/8"
3. AWS No.		SFA F-No A-No. Dia.
Flux Tradename	NONE	Electrode Flux Classification NONE
Consumable Insert	NONE	Other MAX. DEPOSITED METAL 0.600" THICK

8	Positions (QW-405)
Position(s) of Groove	1G TO 6G
Welding Progression	UP
Position(s) of Fillet	ALL
Other	NONE

9	Postweld Heat Treatment (QW-407)
Temperature Range	1175 F + or - 25 F
Time Range	6.25 HR'S MAX
Other	NONE

10	Preheat (QW-406)		
Preheat Temperature	Min.	SEE 'OTHER'	
Interpass Temperature	Max.	350° F	
Preheat Maintenance		SEE 'OTHER'	
Other		NONE	

11	Gas (QW-408)	
Shielding Gas Composition	ARGON 99.9%	
Gas Flow Rate	8-12 CFH	
Backing Gas Composition	ARGON 99.9%	
Trailing Shield Gas Composition	3-5 CFH	
Other	NONE	

12 Electrical Characteristics and Technique (QW-409)-(QW-410)

Weld Layer(s)	Process	Filler Metal		Current				Travel Speed Range
		Classification	Diameter	Type	Polarity	Amp. Range	Volt Range	
ROOT	GTAW	ER70S-2	1/8"	DC	SP	110-130	16-20	3 TO 6
FILL	GTAW	ER70S-2	1/8"	DC	SP	110-130	16-22	3 TO 6
Heat Input (Per QW-409.1) = 57,200 j / in								

Tungsten Electrode Size and Type	2% THORIATED TUNGSTEN							
Mode of Metal Transfer for GMAW	NONE							
String or Weave Bead	STRING							
Method of Back Gouging	GRINDING OR ARC AIR GOUGING AND GRINDING TO SOUND METAL							
Initial and Interpass Cleaning (Brushing, Grinding, etc)	WIRE BRUSH OR GRINDING							
Orifice or Gas Cup Size	3/8" TO 5/8"							
Oscillation	NONE	Width	NONE	Frequency	NONE			
Contact Tube to Work Distance	1/2" TO 1"							
Multiple or Single Pass (per side)	MULTIPLE							
Multiple or Single Electrode	SINGLE							
Electrode Wire feed speed range	NONE							
Other	Preheat Requirements: When welding to or together for the thickness noted below the preheat requirements must be followed. Thickness and minimum temperature 0 to 3/4" thick preheat to 50° F							

13	Supplementary Comments	
1) CHARPY V NOTCH IMPACT TESTED TO - 50 F 2) MACROETCH EVALUATION TEST		
3) VICKERS HARDNESS TRANSFER TEST UNDER 248 HV10		

14 Company Representative Signature Robert C. Bentley Date 15 APRIL, 13
 Robert C. Bentley C.E.T.

Registration of this Welding Procedure (Specification plus Qualification Record) is required pursuant to the provisions of Section 36 (1) of the Boilers and Pressure Vessels Act of Ontario.
 The registration becomes invalid when any essential variable changes, or any requirement of the ASME Code Section IX, affecting this procedure, is altered.

PROCEDURE QUALIFICATION RECORD (PQR)

(Reference: ASME Section IX)

1 Company								
Name / ALL-WELD COMPANY LIMITED								
Address / 49 49 PASSMORE AVENUE								
SCARBOROUGH, ONTARIO								
			Postal Code M 1 V 4 T 1					
4 Welding Process(es)								
1	GTAW	Type	MANUAL					
2		Type						
3		Type						
6 Base Metals (QW-403)								
P No.	1	Gr No.	1 to P. No. 1 Gr No. 2					
Specification		Tensile						
SA-333-GR6		60,000 psi						
SA-350-LF2		70,000 psi						
Thickness	0.300 "	Diameter	3 "					
Other NONE								
7 Filler Metals (QW-405)								
Classification (AWS)	SFA-No.	F - No.	A - No.					
ER70S-2	5.18	6	1					
Other NONE								
8 Positions QW-405								
Position(s) of Groove 6G								
Welding Progression Up <input type="checkbox"/> Down <input type="checkbox"/>								
Other NONE								
9 Preheat (QW-406)								
Preheat Temperature Min		50°F						
Interpass Temperature Max		350°F						
Other NONE								
13 Electrical Characteristics and Technique (QW-409) + (QW-410)								
Weld Layers	Process	Filler Metal		Current				Travel Speed
		Classification	Diameter	Type	Polarity	Amp	Volt	
ROOT	GTAW	ER70S-2	1/16 "	DC	SP	130	20	3
FILL	GTAW	ER70S-2	1/8 "	DC	SP	130	22	4

2 Provincial Registration		WP T4660.5
3 Record Identification		
PQR No.		29X
WPS No.		29-2
5 Groove Design used		
10 Postweld Heat Treatment /		
Temperature		1175 F + or - 25 F
Time		5 HOURS
Other NONE		
11 Gas (QW-408)		
Shielding Gas Composition		ARGON 99.9%
Gas Flow Rate		8 - 12 CFH
Backing Gas composition		ARGON 99.9%
Gas Flow Rate		8 - 12 CFH
Other NONE		
12 Technique (QW-410)		
String or Weave Bead		STRING
Oscillation NONE		
Multipass or Single Pass (per side)		MULTIPLE
Single or Multiple Electrode		SINGLE
Other NONE		

14 Tensile Tests				Reference:		
Specimen	Dimensions in Inches		Area in Inches ²	Ultimate Total Load in Foot Pounds	Ultimate Unit Stress in PSI	Character and Location of Failure
	Width	Thickness				
T1	0.504"	0.287"	0.145"	9,598	66,500	All coupons failed a ductile manner the base metal
T2	0.504"	0.299"	0.151"	9,550	63,500	

15 Guided Bend Tests					Reference:				
Specimen	Face	Root	Side	Result	Specimen	Face	Root	Side	Result
S1			X	ACCEPTED	S3			X	ACCEPTED
S2			X	ACCEPTED	S4			X	ACCEPTED

16 Toughness Tests					Reference:			
Specimen	Notch Location	Notch Type	Specimen Temperature	Impact Value	Lateral Expansion		Drop Weight	
					Shear	Mills	Break	No Break
1	HAZ SA-333-GR6	V NOTCH	-50 F	133 ft-lbf	100	76		
2	HAZ SA-333-GR6	V NOTCH	-50 F	168 ft-lbf	100	74		
3	HAZ SA-333-GR6	V NOTCH	-50 F	171 ft-lbf	100	78		
1	WELD	V NOTCH	-50 F	129 ft-lbf	100	79		
2	WELD	V NOTCH	-50 F	163 ft-lbf	100	84		
3	WELD	V NOTCH	-50 F	164 ft-lbf	100	86		
1	HAZ SA-350-LF2	V NOTCH	-50 F	155 ft-lbf	100	81		
2	HAZ SA-350-LF2	V NOTCH	-50 F	152 ft-lbf	100	74		
3	HAZ SA-350-LF2	V NOTCH	-50 F	97 ft-lbf	100	90		

17 Fillet Weld Test				Reference:				
Result - Satisfactory				Heat Input (Per QW-409.1) = 57,200 J				
Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Penetration Into Parent Metal	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>

Macro - Results

18 Other Tests		Reference:	
1) MACROETCH EXAMINATION PER LAB REPORT 638502-13 (Report A)			
2) NACE MR0175/ISO 15156-2:2009/CIR..2011(E) VICKERS HARDNESS PER LAB REPORT 638502-13 (Report B)			

19 Welder's Name	Hafeez Mirza	Stamp No.	53
Tests conducted by	CAMBRIDGE MATERIAL TESTING LTD.	Laboratory Test No.	638497-2013, 638500-2013, 638501-2013, 638497-2013, 638502-13 (Report A)

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

20 Company Representative's Signature	<i>Robert Bentley</i>	Date	15 April, 2013
	ROBERT C. BENTLEY, C.E.T.		

21 Department Use only	
Samples Welded on	Inspector
Record verified on	Inspector

Welding Procedure Specification (WPS)

Carbon Steel

Customer :
Work Order #

1	Company
Name/ ALL-WELD COMPANY LIMITED	
Address / 49 PASSMORE AVE. , 14 PASSMORE AVE. PLANT 1 PLANT 2	
SCARBOROUGH, ONTARIO	
Postal Code (PLANT 1) M1V-4T1	Postal Code (PLANT 2) M1V-2R6

2	Provincial Registration	WP T4653.5
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3 Procedure Identification			
WPS NO.	52-2	Revision No.	0
Code Section	IX	Date	08 APRIL, 13
PQR No.	52X		

4	Welding Process(es)	1	SMAW	Manual	X	Semi-auto.		Auto.	
		2		Manual		Semi-auto.		Auto.	
		3		Manual		Semi-auto.		Auto.	

5 Joints (QW-402)					
Design	DOUBLE V GROOVE		Backing Material	WELD METAL	
Backing	Yes	No	X	Other	NONE
Sketch					
ALL FILLET WELDS					

6	Base Metals (QW-403)	P. No. <u>1</u> Gr. No. <u>2</u> to P. No. <u>1</u> Gr. No. <u>2</u>
or Specifications type and grade		SA - 516 - GR 70 N to SA - 516 - GR 70 N & SA - 350 - LF2
or Chemical Analysis and Mech. Prop.		
Thickness Range Qualified	Total 1) 5/8 " to 8 " for Impact use 2) 3/16" to 8" Non Impact use	
Other	1) NO SINGLE PASS TO BE GREATER THAN 1/2"	

7 Filler Metals (QW-404)			
1. AWS No	E7018-1H4	SFA	5.1 F-No 4 A-No. 1 Dia. 1/8 "
2. AWS No.	E7018-1H4	SFA	5.1 F-No 4 A-No. 1 Dia. 3/16"
3. AWS No.		SFA	F-No A-No. Dia.
Flux Tradename	NONE	Electrode Flux Classification	NONE
Consumable Insert	NONE	Other	MAX DEPOSITED METAL 8 "

8 Positions (QW-405)	
Position(s) of Groove	1G TO 6G
Welding Progression	UP
Position(s) of Fillet	ALL
Other	NONE

10 Postweld Heat Treatment (QW-407)	
Temperature Range	1175 + 25 ° / - 0 ° F
Time Range	FOR IMPACT TEST 6 1/2 HRS AND PER CODE FOR NON IMPACT
Other	

9	Preheat (QW-406)
Preheat Temperature	Min. IMPACT TEST 200° F/ NON 100° F
Interpass Temperature	Max. 350° F
Preheat Maintenance	IMPACT TEST 200° F/ NON 100° F
Other	NONE

11	Gas (QW-408)
Shielding Gas Composition	NONE
Gas Flow Rate	NONE
Backing Gas Composition	NONE
Trailing Shield Gas Composition	NONE
Other	NONE

12	Electrical Characteristics and Technique (QW-409)-(QW-410)
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Weld Layer(s)	Process	Filler Metal		Current				Travel Speed Range
		Classification	Diameter	Type	Polarity	Amp. Range	Volt Range	
ROOT	SMAW	E7018-1H4	1/8 "	DC	RP	100 - 150	21 - 25	5 - 10 IPM
FILL	SMAW	E7018-1H4	3/16 "	DC	RP	200 - 275	21 - 25	5 - 10 IPM
Max Heat Input (Per QW-409.1) = 79,200 j / in								

Tungsten Electrode Size and Type	NONE
Mode of Metal Transfer for GMAW	NONE
String or Weave Bead	STRING
Method of Back Gouging	GRINDING OR ARC AIR GOUGING AND GRINDING
Initial and Interpass Cleaning (Brushing, Grinding, etc.)	WIRE BRUSH OR GRINDING
Orifice or Gas Cup Size	NONE
Oscillation	NONE
Width	NONE
Frequency	NONE
Contact Tube to Work Distance	NONE
Multiple or Single Pass (per side)	MULTIPLE
Multiple or Single Electrode	SINGLE
Electrode Wire feed speed range	NONE
Other	NONE

13	Supplementary Comments
	NONE

14	Company Representative Signature		Date	08 APRIL, 2013
		Robert C. Bentley C.E.T.		

Registration of this Welding Procedure (Specification plus Qualification Record) is required pursuant to the provisions of Section 36 (1) of the Boilers and Pressure Vessels Act of Ontario. The registration becomes invalid when any essential variable changes, or any requirement of the ASME Code Section IX, affecting this procedure, is altered.

14 Tensile Tests				Reference:		
Specimen	Dimensions in Inches		Area in Inches ²	Ultimate Total Load in Foot Pounds	Ultimate Unit Stress in PSI	Character and Location of Failure
	Width	Thickness				
T2A	0.750"	1.114"	0.836"	60,281	72,000	All coupons failed in ductile manner in weld metal
T2B	0.752"	1.220"	0.917"	64,554	70,500	
T5A	0.750"	1.185"	0.889"	63,442	71,500	
T5B	0.751"	1.150"	0.864"	62,000	72,000	

15 Guided Bend Tests					Reference:				
Specimen	Face	Root	Side	Result	Specimen	Face	Root	Side	Result
S1			X	ACCEPTED	S3			X	ACCEPTED
S2			X	ACCEPTED	S4			X	ACCEPTED

16 Toughness Tests					Reference:			
Specimen	Notch Location	Notch Type	Specimen Temperature	Impact Value	Lateral Expansion		Drop Weight	
					Shear	Mills	Break	No Break
1	Weld (1/16" below)	V NOTCH	-50 F	186 ft-lbf	80	81		
2	Weld (1/16" below)	V NOTCH	-50 F	125 ft-lbf	60	80		
3	Weld (1/16" below)	V NOTCH	-50 F	19 ft-lbf	20	10		
1	HAZ	V NOTCH	-50 F	152 ft-lbf	80	81		
2	HAZ	V NOTCH	-50 F	111 ft-lbf	60	74		
3	HAZ	V NOTCH	-50 F	107 ft-lbf	60	67		
1	Weld (1/4t opposite)	V NOTCH	-50 F	83 ft-lbf	30	59		
2	Weld (1/4t opposite)	V NOTCH	-50 F	28 ft-lbf	20	14		
3	Weld (1/4t opposite)	V NOTCH	-50 F	136 ft-lbf	60	79		

17 Fillet Weld Test				Reference:			
Result - Satisfactory				Heat Input (Per QW-409.1) = 79,200 j / in			
Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Penetration Into Parent Metal	Yes	<input type="checkbox"/>	No

Macro - Results

18 Other Tests		Reference:
1) MACROETCH EXAMINATION PER LAB REPORT 637267-13 (Report A)		
2) NACE MR0175/ISO 15156-2:2009/CIR. 2011(E) VICKERS HARDNESS PER LAB REPORT 637267-13 (Report B)		

19 Welder's Name Steve Liew Stamp No. 90

637260-13, 637264-2013, 637265-2013,
637266-2013, 637267-13 (Report A)
Laboratory Test No. 637267-13 (Report B)

Tests conducted by CAMBRIDGE MATERIAL TESTING LTD.

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

20 Company Representative's Signature *Robert C. Bentley* Date 8 April, 2013
ROBERT C. BENTLEY, Q.E.T.

21	Samples Welded on	REGISTERED	Inspector
			Inspector
	Record verified on		Inspector

Technical Standards and Safety Authority
Boilers and Pressure Vessels Safety Program

Department Use only

W.P.S.: WP-T4653-F
 Signed: S. Lam
 Date: Apr 19, 2013

PQR: 52-X
 WPS: 52-2

Welding Procedure Specification (WPS)

CARBON STEEL

Customer Work Order #

1	Company
Name/ ALL-WELD COMPANY LIMITED	
Address / 49 PASSMORE AVE. / 14 PASSMORE AVE. PLANT 1 / PLANT 2	
SCARBOROUGH, ONTARIO	
Postal Code (PLANT 1) M1V-4T1	Postal Code (PLANT 2) M1V-2R6

2	Provincial Registration	WP P659.5
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3	Procedure Identification	
WPS NO.	SAW-3-2	Revision No. 6
Code Section	IX	Date 27 March, 13
PQR No.	SAW-3	

4	Welding Process(es)	1	SAW	Manual		Semi-auto.		Auto.	<input checked="" type="checkbox"/>
		2		Manual		Semi-auto.		Auto.	
		3		Manual		Semi-auto.		Auto.	

5	Joints (QW-402)					
Design	DOUBLE V GROOVE	Backing Material WELD METAL				
Backing	<table style="width: 100%; border: none;"> <tr> <td style="width: 20%; text-align: center;">Yes</td> <td style="width: 20%;"></td> <td style="width: 20%; text-align: center;">No</td> <td style="width: 20%; text-align: center;"><input checked="" type="checkbox"/></td> </tr> </table>	Yes		No	<input checked="" type="checkbox"/>	Other NONE
Yes		No	<input checked="" type="checkbox"/>			
Sketch						

6	Base Metals (QW-403)	P. No. 1 Gr. No. 2 to P. No. 1 Gr. No. 2
or Specifications type and grade		SA-516-GR 70 to SA-516-GR 70
or Chemical Analysis and Mech. Prop.		NONE
Thickness Range Qualified	Total 1) 5/8 " TO 8 " for Impact use 2) Non Impact use 3/16" to 8"	
Other	1) NO SINGLE PASS TO BE GREATER THAN 1/2"	

7	Filler Metals (QW-404)	
1. AWS No. EH11K		SFA 5.17 F-No 6 A-No. 1 Dia. 0.15625
2. AWS No. EH11K		SFA 5.17 F-No 6 A-No. 1 Dia. 0.125
3. AWS No.		SFA F-No A-No. Dia.
Flux Tradename	LINCONWELD 880M	Electrode Flux Classification F7P6-EH11K-HB
Consumable Insert	NONE	Other MAX DEPOSITED METAL 8 "

8	Positions (QW-405)
Position(s) of Groove	1G
Welding Progression	UP
Position(s) of Fillet	FLAT
Other	1F

10	Postweld Heat Treatment (QW-407)
Temperature Range	1150 F - 0 +25 F
Time Range : for Impact use 2 1/2 Hours Maximum Time Limit	
Time Range : per ASME	

9 Preheat (QW-406)		
Preheat Temperature	Min.	200° F
Interpass Temperature	Max.	300° F
Preheat Maintenance & Tacking		200° F
Other	NONE	

(11) Gas (QW-408)	
Shielding Gas Composition	NONE
Gas Flow Rate	NONE
Backing Gas Composition	NONE
Trailing Shield Gas Composition	NONE
Other	NONE

12 Electrical Characteristics and Technique (QW-409)-(QW-410)

Weld Layer(s)	Process	Filler Metal		Current				Travel Speed Range
		Classification	Diameter	Type	Polarity	Amp. Range	Volt Range	
ROOT	SAW	EH11K	0.1562	DC	RP	745-750	30-32	18 IPM
FILL	SAW	EH11K	0.1562	DC	RP	745-750	34-35	18 IPM
			or					
ROOT	SAW	EH11K	0.125"	DC	RP	450 - 550	33 - 35	20 - 25
FILL	SAW	EH11K	0.125"	DC	RP	450 - 550	33 - 35	20 - 25
Heat Input (Per QW-409.1) = 87,500 j / in Maximum								

Tungsten Electrode Size and Type	NONE	
Mode of Metal Transfer for GMAW	NONE	
String or Weave Bead	STRING	
Method of Back Gouging	GRINDING OR ARC AIR GOUGING AND GRINDING	
Initial and Interpass Cleaning (Brushing, Grinding, etc.)	WIRE BRUSH OR GRINDING	
Orifice or Gas Cup Size	3/4"	
Oscillation	NONE	Width NONE Frequency NONE
Contact Tube to Work Distance	1"	
Multiple or Single Pass (per side)	MULTIPLE	
Multiple or Single Electrode	SINGLE	
Electrode Wire feed speed range	60 IPM	
Other	Preheat Requirements for welding and tacking : See Section # 9	

13 Supplementary Comments

1) NACE MR0175/ISO 15156-2:2009/CIR.1:2011 Per Laboratory No. 636744-13

2) Macroetch to ASTM E3-11 Per Laboratory No. 634810-13

14 Company Representative Signature Robert C Bentley Date 27 March, 13
 Robert C. Bentley C.E.T.

Registration of this Welding Procedure (Specification plus Qualification Record) is required pursuant to the provisions of Section 36 (1) of the Boilers and Pressure Vessels Act of Ontario.
 The registration becomes invalid when any essential variable changes, or any requirement of the ASME Code Section IX, affecting this procedure, is altered.

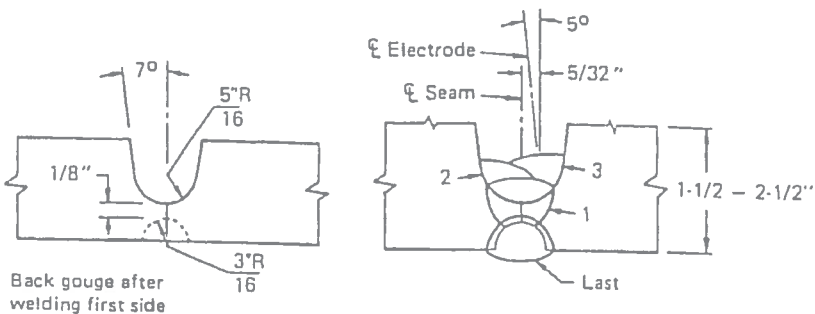
QW-483 SUGGESTED FORMAT FOR PROCEDURE QUALIFICATION RECORD (PQR)

(See QW-201.2, Section IX, ASME Boiler and Pressure Vessel Code)

Record Actual Conditions Used to Weld Test Coupon.

Company Name ALL-WELD CO. LTD., 49 PASSMORE AVE., SCARBOROUGH, ONTARIO, M1V 4T1
 Procedure Qualification Record No. SAW-3 Date OCT. 10, 1991
 WPS No. SAW-3-1
 Welding Process(es) SAW
 Types (Manual, Automatic, Semi-Auto.) AUTOMATIC

JOINTS (QW-402)



Groove Design of Test Coupon

(For combination qualifications, the deposited weld metal thickness shall be recorded for each filler metal or process used.)

<p>BASE METALS (QW-403) Material Spec. <u>SA516-70</u> Type or Grade _____ P-No. <u>1</u> to P-No. <u>1</u> Thickness of Test Coupon <u>2"</u> Diameter of Test Coupon <u>PLATE</u> Other <u>NONE</u></p>	<p>POSTWELD HEAT TREATMENT (QW-407) Temperature <u>1100° F</u> Time <u>2 HOURS</u> Other _____</p>																																	
<p>FILLER METALS (QW-404)</p> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:30%;">SFA Specification</td> <td><u>5.17</u></td> </tr> <tr> <td>AWS Classification</td> <td><u>F7P6-EH1K</u></td> </tr> <tr> <td>Filler Metal F-No.</td> <td><u>6</u></td> </tr> <tr> <td>Weld Metal Analysis A-No.</td> <td><u>1</u></td> </tr> <tr> <td>Size of Filler Metal</td> <td><u>5/32</u></td> </tr> <tr> <td>Other</td> <td><u>FLUX LINCOLN 880M</u></td> </tr> <tr> <td>Deposited Weld Metal</td> <td>_____</td> </tr> </table>	SFA Specification	<u>5.17</u>	AWS Classification	<u>F7P6-EH1K</u>	Filler Metal F-No.	<u>6</u>	Weld Metal Analysis A-No.	<u>1</u>	Size of Filler Metal	<u>5/32</u>	Other	<u>FLUX LINCOLN 880M</u>	Deposited Weld Metal	_____	<p>GAS (QW-408)</p> <table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2"></th> <th colspan="3">Percent Composition</th> </tr> <tr> <th>Gas(es)</th> <th>(Mixture)</th> <th>Flow Rate</th> </tr> </thead> <tbody> <tr> <td>Shielding</td> <td><u>NONE</u></td> <td>_____</td> <td>_____</td> </tr> <tr> <td>Trailing</td> <td><u>NONE</u></td> <td>_____</td> <td>_____</td> </tr> <tr> <td>Backing</td> <td><u>NONE</u></td> <td>_____</td> <td>_____</td> </tr> </tbody> </table>		Percent Composition			Gas(es)	(Mixture)	Flow Rate	Shielding	<u>NONE</u>	_____	_____	Trailing	<u>NONE</u>	_____	_____	Backing	<u>NONE</u>	_____	_____
SFA Specification	<u>5.17</u>																																	
AWS Classification	<u>F7P6-EH1K</u>																																	
Filler Metal F-No.	<u>6</u>																																	
Weld Metal Analysis A-No.	<u>1</u>																																	
Size of Filler Metal	<u>5/32</u>																																	
Other	<u>FLUX LINCOLN 880M</u>																																	
Deposited Weld Metal	_____																																	
	Percent Composition																																	
	Gas(es)	(Mixture)	Flow Rate																															
Shielding	<u>NONE</u>	_____	_____																															
Trailing	<u>NONE</u>	_____	_____																															
Backing	<u>NONE</u>	_____	_____																															
<p>POSITION (QW-405) Position of Groove <u>FLAT</u> Weld Progression (Uphill, Downhill) _____ Other _____</p>	<p>ELECTRICAL CHARACTERISTICS (QW-409) Current <u>DC</u> Polarity <u>POSITIVE (REVERSE)</u> Amps. <u>745-750</u> Volts <u>30-34</u> Tungsten Electrode Size _____ Other <u>NONE</u></p>																																	
<p>PREHEAT (QW-406) Preheat Temp. <u>200° F</u> Interpass Temp. <u>300° F</u> Other <u>MAINT: 200° F</u></p>	<p>TECHNIQUE (QW-410) Travel Speed <u>18' P.M.</u> String or Weave Bead <u>STRING</u> Oscillation <u>NONE</u> Multipass or Single Pass (per side) <u>MULTI-PASS</u> Single or Multiple Electrodes <u>SINGLE</u> Other <u>NONE</u></p>																																	

Tensile Test (QW-150)

Specimen No.	Width	Thickness	Area	Ultimate Total Load lb	Ultimate Unit Stress psi	Type of Failure & Location
T2A	.932	.758	.708	54,500	77,195	DUCTILE IN BASE
T2B	.904	.752	.608	52,600	77,352	" "
T5A	.873	.755	.659	50,500	76,631	" "
T5B	.916	.739	.677	53,000	78,286	" "

Guided-Bend Tests (QW-160)

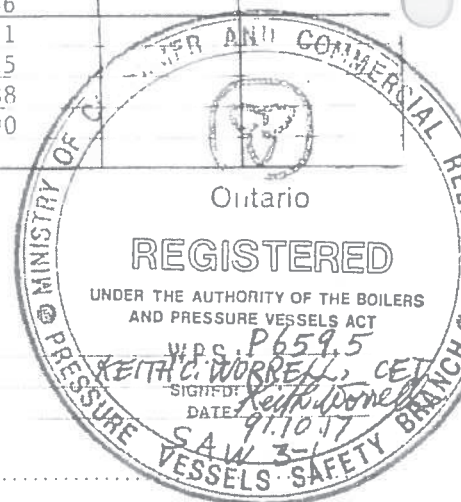
Type and Figure No.	Result
SIDE BEND 3/8" X 2" X 11	BEND AROUND
" " " " " "	1 1/2" D. PIN
" " " " " "	180°
" " " " " "	NO CRACKS OR OPEN DEFECTS GREATER THAN 1/8"

Toughness Tests (QW-170)

Specimen No.	Notch Location	Notch Type	Test Temp.	Impact Values	Lateral Exp.		Drop Weight	
					% Shear	Mils	Break	No Break
1	WELD 1/16	CHARPY	-50°F	51.6	10	46		
2	WELD 1/16	CHARPY	-50°F	62.3	10	59		
3	WELD 1/16	CHARPY	-50°F	85.6	20	71		
1	WELD MIDW	CHARPY	-50°F	45.7	10	34		
2	WELD MIDW	CHARPY	-50°F	60.5	10	46		
3	WELD MIDW	CHARPY	-50°F	79.7	20	61		
1	HAZ.	CHARPY	-50°F	60.5	40	25		
2	HAZ.	CHARPY	-50°F	140.1	90	88		
3	HAZ.	CHARPY	-50°F	143.1	90	90		

Other Tests

Type of Test NONE
 Deposit Analysis NONE
 Other NONE



Welder's Name ROBERT DIAS Clock No. 541 Stamp No. 8

Tests conducted by: CAMBRIDGE TESTING SERVICES LIMITED Laboratory Test No. 67507-91

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

Manufacturer ALL-WELD CO. LTD.

Date Oct 15/91

By [Signature] QC MANAGER

(Detail of record of tests are illustrative only and may be modified to conform to the type and number of tests required by the Code.)

[Signature]
 AUTHORIZED INSPECTOR

Oct. 15TH 1991
 DATE

WPS 2-1
W-0-1173 PQ

PO# 13-0765

5

HOBART BROTHERS

McKay

CERTIFICATE OF ANALYSIS

CUSTOMER:	EXOCOR C/O USF HOLLAND BUFFALO	P.O. #:	021702
MARKED FOR:		DATE:	5/7/2013 2:14:09 PM
PACK SLIP/ORDER #:	A503500	WORK ORDER:	
LBS SHIPPED:	60		
PRODUCT TYPE:	STERL AP 309/309L 1/8 10 CAN	STOCK NUMBER:	S483944-033
LOT NO:	23R056	HEAT NO:	743678
SPECIFICATION:	AWS A5.4, ASME SFA 5.4	CLASS:	E309/309L-16

ACTUAL CHEMICAL ANALYSIS (%)

C	0.028	✓
Mn	1.060	✓
P	0.034	✓
S	0.007	✓
Si	0.534	✓
Cu	0.114	✓
Cr	22.859	✓
Ni	12.983	✓
Mo	0.120	✓

This material has not come in contact with mercury or mercury containing compounds.

Measured FN : 9
 Delong FN : 13
 Schaeffler : 9

TYPICAL MECHANICAL PROPERTIES

Tensile 83,000 psi (575 Mpa)
 Yield 66,000 psi (455 Mpa)
 Elongation 46

Filler Metals Quality Assurance
 Hobart Brothers
 400 Trade Square
 Troy, Ohio 45373

Authorized Signature :

Brian Simpson, Q.A. Technician

Certification and Limited Warranty - Data for the above supplied product are those obtained when welded and tested in accordance with the above specification. All tests for the above classification were satisfied. Other tests and procedures may produce different results. Hobart Brothers produces welding consumables under continuing quality assurance programs audited and approved by the American Bureau of Shipping ("ABS").



W.O.N. 1173 PG
WRS 2-1

HOBART BROTHERS

McKay

CERTIFICATE OF ANALYSIS

CUSTOMER:	EXOCOR % USF HOLLAND BUFFALO	P.O. #:	021769
MARKED FOR:		DATE:	5/21/2013 7:33:39 AM
PACK SLIP/ORDER #:	A7841/00	WORK ORDER:	
LBS SHIPPED:	60		

PRODUCT TYPE:	STERL AP 309/309L 1/8 10 CAN	STOCK NUMBER:	S483944-033
LOT NO:	24R048 ✓	HEAT NO:	744973 ✓
SPECIFICATION:	AWR A5.4, ASME SFA 5.4 ✓	CLASS:	E309/309L-16 ✓

ACTUAL CHEMICAL ANALYSIS (%)

C	0.032 ✓
Mn	1.068 ✓
P	0.020 ✓
S	0.008 ✓
Si	0.574 ✓
Cu	0.070 ✓
Cr	22.722 ✓
Ni	12.735 ✓
Mo	0.147 ✓

This material has not come in contact with mercury or mercury containing compounds.

Measured FN :	10
DeLong FN :	13
Schaeffler :	9

TYPICAL MECHANICAL PROPERTIES

Tensile 83,000 psi (575 Mpa)
Yield 66,000 psi (455 Mpa)
Elongation 46

Filler Metals Quality Assurance
Hobart Brothers
400 Trade Square
Troy, Ohio 45373

Authorized Signature :

Tim Wagner, Q.A. Technician

Certification and Limited Warranty - Data for the above supplied product are those obtained when welded and tested in accordance with the above specification. All tests for the above classification were satisfied. Other tests and procedures may produce different results. Hobart Brothers produces welding consumables under continuing quality assurance programs audited and approved by the American Bureau of Shipping ("ABS").



HOBART BROTHERS



W.O.N' 1173 P^Q
WPS 2-1

McKay

CERTIFICATE OF ANALYSIS

CUSTOMER:	CPG	P.O #:	59751
MARKED FOR:		DATE:	7/24/2012 8:42:12 AM
PACK SLIP/ORDER #:	44941/01	WORK ORDER:	
LBS SHIPPED:	180		
PRODUCT TYPE:	STERL AP 309/309L 5/32 10 CAN	STOCK NUMBER:	S483951-033
LOT NO:	26P006	HEAT NO:	740749
SPECIFICATION:	AWS A5.4, ASME SFA 5.4	CLASS:	E309/309L-16

ACTUAL CHEMICAL ANALYSIS (%)

C	0.028
Mn	1.102
P	0.021
S	0.005
Si	0.647
Cu	0.048
Cr	22.454
Ni	12.309
Mo	0.070

This material has not come in contact with mercury or mercury containing compounds.

Measured FN : 9
Delong FN : 14
Schaeffler : 10

TYPICAL MECHANICAL PROPERTIES

Tensile 83,000 psi (575 Mpa)
Yield 66,000 psi (455 Mpa)
Elongation 46

Filler Metals Quality Assurance
Hobart Brothers
100 Trade Square
Troy, Ohio 45373

Authorized Signature :

Brian Simpson, Q.A. Technician

Certification and Limited Warranty - Data for the above supplied product are those obtained when welded and tested in accordance with the above specification. All tests for the above classification were satisfied. Other tests and procedures may produce different results. Hobart Brothers produces welding consumables under continuing quality assurance programs audited and approved by the American Bureau of Shipping ("ABS").



WPS 29-2
W.O.W' 1176 P&Q

STOCK CODE		DIAMETER	HEAT / LOT #	SPECIFICATION	TYPE
S2116		1.6mm / 1/16"	SF22334	AWS A5.18 ASME SFA 5.18	ER70S-2
					KOREA
CHEMICAL COMPOSITION OF THE WELDING WIRE					
ELEMENT	SPECIFICATIONS	HEAT ANALYSIS (%)			
Al	0.050 - 0.150	0.079			
C	<0.070	0.040			
Cr	<0.150	0.020			
Cu	<0.500	0.150			
Mn	0.900 - 1.400	1.120			
Mo	<0.150	<0.010			
Nb	-	<0.005			
Ni	<0.150	<0.010			
P	<0.025	0.010			
S	<0.035	0.005			
Si	0.400 - 0.700	0.530			
Ti	0.050 - 0.150	0.066			
V	<0.030	<0.005			
Zr	0.020 - 0.120	0.050			
YIELD POINT N/mm2	TENSILE STRENGTH N/mm2	ELONGATION% L ₀ = 50mm	IMPACT STRENGTH ISO-V		
586.1	643.7	26.2	185.1		
<p>THIS TEST REPORT REPRESENTS THE ACTUAL ATTRIBUTES OF THE MATERIAL FURNISHED AND THE TEST RESULTS ARE IN FULL COMPLIANCE WITH ALL APPLICABLE SPECIFICATIONS AND ORDER REQUIREMENTS.</p>					

TECHNIWELD CORPORATION	TECHNIWELD CORPORATION	POWERWELD INC.	POWERWELD INC.
2300 WINSTON PARK DRIVE	9637A 45TH AVENUE	2501 BELCH STREET	602 AVENUE K
OAKVILLE, ONT. L6H 7H7	EDMONTON, ALB. T6E 5Z8	VALPARAISO, IN. 46383	GRAND PRAIRIE, IN. 475050
An employee owned company serving the welding industry worldwide			

Air Liquide Canada Inc.
1250 René-Lévesque Blvd West, Suite 1700
Montreal, Quebec H3B 5E5

Product: *Blueshield ER70S-2*
Item #: BLU-46307208 (3.2mm - 1/8")
Lot #: SF26197

Standard/Classification: AWS/ASME A5.18-2006 / ER70S-2

Test Date: 03-May-2013

WPS 29-Z
C.O. 1176 PQ

This is to certify that the specified lot of the above product has been tested in accordance with the requirements of specific classification of the applicable standard(s) or tested in compliance of customer specific requirements.

<u>CHEMICAL ANALYSIS (%)</u>		Aluminum	Carbon	Chromium	Copper	Manganese	Molybdenum	Nickel	Phosphorus	Silicon	Sulphur	Titanium	Vanadium	Zirconium	Ni + Cr + Mo + V
Wire		0.077	0.04	0.02	0.1	1.11	<0.01	0.01	0.012	0.53	0.005	0.067	<0.005	0.048	0.045
AWS ER70S-2		0.05 - 0.15	<0.07	NR	<0.5	0.9 - 1.4	NR	NR	<0.025	0.4 - 0.7	<0.035	0.05 - 0.15	NR	0.02 - 0.12	<0.5

Radiographic Test

Met requirements

MECHANICAL PROPERTIES

WELDING PARAMETERS

Diameter used for testing mm (in): 3.2 (1/8)

TEST RESULTS

Tensile Strength MPa (ksi): 480 (69.6)
Yield Strength MPa (ksi): 400 (58.0)
Elongation (%): 22.0
Charpy V-notch Impact Energy J (ft-lb): -
Charpy Temperature °C (°F): -

Lot-tested Results

AWS ER70S-2 Requirements

>480 (69.6)
>400 (58.0)
>22.0
>27.0 (19.9)
-30.0 (-22.0)

The undersigned certifies that the product supplied meets the specified requirements

Signed by: *[Signature]*
Jim Murphy, Specialist, Product Management

(2)
+
(4)

SMK
52-2

BLUESHIELD™
Covered electrodes
Électrodes enrobées

LA 7018

BLU-32971708
LOT #: 007929K2

3.2mm X 350mm 20 kg (4X 5.0 kg)
1/8" X 14" 44 lb (4X 11 lb)

AWS A5.1/ASME SA5.1 E7018-J-H4
(gr. F No. 4, an. A No. 1)

CWB to CSA W48 E4918-1-H4
Lloyd's 3YH5/ABS 3YH5/DNV 3YH5

Made in / Fabriqué au Canada



0038

BLUESHIELD™
Covered electrodes
Électrodes enrobées

LA 7018

BLU-32971710
LOT #: 038025A3

3.0mm X 350mm 20 kg (4X 5.0 kg)
5/32" X 14" 44 lb (4X 11 lb)

AWSA51/ASME SEAS I E7018-1-H1
(gr. F No. 4, an. A No. 1)

Made in / Fabriqué en Canada

CWB to CSA W48 E4918-1-H1
Duyda 3YH5 ABS 3YH5 DNV 3YH5



AIR LIQUIDE

BLUESHIELD™

Covered electrodes

Électrodes enrobées

BLU-32971712

LOT# : 030515A3

Made in / Fabriqué au Canada



LA 7018

5.0mm X 450mm 20 kg (4X 5.0 kg)

3/16" X 18" 44 lb (4X 11 lb)

AWS A5.1 DASHIE SPAS1 E7018-1-TH

(gr. F No. 4 an. A No.1)

CWB to CSA W/B E7018-1-H4

Lloyd's 3YHS/ ABS 3YHS/ DNV 3YHS

022



AIR LIQUIDE

Air Liquide Canada Inc.
 1250 René-Lévesque Blvd West, Suite 1700
 Montreal, Quebec H3B 5E5

Lot Number :007929K2

Product: Blueshield LA 7018
Item #: BLU-32971708 (3.2mm - 1/8")

Standard/Classification: CSA W48-06 / E4918-1-H4
AWS 5.1-2004/ASME SFA A5.1 / E7018-1-H4

Test Date: 01-Nov-2010

The above named product is of the same classification as the filler metal used for testing. The typical chemical analysis and mechanical properties were as follows:

<u>CHEMICAL ANALYSIS (%)</u>		Carbon	Chromium	Manganese	Molybdenum	Nickel	Phosphorus	Silicon	Sulphur	Vanadium	Mn + Ni + Cr + Mo + V
Deposit		0.04	0.04	1.11	<0.01	0.01	0.01	0.52	0.01	<0.01	1.16
CSA E4918-1-H4		<0.15	<0.2	<1.6	<0.3	<0.3	<0.035	<0.75	<0.035	<0.08	<1.75
AWS E7018-1-H4		<0.15	<0.2	<1.6	<0.3	<0.3	<0.035	<0.75	<0.035	<0.08	<1.75

Radiographic Test
 Met requirements

Fillet Weld Test
 Met requirements

Diffusible Hydrogen Test (as per AWS A4.3)

RH (%): 21.0 AbsH g/kg (gr/lb): 14.6 (102.2) Temp °C (°F): 20.0
 (68.0) Average (ml/100g): 3.0

MECHANICAL PROPERTIES AS WELDED

WELDING PARAMETERS

Prepared according to : AWS CSA
 Diameter used for testing mm (in): 4.0 (5/32)
 Amperage (A): 180
 Arc Voltage (V): 23.0
 Current Polarity : AC
 Weld Travel Speed cm/min (ipm): 12.8 (5.0)
 No. of passes/layers : 13/6
 Preheat Temp. °C (°F): 105 (221)
 Interpass Temp. °C (°F): 170 (338)
 Base Material : A516 Gr. 70
 Welding Position : Flat

TEST RESULTS

Tensile Strength MPa (ksi): 540 (78.4)
 Yield Strength MPa (ksi): 450 (65.3)
 Elongation (%): 32.0
 Charpy V-notch Impact Energy J (ft-lb): 127.0 (93.7)
 Charpy Temperature °C (°F): -45.0 (-49.0)
 Charpy Lateral Expansion mm (in): 1.5 (0.0604)
 Charpy Shear Fracture (%): 36.7


Typical Results

490-650 (70.0-94.0)
 >400 (58.0)
 >22.0
 >27.0 (20.0)
 -45.0 (-50.0)

AWS E7018-1-H4 Requirements

>490 (70.0)
 >400 (58.0)
 >22.0

The undersigned certifies that the product supplied will meet the requirements of the applicable filler metal standard when tested in accordance with that standard's classification, and that no significant change has been made in the formulation and manufacturing procedures described in the qualification approval.

Signed by:  **Jim Murphy, Specialist, Product Management**

Note: The information showed in the section "Mechanical Properties - Welding Parameters" is the latest test performed to certify this product. Therefore, the diameter chosen for this test gave mechanical and chemical test results which are representative and valid for all the other diameters of the product mentioned above. This certificate complies to the requirements of EN10204 Type 2.2

Air Liquide Canada Inc.

1250 René-Lévesque Blvd West, Suite 1700
Montreal, Quebec H3B 5E5

Lot Number :038025A3

Product: Bluesfield LA 7018

Item #: BLU-32971710 (4.0mm - 5/32")

Standard/Classification: CSA W48-06 / E4918-1-H4

AWS 5.1-2004/ASME SFA A5.1 / E7018-1-H4

Test Date: 01-Nov-2010

The above named product is of the same classification as the filler metal used for testing. The typical chemical analysis and mechanical properties were as follows:

<u>CHEMICAL ANALYSIS (%)</u>		Carbon	Chromium	Manganese	Molybdenum	Nickel	Phosphorus	Silicon	Sulphur	Vanadium	Mn + Ni + Cr + Mo + V
Deposit		0.04	0.04	1.11	<0.01	0.01	0.01	0.52	0.01	<0.01	1.16
CSA E4918-1-H4		<0.15	<0.2	<1.6	<0.3	<0.3	<0.035	<0.75	<0.035	<0.08	<1.75
AWS E7018-1-H4		<0.15	<0.2	<1.6	<0.3	<0.3	<0.035	<0.75	<0.035	<0.08	<1.75

Radiographic Test

Met requirements

Fillet Weld Test

Met requirements

Diffusible Hydrogen Test (as per AWS A4.3)

RH (%): 21.0 AbsH g/kg (gr/lb): 14.6 (102.2) Temp °C (°F): 20.0
(68.0) Average (ml/100g): 3.0

MECHANICAL PROPERTIES

AS WELDED

WELDING PARAMETERS

Prepared according to : AWS CSA

Diameter used for testing mm (in): 4.0 (5/32)

Amperage (A): 180

Arc Voltage (V): 23.0

Current Polarity : AC

Weld Travel Speed cm/min (ipm): 12.8 (5.0)

No. of passes/layers : 13/6

Preheat Temp. °C (°F): 105 (221)

Interpass Temp. °C (°F): 170 (338)

Base Material : A516 Gr. 70

Welding Position : Flat

TEST RESULTS

Tensile Strength MPa (ksi):

Yield Strength MPa (ksi):

Elongation (%):

Charpy V-notch Impact Energy J (ft-lb):

Charpy Temperature °C (°F):

Charpy Lateral Expansion mm (in):

Charpy Shear Fracture (%):

Typical Results

540 (78.4)

450 (65.3)

32.0

127.0 (93.7)

-45.0 (-49.0)

1.5 (0.0604)

36.7

CSA E4918-1-H4 Requirements

490-650 (70.0-94.0)

>400 (58.0)

>22.0

>27.0 (20.0)

-45.0 (-50.0)

AWS E7018-1-H4 Requirements

>490 (70.0)

>400 (58.0)

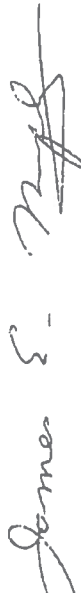
>22.0

>27.0 (20.0)

-45.0 (-50.0)

The undersigned certifies that the product supplied will meet the requirements of the applicable filler metal standard when tested in accordance with that standard's classification, and that no significant change has been made in the formulation and manufacturing procedures described in the qualification approval.

Signed by:



Jim Murphy, Specialist, Product Management

Note: The information shown in the section "Mechanical Properties - Welding Parameters" is the latest test performed to certify this product. Therefore, the diameter chosen for this test gave mechanical and chemical test results which are representative and valid for all the other diameters of the product mentioned above. This certificate complies to the requirements of EN10204 Type 2.2.

Air Liquide Canada Inc.

1250 René-Lévesque Blvd West, Suite 1700
Montreal, Quebec H3B 5E5

Lot Number :030515A3

Product: Blueshield LA 7018

Item #: BLU-32971712 (5.0mm - 3/16")

Standard/Classification: CSA W48-06 / E4918-1-H4

AWS 5.1-2004/ASME SFA A5.1 / E7018-1-H4

Test Date: 01-Nov-2010

The above named product is of the same classification as the filler metal used for testing. The typical chemical analysis and mechanical properties were as follows:

<u>CHEMICAL ANALYSIS (%)</u>		Carbon	Chromium	Manganese	Molybdenum	Nickel	Phosphorus	Silicon	Sulphur	Vanadium	Mn + Ni + Cr + Mo + V
Deposit		0.04	0.04	1.11	<0.01	0.01	0.01	0.52	0.01	<0.01	1.16
CSA E4918-1-H4		<0.15	<0.2	<1.6	<0.3	<0.3	<0.035	<0.75	<0.035	<0.08	<1.75
AWS E7018-1-H4		<0.15	<0.2	<1.6	<0.3	<0.3	<0.035	<0.75	<0.035	<0.08	<1.75

Radiographic Test

Met requirements

Fillet Weld Test

Met requirements

Diffusible Hydrogen Test (as per AWS A4.3)

RH (%): 21.0 AbsH g/kg (gr/lb): 14.6 (102.2) Temp °C (°F): 20.0
(68.0) Average (ml/100g): 3.0

MECHANICAL PROPERTIES

AS WELDED

WELDING PARAMETERS

Prepared according to : AWS CSA

Diameter used for testing mm (in): 4.0 (5/32)

Amperage (A): 180

Arc Voltage (V): 23.0

Current Polarity : AC

Weld Travel Speed cm/min (ipm): 12.8 (5.0)

No. of passes/layers : 13/6

Preheat Temp. °C (°F): 105 (221)

Interpass Temp. °C (°F): 170 (338)

Base Material : A516 Gr. 70

Welding Position : Flat

TEST RESULTS

Tensile Strength MPa (ksi): 540 (78.4)

Yield Strength MPa (ksi): 450 (65.3)

Elongation (%): 32.0

Charpy V-notch Impact Energy J (ft-lb): 127.0 (93.7)

Charpy Temperature °C (°F): -45.0 (-49.0)

Charpy Lateral Expansion mm (in): 1.5 (0.0604)

Charpy Shear Fracture (%): 36.7

CSA E4918-1-H4 Requirements

490-650 (70.0-94.0)

>400 (58.0)

>22.0

>27.0 (20.0)

-45.0 (-50.0)

AWS E7018-1-H4 Requirements

>490 (70.0)

>400 (58.0)

>22.0

>27.0 (20.0)

-45.0 (-50.0)

The undersigned certifies that the product supplied will meet the requirements of the applicable filler metal standard when tested in accordance with that standard's classification, and that no significant change has been made in the formulation and manufacturing procedures described in the qualification approval.

Signed by:



Jim Murphy, Specialist, Product Management

Note: The information showed in the section "Mechanical Properties - Welding Parameters" is the latest test performed to certify this product. Therefore, the diameter chosen for this test gave mechanical and chemical test results which are representative and valid for all the other diameters of the product mentioned above. This certificate complies to the requirements of EN10204 Type 2.2

SAW-3-2

1/8 LINCOLNWELD L-56

60 lb NET COIL

COILED WIRE ELECTRODE
FIL-ELECTRODE ENROULE

3.2 mm 27.22 kg APPROX. EQUIV.

CONF AWS A5 18
ASME SFA 5 18 ER705-9
AWS A5 17 ASME SFA 5 17 EH11K
CERT -C.W.E.
CSA W48 EH11K (B-G 48 A 3 C GR)
EN 756S2 880M EN756542 6 FB 52
0035-CPD-C401 EN 13473 42 183 02



STOCK NO.

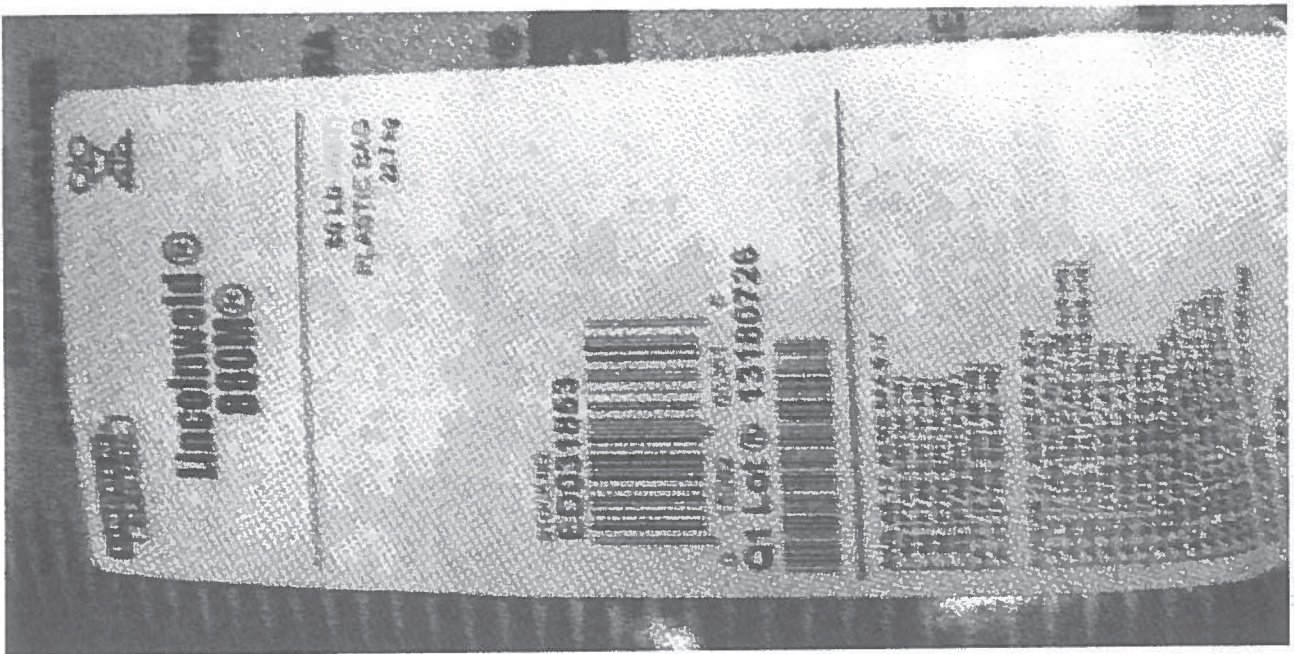
ED500410
01C02AR

Q1 LOT 13208489



MANUFACTURED UNDER A WORLDWIDE QUALITY SYSTEM CERTIFIED TO ISO 9001
FABRIQUE SELON UN SYSTEME DE QUALITE CERTIFIE A ISO 9001
MADE IN CANADA / FABRIQUE AU CANADA TORONTO ON M4G 2G9
L25205-2

LINCOLN ELECTRIC COMPANY OF CANADA LP



SACW-3-2

WPS 3-2
W.O.N 11769

Lincoln Electric Company of Canada LP
178 Wicksteed Ave
Toronto ON M4G 2B9

**Certificate of Conformance to Requirements
For Welding Electrode
(Applies to Canadian Manufactured Product)**



TYPICAL VALUES ONLY

Product: Lincolnweld@ L-56
Classification: EH11K
Specification: CSA W48.06, AWS A5.17-97, A5.23:2007, ASME SFA-5.17, SFA-5.23
Test Completed: May 11, 2011

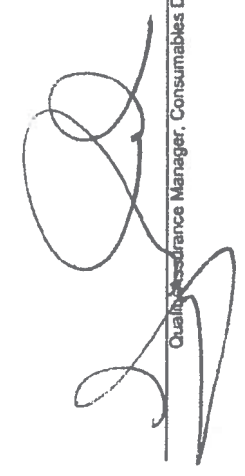
This is to certify that the product named above and supplied on the referenced order number is of the same classification, manufacturing process and material requirements as the material which was used for the test that was concluded on the date shown, the results of which are shown below. All tests required by specifications shown for classification were performed at that time and the material tested met all requirements. It was manufactured and supplied according to the Quality System Program of Lincoln Electric Company of Canada LP, Toronto, Ontario, which meets the requirements of ISO 9001:2008 and other specifications as applicable. The Quality System Program has been approved by ABS Quality Evaluations.

Chemical Composition of the electrode (weight %)

%	CSA / AWS / ASME Requirements	Results
C	0.06 - 0.15	0.09
Mn	1.40 - 1.85	1.59
Si	0.80 - 1.15	0.84
S	0.030 max.	0.01
P	0.030 max.	0.006
Cu (total)	0.35 max.	0.14

Results below the detection limits of the instrument or lower than the precision required by specification are reported as zero.
This certificate complies to the requirements of EN 10204, Type 2.2.
The electrode diameter required to be tested for this classification is 5/32". The other sizes will also meet these requirements.


Technologist - Production Testing and Certification
Date JUNE 24 2011


Quality Assurance Manager, Consumables Division
Date JUNE 24 2011

W.O. N° 1176PQ

W.P.S 3AW-3-2



THE LINCOLN ELECTRIC COMPANY

PRODUCT CERTIFICATE LINCOLNWELD 880M FLUX

The product named above and supplied on the referenced order number is of the same manufacturing process, and material requirements as the material which was used for the tests and calculations, the results of which are shown below. This certificate complies to the requirements of EN 10204, Type 2.2.

- Basicity Index

B.I.* = 3.3

*Calculated using Boniszewski formula shown below

$$B.I. = \frac{0.5 (FeO + MnO) + CaO + MgO + Na_2O + K_2O + CaF_2}{SiO_2 + 0.5 (TiO_2 + ZrO_2 + Al_2O_3)}$$

- Flux Sizing Distribution*

+20 MESH	54%	Maximum
-20 +60 MESH	35%	Minimum
-60 MESH	11%	Maximum

*U.S. sieve number per ASTM E11-04

- Flux Composition (Based on Elemental Values Determined by X-Ray Fluorescence)

Na ₂ O	1%	SiO ₂	12%	MnO	1%
MgO	29%	CaO	8%	K ₂ O	1%
Al ₂ O ₃	18%	CaF ₂	29%		

- Density (g/cm³): 1.2

- Flux Classification: EN 760 – S A FB 1

 February 19, 2008
Phillip J. Woodring, Certification Supervisor, Date



Technical Standards and Safety Authority

1000 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Identification Card
Boilers and Pressure Vessels Regulation

No. 257503

Welder's Personal Information:
 Surname: GREER Initial: ROBIN
 Res. Address: 835 MOUNTAIN ASH RD, PETERBOROUGH, ONT., K9J 1B K2
 Employer Name: ALL-WELD COMPANY LIMITED
 Street Address: 49 PASSMORE AVE., SCARBOROUGH, ONTARIO
 Postal Code: M1V 1A1
 Stamp No: 9
 Provincial Registration No: J745.5
 Company PQR No: 20
 Company WPS No used: 20-1
 Welding Process(es) Used: GTAW
 Type(s): manual machine semi-automatic automatic
 Base Material(s): SA 106-B / SA 106-B Thickness(es): 0.218"

Variables for All Processes	Actual Values	Range Qualified
Backing material (metal, weld metal, welded from both sides, flux, etc.)	WITHOUT	WITH OR WITHOUT
ASME P or S No. to ASME P or S No.	PI to PI	PI THRU P15P, P34 & P4X PL. & PIPE 1" O.D. & UP
() Plate (X) Pipe (enter diameter if pipe)	2 3/8" O.D.	
Filler Metal Specification (SFA) Class (QW-404) (Informational Only)	(S.J.B.) ER-70S-3	
Consumable Insert for GTAW or PAW (QW-404)	--	
Welding Position (1G, 5G, etc.) (QW-405)	6G	6G
Manual or Semi-automatic Variables (QW-350)	Actual Values	Range Qualified
Filler Metal F-No. (QW-404)	F6	F6
Filler Metal Product Form for GTAW, PAW (QW-404)	--	--
Weld deposit thickness for each welding process (QW-404)	0.218"	1/16" TO 0.436" MAX.
Process 1: 3 layers minimum <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	3	--
Process 2: 3 layers minimum <input type="checkbox"/> Yes <input type="checkbox"/> No	--	--
Progression (uphill/downhill) (QW-405)	UPHILL	UPHILL
GTAW, PAW or GMAW backing gas, or OFW fuel gas (QW-408)	ARGON 99.9%	ARGON 99.9%
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)	--	--
GTAW welding current type & polarity (AC, DCEP, DCEN) (QW-409)	DC/SP	DC/SP
Machine Welding Variables (QW-361-2)	Actual Values	Range Qualified
Direct or remote visual control	--	--
Automatic arc voltage control (GTAW)	--	--
Automatic joint tracking	--	--
Multiple or single pass per side	--	--
Automatic Welding Variables (QW-361-1)	Actual Values	Range Qualified
Filler metal (EBW or LBW)	--	--
Laser type for LBW (CO2 to YAG etc.)	--	--
Continuous drive or inertia welding (FW)	--	--
Vacuum or out of vacuum (EBW)	--	--

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) **ACCEPTED**
 Bend test: Transverse root and face [QW-462.3(a)]; Longitudinal root and face [QW-462.3(b)]; Side [QW-462.2];
 Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];
 Macro test for fusion [QW-462.5(b)]; Macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result
ROOT	ACCEPTED	FACE	ACCEPTED		
ROOT	ACCEPTED	FACE	ACCEPTED		

Alternative radiographic examination results (QW-191) --
 Fillet weld -- fracture test (QW-180) -- Length and percent of defects --
 Macro examination (QW-184) -- Fillet size (in.) -- x -- Concavity/convexity (in.) --
 Other tests --

Film or specimens evaluated by -- Company --
 Mechanical tests conducted by ALL-WELD COMPANY LIMITED Laboratory test no. --
 Welding supervised by ANDREW LEWIS
 Test requested by (Print name) ROBERT C. BENTLEY Tested at (Print address) 49 PASSMORE AVE, SCARB, ON

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.
 Organization ALL-WELD COMPANY LIMITED Signature R. Bentley Date JULY 12, 2011 (mm-dd-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's Technical Standards and Safety Act, Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✓) applicable box below:

- To weld for the Employer named above only.
- For seeking employment only.

This Certificate expires: PCE ASME IX (mm-dd-yyyy)

INSPECTOR NAME AND NUMBER (Print) ADHIR SOMI ONT0192

Inspector Signature



Technical Standards and Safety Authority

14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Certificate

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 262456

Welder's Last Name: VALENCIA Initial: First Name: CESAR Signature: [Signature] Stamp No: 44
 Res. Address: 25 RUBEN STREET, WHITBY, ONTARIO Postal Code: L1R0A7 Provincial Registration No.: WP-R7542.5
 Employer Name: ALL - WELD COMPANY LIMITED Company PQR No.: 52-2A
 Street Address: 49 PASSMORE AVE Company WPS No. used: 52-2
 SCARBOROUGH, ONT Postal Code: M1V4T1
 Welding Process(es) Used: SMAW Type(s): manual machine semi-automatic automatic

Base Material(s): SA-516-GR70N TO SA-516-GR70N Thickness(es) 1" Test Coupon Production Weld

Variables for All Processes Actual Values Range Qualified

Backing material (with/without): WITH WITH
 Base Metal P-Number to P-Number: P1 to P1 P1 THRU P15F, P34 & P4X PLATE AND PIPE 2 7/8" OD AND UP
 (X) Plate () Pipe (enter diameter if pipe): 1"
 Filler Metal Specification (SFA) Class (QW-404) (Informational Only): (5.1) E7018-1H4
 Consumable Insert for GTAW or PAW (QW-404): NONE
 Welding Position (1G, 5G, etc.) (QW-405): 2G 1G & 2G

Manual or Semi-automatic Variables (QW-386) Actual Values Range Qualified

Filler Metal F- No. (QW-404): F4 F4
 Filler Metal Product Form for GTAW, PAW (QW-404): NONE NONE
 Weld deposit thickness for each welding process (QW-404): 1" MAX TO BE WELDED (PLATE GROOVE + PIPE 2 7/8" OD + UP + ALL FILLETS)
 Process 1: SMAW 3 layers minimum Yes No
 Process 2: 3 layers minimum Yes No
 Vertical progression (uphill/downhill) (QW-405): NONE NONE
 GTAW, PAW or GMAW backing gas; or OFW fuel gas (QW-406): NONE NONE
 GMAW transfer mode (spray/globular or pulse to short circuit) (QW-406): NONE NONE
 GTAW welding current type & polarity (AC, DCEP, DCEN) (QW-406): NONE NONE

Machine Welding Variables (QW-381.2) Actual Values Range Qualified

Direct or remote visual control: NONE NONE
 Automatic arc voltage control (GTAW): NONE NONE
 Automatic joint tracking: NONE NONE
 Multiple or single pass per side: NONE NONE

Automatic Welding Variables (QW-381.1) Actual Values Range Qualified

Filler Metal (EBW or LBW): NONE NONE
 Laser type for LBW (CO2 to YAG etc.): NONE NONE
 Continuous drive or inertia welding (FW): NONE NONE
 Vacuum or out of vacuum (EBW): NONE NONE

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) ACCEPTED
 Transverse root and face (QW-462.3(a)); Longitudinal root and face (QW-462.3(b)); Side (QW-462.2);
 Pipe bend specimen, corrosion-resistant overlay (QW-462.5(c)); Plate bend specimen, corrosion-resistant overlay (QW-462.5(d));
 Pipe specimen, macro test for fusion (QW-462.5(b)); Plate specimen, macro test for fusion (QW-462.5(e))

Type	Result	Type	Result	Type	Result	Type	Result
QW-462.2 (SIDE)	ACCEPTED	QW-462.2 (SIDE)	ACCEPTED				

Alternative radiographic examination results (QW-191) NONE
 Fillet weld - fracture test (QW-181.2) NONE Length and percent of defects N/A

Fillet welds in plate (QW-462.4(b)) Fillet welds in pipe (QW-462.4(c))
 Macro examination (QW-184) NONE Fillet size (in.) NONE x NONE Concavity/convexity (in.) NONE

Other tests NONE

Film or specimens evaluated by NONE Company NONE

Mechanical tests conducted by ALL - WELD COMPANY LIMITED Laboratory test no. NONE

Welding supervised by (Print name) ANDREW LEWIS

Test requested by (Print name) ROBERT BENTLEY Tested at (Print address) 49 PASSMORE AVE, SCARBOROUGH, ONT

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

Organization ALL - WELD COMPANY LIMITED Signature [Signature] Date 03-28-2013 (mm-dd-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's Technical Standards and Safety Act, Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✓) applicable box below:

- To weld for the Employer named above only.
- For seeking employment only.

This Certificate expires: PER ASME SECTION IX (mm-dd-yyyy)

Inspector Name and Number (Print) COSTICA ROSU ONF915

Inspector Signature and Date [Signature] MAR 28, 13



Technical Standards and Safety Authority

14th Floor - Centre Tower
3500 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Certificate

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 262459

Welder's Last Name: MIRZA Initial: HAFEEZ (ABDUL) First Name: HAFEEZ (ABDUL) Signature: [Signature] Stamp No.: 53

Res. Address: 2050 BRIDLETOWN CRICLE, #607, SCARBOROUGH ONTARIO Postal Code: M1W 2V5 Provincial Registration No.: 14628.5

Employer Name: ALL - WELD COMPANY LIMITED Company PQR No.: 3-3X
Street Address: 19 PASSMORE AVE Company WPS No. used: 3-3B
SCARBOROUGH, ONT Postal Code: M1V 4T1

Welding Process(es) Used: SMAW Type(s): manual machine semi-automatic automatic

Base Material(s): SA-240-316 TO SA-240-316 Thickness(es): 1 3/4" Test Coupon Production Weld

Variables for All Processes

Actual Values	Range Qualified
Backing material (with/without): WITH	WITH
Base Metal P-Number to P-Number: 8 to 8	P1 THRU P15F, P34 & P4X PLATE AND PIPE 2 7/8" OD AND UP
(X) Plate () Pipe (enter diameter if pipe): 1 3/4"	
Filler Metal Specification (SFA) Class (QW-404) (Informational Only): (5.4) E316-18	
Consumable insert for GTAW or PAW (QW-404): NONE	
Welding Position (1G, 5G, etc.) (QW-405): 2G	2G

Manual or Semi-automatic Variables (QW-360)

Actual Values	Range Qualified
Filler Metal F- No. (QW-404): F5	F5
Filler Metal Product Form for GTAW, PAW (QW-404): NONE	
Weld deposit thickness for each welding process (QW-404): 1 3/4"	MAX TO BE WELDED
Process 1: SMAW 3 layers minimum <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	PLATE GROOVE + PIPE 2 7/8" OD + UP + ALL FILLETS
Process 2: 3 layers minimum <input type="checkbox"/> Yes <input type="checkbox"/> No	
Vertical progression (uphill/downhill) (QW-405): NONE	
GTAW, PAW or GMAW backing gas; or OFW fuel gas (QW-406): NONE	
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409): NONE	
GTAW welding current type & polarity (AC, DCEP, DCEN)(QW-409): NONE	

Machine Welding Variables (QW-361.2)

Actual Values	Range Qualified
Direct or remote visual control: NONE	
Automatic arc voltage control (GTAW): NONE	
Automatic joint tracking: NONE	
Multiple or single pass per side: NONE	

Automatic Welding Variables (QW-361.1)

Actual Values	Range Qualified
Filler Metal (EBW or LBW): NONE	
Laser type for LBW (CO2 to YAG etc.): NONE	
Continuous drive or inertial welding (FW): NONE	
Vacuum or out of vacuum (EBW): NONE	

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) ACCEPTED

- Transverse root and face (QW-462.3(a)); Longitudinal root and face (QW-462.3(b)); Side (QW-462.2);
 Pipe bend specimen, corrosion-resistant overlay (QW-462.5(c)); Plate bend specimen, corrosion-resistant overlay (QW-462.5(d));
 Pipe specimen, macro test for fusion (QW-462.5(b)); Plate specimen, macro test for fusion (QW-462.5(e))

Type	Result	Type	Result	Type	Result	Type	Result
QW-462.2 (SIDE)	ACCEPTED	QW-462.2 (SIDE)	ACCEPTED				

Alternative radiographic examination results (QW-181) NONE

Fillet weld - fracture test (QW-181.2) NONE Length and percent of defects NONE

- Fillet welds in plate (QW-462.4(b)) Fillet welds in pipe (QW-462.4(c))

Macro examination (QW-184) NONE Fillet size (In.) NONE x NONE Concavity/convexity (In.) NONE

Other tests NONE

Film or specimens evaluated by NONE Company NONE

Mechanical tests conducted by ALL - WELD COMPANY LIMITED Laboratory test no. NONE

Welding supervised by (Print name) ANDREW LEWIS

Test requested by (Print name) ROBERT BENTLEY Tested at (Print address) 49 PASSMORE AVE, SCARBOROUGH, ONT

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

Organization ALL - WELD COMPANY LIMITED Signature [Signature] Date 03-28-2013
(mm-dd-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's *Technical Standards and Safety Act*, Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✓) applicable box below:

- To weld for the Employer named above only.
 For seeking employment only.

This Certificate expires: PER ASME SECTION IX
(mm-dd-yyyy)

ROSICA ROSU 007915
Inspector Name and Number (Print)

[Signature] 14 APR 28, 2013
Inspector Signature and Date



Technical Standards and Safety Authority

14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

FOR PROCEDURE QUALIFICATION

Welder/Welding Operator Certificate

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 262931

Welder's Last Name: MIRZA Initial: HAFEEZ First Name: HAFEEZ Signature: [Signature] Stamp No: 53

Res Address: 2050 BRIDLETOWN CIRCLE # 607, ONTARIO Postal Code: M1W 2V5 Provincial Registration No: WP-74660-J

Employer Name: ALL - WELD COMPANY LIMITED Company PQR No: 29X

Street Address: 49 PASSMORE AVE Postal Code: M1V 4T1 Company WPS No used: 29-2

Welding Process(es) Used: GTAW Type(s): manual machine semi-automatic automatic

Base Material(s): SA-333-GR6 TO A-350-LF2 Thickness(es): 0.300 " Test Coupon Production Weld

Variables for All Processes	Actual Values	Range Qualified
Backing material (with/without)	WITHOUT	WITH OR WITHOUT
Base Metal P-Number to P-Number	1 GR 1 to 1 GR2	P1 THRU P15F, P34, & P4X PLATE AND PIPE 1/2" OD AND UP
() Plate (X) Pipe (enter diameter if pipe)	3" 0.300"	
Filler Metal Specification (SFA) Class (QW-404) (Informational Only)	5.18 ER70S-2	
Consumable Insert for GTAW or PAW (QW-404)	NONE	
Welding Position (1G, 5G, etc.) (QW-405)	6G	6G

Manual or Semi-automatic Variables (QW-350)	Actual Values	Range Qualified
Filler Metal F-No (QW-404)	F6	F6
Filler Metal Product Form for GTAW, PAW (QW-404)	SOLID	SOLID
Weld deposit thickness for each welding process (QW-404)	0.300"	0.600" MAX PLATE GROOVE + PIPE 2 7/8" OD + UP
Process 1: GTAW 3 layers minimum <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	3	+ ALL FILLETS
Process 2: 3 layers minimum <input type="checkbox"/> Yes <input type="checkbox"/> No	NONE	NONE
Vertical progression (uphill/downhill) (QW-405)	UPHILL	NONE
GTAW, PAW or GMAW backing gas, or OFW fuel gas (QW-408)	ARGON 99.9%	ARGON 99.9%
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)	NONE	NONE
GTAW welding current type & polarity (AC, DCEP, DCEN) (QW-409)	DC / SP	DC / SP

Machine Welding Variables (QW-361.2)	Actual Values	Range Qualified
Direct or remote visual control	NONE	
Automatic arc voltage control (GTAW)	NONE	
Automatic joint tracking	NONE	
Multiple or single pass per side	NONE	

Automatic Welding Variables (QW-361.1)	Actual Values	Range Qualified
Filler Metal (EBW or LBW)	NONE	
Laser type for LBW (CO2 to YAG etc.)	NONE	
Continuous drive or inertia welding (FW)	NONE	
Vacuum or out of vacuum (EBW)	NONE	

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) ACCEPTED

Transverse root and face [QW-462.3(a)]; Longitudinal root and face [QW-462.3(b)]; Side [QW-462.2];

Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];

Pipe specimen, macro test for fusion [QW-462.5(b)]; Plate specimen, macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result	Type	Result
QW-462.3 (a)	ACCEPTED	QW-462.3 (a)	ACCEPTED	QW-462.3 (a)	ACCEPTED	QW-462.3 (a)	ACCEPTED
(Face)		(ROOT)		(Face)		(ROOT)	

Alternative radiographic examination results (QW-191) NONE

Fillet weld — fracture test (QW-181.2) NONE Length and percent of defects NONE

Fillet welds in plate [QW-462.4(b)] Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) NONE Fillet size (in.) NONE x NONE Concavity/convexity (in.) NONE

Other tests NONE

Film or specimens evaluated by NONE Company NONE

Mechanical tests conducted by CAMBRIDGE MATERIAL TESTING Laboratory test no. 638497

Welding supervised by (Print name) ANDREW LEWIS

Test requested by (Print name) ROBERT BENTLEY Tested at (Print address) 49 PASSMORE AVE, SCARBOROUGH, ONT

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

Organization ALL - WELD COMPANY LIMITED Signature [Signature] Date 15-04-2013 (mm-dd-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's Technical Standards and Safety Act, Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate

Check (✓) applicable box below:

- To weld for the Employer named above only.
- For seeking employment only.

This Certificate expires: PER ASME SECTION IX (mm-dd-yyyy)

LOSTICA ROSU ONT 915

Inspector Name and Number (Print)

Inspector Signature and Date



Technical Standards and Safety Authority

14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Certificate

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 262457

Welder's Last Name: MIRZA Initial: HAFEZ(ABDUL) First Name: HAFEZ(ABDUL) Signature: [Signature] Stamp No.: 53

Res. Address: 2050 BRIDLETOWNE CIRCLE, #607, SCARBOROUGH, ONTARIO Postal Code: M1W 2V5 Provincial Registration No.: WP-R75425

Employer Name: ALL - WELD COMPANY LIMITED Company PQR No.: 52-2A
Street Address: 19 PASSMORE AVE Company WPS No. used: 52-2

Welding Process(es) Used: SMAW Type(s): manual machine semi-automatic automatic

Base Material(s): SA-516-GR70N TO SA-516-GR70N Thickness(es) t": Test Coupon Production Weld

Variables for All Processes	Actual Values	Range Qualified
Backing material (with/without)	WITH	WITH
Base Metal P-Number to P-Number	P1 to P1	P1 THRU P15F, P34 & P4X PLATE AND PIPE 2 7/8" OD AND UP
(X) Plate () Pipe (enter diameter if pipe)	1"	
Filler Metal Specification (SFA) Class (QW-404) (Informational Only)	(5.1) E7018-1H4	
Consumable Insert for GTAW or PAW (QW-404)	NONE	
Welding Position (1G, 5G, etc.) (QW-405)	2G	1G & 2G
Manual or Semi-automatic Variables (QW-350)	Actual Values	Range Qualified
Filler Metal F- No. (QW-404)	F4	F4
Filler Metal Product Form for GTAW, PAW (QW-404)	NONE	NONE
Weld deposit thickness for each welding process (QW-404)	1"	MAX TO BE WELDED (PLATE GROOVE + PIPE 2 7/8" OD + UP + ALL FILLETS)
Process 1: SMAW 3 layers minimum <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	-	
Process 2: 3 layers minimum <input type="checkbox"/> Yes <input type="checkbox"/> No	NONE	NONE
Vertical progression (uphill/downhill) (QW-405)	NONE	NONE
GTAW, PAW or GMAW backing gas; or OFW fuel gas (QW-406)	NONE	NONE
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)	NONE	NONE
GTAW welding current type & polarity (AC, DCEP, DCEN) (QW-409)	NONE	NONE
Machine Welding Variables (QW-361.2)	Actual Values	Range Qualified
Direct or remote visual control	NONE	NONE
Automatic arc voltage control (GTAW)	NONE	NONE
Automatic joint tracking	NONE	NONE
Multiple or single pass per side	NONE	NONE
Automatic Welding Variables (QW-361.1)	Actual Values	Range Qualified
Filler Metal (EBW or LBW)	NONE	NONE
Laser type for LBW (CO ₂ to YAG etc.)	NONE	NONE
Continuous drive or inertia welding (FW)	NONE	NONE
Vacuum or out of vacuum (EBW)	NONE	NONE

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) ACCEPTED

- Transverse root and face (QW-462.3(a)); Longitudinal root and face (QW-462.3(b)); Side (QW-462.2);
 Pipe bend specimen, corrosion-resistant overlay (QW-462.5(c)); Plate bend specimen, corrosion-resistant overlay (QW-462.5(d));
 Pipe specimen, macro test for fusion (QW-462.5(b)); Plate specimen, macro test for fusion (QW-462.5(e))

Type	Result	Type	Result	Type	Result	Type	Result
QW-462.2	ACCEPTED	QW-462.2	ACCEPTED				
(SIDE)		(SIDE)					

Alternative radiographic examination results (QW-191) NONE

Fillet weld - fracture test (QW-181.2) NONE Length and percent of defects N/A

Fillet welds in plate (QW-462.4(b)) Fillet welds in pipe (QW-462.4(c))
 Macro examination (QW-184) NONE Fillet size (in.) NONE x NONE Concavity/convexity (in.) NONE

Other tests NONE

Film or specimens evaluated by NONE Company NONE

Mechanical tests conducted by ALL - WELD COMPANY LIMITED Laboratory test no. NONE

Welding supervised by (Print name) ANDREW LEWIS

Test requested by (Print name) ROBERT BENTLEY Tested at (Print address) 49 PASSMORE AVE, SCARBOROUGH, ONT

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

Organization ALL - WELD COMPANY LIMITED Signature: [Signature] Date 03-28-2013 (mm-dd-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's Technical Standards and Safety Act, Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✓) applicable box below:

- To weld for the Employer named above only.
 For seeking employment only.

This Certificate expires: PER ASME SECTION IX (mm-dd-yyyy)

COSTICA ROSU CNTSIS
Inspector Name and Number (Print)

[Signature] MKR 28, 2013
Inspector Signature and Date



Technical Standards and Safety Authority

14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Identification Card

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 207593

Welder's Last Name MIRZA	Initial HAFEEZ	First Name (ABDUL)	Signature 	Stamp No. 53
Res. Address 2050 BRIDLETOWN CIRCLE, # 607, SCARB.	Postal Code M1W 2V5	Provincial Registration No. P 162.5		
Employer Name ALL-WELD COMPANY LIMITED	Street Address 49 PASSMORE AVENUE		Company PQR No. SAW-1	
City SCARBOROUGH, ONTARIO		Postal Code M1V 4T1	Company WPS No used SAW-W-1	
Welding Process(es) Used SAW		Type(s)	<input type="checkbox"/> manual <input type="checkbox"/> machine <input type="checkbox"/> semi-automatic <input checked="" type="checkbox"/> automatic	
Base Material(s) SA 516-GR. 70 / SA 516-GR. 70		Thickness(es)	1"	
Variables for All Processes		Actual Values	Range Qualified	
Base material (metal, weld metal, welded from both sides, flux, etc.)		BASE & WELD METAL	BASE & WELD METAL	
ASME P or S No. to ASME P or S No.		P1 to P1	P1 THROUGH P11 & P4X PLATE & PIPE	
(<input checked="" type="checkbox"/>) Plate () Pipe (enter diameter if pipe)		1"	2 7/8" O.D. & UP MAX. TO BE WELDED	
Filler Metal Specification (SFA) Class (QW-404) (Informational Only)		5.17 EM12K		
Consumable Insert for GTAW or PAW (QW-404)		--		
Welding Position (1G, 5G, etc.) (QW-405)		1G	ALL FILLETS (FLAT ONLY)	
Manual or Semi-automatic Variables (QW-350)		Actual Values	Range Qualified	
Filler Metal F- No. (QW-404)		F6	F6	
Filler Metal Product Form for GTAW, PAW (QW-404)		--		
Weld deposit thickness for each welding process (QW-404)		1"	MAX. TO BE WELDED	
Process 1: _____ 3 layers minimum <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		12		
Process 2: _____ 3 layers minimum <input type="checkbox"/> Yes <input type="checkbox"/> No		--		
Progression (uphill/downhill) (QW-405)		--		
GTAW, PAW or GMAW backing gas, or OFW fuel gas (QW-408)		--		
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)		--		
GTAW welding current type & polarity (AC, DCEP, DCEN)(QW-409)		--		
Machine Welding Variables (QW-381-2)		Actual Values	Range Qualified	
Direct or remote visual control		--		
Automatic arc voltage control (GTAW)		--		
Automatic joint tracking		--		
Multiple or single pass per side		--		
Automatic Welding Variables (QW-381-1)		Actual Values	Range Qualified	
Filler metal (EBW or LBW)		--		
Laser type for LBW (CO ₂ to YAG etc.)		--		
Continuous drive or inertia welding (FW)		--		
Vacuum or out of vacuum (EBW)		--		

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) ACCEPTED

Bend test; Transverse root and face [QW-462.3(a)]; Longitudinal root and face [QW-462.3(b)]; Side [QW-462.2];
 Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];
 Macro test for fusion [QW-462.5(b)]; Macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result

Alternative radiographic examination results (QW-191) ACCEPTED

Fillet weld - fracture test (QW-180) -- Length and percent of defects --

Macro examination (QW-184) -- Fillet size (in.) -- x -- Concavity/convexity (in.) --

Other tests --

Film or specimens evaluated by SCOTT PETERS Company KV INSPECTION SERVICE

Mechanical tests conducted by -- Laboratory test no. --

Welding supervised by ANDREW LEWIS

Test requested by (Print name) ROBERT C. BENTLEY Tested at (Print address) 49 PASSMORE AVE., SCARBOROUGH, ONTARIO

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

Organization ALL-WELD COMPANY LIMITED Signature Date JUNE 24, 2008
(mm-dd-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's *Technical Standards and Safety Act*, Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✓) applicable box below:

- To weld for the Employer named above only.
 For seeking employment only.

This Certificate expires: PER ASME IX
(mm-dd-yyyy)

DOUHIR SONI ONT00952
Inspector Name and Number (Print)

Inspector Signature

Welder's Last Name: **YANG** Initial: **FAN** First Name: **FAN** Signature: *Fan yang* Stamp No: **83**

Res. Address: **39 - 1050 BRISTOL ROAD W. MISSISSAUGA, ONT.** Postal Code: **M1V 4E1** Provincial Registration No: **R2060.5**
D700.5 & R2363.5

Company Name: **ALL-WELD COMPANY LIMITED** Company PQR No: **1**

Street Address: **49 PASSMORE AVENUE** Company WPS No used: **1-1**

City: **SCARBOROUGH, ONTARIO**

Welding Process(es) Used: **SMW** Type(s): manual machine semi-automatic automatic

Base Material(s): **SA 516-GR 70 / SA 516-GR 70** Thickness(es): **5/16"**

Variables for All Processes	Actual Values	Range Qualified
Backing material (metal, weld metal, welded from both sides, flux, etc.)	WITHOUT	WITH OR WITHOUT
ASME P or S No. to ASME P or S No.	P1 to P1	P1 THRU P11 & P4X PLATE & ALL
(<input checked="" type="checkbox"/>) Plate () Pipe (enter diameter if pipe)	5/16"	PIPE 2 7/8" O.D. & UP
Filler Metal Specification (SFA) Class (QW-404) (Informational Only)	(5.1) E7018	
Consumable Insert for GTAW or PAW (QW-404)	--	
Welding Position (1G, 5G, etc.) (QW-405)	2 G	2 G

Manual or Semi-automatic Variables (QW-350)	Actual Values	Range Qualified
Filler Metal F-No. (QW-404)	F4	F4
Filler Metal Product Form for GTAW, PAW (QW-404)	--	--
Weld deposit thickness for each welding process (QW-404)	5/16"	5/8" MAX
Progression (uphill/downhill) (QW-405)	--	PLATE GROOVE & PIPE 2 7/8" O.D. & UP & ALL FILLETS
GTAW, PAW or GMAW backing gas, or OFW fuel gas (QW-408)	--	
GMAW transfer mode (QW-409)	--	
GTAW welding current type & polarity (QW-409)	--	

Machine Welding Variables (QW-361-2)	Actual Values	Range Qualified
Direct or remote visual control	--	--
Automatic voltage control (GTAW)	--	--
Automatic joint tracking	--	--
Multiple or single pass per side	--	--

Automatic Welding Variables (QW-361-1)	Actual Values	Range Qualified
Filler metal (EBW or LBW)	--	--
Laser type for LBW (CO ₂ to YAG etc.)	--	--
Continuous drive or inertia welding (FW)	--	--
Vacuum or out of vacuum (EBW)	--	--

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) **ACCEPTED**

Bend test; Transverse root and face [QW-462.3(a)]; Longitudinal root and face [QW-462.3(b)]; Side (QW-462.2);
 Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];
 Macro test for fusion [QW-462.5(b)]; Macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result
QW 462.3 (a)	ACCEPTED	QW 462.3 (a)	ACCEPTED		
(ROOT)		(FACE)			

Alternative radiographic examination results (QW-191) **--**

Fillet weld — fracture test (QW-180) **--** Length and percent of defects **--**

Macro examination (QW-184) **--** Fillet size (in.) **--** x **--** Concavity/convexity (in.) **--**

Other tests **--**

Film or specimens evaluated by **--** Company **--**

Mechanical tests conducted by **ALL-WELD COMPANY LIMITED** Laboratory test no. **--**

Welding supervised by **ANDREW LEWIS**

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

Organization **ALL-WELD COMPANY LIMITED** Signature *R Bentley* Date **FEB. 15, 2006**



Issued under Ontario's **Technical Standards and Safety Act**
 Boilers and Pressure Vessels Regulation
PER ASME
 Expiry Date: **SECT. IX**

FAN YANG **83**
 Welder Symbol
 Has passed the welding test required under Ontario's **Technical Standards and Safety Act**, Boilers and Pressure Vessels Regulation and is hereby authorized to weld for:
ALL-WELD COMPANY LIMITED
 Subject to the limitations of this certificate
 Authorized Examiner *[Signature]* Director

Office Use Only

Test Requested By **ROBERT BENTLEY**
 (Print Person's Name)
49 PASSMORE AVE., SCARBOROUGH, ONT.
 Tested At **ALL-WELD COMPANY LIMITED**
 (Print Address)

District # **13** Inspector # **021.037** Fee **1051-**



Technical Standards and Safety Authority

14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site www.tssa.org

Welder/Welding Operator Certificate
Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 262889

Welder's Last Name: AI ROUBAYI Initial: A First Name: RAZZAK Signature: [Signature] Stamp No: 109

Res Address: 140 QUANTRELL TRIAL SCARBOROUGH, ONT. Postal Code: M 1 D 1 L B Provincial Registration No: WP-R75425
Company PQR No: 52-2A
Company WPS No used: 52-2

Employer Name: ALL WELD COMPANY LIMITED Street Address: 14 PASSMORE AVE SCARBOROUGH, ONT. Postal Code: M 1 V 4 T 1

Welding Process(es) Used: SMAW Type(s): manual machine semi-automatic automatic

Base Material(s): SA-516-GR70N TO SA-516-GR70N Thickness(es) 1" Test Coupon Production Weld

Variables for All Processes

	Actual Values	Range Qualified
Backing material (with/without)	WITH	WITH
Base Metal P-Number to P-Number	P1 to P1	P1 THRU P15F, P34 & P4X PLATE AND PIPE 2 7/8" OD AND UP
(X) Plate () Pipe (enter diameter if pipe)	1"	
Filler Metal Specification (SFA) Class (QW-404) (Informational Only)	(5.1) E7018-1H4	
Consumable insert for GTAW or PAW (QW-404)	NONE	
Welding Position (1G, 5G, etc.) (QW-405)	2G	1G & 2G
Manual or Semi-automatic Variables (QW-360)	Actual Values	Range Qualified
Filler Metal F- No (QW-404)	F4	F1, F2, F3 & F4
Filler Metal Product Form for GTAW, PAW (QW-404)	NONE	NONE
Weld deposit thickness for each welding process (QW-404)	1"	MAX TO BE WELDED (PLATE GROOVE + PIPE 2 7/8" OD + UP + ALL FILLETS)
Process 1: SMAW 3 layers minimum <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	.	
Process 2: 3 layers minimum <input type="checkbox"/> Yes <input type="checkbox"/> No	NONE	NONE
Vertical progression (uphill/downhill) (QW-405)	NONE	NONE
GTAW, PAW or GMAW backing gas, or OFW fuel gas (QW-408)	NONE	NONE
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)	NONE	NONE
GTAW welding current type & polarity (AC, DCEP, DCEN)(QW-409)	NONE	NONE
Machine Welding Variables (QW-381.2)	Actual Values	Range Qualified
Direct or remote visual control	NONE	NONE
Automatic arc voltage control (GTAW)	NONE	NONE
Automatic joint tracking	NONE	NONE
Multiple or single pass per side	NONE	NONE
Automatic Welding Variables (QW-381.1)	Actual Values	Range Qualified
Filler Metal (EBW or LBW)	NONE	NONE
Laser type for LBW (CO ₂ to YAG etc.)	NONE	NONE
Continuous drive or inertia welding (FW)	NONE	NONE
Vacuum or out of vacuum (EBW)	NONE	NONE

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) ACCEPTED

- Transverse root and face [QW-462.3(a)]; Longitudinal root and face [QW-462.3(b)]; Side [QW-462.2];
 Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];
 Pipe specimen, macro test for fusion [QW-462.5(b)]; Plate specimen, macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result	Type	Result
QW-462.2 (SIDE)	ACCEPTED	QW-462.2 (SIDE)	ACCEPTED				

Alternative radiographic examination results (QW-191) NONE

Fillet weld - fracture test (QW-181.2) NONE Length and percent of defects N/A

- Fillet welds in plate [QW-462.4(b)] Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) NONE Fillet size (in.) NONE x NONE Concavity/convexity (in.) NONE

Other tests NONE

Film or specimens evaluated by NONE Company NONE

Mechanical tests conducted by ALL - WELD COMPANY LIMITED Laboratory test no. NONE

Welding supervised by (Print name) ANDREW LEWIS

Test requested by (Print name) ROBERT BENTLEY Tested at (Print address) 49 PASSMORE AVE. SCARBOROUGH ONT

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

Organization ALL - WELD COMPANY LIMITED Signature [Signature] Date 03-28-2013 (mm-dd-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's Technical Standards and Safety Act, Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✓) applicable box below:

- To weld for the Employer named above only.
 For seeking employment only.

This Certificate expires: PER ASME SECTION IX (mm dd-yyyy)

Inspector Name and Number (Print) COSTA ROSU ONT 915

Inspector Signature and Date [Signature] APR 08, 2013



Technical Standards and Safety Authority

14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Certificate

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 262468

Welder's Last Name STEWART	Initial	First Name STEPHEN	Signature 	Stamp No. 111
Res. Address 49 MANDRAKE ROAD AJAX, ONT		Postal Code L 1 S 5 H 1	Provincial Registration No. D700.5, R2363.5 & R2060.5	
Employer Name ALL - WELD COMPANY LIMITED			Company POR No.	
Street Address 49 PASSMORE AVE			78, 1 & 1-A	
SCARBOROUGH, ONT			Postal Code M 1 V 4 T 1	Company WPS No. used 1-1
Welding Process(es) Used SMAW			Type(s) <input checked="" type="checkbox"/> manual <input type="checkbox"/> machine <input type="checkbox"/> semi-automatic <input type="checkbox"/> automatic	

Base Material(s) **SA-516-GR 70 TO SA-516-GR 70** Thickness(es) **3/8"** Test Coupon Production Weld

Variables for All Processes **Actual Values** **Range Qualified**

Backing material (with/without)	WITHOUT	WITH OR WITHOUT
Base Metal P-Number to P-Number	P1 to P1	P1 THRU P15F, P34 & P4X PLATE AND PIPE 2 7/8" OD AND UP
(X) Plate () Pipe (enter diameter if pipe)	0.375"	
Filler Metal Specification (SFA) Class (QW-404) (Informational Only)	5.1 E7018-1H4	
Consumable Insert for GTAW or PAW (QW-404)	NONE	
Welding Position (1G, 5G, etc.) (QW-405)	2G	1G & 2G

Manual or Semi-automatic Variables (QW-350) **Actual Values** **Range Qualified**

Filler Metal F-No. (QW-404)	F4	F4
Filler Metal Product Form for GTAW, PAW (QW-404)	NONE	
Weld deposit thickness for each welding process (QW-404)	3/8"	3/4" MAX PLATE GROOVE + PIPE 2 7/8" OD + UP
Process 1: _____ 3 layers minimum <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	4	+ ALL FILLETS
Process 2: _____ 3 layers minimum <input type="checkbox"/> Yes <input type="checkbox"/> No	NONE	
Vertical progression (uphill/downhill) (QW-405)	NONE	
GTAW, PAW or GMAW backing gas; or OFW fuel gas (QW-406)	NONE	
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)	NONE	
GTAW welding current type & polarity (AC, DCEP, DCEN) (QW-409)	NONE	

Machine Welding Variables (QW-361.2) **Actual Values** **Range Qualified**

Direct or remote visual control	NONE	
Automatic arc voltage control (GTAW)	NONE	
Automatic joint tracking	NONE	
Multiple or single pass per side	NONE	

Automatic Welding Variables (QW-361.1) **Actual Values** **Range Qualified**

Filler Metal (EBW or LBW)	NONE	
Laser type for LBW (CO ₂ to YAG etc.)	NONE	
Continuous drive or inertia welding (FW)	NONE	
Vacuum or out of vacuum (EBW)	NONE	

Notes: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.
RESULTS

Visual Examination of Completed Weld (QW-302.4) ACCEPTED

Transverse root and face [QW-462.3(a)]; Longitudinal root and face [QW-462.3(b)]; Side (QW-462.2);

Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];

Pipe specimen, macro test for fusion [QW-462.5(b)]; Plate specimen, macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result	Type	Result
QW-462.3 (a)	ACCEPTED	QW-462.3 (a)	ACCEPTED				
(Face)		(ROOT)					

Alternative radiographic examination results (QW-191) NONE

Fillet weld - fracture test (QW-181.2) NONE Length and percent of defects _____

Fillet welds in plate [QW-462.4(b)] Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) NONE Fillet size (in.) NONE x NONE Concavity/convexity (in.) NONE

Other tests NONE

Film or specimens evaluated by NONE Company NONE

Mechanical tests conducted by ALL - WELD COMPANY LIMITED Laboratory test no. NONE

Welding supervised by (Print name) ANDREW LEWIS

Test requested by (Print name) ROBERT BENTLEY Tested at (Print address) 49 PASSMORE AVE, SCARBOROUGH, ONT

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

Organization ALL - WELD COMPANY LIMITED Signature Robert Bentley Date 09-12-2012
(mm-dd-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's **Technical Standards and Safety Act**, Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✓) applicable box below:

To weld for the Employer named above only. This Certificate expires: PER ASME SECTION IX
 For seeking employment only. (mm-dd-yyyy)

WSTICA ROBU ONT915 SEP 12, 2012
Inspector Name and Number (Print) Inspector Signature and Date



Technical Standards and Safety Authority

14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Certificate

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 262446

Welder's Last Name WRIGHT		Initial JOHN	First Name JOHN	Signature 	Stamp No. 118
Res. Address 230 BOYERS SIDE ROAD KESWICK, ONTARIO		Postal Code L 1 P 3 C 8	Provincial Registration No. D700.5, R2363.5 & R2060.5		
Employer Name ALL - WELD COMPANY LIMITED		Company PQR No. 78, 1 & 1-A		Company WPS No. used	
Street Address 49 PASSMORE AVE		Postal Code M 1 V 4 T 1	1-1		
SCARBOROUGH, ONT					
Welding Process(es) Used SMAW		Type(s) <input checked="" type="checkbox"/> manual <input type="checkbox"/> machine <input type="checkbox"/> semi-automatic <input type="checkbox"/> automatic			
Base Material(s) SA-516-GR 70 TO SA-516-GR 70		Thickness(es) 3/8"		<input checked="" type="checkbox"/> Test Coupon <input type="checkbox"/> Production Weld	
Variables for All Processes		Actual Values		Range Qualified	
Backing material (with/without)		WITHOUT		WITH OR WITHOUT	
Base Metal P-Number to P-Number (<input checked="" type="checkbox"/>) Plate () Pipe (enter diameter if pipe)		P1 to P1		P1 THRU P15F, P34 & P4X PLATE AND PIPE 2 7/8" OD AND UP	
Filler Metal Specification (SFA) Class (QW-404) (Informational Only)		5.1 E7018-1H4			
Consumable Insert for GTAW or PAW (QW-404)		NONE			
Welding Position (1G, 5G, etc.) (QW-405)		2G		1G & 2G	
Manual or Semi-automatic Variables (QW-350)		Actual Values		Range Qualified	
Filler Metal F-No. (QW-404)		F4		F4	
Filler Metal Product Form for GTAW, PAW (QW-404)		NONE			
Weld deposit thickness for each welding process (QW-404)		3/8"		3/4" MAX PLATE GROOVE + PIPE 2 7/8" OD + UP	
Process 1: _____ 3 layers minimum <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		4		+ ALL FILLETS	
Process 2: _____ 3 layers minimum <input type="checkbox"/> Yes <input type="checkbox"/> No		NONE			
Vertical progression (uphill/downhill) (QW-405)		NONE			
GTAW, PAW or GMAW backing gas; or OFW fuel gas (QW-408)		NONE			
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)		NONE			
GTAW welding current type & polarity (AC, DCEP, DCEN) (QW-409)		NONE			
Machine Welding Variables (QW-361.2)		Actual Values		Range Qualified	
Direct or remote visual control		NONE			
Automatic arc voltage control (GTAW)		NONE			
Automatic joint tracking		NONE			
Multiple or single pass per side		NONE			
Automatic Welding Variables (QW-361.1)		Actual Values		Range Qualified	
Filler Metal (EBW or LBW)		NONE			
Laser type for LBW (CO ₂ to YAG etc.)		NONE			
Continuous drive or inertia welding (FW)		NONE			
Vacuum or out of vacuum (EBW)		NONE			

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.
RESULTS

Visual Examination of Completed Weld (QW-302.4) ACCEPTED

Transverse root and face [QW-462.3(a)]; Longitudinal root and face [QW-462.3(b)]; Side (QW-462.2);

Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];

Pipe specimen, macro test for fusion [QW-462.5(b)]; Plate specimen, macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result	Type	Result
QW-462.3 (a)	ACCEPTED	QW-462.3 (a)	ACCEPTED				
(Face)		(ROOT)					

Alternative radiographic examination results (QW-191) NONE

Fillet weld - fracture test (QW-181.2) NONE Length and percent of defects _____

Fillet welds in plate [QW-462.4(b)] Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) NONE Fillet size (in.) NONE x NONE Concavity/convexity (in.) NONE

Other tests NONE

Film or specimens evaluated by NONE Company NONE

Mechanical tests conducted by ALL - WELD COMPANY LIMITED Laboratory test no. NONE

Welding supervised by (Print name) ANDREW LEWIS

Test requested by (Print name) ROBERT BENTLEY Tested at (Print address) 49 PASSMORE AVE, SCARBOROUGH, ONT

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

Organization ALL - WELD COMPANY LIMITED Signature Robert Bentley Date 06-12-2012
(mm-dd-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's *Technical Standards and Safety Act*, Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✓) applicable box below:

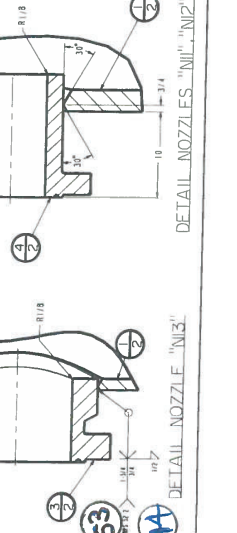
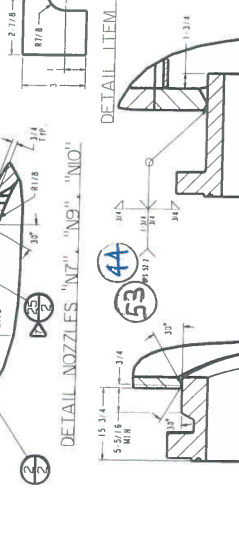
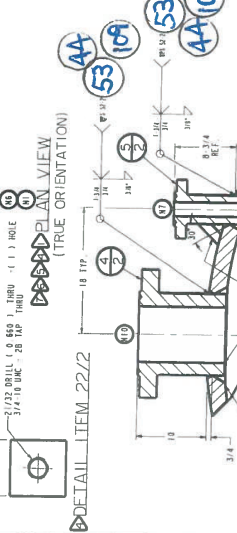
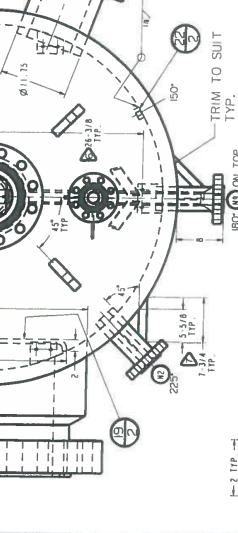
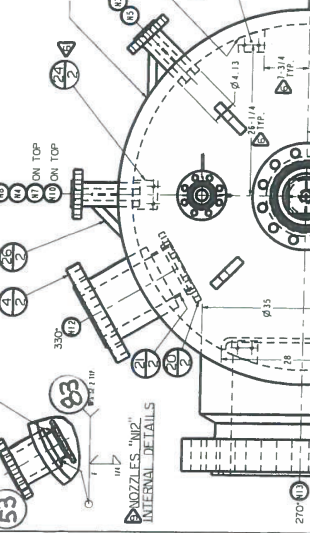
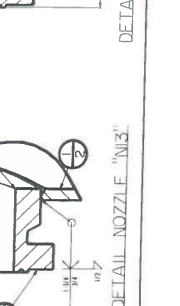
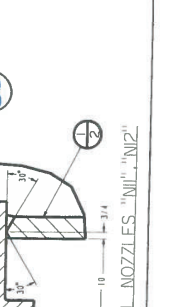
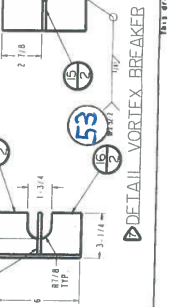
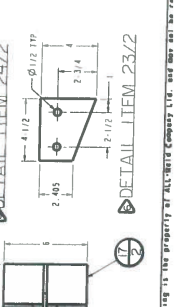
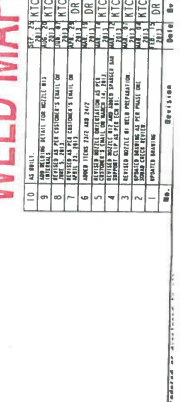
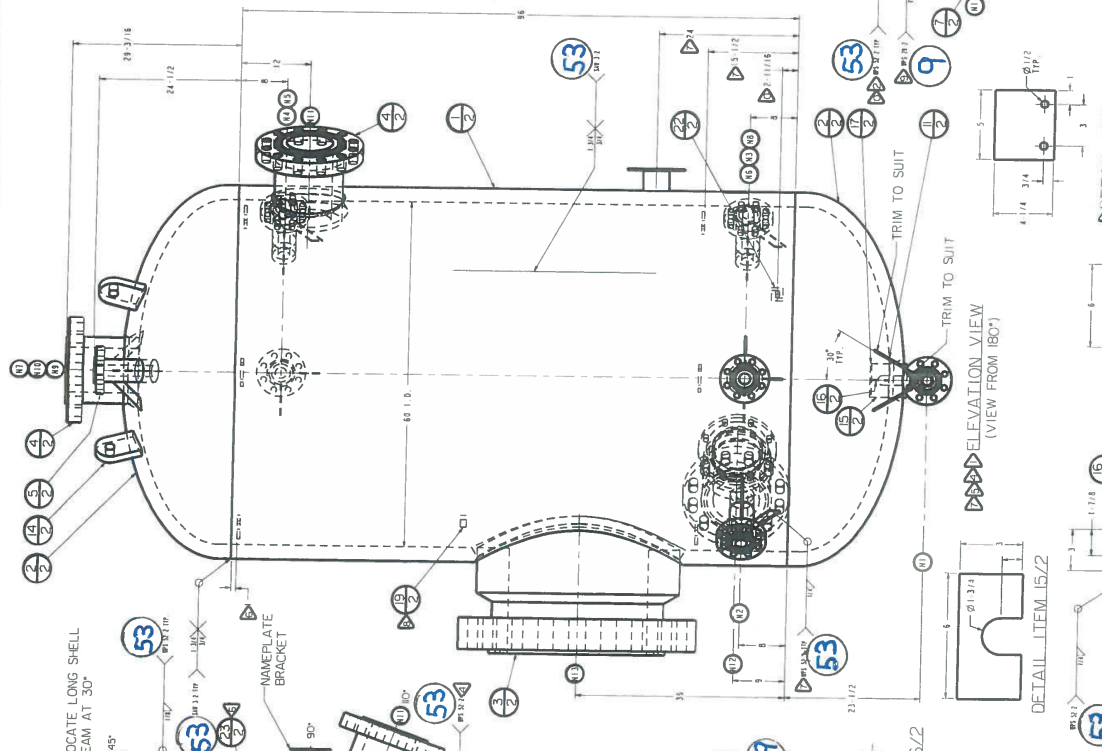
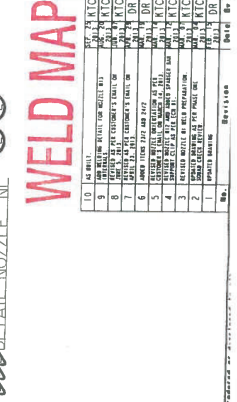
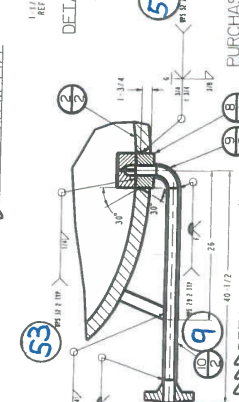
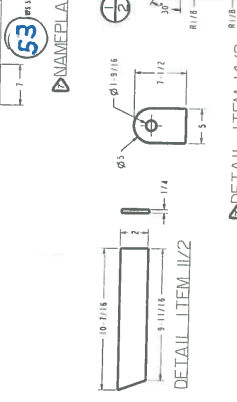
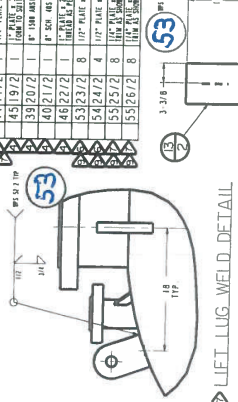
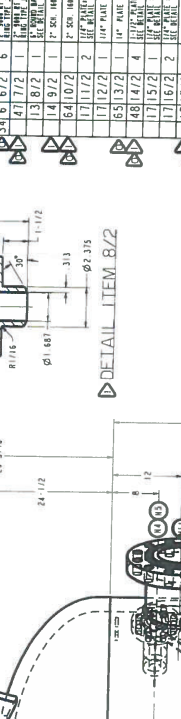
- To weld for the Employer named above only.
 For seeking employment only.

This Certificate expires: PER ASME SECTION IX
(mm-dd-yyyy)

COSTICA ROSU 06/15
Inspector Name and Number (Print)

Robert Bentley JUNE 14, 2012
Inspector Signature and Date

ITEM	QTY.	DESCRIPTION	SPEC.
1	1/2	1/2" DIA. PIPER	SA-516 TM
2	1/2	1/2" DIA. PIPER	SA-516 TM
3	1/2	1/2" DIA. PIPER	SA-516 TM
4	1/2	1/2" DIA. PIPER	SA-516 TM
5	1/2	1/2" DIA. PIPER	SA-516 TM
6	1/2	1/2" DIA. PIPER	SA-516 TM
7	1/2	1/2" DIA. PIPER	SA-516 TM
8	1/2	1/2" DIA. PIPER	SA-516 TM
9	1/2	1/2" DIA. PIPER	SA-516 TM
10	1/2	1/2" DIA. PIPER	SA-516 TM
11	1/2	1/2" DIA. PIPER	SA-516 TM
12	1/2	1/2" DIA. PIPER	SA-516 TM
13	1/2	1/2" DIA. PIPER	SA-516 TM
14	1/2	1/2" DIA. PIPER	SA-516 TM
15	1/2	1/2" DIA. PIPER	SA-516 TM
16	1/2	1/2" DIA. PIPER	SA-516 TM
17	1/2	1/2" DIA. PIPER	SA-516 TM
18	1/2	1/2" DIA. PIPER	SA-516 TM
19	1/2	1/2" DIA. PIPER	SA-516 TM
20	1/2	1/2" DIA. PIPER	SA-516 TM
21	1/2	1/2" DIA. PIPER	SA-516 TM
22	1/2	1/2" DIA. PIPER	SA-516 TM
23	1/2	1/2" DIA. PIPER	SA-516 TM
24	1/2	1/2" DIA. PIPER	SA-516 TM
25	1/2	1/2" DIA. PIPER	SA-516 TM
26	1/2	1/2" DIA. PIPER	SA-516 TM
27	1/2	1/2" DIA. PIPER	SA-516 TM
28	1/2	1/2" DIA. PIPER	SA-516 TM
29	1/2	1/2" DIA. PIPER	SA-516 TM
30	1/2	1/2" DIA. PIPER	SA-516 TM
31	1/2	1/2" DIA. PIPER	SA-516 TM
32	1/2	1/2" DIA. PIPER	SA-516 TM
33	1/2	1/2" DIA. PIPER	SA-516 TM
34	1/2	1/2" DIA. PIPER	SA-516 TM
35	1/2	1/2" DIA. PIPER	SA-516 TM
36	1/2	1/2" DIA. PIPER	SA-516 TM
37	1/2	1/2" DIA. PIPER	SA-516 TM
38	1/2	1/2" DIA. PIPER	SA-516 TM
39	1/2	1/2" DIA. PIPER	SA-516 TM
40	1/2	1/2" DIA. PIPER	SA-516 TM
41	1/2	1/2" DIA. PIPER	SA-516 TM
42	1/2	1/2" DIA. PIPER	SA-516 TM
43	1/2	1/2" DIA. PIPER	SA-516 TM
44	1/2	1/2" DIA. PIPER	SA-516 TM
45	1/2	1/2" DIA. PIPER	SA-516 TM
46	1/2	1/2" DIA. PIPER	SA-516 TM
47	1/2	1/2" DIA. PIPER	SA-516 TM
48	1/2	1/2" DIA. PIPER	SA-516 TM
49	1/2	1/2" DIA. PIPER	SA-516 TM
50	1/2	1/2" DIA. PIPER	SA-516 TM
51	1/2	1/2" DIA. PIPER	SA-516 TM
52	1/2	1/2" DIA. PIPER	SA-516 TM
53	1/2	1/2" DIA. PIPER	SA-516 TM



WELD MAP

PLOTTED:

PURCHASE ORDER NUMBER: III.2.

ALL-WELD COMPANY LIMITED

ULTRAFAB INDUSTRIES LIMITED

60° B. VERTICAL RES. CONTACTOR

APPLICATION AND WELDING DETAILS

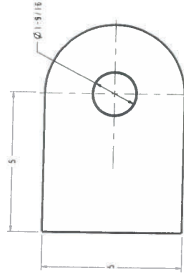
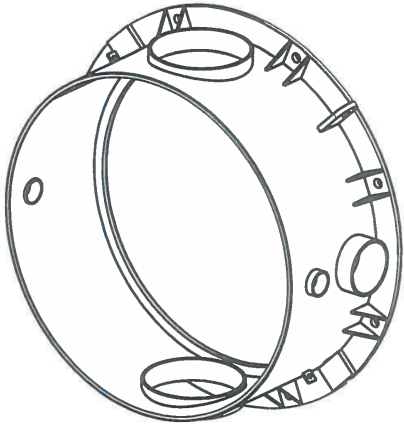
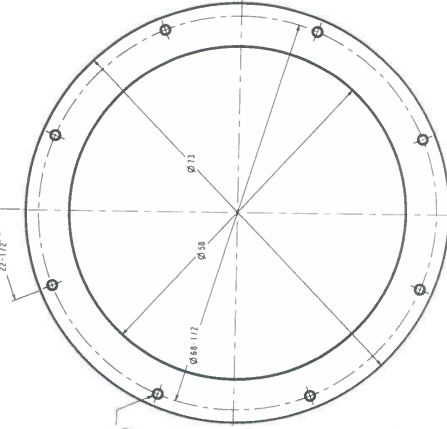
DATE: 11/19/84

REVISION:

BILL OF MATERIAL

ITEM QTY.	ITEM QTY.	DESCRIPTION	SPEC.
1918 1/3	1	1 1/2" DIA. C. 1.125 C. 1.125 C. 1.125	SA-516 DR.
202 2/3	1	1 1/2" DIA. C. 1.125 C. 1.125 C. 1.125	SA-516 DR.
213 3/3	1	1 1/2" DIA. C. 1.125 C. 1.125 C. 1.125	SA-516 DR.
224 4/3	2	1 1/2" DIA. C. 1.125 C. 1.125 C. 1.125	SA-516 DR.
235 5/3	2	1 1/2" DIA. C. 1.125 C. 1.125 C. 1.125	SA-516 DR.
246 6/3	2	1 1/2" DIA. C. 1.125 C. 1.125 C. 1.125	SA-516 DR.
257 7/3	2	1 1/2" DIA. C. 1.125 C. 1.125 C. 1.125	SA-516 DR.
268 8/3	1	1 1/2" DIA. C. 1.125 C. 1.125 C. 1.125	SA-516 DR.
279 9/3	1	1 1/2" DIA. C. 1.125 C. 1.125 C. 1.125	SA-516 DR.

18" HOLES ϕ 1.518
EQUALLY SPACED
ON A ϕ 112 E.C.D.



DETAIL ITEM 9/3



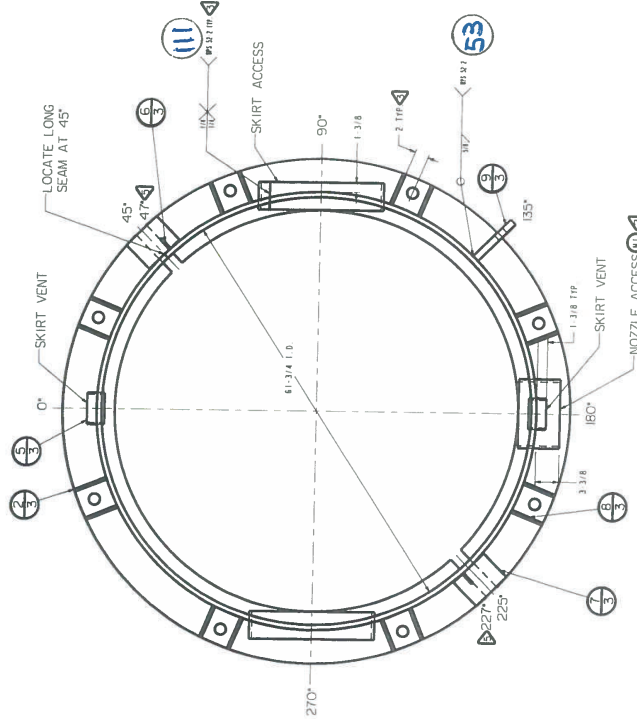
DRAIN CUT OUT DETAIL



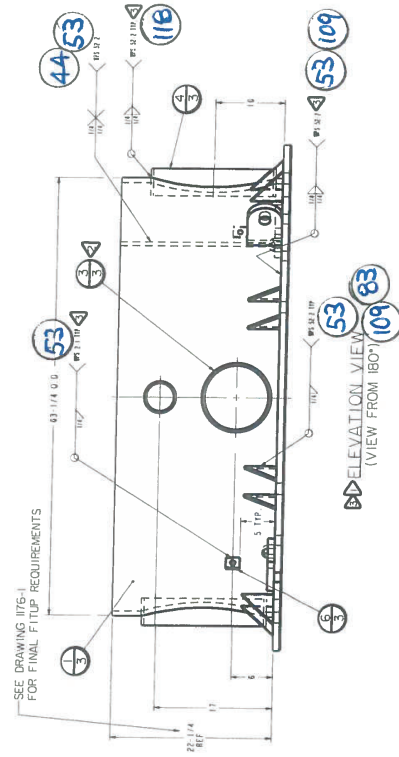
DETAIL ITEM 7/3



DETAIL ITEM 8/3



PLAN VIEW
(TRUE ORIENTATION)



ELEVATION VIEW
(VIEW FROM 180°)

SEE DRAWING 117G-1
FOR FINAL FITUP REQUIREMENTS

S3

44 S3

116

53 109

53

53

53 109 83

53

53

53 109 83

53

53

53 109 83

53

53

53 109 83

(2) REQUIRED
PLOTTED:

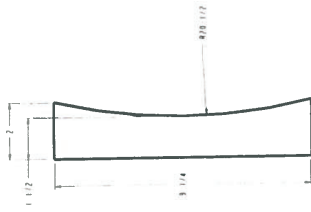
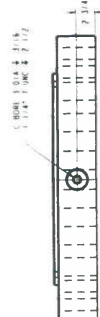
PURCHASE UNDER NUMBER: 1112.

WELD MAP

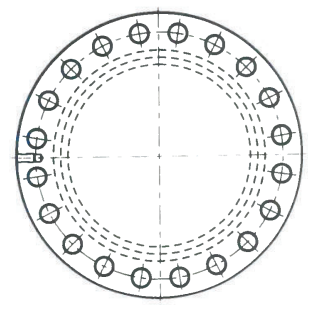
ALL-WELD
COMPANY LIMITED
SPECIALTY WELDING SERVICE

REV. DATE		DESCRIPTION	BY	CHKD.
3	14	REVISED TO INCLUDE 1.125 DIA. HOLES	AG	AG
2	13	REVISED TO INCLUDE 1.125 DIA. HOLES	AG	AG
1	12	ISSUED FOR FABRICATION	AG	AG

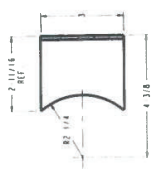
ITEM QTY	DESCRIPTION	SPEC
21 17/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
22 27/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
23 37/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
24 47/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
25 57/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
26 67/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
27 77/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
28 87/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
29 97/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
30 107/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
31 117/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
32 127/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
33 137/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
34 147/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
35 157/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
36 167/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
37 177/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
38 187/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
39 197/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
40 207/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
41 217/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
42 227/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
43 237/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
44 247/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
45 257/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
46 267/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
47 277/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
48 287/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
49 297/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
50 307/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
51 317/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
52 327/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
53 337/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
54 347/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
55 357/4	1/4" DIA. 160 IN. L. ST. 304	SA 192 B



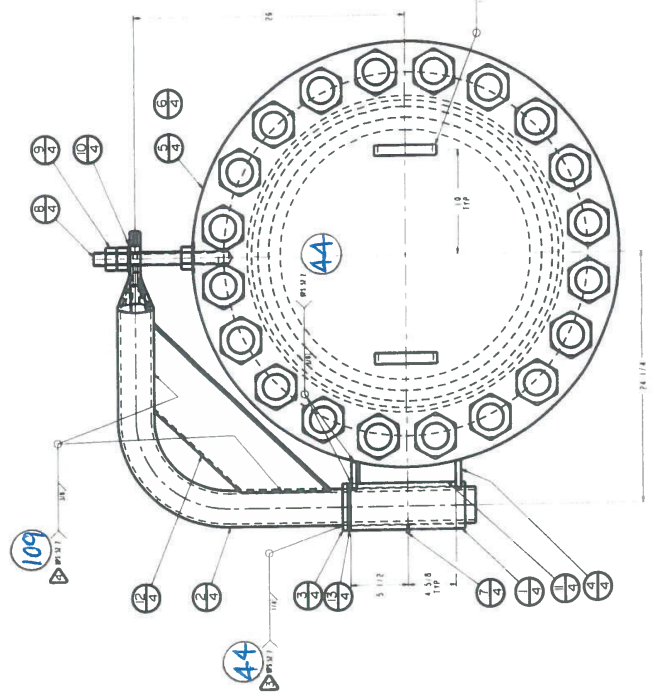
DETAIL ITEM 11/4



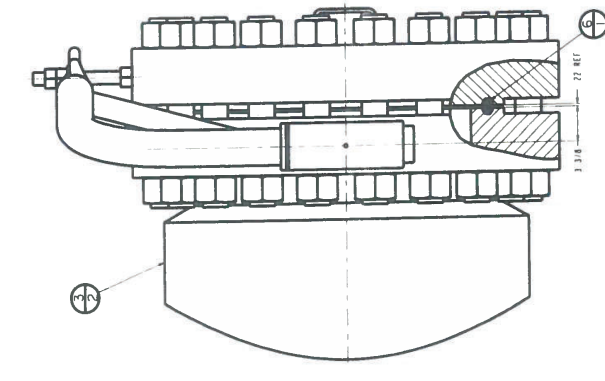
DETAIL ITEM 5/4



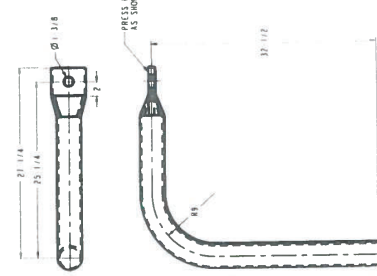
DETAIL ITEM 4/4



NOZZLE 11/31



DETAIL ITEM 2/4



DETAIL ITEM 2/4

NOTE: DAVIT ARM ASSEMBLY IS DESIGNED TO SUPPORT TWICE THE BLIND FLANGE WEIGHT.

PURCHASE ORDER NUMBER: 11112

NOV 13 2013

(2) REQUIRED

PLOTTED:



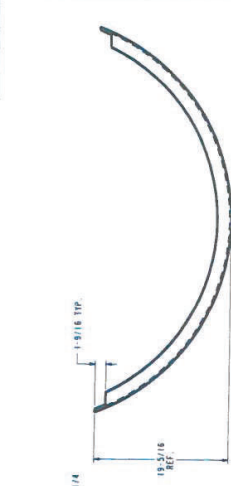
ULTRAFAB INDUSTRIES LIMITED
60° T. D. VERTICAL HOIST CONTRACTOR
24" MANNING ASSEMBLY C/P RE DAVIT ASSEMBLY

4	160 IN. DIA. 160 IN. L. ST. 304	SA 192 B
3	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
2	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
1	1/4" DIA. 160 IN. L. ST. 304	SA 192 B
0	1/4" DIA. 160 IN. L. ST. 304	SA 192 B

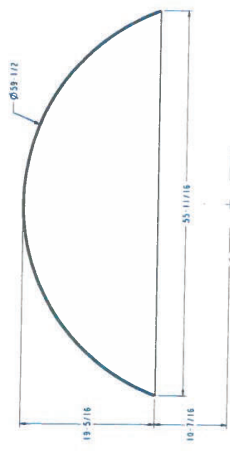
WELD MAP

ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED. ALL DIMENSIONS ARE TO CENTER UNLESS OTHERWISE SPECIFIED.

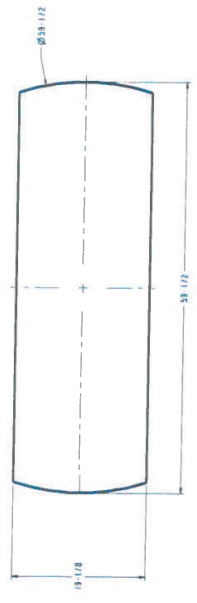
ITEM	QTY	DESCRIPTION	SPEC.
166	1/77	1 1/2" x 3/16" x 1/2" THREADED BAR, 1/2" DIA. IN.	C-1
166	2/77	2 1/2" x 3/16" x 1/2" THREADED BAR, 1/2" DIA. IN.	C-1
167	3/77	3 1/2" x 3/16" x 1/2" THREADED BAR, 1/2" DIA. IN.	C-1
167	4/77	4 1/2" x 3/16" x 1/2" THREADED BAR, 1/2" DIA. IN.	C-1
168	5/77	5 1/2" x 3/16" x 1/2" THREADED BAR, 1/2" DIA. IN.	C-1
168	6/77	6 1/2" x 3/16" x 1/2" THREADED BAR, 1/2" DIA. IN.	C-1
168	7/77	7 1/2" x 3/16" x 1/2" THREADED BAR, 1/2" DIA. IN.	C-1
168	8/77	8 1/2" x 3/16" x 1/2" THREADED BAR, 1/2" DIA. IN.	C-1
169	9/77	9 1/2" x 3/16" x 1/2" THREADED BAR, 1/2" DIA. IN.	C-1
167	10/77	10 1/2" x 3/16" x 1/2" THREADED BAR, 1/2" DIA. IN.	C-1



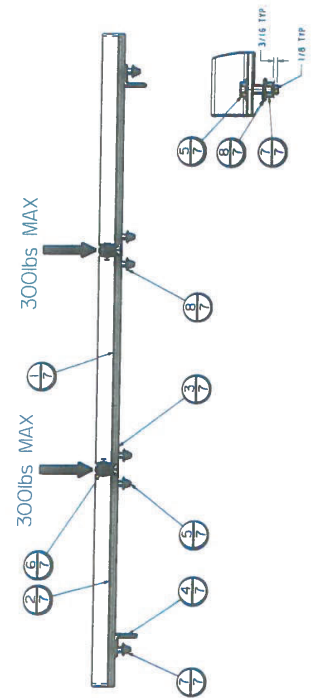
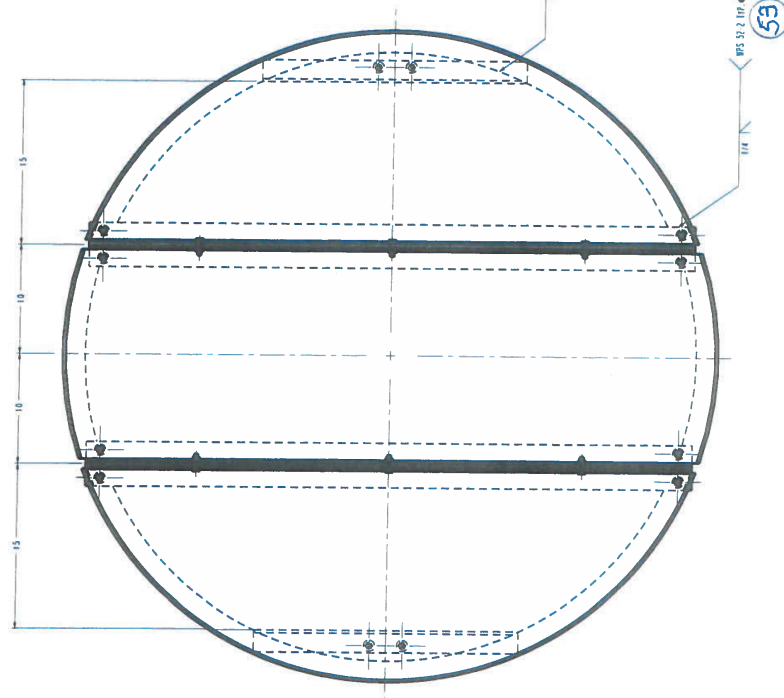
DETAIL ITEM 9/Z



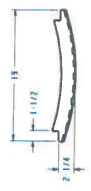
DETAIL ITEM 2/Z



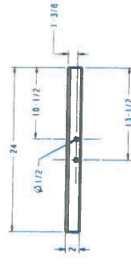
DETAIL ITEM 1/Z



BOILING DETAIL



DETAIL ITEM 10/Z



DETAIL ITEM 4/Z

PURCHASE ORDER NUMBER: 1112.

REQUIRED

PLATED:

WELD MAP

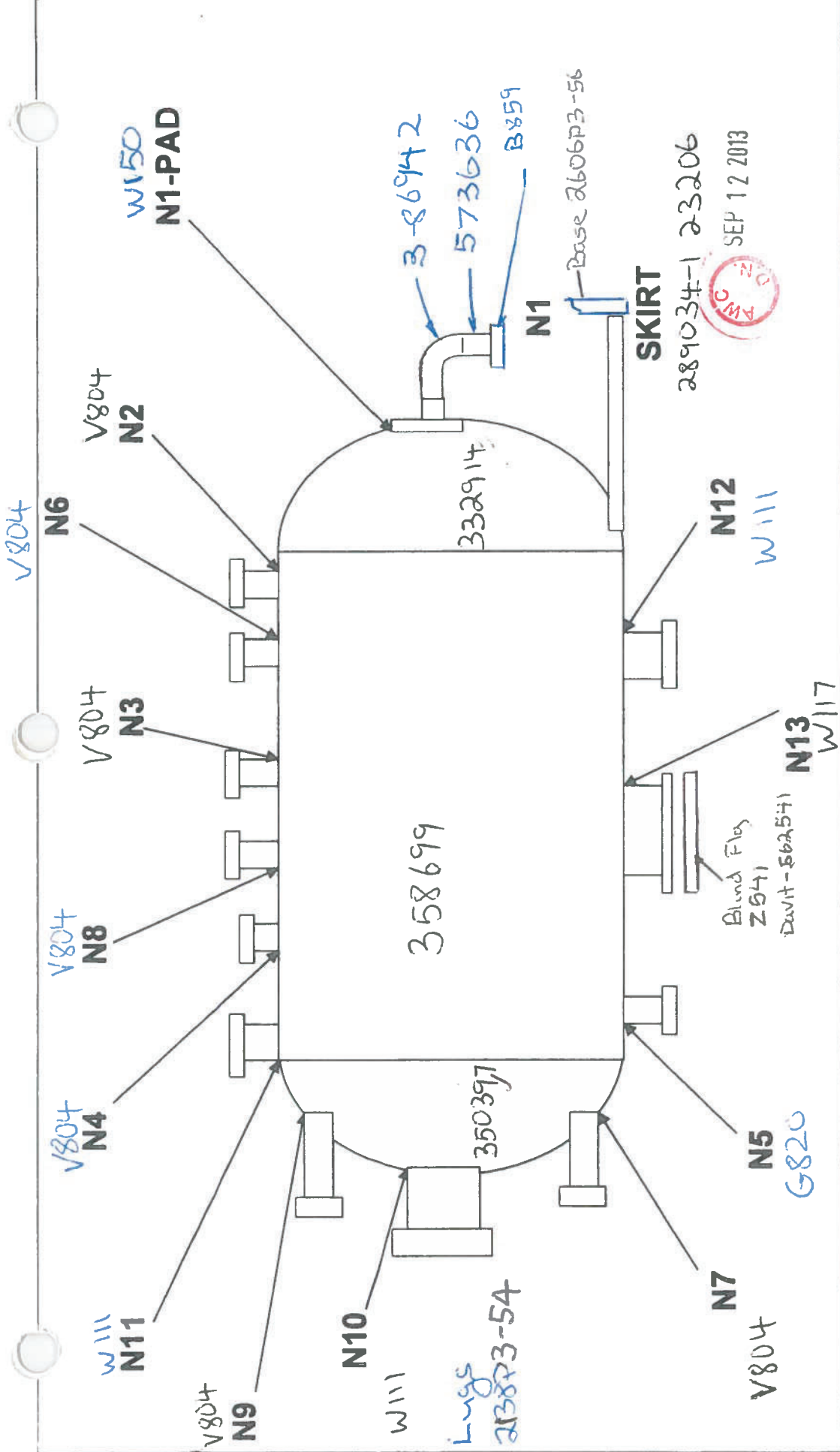
ALL-WELD COMPANY LIMITED
 45 PINE AVE., SCARBOROUGH, ONT. M1V 4Y1
 416-291-1111

ULTRAFAB INDUSTRIES LIMITED

TOP AND BOTTOM PACKING GRID

NO.	REV.	DATE	BY	CHK'D BY	APP'D BY
1	1	11/18/01
2	1	11/18/01
3	1	11/18/01

THIS DRAWING IS THE PROPERTY OF ALL-WELD COMPANY LTD. and may not be reproduced or utilized in others without permission in writing.

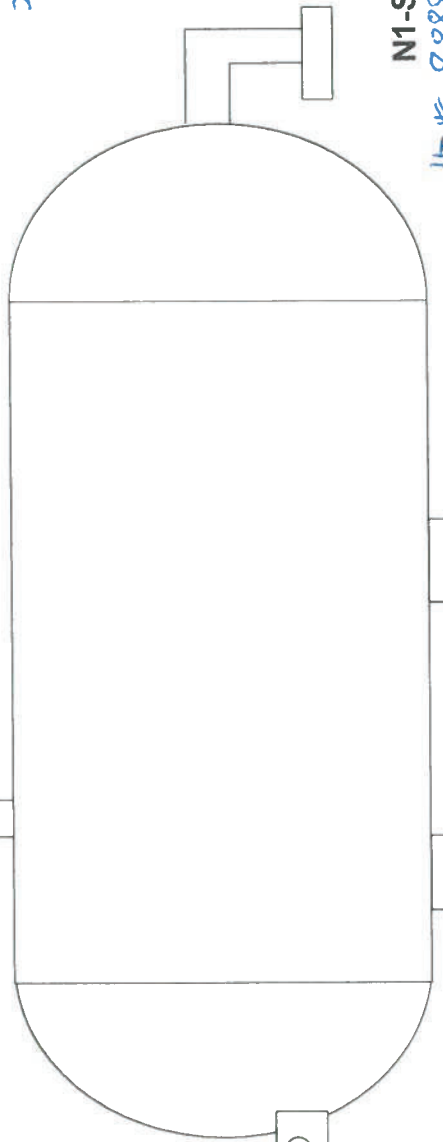


HEAT NUMBER MAP - 1176PQ
 ASME SECTION VIII. DIV. 1
 MATERIAL SA-616 70N, SA-350 LF2, SA-333 6, SA-420 WPLG

ALL-WELD CO. LTD. - HEAT NUMBER MAP	
CLIENT: ULTRAFAB	
WORK ORDER #: 1176PQ	SN 7469
JOB DESCRIPTION: 60" I.D. VERTICAL CONTACTOR	
DRAWING #: 1176-1	
PREPARED BY: D.NESCI	
DATE: March 4, 2013	

N2, N3, N4, N5,
N6, N7, N8, N9- SUPPORTS
HT# 4019P3-52

19/2- 2797P3-05
22/2- 2797P3-05
23-2- 6396P3-01
24/2- 6396P3-01
VORTEX BREAKER- 8888L-386
20/2- A39V3
2 1/2 - J2L 9676



14/2
HT # 2138P3-54

N1-SUPPORTS
HT# 8888L-38624

NAMEPLATE
BRACKET
8888L-38624

DAVIT BRACKET- 8952M356
6/4- 5416M-75082



SEP 23 2013

**ALL-WELD COMPANY LTD. -
HEAT NUMBER MAP - PARTS**

HEAT NUMBER MAP- PARTS - 1176PQ
ASME SECTION VIII. DIV. 1

MATERIAL SA-516 70N

CLIENT: ULTRAFAB
WORK ORDER #: 1176PQ
JOB DESCRIPTION: 60" I.D. VERTICAL CONTACTOR
DRAWING #: 1176-1
PREPARED BY: D.NESCI
DATE: AUGUST 26, 2013



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

A03 Advice of dispatch No./ Date of dispatch
 331063-25.02.09

A08/ Manufacturer's order/ Certificate No.
 345549-003

A05 Established inspecting body
 EDMONTON STEEL, EDMONTON

A07.1 No. ED10523-J1010-LG

A07.2 No. SA20-S5

MATERIAL TEST REPORT (MTR)

DH Final receiver EDMONTON STEEL, EDMONTON

B02/ Steel design. SA516-70

B03 Any suppl. requirements ASME-2A: 07+A08
 DIL-HUE-16:R16-2007-11-20

B01 Product
 HOT ROLLED PLATES

Sheet
 1/...



15033

B01-B99 Description of the product

B14 Item No.	B08 Number of pieces	B09 Thickness	B10 Width	B11 Length	B12 Theoretical mass	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate No./ Test No.	A09 Purchaser article number
01	1	2,5000 x	121,00000 x	480,00000 x	18678 N	N	332914	18895-01	
01	1	2,5000 x	121,00000 x	480,00000 x	18678 N	N	332914	18957-01	
01	1	2,5000 x	121,00000 x	480,00000 x	18678 N	N	332914	19045-01	
**	3				56034				
***	3				56034				

B04 Product delivery condition

ITEM NO.: 01

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

STEEL DESIGNATION SA516 70 MTLTY SA516 60 MTLTY
HEAT NO. / TRADEMARK / ROLLED PLATE NO.-TEST NO. / INSPECTOR'S STAMP

C10-C29 Tensile test

B14 Item No.	B07.2 Heat No.	B05 Rol/plate/ Test No.	B05 Reference (heat) treatment	C01 C02/ C03 C01 Temp. GR.F	C10 KSI RP02	C11 C12 C13 RM	A % LO=2IN
01	332914	18895	K1 QV	RT	48,4	76,1	35,6
01	332914	18957	K1 QV	RT	47,0	76,4	37,8
01	332914	19045	K1 QV	RT	48,3	76,1	37,8

A04

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



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

Inspector's stamp Date 26.02.09

PP 1

046
 ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SAH Saha America
 Print Name: YANESH SAHA
 Signature: [Signature]
 Date: February 13
 APPLUS®
 VELOSI
 Velosi-America LLC



C14-C15
FEB 06 2013



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

A10 Advice of dispatch No./ Date of dispatch
 331063-25.02.09

A08/ Manufacturer's order/ A03 Certificate No.
 345549-003

Sheet
 2/...

MATERIAL TEST REPORT (MTR)

A05 Established inspecting body
 DH

A06 Purchaser
 EDMONTON STEEL, EDMON

A07.1 No. EDI0523-J1010-LG

A07.2 No. SA20-S5

Final receiver
 EDMONTON STEEL, EDMON

B02/ Steel design. SA516-70

B03 Any suppl. requirements DIL-HUE-16:R16-2007-1.1-20

W.O. # 11768
 M.L. #
 THK. #
 P.O. # 12-1619-1789

C30-C39 Hardness test

B14 Item No.	B07.2 Heat No.	B07.1 Roll/plate/ Test No.	B05 Reference (heat) treatment	C01	C02/C01	C03 Temp. GR.F	C33 Testing method	C35 Individual values	C31 Mean value
01	332914	18895		K1	O	RT	RT HBW 10/3000	153	153
01	332914	18957		K1	O	RT	RT HBW 10/3000	144	145
01	332914	19045		K1	O	RT	RT HBW 10/3000	148	154

C40-C49 Impact test

B14 Item No.	B07.2 Heat No.	B07.1 Roll/plate/ Test No.	B05 Reference (heat) treatment	C01	C02/C01	C03 Temp. GR.F	C41 Width of test piece	C44 Testing method	C45 Energy	C43 Mean value
01	332914	18895		K1	LV	-51	CHP-V	AV 82	112	105
01	332914	18957		K1	LV	-51	CHP-V	AV 64	86	108
01	332914	19045		K1	LV	-51	CHP-V	AV 107	128	99

C70-C99 Chemical composition % - Heat analysis

B07.2 Heat No.	C70	C	Si	Mn	P	S	N	CU	MO	NI	CR	V	NB	SN	TI
332914	Y	0,182	0,377	1,17	0,009	0,0006	0,0061	0,033	0,028	0,076	0,212	0,001	0,000	0,000	0,002

C94 Heat analysis Carbon equivalent / Alloying restrictions

B07.2 Heat No.	FO-02=	FO-03=	FO-04=	FO-05=	FO-06=	FO-07=	FO-08=	FO-09=	FO-10=
332914		0,43	0,35	0,24	0,24	0,24	0,24	0,24	0,24

C95 Ladle treatment

ITEM NO.: 01

HEAT OF THE INDICATED ITEM: VACUUM DEGASSED / SULPHIDE SHAPE CONTROL

A04 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

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

Inspector's stamp
 Date 26.02.09

Manufacturer's mark
 PP 1

ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: VELOSI AM
 Print Name: GAMERH SAH
 Signature: [Signature]
 Date: 12-16-19-1789
 046
Appius®
 VELOSI
 Velosi America LLC

Q.C.I.
 E.Y.

Certification of Material - Per ASME
 HT# 332914
 Qualifies to all requirements of
 SAS 1662-1789

Q.C.I.
 N.D.

PERMITS OF UNSPECIFIED
 ELEMENTS PER ASME
 SECTION II (SA-20)
 CU + NI + CR + MO =
 CR + MO =

FEB 04 2010
 349
 24

ADH





DILLINGER HÜTTE

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

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991

MATERIAL TEST REPORT (MTR)
 A05 Established inspecting body A06 Purchaser EDMONTON STEEL, EDMON A07.1 No. ED10523-J1010-LG
 DH Final receiver EDMONTON STEEL, EDMON A07.2 No. SA20-S5

B02/ Steel design. SA516-70
 B03 Any suppl. ASME-2A: 07+A08 requirements DIL-HUE-16:R16-2007-11-20

C70-C99 Chemical composition % - Product analysis

Heat	Test No.	C	SI	MN	P	S	N	CU	MO	NI	CR	V	NB	SN	TI
B07.2	B07.1														
332914	18962	K1 0,181	0,373	1,17	0,009	0,0009	0,0059	0,031	0,027	0,073	0,206	0,001	0,000	0,000	0,003

C94 Product analysis Carbon equivalent / Alloying restrictions

Heat	Test No.	CA	AL-T
B07.2	B07.1		
332914	18962	K1 0,0000	0,036

C94 Carbon equivalent formula / Alloying restrictions
 FO-02 = C + (MN/6) + (CR+MO+V) / 5 + (NI+CU) / 15
 FO-55 = CU+MO+NI+CR
 FO-78 = CR+MO
 FO-91 = MN/C

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

ITEM NO.: 01
 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

ACCEPTED/REVIEWED/RECALCULATED
 for and on behalf of: *Velosi America*
 Print Name: *Gand S* **Applus® VELOSI**
 Signature: *[Signature]* Velosi America LLC
 Date: *March 14/13*

Q.C.I. N.D.
 Q.C.I. E.Y.
 FEB 04 2013
 MTR APPROVED

A04 A01
 201/202/203 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.
QM-System: Certification as per ISO 9001
 AG der Dillinger Hüttenwerke
 Postfach 1580, D-66748 Dillingen/Saar
 Inspection department
 B. MUELLER
 Test House Manager
 Inspector's stamp Date 26.02.09 pp 1



DILLINGER HÜTTE

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

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

A05 Established inspecting body A06 Purchaser EDMONTON STEEL, EDMON A07.1 No. ED10551-J1010-ER
 DH Final receiver EDMONTON STEEL, EDMON A07.2 No. SA20-S5

B02/ Steel design. SA516-70
 B03 Any suppl. ASME-II-A: 07+A09
 requirements DIL-HUE-16:R18-2010-03-19

A10 Advice of dispatch No./ Date of dispatch
 369431-17.09.10

A08/ Manufacturer's order/ A03 Certificate No.
 357366-001

B01 Product
 HOT ROLLED PLATES



B01-B99 Description of the product

B14 Item No.	B08 Number of pieces	B09 Thickness	B10 Width	B11 Length	B12 Theoretical mass	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate No./ Test No.	A09 Purchaser article number
01	1	2,5000 x	121,00000 x	482,00000 x	18756 N	N	350396	60608-01	
01	1	2,5000 x	121,00000 x	482,00000 x	18756 N	N	350396	60610-01	
01	1	2,5000 x	121,00000 x	482,00000 x	18756 N	N	350396	60611-01	
01	1	2,5000 x	121,00000 x	482,00000 x	18756 N	N	350397	57045-01	
**	4				75024				
***	4				75024				

Q.C.I. N.D.
 Q.C.I. E.Y.

FEB 04 2013

B04 Product delivery condition
 ITEM NO.: 01
 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
 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
 THICKNESS REDUCTION RATIO >= 3,0 IS FULFILLED (CF. A/SA20 PAR. 5.3)

ACCEPTED/REVIEWED/RELEASED
 for and on behalf of
 Print Name: YANESH SAHA
 Signature: [Signature]
 Date: 17/09/13
 046
 APPLIS
 VELOSI
 Velosi America LLC

A04 2017Z02/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

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

AHB
 Inspector's stamp Date 17.09.10 BM 1

B. BAUDAUF
 Test House Manager

Manufacturer's mark



DILLINGER HÜTTE

Erläuterungen siehe Rückseite/Explications voir au verso/Ser 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

369431-17.09.10

A08/ Manufacturer's order/
A03 Certificate No.

357366-001

Sheet

2/...

A05 Established inspecting body A06 Purchaser EDMONTON STEEL, EDMON A07.1 No. ED10551-J1010-ER

DH Final receiver EDMONTON STEEL, EDMON A07.2 No. SA20-S5

B02/ Steel design. SA516-70

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

requirements DIL-HUE-16:R18-2010-03-19

B01 Product 046
HOT ROLLED PLATES

ACCEPTED/REVIEWED/RELEASED
for and on behalf of:
Print Name: YANRSI S
Signature: YANRSI S
Date: 17.09.10
Applus
VELOSI
Velosi America LLC

C10-C29 Tensile test

B14 Item No.	B07.2 Heat No.	B07.1 Rol./plate/ Test No.	B05 Reference (heat) treatment	C01 C02/ C03 C01 Temp. GR.F	C10 C11 KSI RP02	C12 C13 RM	A % LO=ZIN
01	350396	60608	K1 QV	RT	49,3	75,8	36
01	350396	60610	K1 QV	RT	46,8	75,5	35
01	350396	60611	K1 QV	RT	46,8	75,4	36
01	350397	57045	K1 QV	RT	47,6	74,4	36

Q.C.I. E.Y.

Q.C.I. N.D.

FEB 0 4 2013

C30-C39 Hardness test

B14 Item No.	B07.2 Heat No.	B07.1 Rol./plate/ Test No.	B05 Reference (heat) treatment	C01 C02/ C03 C01 Temp. GR.F	C30 Method of test	C35 C31 Individual values
01	350396	60608	K1	O	RT HBW 10/3000	HB 141 141 141
01	350396	60610	K1	O	RT HBW 10/3000	HB 143 138 139
01	350396	60611	K1	O	RT HBW 10/3000	HB 143 143 143
01	350397	57045	K1	O	RT HBW 10/3000	HB 146 143 146

C40-C49 Impact test

B14 Item No.	B07.2 Heat No.	B07.1 Rol./plate/ Test No.	B05 Reference (heat) treatment	C01 C02/ C03 C01 Temp. GR.F	C40 Type of test piece	C44 Testing method	C45 C42 Individual values AV=FT.LBF	C46 Energy	C43 Mean value
01	350396	60608	K1	LV	CHP-V	CHP-V	AV 120 100	94	105
01	350396	60610	K1	LV	CHP-V	CHP-V	AV 113 125	119	119
01	350396	60611	K1	LV	CHP-V	CHP-V	AV 122 105	103	110
01	350397	57045	K1	LV	CHP-V	CHP-V	AV 120 122	120	121

A04 201202/203 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



A01

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

B Baldauf



B. BALDAUF
Test House Manager

Inspector's stamp Date 17.09.10

BM 1



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

A02 INSPECTION CERTIFICATE 3.1.1 AS PER EN 10204:2004

INSPECTION CERTIFICATE 3.1.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991

MATERIAL TEST REPORT (NTR)

A05 Established inspecting body A06 Purchaser EDMONTON STEEL, EDMON A07.1 No. ED10551-J1010-ER

DH Final receiver EDMONTON STEEL, EDMON A07.2 No. SA20-S5

B02/ Steel design. SA516-70

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

requirements DIL-HUB-16:R18-2010-03-19

A10 Advice of dispatch No./ Date of dispatch 369431-17.09.10

A03 Certificate No. 357366-001

A08/ Manufacturer's order/ Certificate No. 357366-001

807 Product 046

HOT ROLLED PLATES

APPLIUS VELOSI

Velosi America LLC

ACCEPTED/REVIEWED/RELEASED for and on behalf of SA MESH SA HA

Print Name: G. Frankly Signature: G. Frankly

C70-C99 Chemical composition % - Heat analysis

Table with columns for elements (C, Si, Mn, P, S, N, Cu, Mo, Ni, CR, V) and values for various heat treatments (C70, C70.2, 350396, 350397).

Q.C.I. N.D.

FEB 04 2013

W.O.# 11769 M.L.# THK.# P.O.# 12-1619-178

C94 Heat analysis Carbon equivalent / Alloying restrictions

Table with columns for heat treatments (FO-02, FO-51, FO-55, FO-78, FO-91) and values for carbon equivalent and alloying restrictions.

C95 Ladle treatment

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

Certification of Material - Per ASME HT# 350397

Qualifies to all requirements of SA 516-70 per Sect. II 10 Edition II Addenda

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20) CU + Ni + CR + MO = 342 CR+MO = 249

C70-C99 Chemical composition % - Product analysis

Table with columns for elements (C, Si, Mn, P, S, N, Cu, Mo, Ni, CR, V) and values for various heat treatments (C01, K1, 350397).

2012/20203 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

QM-System: Certification as per ISO 9001



B. BALDAUF Test House Manager

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

Inspector's stamp Date 17.09.10

BM 1



DILLINGER HÜTTE

Erfüllungen siehe Rückseite/Specifications voir au verso/Spec/revise for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991
 MATERIAL TEST REPORT (MTR)

A05 Established inspecting body A06 Purchaser EDMONTON STEEL, EDMON A07.1 No. ED10551-J1010-ER
 DH Final receiver EDMONTON STEEL, EDMON A07.2 No. SA20-S5

B02/ Steel design. SA516-70
 B03 Any suppl. ASME-II-A:07+A09
 requirements DIL-HUE-16:R18-2010-03-19

C70-C99 Chemical composition % - Product analysis

Heat	Test No.	B	CA	AL-T
350396	60610	0,0001	0,0013	0,034
350397	57045	0,0000	0,0015	0,039

C94 Product analysis Carbon equivalent / Alloying restrictions

Heat	Test No.	FO-02=	FO-55=
350396	60610	0,42	0,33
350397	57045	0,42	0,35

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

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

ITEM NO.: 01
 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



046
 ACCEPTED FOR REVIEW / RELEASED
 for and on behalf of: *Arplus*
 Print Name: *John M. Velosi*
 Signature: *[Signature]*
 Date: *FEB 04 2013*

A04 2017/02/203 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

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

B. Baldauf
 B. BALDAUF
 Test House Manager

Inspector's stamp Date 17.09.10 BM 1



edmonton exchanger
& manufacturing ltd.

CERTIFICATE OF COMPLIANCE

MTR List

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 ALL-WELD COMPANY LIMITED

PO 12-1619-1178Q

Work Order C96984 Date 2013/01/21 CoC# 38471

Page 1 of 1

MTR ID	Pages	Heat#	Thickness	Material Grades
15031	4	332914-19027	2.5"	SA 516-70 N
		332914-19130	2.5"	SA 516-70 N
15033	3	332914-18895	2.5"	SA 516-70 N
15749	4	350397-57045	2.5"	SA 516-70 N

Heat#	Material Grades	MTR ID
332914-18895	SA 516-70 N BTM	15033
332914-19027	SA 516-70 N	15031
332914-19130	SA 516-70 N	15031
350397-57045	SA 516-70 N TOP	15749

ACCEPTED/REVIEWED/RELEASED
for and on behalf of: Velosi America
Print Name: ANAND SH SAHAI
Signature: [Signature]
Date: March 14/13
Applus
VELOSI
Velosi America LLC

Q.C.I.
E.Y.

Q.C.I.
N.D.

FEB 04 2013



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 ALL-WELD COMPANY LIMITED PO 12-1619-1178Q Work Order C96984 Date 2013/01/21 ColC# 38471 Page 1 of 1

Item#	Description	Qty	Heat#	Required Min Thk	Recorded Min Thk	Form. Proc.
H96984-1	HEAD(S) - Semi-Elliptical 2:1 - 2.5000" NOM (2.2820" MIN) X 60" ID (Material Spec: SA 516-70 Normalized) Conforms to NACE MR0175 / ISO 15156-2 2009 Annex A	1	350397-57045	2.2820"	2.4630"	1
		1	332914-18895	2.2820"	2.4590"	1
		1	332914-19027	2.2820"	2.4590"	1
		1	332914-19130	2.2820"	2.4350"	1

Forming Procedure:
1. Hot Formed @ 1650F/899C and Air Cooled

Brinell Equipment: Newage Calibrated Pin
Brinell Hardness Tester

Supplementary Requirements

Item H96984-1-3, H96984-1-4 had cosmetic surface repairs done in accordance with ASME Sec.VIII, Div.1 and ASME Sec.IX. Repairs were done per approved Weld Procedure WP-2 (as welded) or WP-63 (PWHT). All repaired areas were MT examined.

Normalized Material Identification Marking:
 'MT' Indicates normalized by the mill per ASME Code Section II, Part A, SA 20, Paragraph 13.1.1.
 'GMT' Indicates normalized by Edmonton Exchanger per ASME Code Section II, Part A, SA 20, Paragraph 13.1.2.
 'GT' Indicates normalized by Edmonton Exchanger per ASME Code Section VIII Division 1, UG-85 or ASME Code Section I, PG-77.4.

The item(s) listed above comply with the requirements of ASME Code Section I, PG-29, PG-81 and ASME Code Section VIII, Division 1, UCS-79(d), UG-79 & UG-81. All welders and procedures are qualified to ASME Code Section IX. Material being supplied conforms to the latest ASME Code Section II, Part A, 2010 Edition, Addenda July 1, 2011.


Supplementary Examination - Items

Edmonton Exchanger
MPI - Dry MPI
(for -1-3, -1-4)
Acceptable to ASME Code

X SEC. VIII, DIV.1	_ SEC. IV
_ SEC. VIII, DIV.2	_ B31.1
_ SEC. I	_ B31.3

_ Bevelled Edge _ Backgouge
 _ Completed Welds
 X Surface Repair Area

EE Procedure: MPI-001 REV.13
 Material: SA 516-70 N
 Thickness: 2.5"
 Parker B300 Yoke
 Magnaflux 8A-Red (Dry)
 AC Continuous
 Light: Natural
 Tech: Roy Brown (#16669)
 CGSB / SNT: Level II
 Date: 2013/01/18
 Time: Day Shift


FEB 04 2013

ACCEPTED/REVIEWED/RELEASED 046

for and on behalf of: SBM

Print Name: GANESH SAHA

Signature: [Signature]

Date: Jan 16/13

Applus®
VELOSI
Veloci America LLC

CONREX STEEL LIMITED
 50 TABER ROAD
 REXDALE, ONTARIO M9W 3A9
 HEAT TRACING RECORD

PAGE # 1

CSL WO# QTY DESCRIPTION CUSTOMER CUST PO#
 73681 4 SE heads 60" ID x 2 1/2" thk Allweld Company 13-0095

ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SDH OFFSHORE
 Print Name: GANESH SATHI
 Signature: *[Signature]*
 Date: July 14/13
 Applus[®] VELOS
 Velosi America L'

HEAT TREATMENT SPECIFICATION: CSL-NR-001
 HEAT AT max 400°F PER HOUR FROM 600°F
 HOLD min 68 MINUTES AT 1670°F +/- 25°F
 COOL AT in air PER HOUR TO —

DCM
 FEB 07 2013

THERMOCOUPLES: # 1, 2, 3 & 4

NOTES: _____

All temperatures in degrees Fahrenheit unless noted

SIGNED FOR CSL *[Signature]* DATE Feb 6/13

TIME	STEP	SETPT	CHART TEMPERATURES					
			TC#1	TC#2	TC#3	TC#4	TC#5	TC#6
14:50	1	133	124	106	130	141	0	0
15:00	1	217	221	178	201	235	0	0
15:10	1	288	308	246	271	321	0	0
15:20	1	366	391	300	352	412	0	0
15:30	1	443	469	378	416	482	0	0
15:40	1	521	544	453	487	555	0	0
15:50	1	598	624	528	569	639	0	0
16:00	1	676	699	607	646	711	0	0
16:10	1	753	771	679	725	789	0	0
16:20	2	817	840	764	792	852	0	0
16:30	2	858	873	808	833	881	0	0
16:40	2	900	910	857	874	919	0	0

CHART TEMPERATURES

TIME	STEP	SETPT	TC#1	TC#2	TC#3	TC#4	TC#5	TC#6
16:50	2	942	949	895	920	962	0	0
17:00	2	983	989	948	958	994	0	0
17:10	2	1025	1028	977	1008	1039	0	0
17:20	2	1067	1067	1024	1049	1079	0	0
17:30	2	1108	1111	1068	1091	1118	0	0
17:40	2	1150	1152	1117	1132	1158	0	0
17:50	2	1192	1194	1160	1178	1203	0	0
18:00	2	1233	1232	1203	1215	1235	0	0
18:10	2	1275	1273	1242	1262	1281	0	0
18:20	3	1310	1311	1285	1296	1316	0	0
18:30	3	1335	1335	1313	1323	1337	0	0
18:40	3	1359	1358	1339	1348	1362	0	0
18:50	3	1384	1379	1364	1375	1386	0	0
19:00	3	1409	1403	1386	1397	1406	0	0
19:10	3	1433	1433	1408	1422	1438	0	0
19:20	3	1458	1455	1435	1449	1463	0	0
19:30	3	1483	1478	1463	1473	1487	0	0
19:40	3	1507	1501	1486	1497	1508	0	0
19:50	3	1532	1531	1512	1526	1538	0	0
20:00	3	1557	1554	1537	1551	1564	0	0
20:10	3	1581	1578	1564	1574	1584	0	0
20:20	3	1606	1606	1590	1603	1610	0	0
20:30	3	1631	1630	1617	1627	1633	0	0
20:40	3	1655	1655	1641	1650	1657	0	0
20:50	4	1670	1675	1661	1669	1674	0	0
21:00	4	1670	1674	1664	1667	1672	0	0
21:10	4	1670	1674	1664	1670	1673	0	0
21:20	4	1670	1672	1665	1670	1673	0	0
21:30	4	1670	1672	1664	1665	1669	0	0
21:40	4	1670	1672	1665	1670	1672	0	0
21:50	4	1670	1675	1667	1672	1674	0	0
22:00	4	1670	1674	1668	1671	1671	0	0
22:10	4	1370	1480	1454	1402	1409	0	0
22:20	4	1158	1216	1243	1170	1181	0	0
22:30	4	921	955	1023	977	948	0	0
22:40	4	761	807	880	809	775	0	0

REF#2617

046

ACCEPTED/REVIEWED/RELEASED

for and on behalf of: SAM OFF SHORE

Print Name: GANESH SAHA

Signature: [Signature]

Date: July 10/13

Applus[®]
VELOSI
Velosi America LLC

CONREX STEEL

A CONREX COMPANY

03/09/90
Rev. 0

PROCEDURE FOR NORMALIZING CSL-NR-001

The following is a standard procedure for normalizing followed unless otherwise specified by the customer.

1. The component shall be heated uniformly to a temperature range of 1600 to 1700 degrees Fahrenheit. The exact temperature depends on the material specification.
2. The temperature of the furnace shall not exceed 800 degrees F at the time the component is placed in it.
3. Above 800 degrees F, the maximum heating rate shall be 400 degrees F/hour. During the heating period, variation in temperature throughout the portion of the component being heated shall not be greater than 250 degrees F within any 15 feet interval of length.
4. The component shall be held within the specified temperature limit for a minimum of time specified in the following table, based on the component thickness, to ensure homogenization :

Minimum Holding Time

Up to 2 inches

Over 2 inches

1/2 hour/inch, 30 minutes
minimum

1/2 hour per inch up to
2 inches, 15 minutes per
inch thereafter

5. The component shall be cooled in still air.

CONREX STEEL LTD.

50 Taber Road, Rexdale, Ontario, M9W 3A9 Phone (416)-747-4665 Fax (416)-747-4667

CALIBRATION CERTIFICATE

INSTRUMENT: Stress Relief Furnace #1
 MANUFACTURER: Allen Bradley (SLC 503)
 SERIAL NUMBER: Conrex #1

Standard	As Found	Calibrated	Standard	As Found	Calibrated
LOAD#1			ADDITIONAL TEMPERATURE CONTROLS		
1125°F	1128°F	8/17/2012	1#: 1125°F	1127°F	8/17/2012
1650°F	1652°F	8/17/2012	1650°F	1652°F	8/17/2012
			2#: 1125°F	1126°F	8/17/2012
LOAD#2			1650°F	1652°F	8/17/2012
1125°F	1126°F	8/17/2012	3#: 1125°F	1126°F	8/17/2012
1650°F	1652°F	8/17/2012	1650°F	1651°F	8/17/2012
			4#: 1125°F	1126°F	8/17/2012
LOAD#3			1650°F	1651°F	8/17/2012
1125°F	1126°F	8/17/2012	5#: 1125°F	1126°F	8/17/2012
1650°F	1652°F	8/17/2012	1650°F	1651°F	8/17/2012
			6#: 1125°F	1126°F	8/17/2012
			1650°F	1651°F	8/17/2012
			7#: 1125°F		
			1650°F		
			8#: 1125°F		
			1650°F		

046

ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SAM OFFSHORE
 Print Name: GANESH SAHA
 Signature: [Signature]
 Date: Aug 17 2012
Applus®
VELOSI
 Velosi America LLC

If 'calibrated' column is blank. No adjustments were necessary

COMMENTS: STANDARD: PPS MINITEMP MODEL 1062, SER# B67568
 QC INSPECTOR: [Signature] QC MANAGER: Ling Tong DATE: Aug 17, 2012

CERTIFICATE OF CALIBRATION**Customer:** CONREX STEEL
50 TABER ROAD
REXDALE, ON M9W 3A9 .**Customer Nbr:** 9-283590-000
PO Nbr: 2292
Date Received: March 29, 2012**Cert/SO Nbr:** 33-8X7EE-1-1
Manufacturer: Transmatom
Model Nbr: 1062**Date Completed:** April 12, 2012
Due Date: April 12, 2013**Description:** Thermocouple Calibrator
Serial Nbr: B67568
ID Nbr: NONE
Unit Barcode: 900A3296141**Calibrated To:** Manufacturer Specification
Calibration Proc: 1-AC17451-1
Item Received: In Tolerance
Item Returned: In Tolerance

For calibration data, see Supplemental Report for SO Nbr 33-8X7EE-1-1

Transcat Calibration Laboratories have been audited and found in compliance with ISO/IEC 17025:2005. Accredited calibrations performed within the Lab's Scope of Accreditation are indicated by the presence of the Accrediting Body's Logo and Certificate Number on this Certificate of Calibration. Any measurements on an accredited calibration not covered by that Lab's Scope are listed in the notes section of the certificate. This report must not be used to claim product certification approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

Transcat calibrations, as applicable, are performed in compliance with the requirements of ISO9001:2008, ISO TS16949, ANSI/NCCL Z540-1994, and ISO 10012-1:1992. When specified contractually the requirements of 10CFR21, 10CFR50 App. B and NQA-1 are also covered.

Traceability includes no less than an unbroken chain of comparison realization of SI units, measurement uncertainty, documentation, competence, periodic recalibration and measurement assurance. Transcat documents the traceability of measurements to the SI units through the National Institute of Standards and Technology (NIST) or the National Research Council of Canada (NRC), or other recognized national measurement institutes (NMI's) or international standard bodies, or to measurable conditions created in our laboratory, or accepted fundamental and/or natural physical constants, ratio type of calibration, or by comparison to consensus standards. The specific path of traceability for the reported measurement results is maintained at the Transcat facility and is available there for review.

Complete records of work performed are maintained by Transcat and are available for inspection. Laboratory standards used in the performance of this calibration are shown on the Supplemental Report.

The results in this report relate only to the item calibrated or tested and the determination of in or out of tolerance is specific to the model/serial no. referenced above based on the tolerances shown on the supplemental report; these tolerances are either the original equipment manufacturer's (OEM's) warranted specifications or the client's requested specifications.

The applied uncertainty is the uncertainty of the calibration process. The Test Uncertainty Ratio (TUR) is calculated as per NCSL International RP9, section 8.2. All calibrations have been performed using processes having a TUR of 4:1 or better, unless otherwise noted on the Supplemental Report. Uncertainties have been estimated at a 95 percent confidence level (k=2). Calibration at a 4:1 TUR (or greater) provides reasonable confidence that the instrument is within the stated tolerances. For measuring instruments in order to consider the contribution to the uncertainty from reproducibility of the unit under test (UUT), add 0.6 of the UUT's least significant digit to the reported uncertainty. For mass calibrations, Conventional mass referenced to 8.0 g/cm³.

Any number of factors can cause a unit to drift out of tolerance at any time following its calibration. Limitations on the uses of this instrument are detailed in the OEM's operating instructions.

Notes:**Calibrated At:**
4043 Carling Avenue
Ottawa, ON K2K 2A4
By: Keith Manson**Facility Responsible:**
4043 Carling Avenue
Ottawa, ON K2K 2A4
613-591-8140 **Digitally Signed By Keith Powell**
Date: April 13, 2012

Keith Powell
Lab Manager Digitally Signed On April 12, 2012**Revision 0**

This certificate may not be reproduced except in full without the written approval of Transcat. Additional information if applicable may be included on separate reports.

QM-System: Certification as per ISO 9001



DILLINGER HÜTTE

Erläuterungen siehe Rückseite/Explications voir au verso/Seprévisionse 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
 388605-15.05.11

A08 Purchaser EDMONTON STEEL, EDMON A07.1 No. ED10566-J1010-ER
 Final receiver EDMONTON STEEL, EDMON A07.2 No.

A06/ Manufacturer's order/ Certificate No.
 364846-001
 B01 Product
 HOT ROLLED PLATES

Sheet
 1/...

B02/ Steel design. SA516-70
 B03 Any suppl. ASME-II-A:10 requirements DIL-HUE-16:R19-2010-11-22

SA20-S5

B01-B99 Description of the product

B14 Item No.	B08 Number of pieces	B09 Thickness	B10 Width	B11 Length	B12 Theoretical mass	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate Test No.	A09 Purchaser article number
01	1	2,5000 x	97,00000 x	482,00000 x	15036 N		358699	92215-01	ITEM 03
01	1	2,5000 x	97,00000 x	482,00000 x	15036 N		358699	92219-01	ITEM 03
01	1	2,5000 x	97,00000 x	482,00000 x	15036 N		358699	92223-01	ITEM 03
01	1	2,5000 x	97,00000 x	482,00000 x	15036 N		358699	92224-01	ITEM 03
01	1	2,5000 x	97,00000 x	482,00000 x	15036 N		358699	92233-01	ITEM 03
01	1	2,5000 x	97,00000 x	482,00000 x	15036 N		358701	90320-01	ITEM 03
01	1	2,5000 x	97,00000 x	482,00000 x	15036 N		358701	92027-01	ITEM 03
**	7				105252				
***	7				105252				

B04 Product delivery condition

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

A04

A01

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

Inspector's stamp
 B. BALDAUF
 Test House Manager

Date 16.05.11

PP 1



ACCEPTED/REVIEWED/REJECTED
 for and on behalf of: S B M off shore
 Print Name: YAN BSH SAHA
 Signature: [Signature]
 Date: 04 FEB 04 2013

046

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 Velosi America LLC



QM-System: Certification as per ISO 9001

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

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991

MATERIAL TEST REPORT (MTR)

A05 Established inspecting body A06 Purchaser EDMONTON STEEL, EDMON A07.1 No. ED10566-J1010-ER
 DH Final receiver EDMONTON STEEL, EDMON A07.2 No. SA20-S5

B02/ Steel design SA516-70

B03 Any suppl. ASME-II-A:10

requirements DIL-HUE-16:R19-2010-11-22

A10 Advice of dispatch No./
Date of dispatch
388605-15.05.11

A08/ Manufacturer's order/
A03 Certificate No.
364846-001

Sheet
2/...

B01 Product
HOT ROLLED PLATES

C10-C29 Tensile test

B14 Item No.	B07.2 Heat No.	B07.1 Rol./plate/ Test No.	B05 Reference (heat) treatment	C01 C02/ C03 C01 Temp. GR.F	C10 C11 KSI RPO2	C12 RM	C13	A % L0=ZIN
01	358699	92215		K1 QV RT	47,9	75,1		36
01	358699	92219		K1 QV RT	48,6	74,5		37
01	358699	92223		K1 QV RT	48,0	75,0		37
01	358699	92224		K1 QV RT	48,7	74,5		36
01	358699	92233		F1 QV RT	47,6	75,0		36
01	358701	90320		K1 QV RT	48,0	75,5		35
01	358701	92027		K1 QV RT	48,1	75,5		35

C14-215

ACCEPTED/REMOVED/RELEASED
 for and on behalf of: *Spit Velosi America*
APPLUS® VELOSI
 Print Name: *G. POI BSH SAH A*
 Signature: *[Signature]*
 Date: *15.05.11*
 Velosi America LLC

C30-C39 Hardness 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	C30 Method of test	C35 C31 Individual values	C32 Mean value
01	358699	92215		K1 O	RT HBW 10/3000	HB 147	147	147
01	358699	92219		K1 O	RT HBW 10/3000	HB 147	147	147
01	358699	92223		K1 O	RT HBW 10/3000	HB 148	147	148
01	358699	92224		K1 O	RT HBW 10/3000	HB 148	147	147
01	358699	92233		F1 O	RT HBW 10/3000	HB 147	147	144
01	358701	90320		K1 O	RT HBW 10/3000	HB 144	144	144
01	358701	92027		K1 O	RT HBW 10/3000	HB 143	145	144

Q.C.I.
N.D.

Q.C.I.
E.V.

FEB 04 2013



A04 Z017202/203 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

[Signature]

AHB

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

B. BALDAUF Test House Manager
 Inspector's stamp Date 16.05.11 PP 1



DILLINGER HÜTTE

QM-System: Certification as per ISO 9001

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

A10 Advice of dispatch No./ Date of dispatch
 388605-15.05.11

A03 Certificate No.
 364846-001

Sheet
 3/...

MATERIAL TEST REPORT (MTR)

A05 Purchaser EDMONTON STEEL, EDMON A07.1 No. ED10566-J1010-ER
 Final receiver EDMONTON STEEL, EDMON A07.2 No. SA20-S5

B02/ Steel design SA516-70
 B03 Any suppl. ASME-II-A:10
 requirements DIL-HUE-16:R19-2010-11-22

W.O. # 11760
 M.L. # 2
 THK. # 2 1/2"
 P.O. # 12-1619-11780

C40-C49 Impact test

B14 Item No.	B07.2 Heat No.	B07.1 Roll plate Test No.	B05 Reference (heat) treatment	C01	C02/ C01	C03 Temp. GRF	C41 Width of test piece	C40 Type of test piece	C44 Testing method	C46 Energy	C45 Individual values AV=FT.LBF	C43 Meas value
01	358699	92215		K1 LV	-51		CHP-V	CHP-V	AV 86	108	103	99
01	358699	92219		K1 LV	-51		CHP-V	CHP-V	AV 98	134	114	115
01	358699	92223		K1 LV	-51		CHP-V	CHP-V	AV 105	94	67	89
01	358699	92224		K1 LV	-51		CHP-V	CHP-V	AV 89	82	91	87
01	358699	92233		F1 LV	-51		CHP-V	CHP-V	AV 119	137	123	126
01	358701	90320		K1 LV	-51		CHP-V	CHP-V	AV 97	111	39	82
01	358701	92027		K1 LV	-51		CHP-V	CHP-V	AV 80	106	77	88

C70-C99 Chemical composition % - Heat analysis

B07.2 Heat	C70	C	SI	MN	P	S	N	CU	MO	NI	CR	VB	SN	TI
358699	Y	0,173	0,372	1,18	0,008	0,0007	0,0081	0,028	0,009	0,065	0,231	0,001	0,000	0,001
358701	Y	0,179	0,377	1,19	0,008	0,0008	0,0068	0,025	0,009	0,039	0,226	0,001	0,000	0,002

C94 Heat analysis Carbon equivalent / Alloying restrictions

B07.2 Heat	B	CA	AL-T
358699	Y	0,0001	0,0024
358701	Y	0,0000	0,0034

FO-02= 0,42 FO-51= 0,001 FO-78= 0,24 FO-91= 6,8
 FO-02= 0,43 FO-51= 0,001 FO-78= 0,24 FO-91= 6,6

Certification of Material - Per ASMB
 HT# 358699
 Qualifies to all requirements of
 SA516-GR70N per
 Sect. II, Ed. III, Addendum 1

Q.C.I. N.D.
 Q.C.I. E.Y.
 FEB 04 2013

LIMITS OF UNSPECIFIED ELEMENTS PER ASMB SECTION II (SA-20)
 CU + Ni + CR + MO = .331
 CR + MO = .24

A04

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

Inspector's stamp
 Date 16.05.11

Test House Manager
 B. BALDAUF

Signature: [Signature]
 Date: [Date]

ACCEPTED/REVIEWED/RELEASED
 046
 that the above mentioned materials have been delivered in accordance with the terms of order: [Signature]
 Print Name: G. HANSEN
 Signature: [Signature]
 Date: [Date]

Manufacturer's mark



DILLINGER HÜTTE

QM-System: Certification as per ISO 9001

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	A10	Advice of dispatch No./ Date of dispatch	388605-15.05.11	A08/ Manufacturer's order/ A03 Certificate No.	364846-001	Sheet	4/...
A03	INSPECTION CERTIFICATE 3.1.B	AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991							

A05	Established inspecting body	Final receiver	A07.1 No.	EDMONTON STEEL, EDMON	A07.2 No.	EDMONTON STEEL, EDMON	B01 Product	HOT ROLLED PLATES
	DH							

MATERIAL TEST REPORT (MTR)
 SA516-70
 ASME-II-A:10
 DIL-HUB-16:R19-2010-11-22
 SA20-S5

C95 Ladle treatment
 ITEM NO.: 01
 HEAT OF THE INDICATED ITEM: VACUUM DEGASSED / SULPHIDE SHAPE CONTROL

C95 Further information about ladle treatment
 ITEM NO.: 01
 CALCIUM TREATED

C70-C99 Chemical composition % - Product analysis

Heat	Test No.	C	SI	MN	P	S	N	CU	MO	NI	CR	V	NB	SN	TI
358699	92219	0,175	0,367	1,17	0,008	0,0008	0,0068	0,027	0,010	0,065	0,226	0,001	0,001	0,001	0,002
358701	92027	0,180	0,369	1,17	0,008	0,0006	0,0064	0,024	0,009	0,043	0,221	0,000	0,000	0,000	0,002

C94 Product analysis Carbon equivalent / Alloying restrictions

Heat	Test No.	B	CA	AL-T
358699	92219	0,0001	0,0025	0,037
358701	92027	0,0001	0,0017	0,033

C94 Carbon equivalent formula / Alloying restrictions

Heat	Test No.	FO-02=	FO-55=
358699	92219	0,42	0,33
358701	92027	0,43	0,30

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

ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SBM Off Shore
 Print Name: YFANBIT SAITA
 Signature: [Signature]
 Date: 16.05.11
 APPLUS® VELOSI
 Velosi America LLC

Z01Z02Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.
 B. BALDAUF
 Test House Manager
 AHB
 AG der Dillinger Hüttenwerke
 Postfach 1580, D-66748 Dillingen/Saar
 Inspection department
 Date 16.05.11
 PP 1



QM-System: Certification as per ISO 9001

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

<p>A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991</p>	<p>A10 Advice of dispatch No./ Date of dispatch 388605-15.05.11</p>	<p>A08/ Manufacturer's order/ A03 Certificate No. 364846-001</p>	<p>Sheet 5</p>
<p>MATERIAL TEST REPORT (MTR)</p>		<p>B01 Product HOT ROLLED PLATES</p>	
<p>A05 Established inspecting body DH</p>	<p>A06 Purchaser EDMONTON STEEL, EDMON</p>	<p>A07.1 No. ED10566-J1010-ER</p>	<p>A07.2 No. EDMONTON STEEL, EDMON</p>
<p>B02 Steel design. SA516-70</p>	<p>SA20-S5</p>	<p>Final receiver EDMONTON STEEL, EDMON</p>	
<p>B03 Any suppl. requirements</p>	<p>ASME-II-A:10 DIL-HUE-16:R19-2010-11-22</p>	<p>SA20-S5</p>	

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

ITEM NO.: 01
 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



ACCEPTED/REVIEWED/RELEASED 046
 for and on behalf of: S. Bhat off shore
 Print Name: GANESH SAHA
 Signature: [Signature]
 Date: March 14/13
APPLUS®
VELOSI
 Velosi America LLC

<p>A04</p>	<p>Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.</p>	<p>AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar inspection department</p>	<p>A01</p>
<p>Manufacturer's mark</p>	<p>Inspector's stamp</p>	<p>Date 16.05.11</p>	<p>PP</p>



CERTIFICATE OF COMPLIANCE

MTR List

edmonton exchanger
& manufacturing ltd.

5000 99 Street Edmonton, Alberta Canada T6E 5W9 www.edmontonexchanger.com tel 780.468.6722 • QC fax 780.466.4668 • sales fax 780.466.5155

Customer ALL-WELD COMPANY LIMITED PO 12-1619-1178Q Work Order C96984 Date 2013/01/10 CotC# 38253 Page 1 of 1

MTR ID	Pages	Heat#	Thickness	Material Grades
16196	5	358699-92224	2.5"	SA 516-70 N

Heat#	Material Grades	MTR ID
358699-92224	SA 516-70 N	16196

ACCEPTED/REVIEWED/RELEASED 046
 for and on behalf of: SBM OFFSHORE
 Print Name: GAURESH SAHA
 Signature: [Signature]
 Date: March 14/13
Applus
VELOSI
 Velosi America LLC



FEB 04 2013



edmonton exchanger
& manufacturing ltd.

CERTIFICATE OF COMPLIANCE

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 ALL-WELD COMPANY LIMITED po 12-1619-1178Q Work Order C96984 Date 2013/01/10 CofC# 38253 Page 1 of 1

Item#	Description	Qty	Heat#	Weld Proc.	Form. Proc.
S96984-2-1	SHELL(S) - 2.5000" NOM X 60" ID X 96" (Material Spec: SA 516-70 Normalized) Conforms to NACE MR0175 / ISO 15156-2 2009 Annex A	1	358699-92224	WP600	4
S96984-2-2	SHELL(S) - 2.5000" NOM X 60" ID X 96" (Material Spec: SA 516-70 Normalized) Conforms to NACE MR0175 / ISO 15156-2 2009 Annex A	1	358699-92224	WP600	4

Forming Procedure:
4. Cold Formed

Brinell Equipment: Newage Calibrated Pin
Brinell Hardness Tester

Supplementary Requirements

Item S96984-2-2 had cosmetic surface repairs done in accordance with ASME Sec.VIII, Div.1 and ASME Sec.IX. Repairs were done per approved Weld Procedure WP-2 (as welded) or WP-63 (PWHT). All repaired areas were MT examined.

Normalized Material Identification Marking:
 'MT' indicates normalized by the mill per ASME Code Section II, Part A, SA 20, Paragraph 13.1.1.
 'GMT' indicates normalized by Edmonton Exchanger per ASME Code Section II, Part A, SA 20, Paragraph 13.1.2.
 'GT' indicates normalized by Edmonton Exchanger per ASME Code Section VIII Division 1, UG-85 or ASME Code Section I, PG-77.4.


The item(s) listed above comply with the requirements of ASME Code Section I, PG-80 and ASME Code Section VIII, Division 1, UCS-79(d), UG-79 & UG-80. All welders and procedures are qualified to ASME Code Section IX. For tacking carbon steel items, roundbar used is 1018 Cold Rolled. Material being supplied conforms to the latest ASME Code Section II, Part A, 2010 Edition, Addenda July 1, 2011.

Supplementary Examination - Items

Edmonton Exchanger
MPI - Dry MPI
(for -2-2)
Acceptable to ASME Code

X SEC. VIII, DIV.1	_ SEC. IV
_ SEC. VIII, DIV.2	_ B31.1
_ SEC. I	_ B31.3
_ Bevelled Edge	_ Backgouge
_ Completed Welds	
X Surface Repair Area	

EE Procedure: MPI-001 REV.13
 Material: SA 516-70 N
 Thickness: 2.5"
 Parker B300 Yoke
 Magnaflux 8A-Red (Dry)
 AC Continuous
 Light: Natural
 Tech: Tracy Enman (#11226)
 CGSB / SNT: Level II
 Date: 2013/01/09
 Time: Day Shift


FEB 04 2013

046

ACCEPTED/REVIEWED/RELEASED

for and on behalf of: SIBM

Print Name: GAMBISH SAHA

Signature: [Signature]

Date: March 24/13

Applus[®] VELOSI
Velosi America LLC



14527 Smith Rd.
Humble, Texas 77396
TEL: (281) 441-4088
FAX: (281) 441-8899

REPORT NUMBER 71990

DATE 2/21/2013

FCI ORDER NUMBER 59174

Processed I.A.W. EN10204 3.1
I.A.W. NACE MR0175

CUSTOMER ORDER NUMBER 13-0073
SOLD/SHIPPED TO ALL WELD COMPANY LTD.
49 Passmore Ave.

Scarborough ON M1V 4T1 Canada

Item Quantity Description

1 2 24" X 900 X 24.50" LG RTJ I-2 WITH 35" OD, REINFORCEMENT ITEM 1176-3

HEAT NUMBER: W117

MATERIAL TYPE: SA350LF2CL1

Manufactured in USA

I.A.W. ASME 2010 LB 11AD

CHEMICAL ANALYSIS

PHYSICAL PROPERTIES

	PRODUCT	
C	.185	.180 ✓
Mn	1.080	1.087 ✓
P	.0100	.0050 ✓
S	.0030	.0060 ✓
Si	.180	.165 ✓
Cr	.180	.139 ✓
Mo	.030	.036 ✓
V	.023	.021 ✓
Cu	.160	.144 ✓
Ni	.080	.070 ✓
Cb	.001	.005 ✓
Sn	.011	.010 ✓
As	.008	
Sb	.001	
Ti	.0022	.0020 ✓
Al	.018	.024 ✓
B	.0001	
C E	42 ✓	414 ✓

Yield PSI	57,200 ✓
Tensile PSI	83,600 ✓
Elongation	23 ✓
Reduction of Area	63
Hardness	163 HBW ✓
CVN @ -51 °F FT LBS	25/27 28
% Shear	20 20 20
MLE	

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
 CU + Ni + CR + MO = 1.389
 CR + MO = 1.175

W.O. # 1176Q
 M.L. # 3 (3/2)
 THK. #
 P.O. # 13-0073



Certification of Material - Per ASME
 HT# W117
 Qualifies to all requirements of SA350-LF2-CL1 per Sect. II 10 Edition 11 Addenda

MAR 18 2013



Heat Treatment NORMALIZED ✓
 Temperature 1650 °F
 Time at Temperature 13 HRS
 Cooling Media AIR

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

Prepared by [Signature]

Name: Rene Ordonez Title: QA Representative ✓

ACCEPTED/REVIEWED/RELEASED 046
 for and on behalf of: SPM
 Print Name: GANESH SAHA
 Signature: [Signature]
 Date: March 26/13
 Applus® VELOSI
 Velosi America LLC



14527 Smith Rd.
Humble, Texas 77396
TEL: (281) 441-4088
FAX: (281) 441-8899

Page 1 of 1
REPORT NUMBER 71957
DATE 2/20/2013
FCI ORDER NUMBER 59174
Processed I A W EN10204 3.1
I A W. NACE MR0175

CUSTOMER ORDER NUMBER 13 0073
SOLD/SHIPPED TO ALL WELD COMPANY LTD.
49 Passmore Ave.

Scarborough ON M1V 4T1 Canada

Item Quantity Description

2 6 8" X 900 X 14.25" LG RTJ LWN ITEM 1176-4

HEAT NUMBER: W111

MATERIAL TYPE: SA350LF2CL1

Material Origin: USA
Manufactured in USA

I A W. ASME 2010 ED 11AD.

CHEMICAL ANALYSIS

PHYSICAL PROPERTIES

PRODUCT	
C	.180 .190 ✓
Mn	1.120 1.090 ✓
P	.0100 .0080 ✓
S	.0050 .0050 ✓
Si	.220 .200 ✓
Cr	.120 .130 ✓
Mo	.040 .040 ✓
V	.016 .000 ✓
Cu	.180 .050 ✓
Ni	.110 .120 ✓
Cb	.001 .000 ✓
	.0063
Sn	.008
As	.004 .004
Sb	.003 .003
Ti	.0140 .0140
Al	.020 .022
B	.0003
C E	.42 ✓

Yield PSI	49,800 ✓
Tensile PSI	73,600 ✓
Elongation	33 ✓
Reduction of Area	71
Hardness	143 HBW ✓
CVN @ -51 °F FT LBS	68-67-64
% Shear	40-40-40
MLE	054-053-050

Certification of Material - Per ASME
HT# W111
Qualifies to all requirements of
SA350 LF2CL1 per
Sect. II 10 Edition II Addenda

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
CU + Ni + CR + MO = .34
CR+MO = .170

W.O. # 11760
M.L. # 4 (4/2)
THK. # 1.967
P.O. # 13-0073

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

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

Prepared by [Signature]

Name Rene Ordonez Title QA Representative ✓

ACCEPTED/REVIEWED/RELEASED
for and on behalf of: SBM
Print Name: GAMBESH SAHA
Signature: [Signature]
Date: March 26/13
Applus[®] VELOST
Velosi America LLC

Q.C.I. E.Y.

Q. 048 N.D.

8 2013

FCI ORDER NUMBER 59174
Processed I.A.W. EN10204 3.1
I.A.W. NACE MR0175

CUSTOMER ORDER NUMBER 13-0073
SOLD/SHIPPED TO ALL-WELD CO., LTD.
49 PASSMORE AVE.

SCARBOROUGH ONT M1V 4T1 CANADA

Item Quantity Description

4 13 2" X 900 X 11.75" LG RTJ LWN

ITEM 1176-6

HEAT NUMBER: V804

MATERIAL TYPE: SA350LF2CL1

Manufactured in USA

I.A.W. ASME 2010 ED 11AD

CHEMICAL ANALYSIS

PHYSICAL PROPERTIES

PRODUCT		
C	.180	.199
Mn	1.040	1.057
P	.0060	.0090
S	.0000	.0060
Si	.230	.230
Cr	.140	.137
Mo	.030	.026
V	.014	.012
Cu	.190	.179
Ni	.070	.064
Cb	.000	.001
	.0055	
	.013	
As	.003	
Sb	.001	
Ti	.0010	
Al	.026	
B	.0000	
C E	.41	.430

Yield PSI	48,153
Tensile PSI	78,043
Elongation	35
Reduction of Area	70
Hardness	156 HBW
CVN @ -58 °F FT LBS	25/27/28
% Shear	
MLE	

N2,3,4,6,7,8,9
Certification of Material - Per ASME
HT# **V804**
Qualifies to all requirements of
SA350-LF2CL1 per
Sect. II **10** Edition **11** Addenda

W.O. # **11760**
M.L. # **6 (6/2)**
THK. #
P.O. # **13-0073**

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
CU + Ni + CR + MO = **.406**
CR+MO = **.163**

MAR 18 2013

Q.C.I. E.Y. Q.C.I. N.D.

Heat Treatment NORMALIZED
Temperature 1670 °F
Time at Temperature
Cooling Media AIR

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

Prepared by *Helen Fielder*

Name Helen Fielder Title QA Representative

ACCEPTED/REVIEWED/RELEASED 046
for and on behalf of: **SAM**
Print Name: **GANESH SAHA**
Signature: *[Signature]*
Date: **2/19/13**
Applus[®] VELOSI
Velosi America LLC



14527 Smith Rd.
Humble, Texas 77396
TEL: (281) 441-4088
FAX: (281) 441-8899

REPORT NUMBER 72048

DATE 2/21/2013

FCI ORDER NUMBER 59174

Processed I.A.W. EN10204 3.1
I.A.W. NACE MR0175

CUSTOMER ORDER NUMBER 13-0073
SOLD/SHIPPED TO ALL WELD COMPANY LTD.
49 Passmore Ave.

Scarborough ON M1V 4T1 Canada

Item Quantity Description

6 2 24" X 900 RTJ BLIND

ITEM 1176-B

HEAT NUMBER: Z541

MATERIAL TYPE: SA350LF2CL1

Material Origin: USA
Manufactured in USA

I.A.W. ASME 2010 ED 11AD

CHEMICAL ANALYSIS

PHYSICAL PROPERTIES

PRODUCT

C	160	170 ✓
Mn	1190	1130 ✓
P	.0090	.0070 ✓
S	.0040	.0030 ✓
Si	.220	.200 ✓
Cr	.070	.070 ✓
Mo	.010	.009 ✓
V	.042	.040 ✓
Cu	.060	.040 ✓
Ni	.030	.030 ✓
Cb	.001	.002 ✓
	.0152	
Sn	.007	
As	.003	
Sb	.006	
Ti	.0030	
Al	.020	
B	.0002	
C E	.39 ✓	.390 ✓

Yield PSI	52,600 ✓
Tensile PSI	74,400 ✓
Elongation	37.6 ✓
Reduction of Area	68.3 ✓
Hardness	143-149 HBW ✓
CVN @ -51 F FT LBS	130-128-132 ✓
% Shear	50:50:50 ✓
MLE	090-088-092 ✓

Certification of Material - Per ASME
HT# Z541
Qualifies to all requirements of
SA350-LF2CL1 per
Sect. II 10 Edition 11 Addenda

W.O. # 1176Q
M.L. # 8(514)
THK. # -
P.O. # 13-0073

Q.C.I.
E.Y.

Q.C.I.
N.D.

LIMITS OF UNSPECIFIED
ELEMENTS PER ASME
SECTION II (SA-20)
CU + NI + CR + MO = .189
CR + MO = .079

MAR 18 2013

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

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

Prepared by [Signature]

Name: Rene Ordoñez Title: QA Representative

ACCEPTED/REVIEWED/RELEASED 046
for and on behalf of: S B M
Print Name: LIANEESH SAHA
Signature: [Signature]
Date: 2/21/13
Applus® VELOSI
Velosi America LLC

CUSTOMER ORDER NUMBER 13-0073
SOLD/SHIPPED TO ALL WELD COMPANY LTD.
49 Passmore Ave.

Processed I.A.W. EN10204 3.1
I.A.W. NACE MR0175

Scarborough ON M1V 4T1 Canada

Item Quantity Description

7 2 8" X 900 RTJ BLIND ITEM 11769

HEAT NUMBER: W122

MATERIAL TYPE: SA350LF2CL1

Material Origin: USA
Manufactured in USA
I.A.W. ASME 2010 ED 11AD.

CHEMICAL ANALYSIS

PHYSICAL PROPERTIES

PRODUCT		
C	190	191
Mn	1180	1030
P	0080	0000
S	0030	0050
Si	250	227
Cr	040	034
Mo	011	015
V	017	015
Cu	080	077
Ni	020	018
Cb	001	003
	0080	
Sn	017	015
As	003	
Sb	006	
Ti	0030	0010
Al	025	025
B	0004	
C E	41	380

Yield PSI	46,400
Tensile PSI	71,500
Elongation	34
Reduction of Area	75
Hardness	152 HBW
CVN @ -51 °F FT LBS	80 64 82
% Shear	50.50 50
MLE	059 064 067

Certification of Material - Per ASME
HT# W122
Qualifies to all requirements of
SA350 LF2CL1 per
Sect. II 10 Edition 11 Addenda

W.O. # 1176Q
M.L. # 9(41)
THK. # -
P.O. # 13-0073

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

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
CU + Ni + CR + MO=
CR+MO=

Q.C.I. N.D.
MAR 18 2013

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

Prepared by [Signature]

Name: Rene Ordóñez Title: QA Representative

ACCEPTED/REVIEWED/RELEASED 046
for and on behalf of: SBM
Print Name: GABRIEL SAHIA
Signature: [Signature]
Date: February 26/13
Applus® VELOSI
Velosi America LLC



14527 Smith Rd.
Humble, Texas 77396
TEL: (281) 441-4088
FAX: (281) 441-8899

REPORT NUMBER 72565

DATE 3/8/2013

FCI ORDER NUMBER 59720

Processed I.A.W. EN10204 3.1
I.A.W. NACE MR0175

CUSTOMER ORDER NUMBER 13-0206
SOLD/SHIPPED TO ALL-WELD CO., LTD.
49 PASSMORE AVE.

SCARBOROUGH ONT MIV 4T1 CANADA

Item	Quantity	Description
1	2	FORGINGS SUFFICIENT TO FINISH TO 6" OD X 5" LG

HEAT NUMBER: W150

MATERIAL TYPE: SA350LF2CL1

Material Origin: USA
Manufactured in USA
I.A.W. ASME 2010 ED 11AD.

CHEMICAL ANALYSIS

PHYSICAL PROPERTIES

C	.190
Mn	1.130
P	.0110
S	.0030
Si	.180
Cr	.090
Mo	.020
V	.005
Cu	.220
Ni	.070
C	.001
N	.0050
Sn	.008
As	.005
Sb	.000
Ti	.0010
Al	.024
B	#Type!
CE	.42

Yield PSI	47,800
Tensile PSI	72,900
Elongation	38.9
Reduction of Area	68.2
Hardness	137/137 HBW
CVN @ -51 °F FT LBS	73/78/70
% Shear	40/40/40
MLE	.064/.066/.061

PART HARDNESS (HBW): 143/143

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
CU + Ni + CR + MO = .4
CR + MO = .11

Q.C.I. N.D.

MAR 13 2013

Certification of Material - Per ASME HT# W150
Qualifies to all requirements of SA350-LF2CL1 per Sect. II 10 Edition II Addenda

Q.C.I. E.Y.

MAR 13 2013

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

W.O. # 11760
M.L. # 13 (8/13)
THK. # 6.0
P.O. # 13-0206

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

Prepared by: *[Signature]*
Name: Helen Fielder Title: QA Representative

ACCEPTED/REVIEWED/RELEASED
for and on behalf of: *SBM off shore*
Print Name: *U A NISH SAHA*
Signature: *[Signature]*
Date: *March 14/13*
Applus VELOSI
Velosi America LLC

SUNGKWANG BEND CO., LTD. (SKB)
 1720, Songjeong-Dong, Gyeongju-Ku, Busan Korea
 TEL : 82-051-3300-430
 FAX : 82-051-3300-335
 http://www.skbend.com

MATERIAL TEST & INSPECTION CERTIFICATE

According to
 DIN 50049 3.1 / EN 10204 3.1 / ISO 10474-3.1

CUSTOMER: N/A
 PROJECT NAME: N/A

CERTIFICATE NO. CCLA2012060003
 DATE OF ISSUE 2012.06.11
 VISUAL & DIMENSION SATISFACTORY
 PORCODE/TAG NO

ASTM A420WPL6-S-07, ASME SA20WPL6-S-07ED
 ASME B16.9
 2011071803

PURCHASE ORDER NO. 71311ASB
 N/A
 STARTING MATERIAL SEAMLESS PIPE

NO.	DESCRIPTION	QTY	HEAT NO.	MFG ID NO.	MILL MAKER
102	90D ELBOW(L) S160 B.W SMLS Black	647	3-86942	3-86942	JFE STEEL
119	90D ELBOW(R) X-S B.W SMLS Black	1,000	2-76300	2-76300	JFE STEEL

CHEMICAL COMPOSITION(A) (L: LADE, P: PRODUCT)

STD.	SPEC.	CHEMICAL COMPOSITION(A)														TENSILE TEST								
		C	SI	Mn	P	S	NI	Cr	Mo	Cu	V	Nb	N	Al	B	Zr	Fe	TI	CE	SPEC.	Y/S 0.2% offset KSI	T.S KSI	EL %	RA %
HEAT NO.	MIN	0.23	0.15	0.50	0.035	0.040	0.40	0.30	0.12	0.48	0.08	0.02							0.42	MIN	35.0	60.0	30.0	
	MAX	0.19	0.20	0.86	0.012	0.005	0.01	0.03	0.01	0.02	<0.001	<0.001						0.25	MAX	41.5	85.0	40.0		
2-76300	L	0.13	0.23	0.66	0.012	0.002	0.01	0.03	0.01	<0.01	0.001	0.001						0.28		41.6	62.8	45.0		
3-86942	P																							

HEAT TREATMENT: NORMALIZED, 900°C, 30Min., 'A'

HEAT NO.	PERCENT SHEAR		LATERAL EXPANSION		ABSORBED ENERGY		HARDNESS HB		HEAT TREATMENT		N.D.E	N/A
	STD. I	VALUE	STD. I	AVE.	STD. I	AVE.	MIN	MAX	PHI	FLATTENING TEST		
2-76300	10x7.5				146.00	147.50	144.00	145.83	HB 147	BENDING TEST	N/A	"MEMO"
3-86942	10x7.5				148.30	151.80	143.20	147.77	HB 143	HYDROSTATIC TEST	N/A	

WE CERTIFY THIS MATERIAL HAS BEEN MANUFACTURED AND EXAMINED IN ACCORDANCE WITH ALL REQUIREMENTS OF THE SPECIFICATION AND THE RESULTS OF ALL EXAMINATION ARE ACCEPTABLE.

- MANUFACTURED IN ACCOR. TO DIN 50049-3.1 & MEET NACE MR0175 & 0103-2003 STANDARD SPEC

Q.C.I. N.D.
 Q.C.I. E.Y.

APR 05 2013
 QM DIV. SENIOR MANAGING DIRECTOR

W.O. # 117808
 M.L. # 147812
 THK. # -394
 P.O. # 13-0249

Certification of Material - Per ASME
 HT# 3-86942
 Qualifies to all requirements of
 SA20WPL6 per
 Sect. II 10 Edition II Addenda

APR 04 2013
 per [Signature]
 279
 APR 5 2013



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

0006053

SO No., Item & Date:	8006091 000100 2012/12/13	Shipment No. & Date:	100022769 2012/12/31	TC No., Date & Time:	ESA-38154 2013/01/03 - 11:42:10
Sold to Customer Name and Address:	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	Ship to Customer Name and Address:	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	Customer PO/Item:	19025-STK / 10
				BOL NO.:	100022769
				Cust Part No.:	
				Carrier:	INTERNATIONAL FREIGHT SYSTEMS.

Customer Specification: HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (11A) / ASME SA516 GR 70 (11A) Meets NACE MR 0103 latest Ed. NACE MR 0175 latest Ed. BHN < 200. Calcium Treated for Sulphide Shape Control Normalized/Normalize Temp 1670 °F 30 min per inch CVNL Req 15 / 12 FT LBF at 0-500 P Sid Thickness Tol of PVO Top and Bottom Standard Surface Finishness 1/2 A20 Fine Grain Fully Killed No Weld Repair

Supplementary Instructions: Test Cert 1 drafting@canadianplate.com Test Cert 2: 905-206-1370

Inspection: Test Report As Per Spec
 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.
 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) 945-4095 FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.

WELDS PER 1176-2-14 TYPE 31
 100% QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM
 ALL HEATS FULLY NITROGENATED
 HEATS INDICATED WITH (*) ARE GRAINED
 HEATS INDICATED WITH (**) ARE MADE IN CANADA WITH DOMESTIC AND NORTH AMERICAN MATERIALS

Dimensions (L x W x L)	Heat No./AS	Quantity	Pcs
1.5000" x 12.0000" x 480.00"	2138P3-54	24,503 LB	1

Heat No. (wt%)	CHEMICAL PROPERTIES										MECHANICAL PROPERTIES				
	C	Mn	P	S	Si	Cr	Ni	Cu	Mo	Al	Nb	V	B	TI	DO
2138P3*	0.19	1.08	0.012	0.004	0.320	0.02	0.15	0.03	0.00	0.026	0.000	0.014	0.0003	0.002	0.3900

Hardness Tests		SRCE LAB GAUGE COND LOC MTHD		HARDNESS		
Heat No.	Batch No.	166*	ALG 15000	NORM B	HBW	151
2138P3	AB6713					

Impact Tests		SRCE LAB GAUGE COND METH DIR LOC SIZE		TEMP (°F) ENERGY (ft-lb) ENERGY AVG (ft-lb)				
Heat No.	Batch No.	166*	ALG 15000	NORM CVN	L B FULL	-50	81.94 B2	86
2138P3	AB6713							

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
CU + Ni + CR + MO = 0.2
CR + MO = 0.02

MILL TEST REPORTS APPROVED BY Q.C.
 P.O. _____

Q.C.I. N.D.

MAR 27 2013

Certification of Material - Per ASME
 HT# 2138P3-54
 Qualifies to all requirements of SA 516-GR 70 N per Sect. II 10 Edition II Addenda

K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

WARNING: THE INFORMATION AVAILABLE HEREON IS THE PROPERTY OF THE ISSUING PARTY. IT IS THE USER'S RESPONSIBILITY TO VERIFY THE INFORMATION IN THIS REPORT. THE INFORMATION CONTAINED HEREIN IS FOR INFORMATIONAL PURPOSES ONLY AND IS NOT TO BE USED TO DETERMINE THE MILL TEST RESULTS. THE USER SHALL BE RESPONSIBLE FOR VERIFYING THE INFORMATION CONTAINED HEREIN AGAINST THE ACTUAL SPECIFICATION OF THE MATERIAL.

11760
 16 (1 1/2)
 1 1/2
 13-0220
 MCA#48(172)

Velosi America
 279
 April 1, 2013



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

SO No. Item & Date:	8006091 000100 2012/12/13	Shipment No. & Date:	1000022769 2012/12/31	TC No. , Date & Time :	ESA-38154 2013/01/03 - 11:42:10							
Sold to Customer Name and Address:	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	Ship to Customer Name and Address:	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	Customer PO NO./Item:	19025-STK / 10							
				BOL NO.:	1000022769							
				Cust Part No.:								
				Carrier :	INTERNATIONAL FREIGHT SYSTEMS -							
Customer Specification :	HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (10) / ASME SA516 GR 70 (11A) Meets NACE MR 0103 latest Ed. NACE MR 0175 latest Ed. BHIN < 200, Calcium treated for Sulphide Shape Control Normalized Temp 1670 °F 30 min per inch CVNL Req 15 / 12 FT-LBF at 0-50.0 F Std Thickness Tol PVG Top and Bottom Standard Surface Flatness 1/2 A20 Fine Grain Fully Killed No Weld Repair											
Supplementary instructions :	Test Cert 1:drafting@canadianplate.com Test Cert 2:905-206-1370											
Insp T/R :	Test Report As Per Spec											
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. 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)945-4095 FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.												
SHEETS PER 10234 2004 TYPE 3.1 BEST QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM												
. MECHANICAL PROPERTIES												
Tensile Test	Batch No.	SRCE	LAB	GAUGE	CORD	METH	DIR	LOC	YIELD(SI)	TENSILE(SI)	EL SCALE	ELONG(%)
2138P3	A86713	166*	ALG	1 5000	NUHM	2	H	760	49.9	76.0	2"	30

Q.C.I. E.Y.
 APR 03 2013
 Velosi America
 279
 March 1, 2013

MAR 27 2013

K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

****WARNING**** THE TEST RESULTS AND VALUES REPORTED HEREON ARE VALID ONLY FOR THE PARTICULAR STEEL FOR WHICH THE CERTIFICATE IS ISSUED. THE ABOVE SPECIFIED YIELD STRENGTH IS A MINIMUM AND PHYSICAL PROPERTIES OF THE SPECIFICATION INDICATED. THE YIELD STRENGTH VALUES REPORTED HEREON MAY NOT BE USED TO DETERMINE THE QUALITY OF THE STEEL FOR ANY SPECIFIC APPLICATION UNLESS THE USER HAS BEEN ADVISED BY THE MANUFACTURER OF SUCH A POSSIBILITY. THE USER SHALL BE RESPONSIBLE FOR VERIFYING THE ACTUAL STRENGTH OF SUCH STEEL.

ESSAR Steel Algoma Inc. 105 West St., Sault Ste. Marie, Ontario, Canada, P6A 7B4
 CUSTOMER PURCHASE ORDER NUMBER: P005643
 ENTRY DATE: 2011/08/29
 CREATE DATE: 2011/10/17
 TALLY NUMBER: 246425
 SHIPPERS NUMBER: W.J. DEANS
 TRANSPORTATION: -2221 A/B
 MILL ORDER: 10816

SHIP TO CUSTOMER NAME & ADDRESS
 QUALITY PLATES & PROFILES LTD
 20 NICHOLAS BEAVER ROAD
 RR#3
 ABERFOYLE, ON
 CUSTOMER SPECIFICATION
 HR PLATE - CARBON - ASME SA516 GR 70 (10) - CVNL 15/12 FT LBS AT -50 F - C .23
 MAX, DO CE 0.43 MAX, V 0.02% MAX, NB 0.02% MAX, V+NB 0.03% MAX - FINE GRAIN
 - MEETS ASME SECTION II LASTEST ADDENDA - PVQ - NORMALIZED - FLATNESS 1/2 A-20

SUPPLEMENTARY INSTRUCTIONS
 TEST CERT 1: MICHELLE CRAVEIRO 519-837-2227 TEST CERT 2: PLAT
 E TEST COUPON:
 INSP T/R TEST REPORTS REQUIRED 2000200546 PF
 CUST USE RESALE 2011/10/17 18:27

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

CUSTOMER ITEM 00001 OUR ITEM 002 DIMENSIONS .250 X 96 X 288 "

PLATE NUMBER	HEAT-MS	PIECES	NO.	WEIGHT
38621	8888L-04	3	3	5880
38623	8888L-04	3	3	5880
38625	8888L-04	3	3	5880

TENSILE TESTS:

PLATE NUMBER	SAMPLE GAUGE	COND METH	DIR	YIELD KSI	TENSILE KSI	% ELONG
8888L 38621	166"	N	T	54.0	74.0	26(8")
8888L 38622	166"	N	T	51.0	74.0	24(8")
8888L 38623	166"	N	T	53.2	74.0	25(8")
8888L 38624	166"	N	T	54.2	74.4	27(8")
8888L 38625	166"	N	T	54.0	74.4	25(8")
8888L 38627	166"	N	T	54.4	75.0	25(8")

LAB ALG ALG ALG ALG ALG ALG
 MILL TEST REPORTS APPROVED BY Q.C.
 P.O.
 APR 03 2013
 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)945-2624 COLLECT FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.
 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.
 PAGE 1 OF 2

Certificate of Mill Test Results

QUALITY PLATES & PROFILES LIMITED
 20 Nicholas Bay Road, R.R.#3 (Aberfoyle), Guelph, ON N1H 6H9
 ALL-WELD COMPANY LIMITED PO/Rel: 13-0220
 PLATE CPL-516N-1/4" x 2" x 10-3/8" TAG 1176-17

Contact: HELENE/BRIAN Inv: 1055184 Date: 03/19/2013 Heat: 8888

ESSAR Steel Algoma Inc. 105 West St., Sault Ste. Marie, Ontario, Canada, P6A 7B4

CUSTOMER PURCHASE ORDER NUMBER: P005643
 ENTRY DATE: 2011/08/29
 TALLY NUMBER: 246425
 SHIPPERS NUMBER: -
 CARRIER: W.J. DEANS TRANSPORTATION - 2221 A/B
 MILL ORDER: 10816

SHIP TO CUSTOMER NAME & ADDRESS:
 QUALITY PLATES & PROFILES LTD
 20 NICHOLAS BEAVER ROAD
 RR#3
 ABERFOYLE, ON

SHIP TO CUSTOMER NAME & ADDRESS:
 QUALITY PLATES & PROFILES LTD
 20 NICHOLAS BEAVER ROAD
 RR#3
 ABERFOYLE, ON

CUSTOMER SPECIFICATION:
 HR PLATE - CARBON - ASME SA516 GR 70 (10) - CVNL 15/12 FT LBS AT -50 F - C.23
 MAX, DO CE 0.43 MAX, V 0.02% MAX, NB 0.02% MAX, V+NB 0.03% MAX - FINE GRAIN
 - MEETS ASME SECTION II LATEST ADDENDA - PVQ - NORMALIZED - FLATNESS 1/2 A-20

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)945-2624 COLLECT FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.

SUPPLEMENTARY INSTRUCTIONS:
 TEST CERT 1: MICHELLE CRAVEIRO 519-837-2227 TEST CERT 2: PLAT
 E TEST COUPON:
 2000200546 PF
 2011/10/17 18:27

INSP T/R	CUST USE	RESALE	TEST REPORTS REQUIRED
8888L**			

HEAT	(WT %)	C	TI	MN	SN	P	S	AS	ZR	SI	CR	PB	SE	NI	CU	MO	AL	CB	V	CB	B	DO
8888L**		0.19	0.003	1.08	0.011	0.007	0.007	0.007	0.31	0.02	0.02	0.02	0.02	0.02	0.03	0.01	0.044	0.000	0.001	0.0002		0.38

IMPACT TESTS:

HEAT	PLATE NUMBER	SRCE	IN	GAUGE	COND	METH	DIR	TEST	SIZE	TEMP	FTLB	AVG*
8888L	38621	166"	2500	N	N	CVN	L	L	1/2	-50F	104	108
8888L	38622	166"	2500	N	N	CVN	L	L	1/2	-50F	73	77
8888L	38623	166"	2500	N	N	CVN	L	L	1/2	-50F	68	90
8888L	38624	166"	2500	N	N	CVN	L	L	1/2	-50F	100	87
8888L	38625	166"	2500	N	N	CVN	L	L	1/2	-50F	76	88
8888L	38627	166"	2500	N	N	CVN	L	L	1/2	-50F	66	70

W.O. # 11760
M.L. # 17(11215, 15, 16, 17, 18)
THK. # 6 264
P.O. # 13-0220

Certification of Material - Per ASME
 HT# 8888L-38624
 Qualifies to all requirements of
 SA516-GR70N per
 Sect. II 10 Edition 1 Addenda

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
 CU + Ni + CR + MO = 0.08
 CR + MO = 0.03

Q.C.I. E.Y.
Q.C.I. N.D.
 APP 0 3 2013
 Velos America
 279
 2013



Cambridge

materials testing limited

1177 Franklin Boulevard,
Cambridge, Ontario N1R 7W4
Tel: (519) 621-6600 Fax: (519) 621-6082
www.cambridgematerials.com

ISO17025 Accredited

Report for: Quality Plates & Profiles Ltd.
20 Nicholas Beaver Road
R. R. # 3
ABERFOYLE, Ontario
N1H 6H9
Phone: 1-800-268-2853
Fax: 1-519-837-2224

Laboratory No. 598087-2012

Report Date: January 24, 2012
Received Date: January 19, 2012

Customer P.O.#: P006311


Attention: Dave Braga

Specimen: Material: ASME SA516 - 70 Normalized ✓
.25" Thick x 3" x 3", Algoma Heat # 8888L-38625

ROCKWELL HARDNESS TEST REPORT

80,79,79 HRBW

Reviewed
Rob
April 5, 2013



NACE MR0175/ISO 15156-2 (A.2.1.2) Rockwell Hardness Requirement:
22 HRC maximum

Conclusion: Pass

Testing performed according to
NACE MR0175/ISO 15156-2:2009/Cir.1:2011(E), ISO 6508-1:1999(E),
ASME Boiler and Pressure Vessel Code Section II, Part A, SA-370
(2010 Edition, 2011 Addenda) and ASTM E18-08b.



APR 03 2013

Page 1 of 1

This report is subject to the following terms and conditions: 1. This report relates only to the specimen provided and there is no representation or warranty that it applies to similar substances or materials or the bulk of which the specimen is a part. 2. The content of this report is for the information of the customer identified above only and it shall not be reprinted, published or disclosed to any other party except in full. Prior written consent from Cambridge Materials Testing Limited is required. 3. The name Cambridge Materials Testing Limited shall not be used in connection with the specimen reported on or any substance or materials similar to that specimen without the prior written consent of Cambridge Materials Testing Limited. 4. Neither Cambridge Materials Testing Limited nor any of its employees shall be responsible or held liable for any claims, loss or damages arising in consequence of reliance on this report or any default, error or omission in its preparation or the tests conducted. 5. Specimens are retained 6 months, test reports and test data are retained 7 years from date of final test report and then disposed of, unless instructed otherwise in writing.

Cambridge Materials Testing Limited

Per

R. D. [Signature]

Quality Assurance

Per

Matthew [Signature]

Technician

CANPRESS METAL FABRICATORS INC.

1610 Feldspar Court, Pickering, Ontario, L1W 3R7, CANADA

tel. (905) 831-2882 fax (905) 831-2880

<http://www.canpressmetalfab.com>

e-mail: info@canpressmetalfab.com

Certificate Of Compliance

Customer: All-Weld

Date: March 12/13

Attn: Quality Control

Purchase Order: 13-0209

Work Order #9913

Material SA 516-70N Impact Tested -20 degree min.

Item #1176-19 Qty 2 3/4" x 61 3/4" ID x 25" Long

We hereby certify that these shells conform to the above description and that they were cold formed to A.S.M.E. Code section VIII division 1 latest edition and latest addenda including UG 79 and were not post formed heat treated.


Authorized Signature

Inspection certificate 3.1 /
DIN EN 10204
 (A02)

No. (A03) 761758
 Page 2/11
 Date 10.07.2012

No (A07) 9381 20.04.2012 No (A07)
 Purchaser Olbert Metal Sales Limited Customer (A06) Olbert Metal Sales Limited
 (A06) MISSISSAUGA, ONT. L5T 2J8 (A06) MISSISSAUGA, ONT. L5T 2J8
 KANADA KANADA

Product Heavy plate Works order No 0000059029
 (B01) (A08)

Steel grade and terms of delivery SA 516 Gr. 70 MTLTV Inspection WS
 (B02-B03) ASME sect. II part A ed.2010, add.2011
 ASME SA 20, SA 516
 ASTM A 20 -10, A 516 -10
 PO 9381 (A05)

Material data (B01-B99)

Item	Quantity (B08)	Product No. (B07)	Heat No. (B07)	Cond. of delivery (B04)	Thickness x Width x Length (B09-B11)	in x in x in
05	1	283937	1	22644	N	0,562 x 120,000 x 480,000
06	1	283932	1	74313	N	0,625 x 120,000 x 480,000
06	1	283933	1	74313	N	0,625 x 120,000 x 480,000
06	1	283934	1	74313	N	0,625 x 120,000 x 480,000
06	1	283935	1	74313	N	0,625 x 120,000 x 480,000
07	1	289030	1	23206	N	0,750 x 120,000 x 480,000
07	1	289031	1	23206	N	0,750 x 120,000 x 480,000
07	1	289032	1	23206	N	0,750 x 120,000 x 480,000
07	1	289033	1	23206	N	0,750 x 120,000 x 480,000
07	1	289034	1	23206	N	0,750 x 120,000 x 480,000
07	1	289035	1	23206	N	0,750 x 120,000 x 480,000
08	1	288317	1	22059	N	1,000 x 120,000 x 480,000
08	1	288318	1	22058	N	1,000 x 120,000 x 480,000
08	1	289041	1	23206	N	1,000 x 120,000 x 480,000
08	1	289042	1	23206	N	1,000 x 120,000 x 480,000
08	1	289043	1	23206	N	1,000 x 120,000 x 480,000
08	1	289649	1	23206	N	1,000 x 120,000 x 480,000
09	1	284096	1	22058	N	1,250 x 120,000 x 480,000
09	1	286958	1	21795	N	1,250 x 120,000 x 480,000
10	1	284095	1	22058	N	1,500 x 120,000 x 480,000
10	1	286956	1	21795	N	1,500 x 120,000 x 480,000
12	1	282733	1	22059	N	2,250 x 120,000 x 288,000
12	1	282734	1	22059	N	2,250 x 120,000 x 288,000
14	1	286430	1	44491	N	2,750 x 120,000 x 288,000
14	1	286959	1	21795	N	2,750 x 120,000 x 288,000
15	1	282730	1	22059	N	3,000 x 120,000 x 242,000
15	1	282731	1	22059	N	3,000 x 120,000 x 242,000
16	1	286587	1	22910	N	3,250 x 102,000 x 242,000
17	1	286589	1	22910	N	3,500 x 102,000 x 242,000
17	1	286590	1	22910	N	3,500 x 102,000 x 242,000
18	1	286559	1	22577	N	3,750 x 102,000 x 182,000
18	1	286560	1	16412	N	4,000 x 102,000 x 178,071
19	1	286577	1	22910	N	4,250 x 102,000 x 182,000
19	1	286578	1	22910	N	4,250 x 102,000 x 182,000
20	1	286576	1	22910	N	4,500 x 102,000 x 182,000
21	1	286573	1	22910	N	4,500 x 102,000 x 182,000
21	1	286574	1	22910	N	4,500 x 102,000 x 182,000

N normalized

046
 ACC:11 ED/REVIEWED/RELEASED
 for and on behalf of: S.B.M. off shore
genet sales
 Print Name: genet sales
 Signature: [Signature]
 Date: March 14/13
Arpius
VELOSI
 Velosi America LLC

Q.C.I.
N.D.

Q.C.I.
E.Y.

MAR 13 2013

We hereby certify that the delivered material complies with the terms of the order
 (Z01)

QM-System Certification as per ISO 9001 since 28 February 1990



Ilsenburger Grobblech GmbH
 Veckenstedter Weg 10
 D-38871 Ilsenburg
 (A01)



Inspection Representative
 (Z02)

Inspection Representative
 (Z02)

Cyron

Inspection certificate 3.1
DIN EN 10204 (A02)

No. (A03) 761758
Page 4/11
Date 10.07.2012

No (A07) 9381 20.04.2012 No (A07)
Purchaser Olbert Metal Sales Limited Customer Olbert Metal Sales Limited
(A06) MISSISSAUGA, ONT. L5T 2J8 (A06) MISSISSAUGA, ONT. L5T 2J8
KANADA KANADA

Product Heavy plate
(B01)

Works order No 0000059029
(A08)

Steel grade and terms of delivery SA 516 Gr. 70 MTLTV
(B02-B03) ASME sect. II part A ed. 2010, add. 2011
ASME SA 20, SA 516
ASTM A 20 -10, A 516 -10
PO 9381

Inspection WS
(A05)

ACCEPTED/REVIEWED/RELEASED
for and on behalf of: SAM offshore 046
Print Name: WANISH SANA
Signature: [Signature]
Date: March 13

Applus® VELOSI
Velosi America LLC

Ladle analysis (C70-C99)
Manufacturer standard

Heat No. (B07)	C %	Si % 0,15 - 0,40	Mn % 0,85 - 1,50	P % ≤ 0,015	S % ≤ 0,005	N %	Al % ≥ 0,020	Cu % ≤ 0,40	Cr % ≤ 0,30	Ni % ≤ 0,40
22058	0,20	0,25	1,15	0,013	0,002	0,003	0,047	0,03	0,04	0,04
22059	0,21	0,25	1,18	0,010	0,002	0,003	0,043	0,02	0,03	0,04
22577	0,17	0,20	1,43	0,011	0,001	0,004	0,033	0,03	0,04	0,03
22644	0,17	0,36	1,14	0,014	0,001	0,004	0,053	0,03	0,03	0,17
22910	0,17	0,21	1,48	0,012	0,001	0,003	0,032	0,02	0,03	0,17
23206	0,19	0,24	1,14	0,015	0,001	0,004	0,049	0,03	0,04	0,03
44491	0,19	0,25	1,14	0,007	0,002	0,005	0,036	0,01	0,02	0,03
74313	0,15	0,33	1,16	0,013	0,001	0,005	0,046	0,01	0,03	0,17

Heat No. (B07)	Mo % ≤ 0,12	V % ≤ 0,03	Ti % ≤ 0,03	Nb % ≤ 0,02	B % ≤ 0,001	Ca %	EV1 1) % ≤ 0,45	Nb+V % ≤ 0,03	EV2 2) %
22058	0,01	0,003	0,003	0,02	0,0002	0,001	0,41	0,02	0,03
22059	0,003	0,003	0,003	0,02	0,0002	0,001	0,42	0,02	0,03
22577	0,004	0,01	0,002	0,02	0,000	0,001	0,42	0,03	0,03
22644	0,004	0,004	0,004	0,02	0,000	0,002	0,38	0,02	0,03
22910	0,003	0,003	0,002	0,02	0,0001	0,001	0,43	0,02	0,03
23206	0,003	0,003	0,01	0,02	0,0001	0,001	0,39	0,02	0,03
44491	0,002	0,003	0,003	0,02	0,0002	0,001	0,39	0,02	0,03
74313	0,003	0,004	0,004	0,02	0,0004	0,001	0,36	0,02	0,03

1) EV1: CEV=C+Mn/5+Mo/5+Ni/15+Cr/5+V/5+Cu/15
2) EV2: V+Nb+Ti

Steel making: Basic oxygen process (C70)

Material is vacuum degassed

Fully killed and fine grained steel produced with shape control

Ca- treated

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
CU + Ni + CR + MO = 0,13
CR+MO = 0,043

Q.C.I. N.D.

W.O. # 11760
M.L. # 18 (1/3)
THK. # 760
P.O. # 13-0207

Q.C.I. E.Y.

Certification of Material - Per ASME
HT# 23206-1-289034
Qualifies to all requirements of
SASIE GRTON per
Sect. II 10 Edition II Addenda

We hereby certify that the delivered material complies with the terms of the order (Z01)
QM-System: Certification as per ISO 9001 since 28 February 1990



Ilsenburger Grobblech GmbH
Veckenstedter Weg 10
D-38871 Ilsenburg
(A01)

Inspection Stamp (Z03)
[Signature]

Inspection Representative (Z02)

Cyron

MAR 13 2013

Inspection certificate 3.1 DIN EN 10204 (A02)		No. (A03) 761758 Page 6/11 Date 10.07.2012
No. (A07) 9381 Purchaser (A06) Olbert Metal Sales Limited MISSISSAUGA, ONT. L5T 2J8 KANADA	20.04.2012	No. (A07) Customer (A06) Olbert Metal Sales Limited MISSISSAUGA, ONT. L5T 2J8 KANADA
Product (B01) Heavy plate		Works order No. (A08) 0000059029 Inspection (A05) WS
Steel grade and terms of delivery (B02-B03) SA 516 Gr. 70 MTLTV ASME sect. II part A ed. 2010, add. 2011 ASME SA 20, SA 516 ASTM A 20 -10, A 516 -10 PO 9381		

Tensile test (C10-C29)

Specimen No. (C00)	Heat No. (B07)	Location (C01)		Direct (C02)	Cond. (B05)	Type (C10)	Yield strength (C11) Rp0,2 N/mm2 ≥ 260	Tensile strength (C12) Rm N/mm2 485 - 620	Elongation (C13) 8 in %	Elongation (C13) 2 in %
		1) 2) 3)	4)							
286577	22910	K6V	Q	N	C	313	514		39	
286578	22910	K6V	Q	N	C	321	509		36	
286587	22910	K6V	Q	N	C	339	515		39	
286589	22910	K6V	Q	N	C	327	513		41	
286590	22910	K6V	Q	N	C	319	513		37	
286889	74313	K6G	Q	N	P	390	518	23		
286956	21795	K6G	Q	N	P	352	523	28		
286958	21795	K6G	Q	N	P	354	527	27		
286959	21795	K6V	Q	N	C	340	514		39	
287048	20870	K6G	Q	N	P	416	535	24		
288317	22059	K6G	Q	N	P	350	528	24		
288318	22058	K6G	Q	N	P	340	527	26		
289030	23206	K6G	Q	N	P	360	522	29		
289031	23206	K6G	Q	N	P	360	522	28		
289032	23206	K6G	Q	N	P	365	523	26		
289033	23206	K6G	Q	N	P	363	525	29		
289034	23206	K6G	Q	N	P	366	522	28		
289035	23206	K6G	Q	N	P	371	528	27		
289041	23206	K6G	Q	N	P	356	521	29		
289042	23206	K6G	Q	N	P	351	520	27		
289043	23206	K6G	Q	N	P	359	523	29		
289649	23206	K6G	Q	N	P	357	523	24		

- | | |
|--|--|
| 1) K: Top
2) 6: 1/6 Width
3) G: Thickness of product
V: 1/4 Thickness | 4) Q: transversal
5) N: normalized
6) C: cylindric
P: prismatic |
|--|--|

046

ACCEPTED/REVIEWED/RELEASED

for and on behalf of: S B M Off Shore

Print Name: G A NRESH SAHA

Signature: [Signature]

Date: March 14/13

Applus®
VELOSI
Velosi America LLC

Q.C.I.
N.D.

Q.C.I.
E.Y.

MAR 13 2013

We hereby certify that the delivered material complies with the terms of the order
(Z01)

QM-System: Certification as per ISO 9001 since 28 February 1990



Ilsenburger Grobblech GmbH
Veckenstedter Weg 10
0-38871 Ilsenburg
(A01)

Inspection Stamp
(Z03)

Inspection Representative
(Z02)

Cyron

Inspection certificate 3.1
DIN EN 10204
(A02)

No. (A03) 761758
Page 8/11
Date 10.07.2012

No. (A07) 9381 20.04.2012 No. (A07)
Purchaser Olbert Metal Sales Limited Customer Olbert Metal Sales Limited
(A06) MISSISSAUGA, ONT. L5T 2J8 (A06) MISSISSAUGA, ONT. L5T 2J8
KANADA KANADA

Product Heavy plate Works order No 0000059029
(B01)

Steel grade and terms of delivery SA 516 Gr. 70 MTLTV
(B02-B03) ASME sect. II part A ed.2010, add.2011
ASME SA 20, SA 516
ASTM A 20 -10, A 516 -10
PO 9381

Inspection (A05) WS

Impact test (C40-C49)

Specimen No. (C00)	Heat No. (B07)	Location (C01)		Direct. (C02)	Cond. (B05)	Type of specimen (C40-C41)	Temperature (C03) °F	Impact energy (C42-C43)			
		1) 2) 3)	4)					5)	1 ftlb	2	3
286578	22910	K6V	L	N		Charpy V-notch	-051	65	131	144	114
286587	22910	K6V	L	N		Charpy V-notch	-051	127	41	119	96
286589	22910	K6V	L	N		Charpy V-notch	-051	125	122	116	121
286590	22910	K6V	L	N		Charpy V-notch	-051	45	124	119	96
286889	74313	K60	L	N		Charpy V-notch	-051	75	75	44	65
286956	21795	K6V	L	N		Charpy V-notch	-051	50	78	61	63
286958	21795	K6V	L	N		Charpy V-notch	-051	107	87	72	89
286959	21795	K6V	L	N		Charpy V-notch	-051	56	71	34	54
287048	20870	K60	L	N		Charpy V-notch	-051	76	83	50	69
288317	22059	K6V	L	N		Charpy V-notch	-051	78	49	95	74
288318	22058	K6V	L	N		Charpy V-notch	-051	27	83	47	52
289030	23206	K6V	L	N		Charpy V-notch	-051	100	63	106	89
289031	23206	K6V	L	N		Charpy V-notch	-051	92	74	46	71
289032	23206	K6V	L	N		Charpy V-notch	-051	66	77	66	70
289033	23206	K6V	L	N		Charpy V-notch	-051	72	58	30	53
289034	23206	K6V	L	N		Charpy V-notch	-051	82	97	91	90
289035	23206	K6V	L	N		Charpy V-notch	-051	67	34	86	63
289041	23206	K6V	L	N		Charpy V-notch	-051	106	91	70	89
289042	23206	K6V	L	N		Charpy V-notch	-051	74	118	74	89
289043	23206	K6V	L	N		Charpy V-notch	-051	79	20	86	62
289649	23206	K6V	L	N		Charpy V-notch	-051	72	80	67	73

1) K: Top
2) 6: 1/6 Width
3) O: near surface
V: 1/4 Thickness

4) L: longitudinal
5) N: normalized
6) MW: Average

Specimen size:
5,0 x 10 x 55 mm (from 5,00 mm up to 8,99 mm plate thickness)
7,5 x 10 x 55 mm (from 9,00 mm to 11,99 mm plate thickness)
10 x 10 x 55 mm (from 12,00 mm plate thickness)

ACCEPTEDE/REVIEWED/RELEASED
for and on behalf of: SBM offshore
Print Name: G.A. WESLEY SAHA
Signature: [Signature]
Date: March 14/13

046
Q.C.I.
E.Y.
Applus®
VELOS
Velosi America LLC
MAR 13 2013
Q.C.I.
N.D.

We hereby certify that the delivered material complies with the terms of the order.
(Z01)
QM-System: Certification as per ISO 9001 since 28 February 1990



Ilseburger Grobblech GmbH
Veckenstedter Weg 10
D-38871 Ilseburg
(A01)

Inspection Stamp
(Z02)

Inspection Representative
(Z02)

Cyron

Inspection certificate 3.1		No. (A03)	761758
DIN EN 10204		Page	10/11
(A02)		Date	10.07.2012
No. (A07)	9381	20.04.2012	No. (A07)
Purchaser (A06)	Olbert Metal Sales Limited MISSISSAUGA, ONT. L5T 2J8 KANADA	Customer (A06)	Olbert Metal Sales Limited MISSISSAUGA, ONT. L5T 2J8 KANADA
Product (B01)	Heavy plate	Works order No. (A09)	0000059029
Steel grade and terms of delivery (B02-B03)	SA 516 Gr. 70 MTLTV ASME sect. II part A ed.2010, add.2011 ASME SA 20, SA 516 ASTM A 20 -10, A 516 -10 PO 9381	Inspection (A05)	WS

Other tests (C50-C69)

Specimen No. (C00)	Heat No. (B07)	Location (C01)	Direct. (C02)	Cond. (B05)	Hardness test (C30-C39)			
		1) 2) 3)	4)	5)	HB30 ≤ 199			
286589	22910	K6		N	152			
286590	22910	K6		N	153			
286889	74313	K6		N	156			
286956	21795	K6		N	156			
286958	21795	K6		N	157			
286959	21795	K6		N	152			
287048	20870	K6		N	158			
288317	22059	K6		N	155			
288318	22058	K6		N	155			
289030	23206	K6		N	155			
289031	23206	K6		N	154			
289032	23206	K6		N	156			
289033	23206	K6		N	156			
289034	23206	K6		N	155			
289035	23206	K6		N	158			
289041	23206	K6		N	155			
289042	23206	K6		N	153			
289043	23206	K6		N	155			
289649	23206	K6		N	156			

1) K: Top
2) 6: 1/8 Width
5) N: normalized

Our products are free of radioactive substances and do not exceed the clearing limit value of 100 Bq/kg, which guarantees the compliance with limit values given in the Radiation Protection Ordinance (StrlSchV) for the unrestricted clearance of solid material (StrlSchV Annex III, Section 5) for ferrous nuclides.

Heat treatment: Temperature : 910 +/-10°C
Soaking time: 30 min/inch
Cooling in still air

NACE MR-0103 (2.1.1-2.1.4) - 2010
NACE MR-0175 2003

no weld repair

Melted and manufactured in Germany



MAR 13 2013

ACCEPTED/REVIEWED/RELEASED
for and on behalf of: SBM OFFSHORE

Print Name: G. A. VELC SAHA

Signature: [Signature]

Date: March 13/13

Applus VELC
Velosi Americ

We hereby certify that the delivered material complies with the terms of the order (Z01)

QM-System: Certification as per ISO 9001 since 28 February 1990

 Trademark (A04)

Ilsenburger Grobblech GmbH
Veckenstedter Weg 10
D-38871 Ilsenburg
(A01)

 Inspection Stamp (Z03)

Inspection Representative (Z02)

Cyron

Inspection certificate 3.1		No. (A03)	761758
DIN EN 10204		Page	1/11
(A02)		Date	10.07.2012
No. (A07)	9381	20.04.2012	No. (A07)
Purchaser (A06)	Olbert Metal Sales Limited MISSISSAUGA, ONT. L5T 2J8 KANADA	Customer (A06)	Olbert Metal Sales Limited MISSISSAUGA, ONT. L5T 2J8 KANADA
Product (B01)	Heavy plate	Works order No (A08)	0000059029
Steel grade and terms of delivery (B02-B03)	SA 516 Gr. 70 MTLTV ASME sect. II part A ed.2010, add.2011 ASME SA 20, SA 516 ASTM A 20 -10, A 516 -10 PO 9381	Inspection (A05)	WS
Marking of the product (B06) Trademark/Steelgrade/Heat-No/Product-No/ inspector's stamp			

Material data (B01-B99)						
Item	Quantity (B08)	Product No. (B07)	Heat No. (B07)	Cond. of delivery (B04)	Thickness x Width x Length (B09-B11)	in x in x in
01	1	282780 1	22644	N	0,250 x 120,000 x 480,000	
01	1	282783 1	22644	N	0,250 x 120,000 x 480,000	
01	1	282783 2	22644	N	0,250 x 120,000 x 480,000	
01	1	283904 1	22644	N	0,250 x 120,000 x 480,000	
01	1	283904 2	22644	N	0,250 x 120,000 x 480,000	
01	1	286889 1	74313	N	0,250 x 120,000 x 480,000	
01	1	286889 2	74313	N	0,250 x 120,000 x 480,000	
01	1	287048 1	20870	N	0,250 x 120,000 x 480,000	
02	1	283899 1	22644	N	0,312 x 120,000 x 480,000	
02	1	283899 2	22644	N	0,312 x 120,000 x 480,000	
02	1	283900 1	22644	N	0,312 x 120,000 x 480,000	
02	1	283900 2	22644	N	0,312 x 120,000 x 480,000	
02	1	283901 1	22644	N	0,312 x 120,000 x 480,000	
02	1	283901 2	22644	N	0,312 x 120,000 x 480,000	
02	1	283902 1	22644	N	0,312 x 120,000 x 480,000	
02	1	283902 2	22644	N	0,312 x 120,000 x 480,000	
02	1	283903 1	22644	N	0,312 x 120,000 x 480,000	
02	1	283903 2	22644	N	0,312 x 120,000 x 480,000	
03	1	283905 1	22644	N	0,375 x 120,000 x 480,000	
03	1	283905 2	22644	N	0,375 x 120,000 x 480,000	
03	1	283906 1	22644	N	0,375 x 120,000 x 480,000	
03	1	283906 2	22644	N	0,375 x 120,000 x 480,000	
03	1	283907 1	22644	N	0,375 x 120,000 x 480,000	
03	1	283907 2	22644	N	0,375 x 120,000 x 480,000	
03	1	283908 1	22644	N	0,375 x 120,000 x 480,000	
03	1	283908 2	22644	N	0,375 x 120,000 x 480,000	
03	1	283909 1	22644	N	0,375 x 120,000 x 480,000	
03	1	283909 2	22644	N	0,375 x 120,000 x 480,000	
04	1	283939 1	22644	N	0,500 x 120,000 x 480,000	
04	1	283939 2	22644	N	0,500 x 120,000 x 480,000	
04	1	283940 1	22644	N	0,500 x 120,000 x 480,000	
04	1	283940 2	22644	N	0,500 x 120,000 x 480,000	
04	1	283941 1	22644	N	0,500 x 120,000 x 480,000	
04	1	283941 2	22644	N	0,500 x 120,000 x 480,000	
04	1	286153 1	74313	N	0,500 x 120,000 x 480,000	
04	1	286153 2	74313	N	0,500 x 120,000 x 480,000	
05	1	283936 1	22644	N	0,562 x 120,000 x 480,000	
				N	normalized	

We hereby certify that the delivered material complies with the terms of the order (Z01)

QM-System: Certification as per ISO 9001 since 28 February 1990


 Ilsenburger Grobblech GmbH
 Veckenstedter Weg 10
 D-38871 Ilsenburg
 (A01)


Inspection Representative (Z02)

Cyron

Inspection certificate 3.1		No. (A03)	761758
DIN EN 10204		Page	3/11
(A02)		Date	10.07.2012
No. (A07)	9381	20.04.2012	No. (A07)
Purchaser (A06)	Olbert Metal Sales Limited MISSISSAUGA, ONT. L5T 2J8 KANADA	Customer (A06)	Olbert Metal Sales Limited MISSISSAUGA, ONT. L5T 2J8 KANADA
Product (B01)	Heavy plate	Works order No. (A08)	0000059029
Steel grade and terms of delivery (B02-B03)	SA 516 Gr. 70 MTLTV ASME sect. II part A ed.2010, add.2011 ASME SA 20, SA 516 ASTM A 20 -10, A 516 -10 PO 9381	Inspection (A05)	WS

Material data (B01-B99)			
01	8	Weight	14.816 kgs
02	10	(B12)	23.100
03	10		27.800
04	8		29.640
05	2		8.326
06	4		18.528
07	6		33.342
08	6		44.460
09	2		18.524
10	2		22.228
12	2		20.006
14	2		24.450
15	2		22.414
16	1		10.320
17	2		22.228
18	2		17.912
19	2		18.231
20	1		10.150
21	2		21.494
Σ	74		407.969

Dimensional check and visual examination of the surface condition:
without objection

Ladle analysis (C70-C99)										
Manufacturer standard										
Heat No (B07)	C %	Si % 0,15 - 0,40	Mn % 0,85 - 1,50	P % ≤ 0,015	S % ≤ 0,005	N %	Al % ≥ 0,020	Cu % ≤ 0,40	Cr % ≤ 0,30	Ni % ≤ 0,40
16412	0,18	0,19	1,46	0,014	0,004	0,004	0,042	0,06	0,03	0,06
20870	0,15	0,35	1,16	0,010	0,003	0,005	0,040	0,04	0,04	0,17
21795	0,20	0,24	1,16	0,006	0,002	0,007	0,042	0,03	0,02	0,04
Heat No (B07)	Mo % ≤ 0,12	V % ≤ 0,03	Ti % ≤ 0,03	Nb % ≤ 0,02	B % ≤ 0,001	Ca %	EV1 1) % ≤ 0,45	Nb+V % ≤ 0,03	EV2 2) %	
16412	0,004	0,01	0,003	0,02	0,0002	0,001	0,44	0,03	0,03	
20870	0,004	0,003	0,002	0,02	0,000	0,002	0,37	0,02	0,03	
21795	0,004	0,002	0,003	0,02	0,0001	0,001	0,40	0,02	0,03	

1) EV1: CEV=C+Mn/6+Mo/5+Ni/15+Cr/5+V/5+Cu/15 2) EV2: V+Nb+Ti

We hereby certify that the delivered material complies with the terms of the order (Z01)

QM-System: Certification as per ISO 9001 since 28 February 1990



Ilsenburger Grobblech GmbH
Veckenstedter Weg 10
D-38871 Ilsenburg
(A01)

Inspection Stamp (Z03) 

Inspection Representative (Z02)

Cyron

Inspection certificate 3.1		No. (A03)	761758
DIN EN 10204		Page	5/11
(A02)		Date	10.07.2012
No. (A07)	9381	20.04.2012	No. (A07)
Purchaser (A06)	Olbert Metal Sales Limited	Customer (A06)	Olbert Metal Sales Limited
	MISSISSAUGA, ONT. L5T 2J8		MISSISSAUGA, ONT. L5T 2J8
	KANADA		KANADA
Product (B01)	Heavy plate	Works order No (A08)	0000059029
Steel grade and terms of delivery (B02-B03)	SA 516 Gr. 70 MTLTV ASME sect. II part A ed.2010, add.2011 ASME SA 20, SA 516 ASTM A 20 -10, A 516 -10 PO 9381	Inspection (A05)	WS

Tensile test (C10-C29)

Specimen No (C30)	Heat No (B07)	Location (C01)	Direct. (C02)	Cond. (B05)	Type (C10)	Yield strength (C11) Rp0,2 N/mm2 ≥ 250	Tensile strength (C12) Rm N/mm2 485 - 620	Elongation (C13) 8 in % ≥ 17	Elongation (C13) 2 in %
282730	22059	K6V	Q	N	C	334	517		39
282731	22059	K6V	Q	N	C	310	513		36
282733	22059	K6G	Q	N	P	320	508	32	
282734	22059	K6G	Q	N	P	325	511	31	
282780	22644	K6G	Q	N	P	407	522	19	
282783	22644	K6G	Q	N	P	405	528	23	
283899	22644	K6G	Q	N	P	393	531	25	
283900	22644	K6G	Q	N	P	392	528	21	
283901	22644	K6G	Q	N	P	398	531	24	
283902	22644	K6G	Q	N	P	398	530	25	
283903	22644	K6G	Q	N	P	403	530	24	
283904	22644	K6G	Q	N	P	397	523	23	
283905	22644	K6G	Q	N	P	389	524	21	
283906	22644	K6G	Q	N	P	388	527	22	
283907	22644	K6G	Q	N	P	402	530	23	
283908	22644	K6G	Q	N	P	401	528	23	
283909	22644	K6G	Q	N	P	392	527	21	
283932	74313	K6G	Q	N	P	365	507	26	
283933	74313	K6G	Q	N	P	357	504	27	
283934	74313	K6G	Q	N	P	347	503	26	
283935	74313	K6G	Q	N	P	356	503	26	
283936	22644	K6G	Q	N	P	376	520	24	
283937	22644	K6G	Q	N	P	377	517	25	
283939	22644	K6G	Q	N	P	373	519	22	
283940	22644	K6G	Q	N	P	384	522	25	
283941	22644	K6G	Q	N	P	380	520	25	
284095	22058	K6G	Q	N	P	350	520	28	
284096	22058	K6G	Q	N	P	346	524	27	
286153	74313	K6G	Q	N	P	369	512	27	
286430	44491	K6V	Q	N	C	330	506		38
286559	22577	K6V	Q	N	C	333	503		40
286560	16412	K6V	Q	N	C	341	522		38
286573	22910	K6V	Q	N	C	329	507		41
286574	22910	K6V	Q	N	C	323	507		37
286576	22910	K6V	Q	N	C	314	511		39

1) K: Top
2) G: 1/8 Width
3) G: Thickness of product
V: 1/4 Thickness

4) Q: transversal
5) N: normalized
6) C: cylindrical
P: prismatic

We hereby certify that the delivered material complies with the terms of the order (Z01)

QM-System: Certification as per ISO 9001 since 28 February 1990



Trademark (A04)

Ilseburger Grobblech GmbH
Veckenstedter Weg 10
D-38871 Ilseburg
(A01)



Inspection Stamp (Z03)

Inspection Representative (Z02)

Cyron

Inspection certificate 3.1		No. (A03)	761758
DIN EN 10204		Page	7/11
(A02)		Date	10.07.2012
No. (A07)	9381	20.04.2012	No. (A07)
Purchaser (A06)	Olbert Metal Sales Limited MISSISSAUGA, ONT. L5T 2J8 KANADA	Customer (A06)	Olbert Metal Sales Limited MISSISSAUGA, ONT. L5T 2J8 KANADA
Product (B01)	Heavy plate	Works order No. (A08)	0000059029
Steel grade and terms of delivery (B02-B03)	SA 516 Gr. 70 MTLTV ASME sect. II part A ed. 2010, add. 2011 ASME SA 20, SA 516 ASTM A 20 -10, A 516 -10 PO 9381	Inspection (A05)	WS

Impact test (C40-C49)										
Specimen No (C00)	Heat No. (B07)	Location (C01)	Direct. (C02)	Cond (B05)	Type of specimen (C40-C41)	Temperature (C03)	Impact energy (C42-C43)			
							1	2	3	MW 6)
		1) 2) 3)	4)	5)		°F	ftlbf			ftlbf
282730	22059	K6V	L	N	Charpy V-notch	-051	41	18	32	30
282731	22059	K6V	L	N	Charpy V-notch	-051	20	55	45	40
282733	22059	K6V	L	N	Charpy V-notch	-051	44	40	59	48
282734	22059	K6V	L	N	Charpy V-notch	-051	53	45	46	48
282780	22644	K60	L	N	Charpy V-notch	-051	49	43	74	55
282783	22644	K60	L	N	Charpy V-notch	-051	41	69	43	51
283899	22644	K60	L	N	Charpy V-notch	-051	30	44	35	36
283900	22644	K60	L	N	Charpy V-notch	-051	36	23	41	33
283901	22644	K60	L	N	Charpy V-notch	-051	35	47	38	40
283902	22644	K60	L	N	Charpy V-notch	-051	42	38	58	46
283903	22644	K60	L	N	Charpy V-notch	-051	39	46	34	40
283904	22644	K60	L	N	Charpy V-notch	-051	28	44	44	38
283905	22644	K60	L	N	Charpy V-notch	-051	122	107	93	107
283906	22644	K60	L	N	Charpy V-notch	-051	148	135	140	141
283907	22644	K60	L	N	Charpy V-notch	-051	142	147	99	129
283908	22644	K60	L	N	Charpy V-notch	-051	136	139	132	136
283909	22644	K60	L	N	Charpy V-notch	-051	145	99	139	128
283932	74313	K6V	L	N	Charpy V-notch	-051	206	100	140	149
283933	74313	K6V	L	N	Charpy V-notch	-051	225	224	204	218
283934	74313	K6V	L	N	Charpy V-notch	-051	128	131	207	156
283935	74313	K6V	L	N	Charpy V-notch	-051	105	129	96	110
283936	22644	K6V	L	N	Charpy V-notch	-051	170	114	119	134
283937	22644	K6V	L	N	Charpy V-notch	-051	90	69	107	89
283939	22644	K6V	L	N	Charpy V-notch	-051	110	117	102	109
283940	22644	K6V	L	N	Charpy V-notch	-051	119	132	105	119
283941	22644	K6V	L	N	Charpy V-notch	-051	115	46	58	73
284095	22058	K6V	L	N	Charpy V-notch	-051	64	61	35	53
284096	22058	K6V	L	N	Charpy V-notch	-051	44	30	46	40
286153	74313	K6V	L	N	Charpy V-notch	-051	211	204	99	171
286430	44491	K6V	L	N	Charpy V-notch	-051	61	35	47	48
286559	22577	K6V	L	N	Charpy V-notch	-051	131	145	130	135
286560	16412	K6V	L	N	Charpy V-notch	-051	72	116	106	98
286573	22910	K6V	L	N	Charpy V-notch	-051	96	114	105	105
286574	22910	K6V	L	N	Charpy V-notch	-051	114	134	126	125
286576	22910	K6V	L	N	Charpy V-notch	-051	112	140	136	129
286577	22910	K6V	L	N	Charpy V-notch	-051	205	128	58	131

1) K: Top
2) 6: 1/6 Width
3) 0: near surface
V: 1/4 Thickness

4) L: longitudinal
5) N: normalized
6) MW: Average

We hereby certify that the delivered material complies with the terms of the order
(Z01)

QM-System: Certification as per ISO 9001 since 28 February 1990



Ilseburger Grobblech GmbH
Veckenstedter Weg 10
D-38871 Ilseburg
(A01)

Inspection Stamp
(Z03)

Inspection Representative
(Z02)

Cyron

Inspection certificate 3.1 DIN EN 10204 (A02)		No. (A03) Page Date	761758 9/11 10.07.2012
No. (A07) Purchaser (A06)	9381 Olbert Metal Sales Limited MISSISSAUGA, ONT. L5T 2J8 KANADA	20.04.2012 No. (A07) Customer (A06)	Olbert Metal Sales Limited MISSISSAUGA, ONT. L5T 2J8 KANADA
Product (B01)	Heavy plate	Works order No. (A08)	0000059029
Steel grade and terms of delivery (B02-B03)	SA 516 Gr. 70 MTLTV ASME sect. II part A ed.2010, add.2011 ASME SA 20, SA 516 ASTM A 20 -10, A 516 -10 PO 9381	Inspection (A05)	WS

Other tests (C50-C69)							
Specimen No (C00)	Heat No (B07)	Location (C01)	Direct (C02)	Cond (B05)	Hardness test (C30-C39) HB30 ≤ 199		
						1) 2) 3)	4)
282730	22059	K6		N	155		
282731	22059	K6		N	153		
282733	22059	K6		N	151		
282734	22059	K6		N	150		
282780	22644	K6		N	156		
282783	22644	K6		N	155		
283899	22644	K6		N	157		
283900	22644	K6		N	157		
283901	22644	K6		N	156		
283902	22644	K6		N	157		
283903	22644	K6		N	159		
283904	22644	K6		N	156		
283905	22644	K6		N	155		
283906	22644	K6		N	158		
283907	22644	K6		N	157		
283908	22644	K6		N	158		
283909	22644	K6		N	157		
283932	74313	K6		N	151		
283933	74313	K6		N	150		
283934	74313	K6		N	149		
283935	74313	K6		N	148		
283936	22644	K6		N	156		
283937	22644	K6		N	153		
283939	22644	K6		N	155		
283940	22644	K6		N	156		
283941	22644	K6		N	154		
284095	22058	K6		N	154		
284096	22058	K6		N	155		
286153	74313	K6		N	150		
286430	44491	K6		N	151		
286559	22577	K6		N	149		
286560	16412	K6		N	154		
286573	22910	K6		N	149		
286574	22910	K6		N	152		
286576	22910	K6		N	151		
286577	22910	K6		N	152		
286578	22910	K6		N	151		
286587	22910	K6		N	153		

1) K: Top
2) S: 1/6 Width
5) N: normalized

We hereby certify that the delivered material complies with the terms of the order
(Z01)

QM-System: Certification as per ISO 9001 since 28 February 1990



Ilseburger Grobblech GmbH
Vockenstedter Weg 10
D-38871 Ilseburg
(A01)



Inspection Representative
(Z02)

Cyron

Inspection certificate 3.1		No. (A03)	761758
DIN EN 10204		Page	11/11
(A02)		Date	10.07.2012
No. (A07)	9381	20.04.2012	No. (A07)
Purchaser (A06)	Olbert Metal Sales Limited		Customer (A06)
	MISSISSAUGA, ONT. L5T 2J8		MISSISSAUGA, ONT. L5T 2J8
	KANADA		KANADA
Product (B01)	Heavy plate	Works order No. (A08)	0000059029
Steel grade and terms of delivery (B02-B03)	SA 516 Gr. 70 MTLTV	Inspection (A05)	WS
	ASME sect. II part A ed.2010, add.2011		
	ASME SA 20, SA 516		
	ASTM A 20 -10, A 516 -10		
	PO 9381		
PED 97/23 EG			

We hereby certify that the delivered material complies with the terms of the order (Z01)

DM-System: Certification as per ISO 9001 since 28 February 1990



Ilsenburger Grobblech GmbH
Veckenstedter Weg 10
D-38871 Ilsenburg
(A01)

Aj Inspection Stamp (Z03)

Inspection Representative (Z02)

Cyron

ESSAR STEEL ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4
 Shipment No. & Date: 1000023647 2013/01/06
 Ship to Customer Name and Address:
 QUALITY PLATES & PROFILES LTD
 NICHOLAS BEAVER ROAD RR#3 2C
 ABERFOYLE, Ontario, Canada
 N1H 6H9

SO No., Item & Date.: 8006515 000020 2013/01/05
 Sold to Customer Name and Address:
 QUALITY PLATES & PROFILES LTD
 NICHOLAS BEAVER ROAD RR#3 2C
 ABERFOYLE, Ontario, Canada
 N1H 6H9

Customer Specification: HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (11A) Meets NACE MR 0175 latest Ed. BHN < 200, D.O.CEQ. 4.3 max. Inclusion Class Control Calcium Treated Normalized Temp 1670 F 34 min C/N, R/q 15.12 FT/LBF at 0-50.0 F Std thickness for PVO Top and Bottom Standard Surface Flatness 1/2 A20 Latest Ed + Addenda of ASME Code section II part A applies Final Grain Fully Killed No Weld Repair

Supplementary Instructions: Test Cert 1519-837-2227
 Insp TR: Test Report As Per Spec
 Customer Use: PVO

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 RECORDING PRACTICES.
 THIS MILL TEST REPORT MAY NOT BE REPRODUCED OR USED IN FULL WITHOUT WRITTEN APPROVAL OF ESSAR STEEL ALGOMA INC. IF YOU RECEIVE THIS DOCUMENT AND ARE NOT THE INTENDED RECEIVER PLEASE CALL 1705-945-4025 FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.

WELTS EN 10204 2004 "TYPE 3.1"
 ISO QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM

ALL HEATS FULLY KILLED
 HEATS INDICATED WITH (*) FINE GRANDED
 HEATS INDICATED WITH (+) MADE IN CANADA WITH DOMESTIC AND NORTH AMERICAN MATERIALS

Dimensions (T x W x L)	Heat No.-MS	Quantity	No of PCS	Dimensions (T x W x L)	Batch No.	Quantity	Heat No.-MS	Quantity	No of PCS
1 0000 " x 120 000 " x 384 00 "	AB8769	13 068 LB	1	1 0000 " x 120 000 " x 384 00 "	AB8770	2606P3-56	2606P3-56	13 068 LB	1
1 0000 " x 120 000 " x 384 00 "	AB8771	13 068 LB	1						

Heat No. (wt%)	C	Mn	P	S	Si	Cr	Ni	Cu	Mo	Al	Nb	V	B	TI	DO
2606P3*	0.20	1.06	0.012	0.004	0.340	0.02	0.15	0.02	0.01	0.027	0.000	0.014	0.0003	0.002	0.4000
2797P3*	0.19	1.06	0.009	0.005	0.310	0.02	0.15	0.03	0.00	0.024	0.000	0.015	0.0002	0.003	0.3900

Hardness Tests	SRCE	LAB	GAUGE	COND	LOC	MTHD	HARDNESS
2606P3	166"	ALG	1.0000	NORM B	HBW		153
2606P3	166"	ALG	1.0000	NORM B	HBW		153
2797P3	166"	ALG	1.0000	NORM B	HBW		150

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
 CU + Ni + CR + MO = 2.22
 CR + MO = 0.22

W.O. # 11768
 M.L. # 2606P3
 THK. # 13-0220

Certification of Material - Per ASME
 HT# 2606P3-56
 Qualifies to all requirements of
 SAS166702N
 Sect. II 10 Edition 11 Addenda

MILL TEST REPORTS APPROVED BY Q.C.
 P.O. # 13-0220

Q.C.I. E.Y.

Q.C.I. N.D.

K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

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

Velocity America
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SO No., Item & Date:	8006515 000020 2013/01/05	Shipment No & Date:	1000023647 2013/01/06	TC No., Date & Time:	ESA-38932 2013/01/07 - 10 15 07
Sold to Customer Name and Address:	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE, Ontario Canada N1H 6H9	Ship to Customer Name and Address:	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE, Ontario Canada N1H 6H9	Customer PO NO./Item:	P007755 / 2 1000023647
Customer Specification:	HR STEEL PLATE Carbon Mjbt Cert ASTM A516 GR 70 (10) / ASME SA516 GR 70 (11A) Meets NACE MR 0103 latest Ed. BHN < 200, D O CEQ .43 max Inclusion Shape Control Calcium Treated Normalized Temp. 1670 ° F 3.4 min CVNL Req. 157 12 FT-LBF at 0-.50 0 F Std Thickness Tol PVQ Top and Bottom Standard Surface Flatness 1/2 A20 Latest Ed + Addenda of ASME Code section II part A applies Fine Grain Fully Killed No Weld Repair	Carrier:	ROBINSON TRANSPORT LTD - 205(661)		

Supplementary Instructions: Test Cert 1519-837-2227

Insp TR: Test Report As Per Spec

Cur Use: PVQ

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. 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) 945-4006 FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.

MEETS EN 10204 2004 TYPE 3.1
 ISO QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM

Head No.	Batch No.	SRCE	LAB	GAUGE	COND	METH	DIR	LOC	SIZE	TEMP (°F)	ENERGY (R-Jbt)	ENERGY AVG (R-Jbt)
2606P3	A88769	166"	ALG	1.0000	NORM	CVN	L	B	FULL	-50	71 69 77	72
2606P3	A88770	166"	ALG	1.0000	NORM	CVN	L	B	FULL	-50	59 61 73	64
2797P3	A88771	166"	ALG	1.0000	NORM	CVN	L	B	FULL	-50	84 86 65	79

Head No.	Batch No.	SRCE	LAB	GAUGE	COND	METH	DIR	LOC	YIELD (KSI)	TENSILE (KSI)	EL SCALE	ELONG (%)
2606P3	A88769	166"	ALG	1.0000	NORM	2	T	B	49.5	78.2	2"	33
2606P3	A88770	166"	ALG	1.0000	NORM	2	T	B	49.0	77.1	2"	32
2797P3	A88771	166"	ALG	1.0000	NORM	2	T	B	50.7	77.2	2"	31

Velocity America
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 March 1, 2013

Q.C.I. N.D.

Q.C.I. E.Y.

MAR 27 2013

K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

APR 03 2013

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 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.

Date 2013/01/07 Time 12:25:32 Page no 2 of 2

Certificate of Mill Test Results

QUALITY PLATES & PROFILES LIMITED
 20 Nicholas Boulevard, R.R.#3 (Aberfoyle), Guelph, ON N1H 6H9
 ALL-WELD COMPANY LIMITED
 PO/Rel: 13-0220
 PLATE C/PL 516N 3/8" x 6" x 30-1/4" TAG 1176-21

Contact: HELENE/BRIAN
 Inv: 1055184 Date: 03/19/2013
 Heat: 7905M



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

SO No., Item & Date:	8003926 000010 2012/11/08	Shipment No. & Date:	1000014698 2012/11/08	TC No., Date & Time:	ESA-24903 2012/11/09 - 20:48:10
Sold to Customer Name and Address:	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE, Ontario, Canada N1H 6H9	Ship to Customer Name and Address:	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE, Ontario, Canada N1H 6H9	Customer PO NO./Item:	P007192 / 1 1000014698
Customer Specification:	HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (11A) Meets NACE MR 0175 latest Ed., NACE MR 0175 latest Ed., BHN < 200, D.O.CEQ. 43 max, Inclusion Shape Control Calcium Treated Normalized Temp 1670 °F 12 min CVNL Req. 15 / 12 FT-LBF at -50.0 F Std Thickness Tol PVQ Top and Bottom Standard Surface Flatness 1/2 A20 Niobium max 0.015 Sum-Nb+V max 0.030 Vanadium max 0.020 Latest Ed. +Addenda of ASME Code section II part A applies Fine Grain Fully Killed No Weld Repair	Carrier:	INTERNATIONAL FREIGHT SYSTEMS - OSH44		

Customer Specification: HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (11A) Meets NACE MR 0175 latest Ed., NACE MR 0175 latest Ed., BHN < 200, D.O.CEQ. 43 max, Inclusion Shape Control Calcium Treated Normalized Temp 1670 °F 12 min CVNL Req. 15 / 12 FT-LBF at -50.0 F Std Thickness Tol PVQ Top and Bottom Standard Surface Flatness 1/2 A20 Niobium max 0.015 Sum-Nb+V max 0.030 Vanadium max 0.020 Latest Ed. +Addenda of ASME Code section II part A applies Fine Grain Fully Killed No Weld Repair

Supplementary Instructions: Test Cert 1:519-837-2227
 Insp T/R: Test Report As Per Spec
 Cust Use: PVQ

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
 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)945-4095 FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.

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

Dimensions (T x W x L)	0.3750" x 120.0000" x 384.00"	Batch No.	AA5430	Heat No.-MS	7905M-55	Quantity	9,802 LB	Pcs	2
Heat No. (wt%)	7905M+	C	0.19	Mn	1.08	P	0.016	S	0.004
		Si	0.320	Cr	0.03	Ni	0.15	Cu	0.02
		Mo	0.01	Nb	0.000	Al	0.029	V	0.015
		B	0.0002	Ti	0.003	DO	0.3900		

Hardness Tests	SRCE LAB GAUGE COND LOC MTHD	HARDNESS
Heat No.	AA5430 166" ALG 0.3750 NORM B HBW	154
Impact Tests	SRCE LAB GAUGE COND METH DIR LOC SIZE TEMP (F) ENERGY (ft-lbf) ENERGY AVG (ft-lbf)	
Heat No.	AA5430 166" ALG 0.3750 NORM CVN L B 3/4 -50	54 71 54 60

W.O. # 11769
 M.L. # 21 (3/3)
 TRK. # 381
 P.O. # 13-0220

Velocity America 279
 Review
 April 1, 2013

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
 CU + Ni + CR + MO = 0.24
 CR + MO = 0.04

MILL TEST REPORTS APPROVED BY Q.C. P.O.
 K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

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 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.

Certificate of Mill Test Results

QUALITY PLATES & PROFILES LIMITED

20 Nicholas Bay Road, R.R.#3 (Aberfoyle), Guelph, ON N1H 6H9
 ALL-WELD COMPANY LIMITED
 PO/Rel: 13-0220
 TAG 1176-21

Contact: HELENE/BRIAN
 Inv: I055184 Date: 03/19/2013
 Heat: 7905M



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

SO No., Item & Date.: 8003926 000010 2012/11/08	Shipment No. & Date.: 1000014698 2012/11/08	TC No., Date & Time : ESA-24903 2012/11/09 - 20:48:10
Sold to Customer Name and Address : QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE, Ontario, Canada N1H 6H9	Ship to Customer Name and Address: QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE, Ontario, Canada N1H 6H9	Customer PO NO./Item: P007192 / 1 BOL NO.: 1000014698 Cust. Part No.: Carrier : INTERNATIONAL FREIGHT SYSTEMS - OSH44
Customer Specification : HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (10) / ASME SA516 GR 70 (11A) Meets NACE MR 0103 latest Ed., NACE MR 0175 latest Ed., BHN < 200, D.O.CEQ. 43 max, Inclusion Shape Control Calcium Treated Normalized Temp 1670 °F 12 min CVNL Req. 15 / 12 FT-LBF at -50.0 F Sid Thickness Tol PVQ Top and Bottom Standard Surface Flatness 1/2 A20 Niobium max 0.015 Sum-Nb+V max 0.030 Vanadium max 0.020 Latest Ed. +Addenda of ASME Code section II part A applies Fine Grain Fully Killed No Weld Repair		
Supplementary Instructions : Test Cert 1:519-837-2227		
Insp T/R : Test Report As Per Spec		Cust Use : PVQ
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. 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)945-4095 FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.		
MEETS EN 10204:2004 TYPE 3.1 ISO QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM		
***** MECHANICAL PROPERTIES *****		
Tensile Tests		
Heat No. 7905M	Batch No. AA5430	SRCE LAB GAUGE COND METH DIR LOC YIELD(KSI) TENSILE(KSI) EL SCALE ELONG(%)
		166° ALG 0.3750 NORM .2 T B 52 76 8" 24

Q.C.I.
E.Y.

APR 3 2013

Q.C.I.
N.D.

MAR 27 2013

Benjamin
 Velocity America
 279
 April 1, 2013

K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

****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 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.

Certificate of Mill Test Results

QUALITY PLATES & PROFILES LIMITED

20 Nicholas B...r Road, R.R.#3 (Aberfoyle), Guelph, ON N1H 6H9
 ALL-WELD COMPANY LIMITED
 PO/Rel: 13-0220
 PLATE CPL 516N 3/8" x 4" x 55-3/8" TAG 1176-21

Contact: HELENE/BRIAN
 Inv: 1055184
 Date: 03/19/2013
 Heat: 5416M

ESSAR Steel Algoma Inc. 105 West Street, Sault Ste. Marie, Ontario Canada P6A 7B4

CUSTOMER PURCHASE ORDER NUMBER P006596	ENTRY DATE 2012/03/29	CREATE DATE 2012/05/23	TALLY NUMBER 278694	SHIPPER'S NO. 02-3498	CARRIER NATIONAL TRANSPORTATION C	WILL ORDER 18996
---	--------------------------	---------------------------	------------------------	--------------------------	--------------------------------------	---------------------

CHARGE TO CUSTOMER NAME AND ADDRESS

QUALITY PLATES & PROFILES LTD.
 20 NICHOLAS BEAVER ROAD RR#3
 ABERFOYLE, ON
 N1H 6H9

QUALITY PLATES & PROFILES LTD
 20 NICHOLAS BEAVER ROAD
 RR#3
 ABERFOYLE, ON

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

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CUSTOMER SPECIFICATION
 HR PLATE - CARBON - ASME SA516 GR 70 (11A) - CVNL 15/12 FT LBS AT -50 F - FULLY KILLED - FINE GRAIN - SULFIDE SHAPE CONTROL CALCIUM TREATED - MEETS NACE MR 0103 LATEST ED. - NACE MR 0175 LATEST ED. - BEN 200 MAX - PER EN 10204 3.1 - PVO - NORMALIZED - FLATNESS 1/2 A-20 - NORM 12 MIN MIN. @ 1670F-NO WELD REPAIRS - CE. 43 MAX - TO MEET ASME SEC II LAT ADD

SUPPLEMENTARY INSTRUCTIONS
 TEST CERT 1: MICHELLE CRAVEIRO 519-837-2227 TEST CERT 2: PLAT
 E TEST COUPON:

TEST REPORTS REQUIRED
 2000226082 PF
 2012/05/23 19:21

RESALE
 M E C H A N I C A L P R O P E R T I E S * * * * *

HEAT NUMBER 5416M 75082	SRC# 166	GAUGE IN .3750	COND METH N	DIR SIZE 3/4	TEMP -50F	FULLSIZE ENERGY * AVG* 83 73	W.O. # 11760	M.L. # 2143614	THK. # .381	P.O. # 13-0220		
HEAT (WT %) 5416M**	C 19	MN 1.08	P 0.13	NI 0.01	SI 0.31	CR 0.02	CU 0.03	MO 0.00	AL 0.03	CB 0.00	B 0.0002	DO 0.38

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
 CU + Ni + CR + MO = 0.06
 CR + MO = 0.02

Certification of Material - Per ASME
 HT# 5416M-75082
 Qualifies to all requirements of
 SA516-GR70N per
 Sect. II Edition II Addenda



Q.C.I. E.V.

APR 03 2013

Q.C.I. N.D.

MAR 7 7 2013

PAGE 2 OF 2

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.

QUALITY PLATES & PROFILES LIMITED

20 Nicholas Bay Road, R.R.#3 (Aberfoyle), Guelph, ON N1H 6H9
 ALL-WELD COMPANY LIMITED PO/Rel: 13-0220
 PLATE CPL 516N 3/8" x 4" x 55-3/8" TAG 1176-21

Contact: HELENE/BRIAN
 Inv: 1055184 Date: 03/19/2013
 Heat: 5416M

105 West Street, Sault Ste. Marie, Ontario Canada P6A 7B4 005491

ESSAR Steel Algoma Inc.

CUSTOMER PURCHASE ORDER NUMBER: P006596
 ENTRY DATE: 2012/03/29
 CREATE DATE: 2012/05/23
 TALLY NUMBER: 278694
 SHIPPER'S NO: 02-3498
 NATIONAL TRANSPORTATION C - 0695 (100)
 MILL ORDER: 18996

SHIP TO CUSTOMER NAME AND ADDRESS

QUALITY PLATES & PROFILES LTD.
 20 NICHOLAS BEAVER ROAD RR#3
 ABERFOYLE, ON N1H 6H9

QUALITY PLATES & PROFILES LTD
 20 NICHOLAS BEAVER ROAD
 RR#3
 ABERFOYLE, ON

MILL TEST REPORTS

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K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

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CUSTOMER SPECIFICATION
 HR PLATE - CARBON - ASME SA516 GR 70 (11A) - CVNL 15/12 FT LBS AT -50 F - FULLY KILLED - FINE GRAIN SULFIDE SHAPE CONTROL CALCIUM TREATED - MEETS NACE MR 0103 LATEST ED. - NACE MR 0175 LATEST ED. - BHN 200 MAX - PER EN 10204 3.1 - PVO NORMALIZED - FLATNESS 1/2 A-20 - NORM 12 MIN MIN. @ 1670F-NO WELD REPAIRS -CE.43 MAX-TO MEET ASME SEC II LAT ADD

SUPPLEMENTARY INSTRUCTIONS
 TEST CERT 1: MICHELLE CRAVEIRO 519-837-2227 TEST CERT 2: PLAT
 E TEST COUPON:

TEST REPORTS REQUIRED
 2000226082 PF
 2012/05/23 19:21

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

***** P R O D U C T S H I P P E D *****

CUSTOMER ITEM 00001 OUR ITEM 003 DIMENSIONS .375 X 120 X 384 "

PLATE NUMBER	HEAT-MS	PIECES	NO.	WEIGHT	PLATE NUMBER	HEAT-MS	PIECES	NO.	WEIGHT
75082	5416M-52	2	9801						



TENSILE TESTS:

PLATE NUMBER	SAMPLE SRCE	GAUGE	COND METH	DIR	YIELD TENSILE KSI	TENSILE KSI	* ELONG
5416M 75082	166"	.3750	N	.2	52.4	75.3	26(8")

HARDNESS TESTS:

PLATE NUMBER	SAMPLE SRCE	GAUGE	COND METH	HARDNESS
5416M 75082	166"	.3750	N	152

MILL TEST REPORTS APPROVED BY Q.C.

LAB ALG

P.O. APR 03 2013 LAB ALG



MAR 27 2013

PAGE 1 OF 2

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.

Tubos de Acero de Mexico, S.A.
 Oficina Administrativa No. 432, 7 SN
 Carretera Villahermosa-Tuxtla, Villahermosa, Veracruz
 C.P. 81687-REYICO
 (52) 229 929 1 000 Int.
 (52) 229 929 1600 Int.

INSPECTION CERTIFICATE 3.1
CERTIFICADO DE INSPECCIÓN 3.1
 EN 10204 3.1: 2004



Page / Página: 1 / 7

Number / Número: 12074141

Date / Día: October 30, 2012

Customer / Cliente: COMCO PIPE & SUPPLY	Customer's Order Item / Orden Cliente - Item: G1-3611 ITEM 2	Customer's Reference / Ref. del Cliente: N/A	Manufacturer's Works Order N° / Confirmación de Venta: 186861702
Manufacturing Process / Proceso de Manufactura: SEAMLESS HOT ROLLED LAMINADO EN CALIENTE SIN COSTURA	Product Type / Tipo de Producto: LINE PIPE SEAMLESS CONDUCCION SIN COSTURA	Surface / Superficie: VARNISHED BARNIZADO	Ends / Extremos: NORMAL BEVEL BISELADO NORMAL
Standard or Specification / Normas o Especificaciones: A STM A 106.11	Schedule / Calcular: 040	Quantity / Cantidad: 99 Pcs/Pz 42721.212 LB 1181,490 MTS	Nominal Weight / Peso Nominal: 10.80 LB/FT 16.08 KG/M
Dimensions / Dimensiones: 4 1/2 X 0.237 INCH 114.3 X 6 MM	Length / Longitud: 38.02 / 39.37 FT 11.59 / 12.00 MTS	Site / Grado / Grado de acero: B	

TENSILE TEST / ENSAYO DE TENSION

Heat N° Coada N°	Sample N° Muestra N°	Specimen condition Condición de la probeta	Specimen dimensions Dimensiones de la probeta	Test temp Temp. ensayo	Y.S. Eul 0.50 %	U.T.S. Req. Min: 60 000 Max: 90 650	Elongation / Alargamiento	
							Req. Max.	Obt.
04385	67422	B AM	25.51 X 06.20	RT	58.437	80.787	2	23.7
04385	67423	B AM	25.53 X 06.04	RT	57.048	82.109	2	23.6
04389	67425	B AM	25.59 X 06.37	RT	54.915	78.269	2	23.8
04389	67426	B AM	25.76 X 06.15	RT	54.062	77.870	2	23.7

AM: As manufactured / Según proceso de fabricación
 B: Body / Cuerpo
 L: Longitud / Longitud inicial
 Lo: Initial length / Longitud inicial

Or: Orientation / Orientación
 Req. Max: Required maximum / Máximo requerido
 Req: Required / Requerido
 RT: Room temperature / Temperatura ambiente

Sc: Specimen condition / Condición de la probeta
 Ss: Strip specimen / Muestra rectangular
 U.T.S: Ultimate tensile strength / Resistencia
 Y.S: Yield strength / Fluencia

América
 Velosi America
 279
 APR 04 2013



This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the paper-mark green colored "Tenaris" is stamped. In case the owner of this original certificate would release a copy of it, he must attest its conformity to the original one taking upon himself the responsibility for any unlawful or not a bonded use. Any alteration minor or substantial will be subjected to the law.

FOR03171

Tubos de Acero de Mexico, S.A.
 Calle: Mexico Jimenez Km 45.7 SN
 Carretera a Tepic, Jalisco, Veracruz
 C.P. 16250
 (52) 228 646 1100 Lx
 (52) 228 646 1000 fax

INSPECTION CERTIFICATE 3.1 CERTIFICADO DE INSPECCIÓN 3.1		Number / Número: 12074141	Page / Página: 2 / 7
EN 10204 3.1: 2004		Date / Día: October 30, 2012	
Customer / Cliente: COMCO PIPE & SUPPLY	Customer's Order / Item / Orden Cliente - Item: G1-3811 ITEM 2	Customer's Reference / Ref. del Cliente: 198861/02	Manufacturer's Works Order N° / Confirmación de Venta: 198861/02
Manufacturing Process / Proceso de Manufactura: SEAMLESS HOT ROLLED	Product Type / Tipo de Producto: LINE PIPE SEAMLESS	Surface / Superficie: VARNISHED	
LAMINADO EN CALIENTE SIN COSTURA	CONDUCCION SIN COSTURA	Ends / Extremos: NORMAL BEVEL	
Standard or Specification / Normas o Especificaciones: ASTM A 106, 11	Sleeve Grade / Grado de acero: B	BISELADO NORMAL	
Dimensions / Dimensiones: 4.712 X 0.237 INCH	Schedule / Cédula: 040	Nominal Weight / Peso Nominal: 10.80 LB/FT	
114.3 X 6 MM	Length / Longitud: 38.02 / 39.37 FT	16.08 KG/M	
	11.59 / 12.00 MTS	Quantity / Cantidad: 99 Pcs/Pz	42721.212 LB
		1181.490 MTS	19378.000 KG

CHEMICAL COMPOSITION / COMPOSICION QUIMICA

Heat N° / Muestra N°	Composition % / Composición %																							
	x 100							x 1000																
	C	Mn	Si	Cr	Mo	S	P	Ni	V	Cu	Al	Sn	As	Nb	Ti	Ca	B	N	Co	1	2	Col. 1	Col. 2	
H Max	25	135	50	40	15	35	30	400	80	400	-	-	-	110	110	-	10	-	40	-	-	-	-	99.99
H Min	29	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	300
P Max	25	135	50	40	15	35	30	400	80	400	-	-	-	110	110	-	10	-	40	-	-	-	-	99.99
P Min	29	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	300
04385	20	92	22	2	0.5	3	9	10	4	39	17	9	1	0	2	17	2	47	37	36	480	7.8	-	-
04385	21	91	23	2	0.5	2.2	9	20	0	34	20	4	1	0	0	21	0	47	38	37	433.33	7.9	-	-
04385	22	94	24	2	0.5	2.3	10	20	0	35	20	5	1	0	0	20	0	47	39	39	427.27	8	-	-
04389	20	91	22	2	0.5	1	8	20	2	48	21	8	1	0	1	13	1	56	37	38	455	9.5	-	-
04389	21	90	22	2	0.5	1.1	7	20	0	41	24	5	1	0	0	19	0	56	38	37	428.57	8.6	-	-
04389	21	91	23	2	0.5	1.2	7	20	0	41	23	5	1	0	0	18	0	56	38	37	433.33	8.6	-	-

Certification of Material - Per ASME
 HT# **04389**
 Qualifies to all requirements of
SA106-GRB per
 Sect. II 10 Edition II Addenda

Col. 1: REL Mn/C	Max: Maximum / Máximo
Col. 2: SUMA Mo+Cr+Ni+Cu+V	Min: Minimum / Mínimo
H: Heat / Colada	P: Product / Producto
W.O. # 11760	M.L. # 22(5/3)
THK. # 0.237	P.O. # 13-0249
Q.C.I. N.D.	
Q.C.I. E.Y.	
APR 04 2013	
Velosi America 279	

This certificate is issued by a computerized system and it is valid only electronic signature. On the original certificate the trace-back system cannot be used. In case the owner of the original certificate needs a copy of it, he must attest its conformity to the original one taking upon himself the responsibility for any alteration or not allowed data. Any alteration under falsification will be subjected to the law.

Este certificado es emitido por un sistema electrónico de firmas. En el caso de que el poseedor del certificado necesite una copia, deberá garantizar la conformidad con el original haciéndose responsable por cualquier uso ilegal o indebido. Cualquier alteración u/o falsificación estará sujeta a la ley.

FOR03171

Tubos de Acero de Mexico, S.A.
 Calle: Mexico Venezuela #433.7 SN
 Apartado Postal: 10000
 C.P. 81487, MEXICO
 (52) 223 260 1100 (d)
 (52) 223 089 1800 (t)

INSPECTION CERTIFICATE 3.1 CERTIFICADO DE INSPECCIÓN 3.1 EN 10204 3.1: 2004		Number / Número: 12074141	Page / Página: 3 / 7
Customer / Cliente: COMCO PIPE & SUPPLY		Date / Día: October 30, 2012	Manufacturer's Works Order N° / Confirmación de Venta: 186861702
Product Type / Tipo de Producto: LINE PIPE SEAMLESS CONDUCCION SIN COSTURA		Customer's Reference / Ref. del Cliente: N/A	Surface / Superficie: VARNISHED BARNIZADO
Standard or Specification / Normas o Especificaciones: ASTM A106-11		Steel Grade / Grado de acero: B	Ends / Extremos: NORMAL BEVEL BISELADO NORMAL
Dimensions / Dimensiones: 4 1/2 X 0.237 INCH 114.3 X 6 MM	Schedule / Cédula: 040	Quantity / Cantidad: 99 Pcs/Pz	Nominal Weight / Peso Nominal: 10.80 LBI/FT 16.08 KG/M
Length / Longitud: 38.02 / 39.37 FT 11.59 / 12.00 MTS	Weight / Peso: 3876.280 FT 1181.490 MTS	Harcness type HRC Tipo de dureza	

THROUGH WALL HARDNESS / DUREZA EN EL ESPESOR

Heat N° Colada N°	Sample N° Muestra N°	Individuals / Individuales		Average / Promedio		Harcness type HRC			
		Min. --	Max. --	Min. --	Max. --	Var. --	1	2	3
04385	67422	B	AM	80.2	80.1	80.1	80.1	80.1	80.1
04385	67423	B	AM	82.8	81.1	82.2	82.0	81.9	81.6
04389	67425	B	AM	81.0	81.9	81.9	81.9	81.9	81.6
04389	67426	B	AM	82.1	81.8	82.0	82.0	82.0	82.0

046
ACCEPTED / REBIVIBED / RELEASED
for and on behalf of: SIM DFSI HAVZ
Print Name: CARLOS SAHA
Signature: [Signature]
Date: [Date]
Applus® VELOSI
Velori America LLC

AM: As manufactured / Según proceso de fabricación
 Avg: Average / Promedio
 B: Body / Cuerpo
 Ls: Location of sample / Ubicación de la muestra
 Max: Maximum / Máximo
 Min: Minimum / Mínimo
 MW: Middle wall / Centro
 Quad: Quadrant / Cuadrante
 Sc: Specimen condition / Condición de la probeta
 Var: Variation / Variación

FLATTENING TEST / ENSAYO DE APLASTAMIENTO

Standard / Norma:	Heat N°	Sample N°	Result
04385	67422	67422	Good / Bueno

Standard / Norma:	Heat N°	Sample N°	Result
04385	67425	67425	Good / Bueno

Standard / Norma:	Heat N°	Sample N°	Result
04389	67426	67426	Good / Bueno

APR 04 2013

Q.C.I.
N.D.

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the trace-mark green colored "Tenaris" is stamped. In case the owner of the original certificate would release a copy of it, he must attest its conformity to the original one taking upon himself the responsibility for any alteration or not allowed use. Any alteration and/or falsification will be subjected to the law.

FOR03171

Tubos de Acero de Mexico, S.A.
 Central Mexico Veracruz Rd. 4337 SN
 Distrito Valenciana Tuxtla, Veracruz, Veracruz
 C.P. 21600
 C.T. 21 688 1100-1
 C.T. 21 688 1100-2
 (52) 229 688 1100-114

INSPECTION CERTIFICATE 3.1
CERTIFICADO DE INSPECCIÓN 3.1
EN 10204 3.1: 2004



Numero / Número: 12074141
 Pago / Página: 4 / 7
 Date / Día: October 30, 2012

Customer / Cliente: COMCO PIPE & SUPPLY		Customer's Order / Orden Cliente - Item: N/A		Manufacturer's Works Order N° / Confirmación de Venta: 18685102	
Manufacturing Process / Proceso de Manufactura: SEAMLESS HOT ROLLED		Product Type / Tipo de Producto: LINE PIPE SEAMLESS		Surface / Superficie: VARNISHED	
LAMINADO EN CALIENTE SIN COSTURA		CONDUCCION SIN COSTURA		BARNIZADO	
Standard or Specification / Normas o Especificaciones: ASTM A106,11					
Dimensions / Dimensiones: 4 1/2 X 0.237 INCH		Schedule / Cédula: 040		Ends / Extremos: NORMAL BEVEL	
114.3 X 6 MM		Length / Longitud: 38.02 / 39.37 FT		BISELADO NORMAL	
		11.59 / 12.00 MTS		Nominal Weight / Peso Nominal: 10.80 LB/FT	
		Quantity / Cantidad: 99 Pcs/Pz		16.08 KG/M	
		3876.280 FT			
		1181.490 MTS			

HYDROSTATIC TEST / PRUEBA HIDRAULICA

Pressure / Presión	Time / Tiempo	Result / Resultado
psi	Seconds / Segundos	Satisfactory / Satisfactorio
2,660	5	

HEAT TREATMENT / TRATAMIENTO TERMICO

Heat treatment / Tratamiento térmico: Pipe / Tubo
 Quench media of heat treatment process / Medio de enfriamiento del tratamiento térmico: N/A
 Temperature Scale / Escala de Temperatura: N/A

SUPPLEMENTARY INFORMATION / INFORMACION SUPLEMENTARIA

Supplementary Information / Información Suplementaria
 Manufactured by Tenaris / Fabricado por Tenaris
 Steel making process: Electric-Arc Furnace-Ladle Furnace-Continuous Casting Machine / Acero calado con aluminio
 Fully Killed Steel / Material libre de contaminación de Mercurio

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the manufacturer's green color "Tenaris" is stamped. In case the owner of the original certificate would release a copy of it, he must attest its conformity to the original one taking upon himself the responsibility for any unlawful or not allowed use. Any alteration and/or falsification will be subjected to the law.
 Este certificado es emitido mediante sistema automatizado y es válido con firma electrónica. El certificado original posee impreso el logo "Tenaris" en color verde. En caso de que el poseedor del certificado entregue una copia, deberá garantizar la conformidad con el original bajo su propia responsabilidad por cualquier uso ilegal o no autorizado. Cualquier alteración u/o falsificación estará sujeta a la ley.

FOR03171

046
ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SBM OFFSHORE
 Print Name: W. P. S. SAJA
 Signature: [Signature]
 Date: 10/30/12
APLIS®
VELOSI
VELOSI AMERICA LLC

Tubo de Acero de Mexico, S.A.
 Calle: Mexico Sur 4014 433 7 BN
 Ciudad: Veracruz, Veracruz, Veracruz
 C.P. 91697 JEXYCO
 (52) 228 989 1100 bx
 (52) 228 989 1600 fax

INSPECTION CERTIFICATE 3.1 CERTIFICADO DE INSPECCIÓN 3.1 EN 10204 3.1: 2004		Number / Número: 12074141	Page / Página: 5 / 7
Customer's Order Item / Orden Cliente - Item: G1-3811 ITEM 2		Date / Día: October 30, 2012	
Customer's Reference / Ref. del Cliente: N/A		Manufacturer's Works Order N° / Confirmación de Venta: 186861702	
Product Type / Tipo de Producto: LINE PIPE SEAMLESS CONDUCCION SIN COSTURA			
Steel Grade / Grado de acero: B			
Dimensions / Dimensiones: 4-1/2 X 0.237 INCH 114.3 X 6 MM	Schedule / Cédula: 040	Quantity / Cantidad: 99 Pcs/Pz 3876.280 FT 1181.490 MTS	Nominal Weight / Peso Nominal: 10.80 LB/FT 16.08 KG/M
Surface / Superficie: VARNISHED BARNIZADO			
Edges / Extremos: NORMAL BEVEL BISELADO NORMAL			

SUPPLEMENTARY INFORMATION / INFORMACION SUPLEMENTARIA

Supplementary Information / Información Suplementaria	Supplementary Information / Información Suplementaria
Not repaired by welding Non destructivo test. Satisfactory Inspección método - EMI - FLVI - MPI - VEM MATERIAL ACCORDING TO ASTM A106 GR. B, 11 / ASME SA106 GR. B, 2010 / CSA Z245.1 GR.290 CAT.I SS. APRIL 2007 MATERIAL ACCORDING TO NACE MR0175-2003 & NACE MR01 03-2003 REL Mn/C MIN 3 SUM Mn-C-Mn-Cu-V MAX 0.9999 CERTIFICATE ACCORDING TO EN 10204 3.1: 2004	No reparado por soldadura Control no destructivo. Satisfactorio Método de Inspección - EMI - FLVI - MPI - VEM MATERIAL ACCORDING TO ASTM A106 GR. B, 11 / ASME SA106 GR. B, 2010 / CSA Z245.1 GR.290 CAT.I SS. ABRIL 2007 MATERIAL DE ACUERDO A NACE MR0175-2003 & NACE MR01 03-2003 REL Mn/C MIN 3 SUM Mn-C-Mn-Cu-V MAX 0.9999 CERTIFICADO DE ACUERDO A EN 10204 3.1: 2004

046
 ACCEPTED / REVIEWED / REVISADO
 BY: SDM OFFSHORE
 DATE: SEP 18 2012
 Signature: [Signature]
 Title: Inspector

MARKING / MARCACION

PIPE STEENCIL: #N**** TENARIS TM ASTM A106/ASME SA106 / CSA Z245.1 #FE1 114.3 6.00 16.08 SCH 040 GR B/290 CAT I SS S TEST PRESSURE/ENDE #M**** MT #K**** KG HEAT #C**** O.P 209426 / #N**** HABILITADA MADE IN MEXICO WHERE: Heat number #C**** Manufacturing Date #FE1:	MASCARILLA DE TUBO ESTARCIDO: #N**** TENARIS TM ASTM A106/ASME SA106 / CSA Z245.1 #FE1 114.3 6.00 16.08 SCH 040 GR B/290 CAT I SS S TEST PRESSURE/ENDE #M**** MT #K**** KG HEAT #C**** O.P 209426 / #N**** HABILITADA MADE IN MEXICO DONDE: Numero de colada #C**** Fecha de Fabricación #FE1:
---	---

This certificate is issued by a computerized system and it is void with electronic signature. On the original certificate the radio-mark green color "Tenaris" is stamped. In case the owner of the original certificate would please a copy of it, he must ensure its conformity to the original one being responsible for any unlawful or not allowed use. Any alteration and/or falsification w.c.l be subjected to the law.

FOR03171

Tubo de Acero de Mexico, S.A.
 Mexico Velosita MA-423 T SH
 Calle US-2000000 Tepetitl, Veracruz, Veracruz
 C.P. 81687 MEXICO
 (52) 229 966 1100 01
 (52) 229 966 1600 04

INSPECTION CERTIFICATE 3.1
CERTIFICADO DE INSPECCIÓN 3.1
 EN 10204 3.1: 2004



Customer / Cliente: COMCO PIPE & SUPPLY		Customer's Order Item / Orden Cliente - Item: G1-3811 ITEM 2	Customer's References / Ref. del Cliente: N/A	Manufacturer's Works Order N° / Confirmación de Venta: 186861702
Manufacturing Process / Proceso de Manufactura: SEAMLESS HOT ROLLED		Product Type / Tipo de Producto: LINE PIPE SEAMLESS	Surface / Superficie: VARNISHED	
Standard or Specification / Normas o Especificaciones: ASTM A106, 11		Steel Grade / Grado de acero: B	Ends / Extremos: NORMAL BEVEL	
Dimensions / Dimensiones: 4 1/2 X 0.237 INCH 114.3 X 6 MM	Schedule / Cádula: 040	Length / Longitud: 38.02 / 39.37 FT 11.59 / 12.00 MTS	Nominal Weight / Peso Nominal: 10.80 LB/FT 16.08 KG/M	
		Quantity / Cantidad: 99 Pcs/Pz		

MARKING / MARCACION

Marking / Marcación

Net weight of pipe in Kgs #K****: _____
 Length Mts #M****: _____
 Pipe number #N****: _____
 HABILITADA G1-3811

SUMMARY REPORT / REPORTE RESUMEN

Heat N° Caleada N°	Quantity Cantidad (Pieces)	Length Longitud (ft)	Weight Peso (Tons)	Quantity Cantidad (Pieces)	Length Longitud (m)	Weight Peso (Tons)
04389	3	117.62	35.85	99	3,758.66	1,145.64
Average length per pipe Longitud promedio por tubo (ft)		11.021	16.401			18.79

ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: S.B.M OFF-SHORE
 Print Name: LAUREN H. SAHA
 Signature: [Signature]
 Date: Apr 11 2013

046
Applus
VELOSI
 Velosi America LLC

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate, the mark-mark (poco colorado "Tenaris" is stamped. In case the owner of the original certificate would release a copy of it, he must attest its conformity to the original one taking upon himself the responsibility for any unlawful or not allowed use. Any alteration and/or falsification will be subjected to the law.

FOR03171

Tubos de Acero de Mexico, S.A.
 Carretera Mexico Veracruz Km 43.7 SN
 D.F. Mexico, Veracruz, Mexico
 C.P. 81697 MEXICO
 (52) 229 489 1100 Ext
 (52) 229 039 1600 fax

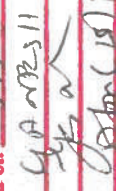
INSPECTION CERTIFICATE 3.1
CERTIFICADO DE INSPECCION 3.1
EN 10204 3.1: 2004

Page / Página: **7 / 7**
 Number / Número: **12074141**
 Date / Dia: **October 30, 2012**

Customer / Cliente: COMCO PIPE & SUPPLY		Customer's Order Item / Orden Cliente - Item: N/A		Manufacturer's Works Order N° / Confirmación de Venta: 188667102	
Manufacturing Process / Proceso de Manufactura: SEAMLESS HOT ROLLED		Product Type / Tipo de Producto: LINE PIPE SEAMLESS		Surface / Superficie: VARNISHED	
Standard or Specification / Normas o Especificaciones: ASTM A106, 11		Steel Grade / Grado de acero: B		Ends / Extremos: NORMAL BEVEL	
Dimensions / Dimensiones: 4 1/2 X 0.237 INCH		Length / Longitud: 38.02 / 39.37 FT		Nominal Weight / Peso Nominal: 10.80 LB/FT	
114.3 X 6 MM		11.59 / 12.00 MTS		16.08 KG/M	
Schedule / Código: 040		Quantity / Cantidad: 99 Pcs/Pz		Net Weight / Peso Neto: 42721.212 LB	
				19378.000 KG	

This is to certify that the product described here has been manufactured, sampled, tested, and inspected in accordance with purchaser order requirements. This certificate is not a declaration of origin nor may it be used as a declaration of origin.

CUSTOMER - THIRD PARTY		TENARIS QUALITY DEPARTMENT SIGNATURE	
INSPECTION COMPANY COMPAÑIA DE INSPECCION		 CHIEF OF QUALITY CERTIFICATION DEPT. RESPONSABLE DEL DEPTO. DE CERTIFICACION DE CALIDAD Ricardo Lozano Arreola	
NO APLICA Employee Name: N/A		 QUALITY CERTIFICATION DEPT. DEPTO. DE CERTIFICACION DE CALIDAD Antonio Fontanes Gonzalez	

ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SBM OFFSHORE
 Print Name: GABRIEL SAHA
 Signature: 
 Date: 10/31/12
Applus®
VELOSI
 Velosi America LLC

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the non-mark green color "Tenaris" is stamped. In case the owner of the original certificate would release a copy of it, he must attest its conformity to the original one taking upon himself the responsibility for any use or misuse of the copy. Any alteration and/or falsification will be subjected to the law.

FOR03171



INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)



SIDERCA S.A.I.C.
Dr. Jorge A. Simini 250
(B2804MHA) Campana
Buenos Aires, Argentina
(54) 3489 433100 tel.
(54) 3489 433405 fax

Cliente / Customer COMCO PIPE & SUPPLY CO.		Expediental / Manufacturing Order 50143.02		Número / Number 265419		Fecha / Date 24/06/2005		Pág./Page 1 / 5	
Producto / Product SMILS LINE PIPE		Orden de Compra / Purchase Order G1609215		Item 00008		Referencia del Cliente / Customer Reference 			
Norma / Standard API 5L/ASTM A-106/ASME SA-106 + CSAZ45.1-PA.17		Grado / Grade B7X42+290SS		Extremos / Ends ASMEB16.25FZA(ANSIB16.25)		Cantidades / Quantities 			
Dimensiones / Dimensions 114.30 x 11.10 mm 4 1/2 x 0.438 inches		Peso Nominal / Nominal Weight 28.25 KG/MT 19.02 LB/FT		Superficie Externa / External Surface VARNISHED		Longitud / Length 11,613,4 m		Cantidades / Quantities 27 Pz 326.02 m 27 Pcs 1069.62 Ft	

ENSAYOS DE TRACCION / TENSILE TEST

Nº de Ensayo	Condición de la probeta	Temp de Ens	Dimensiones	Sección	Fluencia / Yield Strength		Rotura/UT.S		Rebote FR	Alargamiento Elongation		Red. de area	Dureza / Hardness Tipo / Type: BHN
					Offset Method	EUL Method	Req. Min	V. obt.		Req. Min	V. obt.		
30330	CB PRO	TART	0.084 X 0.435 inches	0.43 inches2	0.5 %	42 Ksi	60 Ksi	70.9 Ksi	44.9 Ksi	28.4 %	42.0 %	143	200
<p>W.O. # 117603 M.I. # 230147314 THK. # 430 P.O. # D56773328</p> <p>certification of Material - Per ASME T# 29330 qualifies to all requirements of SA-106-3 sect II 10 Edición 1998</p>													

TEST TECNOLÓGICO / TECHNOLOGICAL TEST

Apertamiento Flattening Test	Curvado Bend Test	Abocardado Flaring Test	Puestado Flange Test	Ent. De Tracción de enslo Ring tensile Test
NA	NA	NA	NA	NA

RE = Rectangular
 CI = Cilíndrico / Cylindrical
 ST = Segmento Tubular / Tubular segment
 T = Temperatura / Temperature

Pro = Proceso / Process
 N = Normalizado / Normalized
 DAST = Diferenciadas / Stress Relief
 Q & T = Templado y Revenido / Quenched & Tempered
 TART = Temp. Ambiente / Room Temperature

ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SAH SAH
 Print Name: GANESH SAH
 Signature: [Signature]
 Date: 2004 10 13



INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

SIDERCA S.A.I.C.
Dr. Jorge A. Simóni 250
(B2604)HHA Campana
Buenos Aires, Argentina
(54) 3489 433100 tel
(54) 3489 433405 fax

Cliente / Customer COMCO PIPE & SUPPLY CO.		Expediental / Manufacturing Order 58143.02		Número / Number 265419		Fecha / Date 24/06/2005		Pág./Page 3 / 5	
Producto / Product SMLS LINE PIPE		Orden de Compra / Purchase Order G1609215		Item 00008		Referencia del Cliente / Customer Reference			
Norma / Standard API 5L/ASTM A-106/ASME SA-106 + CSAZ245.1-PA.17		Grado / Grade B/X42+280SS		Extremo / Ends ASMEB16.25F2A/ANSIB16.25		Cantidades / Quantities 27 Pz 326.02 m 9169 Kg 27 Pcs 1069.62 Ft 20214 Lb			
Dimensiones / Dimensions 114.30 x 11.10 mm		Peso Nominal / Nominal Weight 28.25 KG/MIT 19.02 LB/FT		Superficie Externa / External Surface VARNISHED		Longitud / Length 11,6713,4 m			
4 1/2 x 0.438 inches		Schedule 120		Longitud / Length 11,6713,4 m		Marcas / Marking LLL = Longitud / length PPP = Peso / Weight HN000000 = Coleada / Heat			
& = Monograma / Monogram SIDERCA MM.YY = Mes / Año Month / Year YYT = Año / Trimestre Year / Quarter		NNNN = Número de tubo / Nbr of pipe YTT = Año / Trimestre Year / Quarter		Prueba Hidráulica / Hydrostatic Test Tiempo / Time Segundos / Seconds 5,00		Resultado / Result Satisfactorio / Satisfactory			
Unidad / Unit PSI		Valor / Value 3000,00		Presión / Pressure		Estándar (Tubo) / Stencilling (Pipe) NNNN LLLL PPRPP TENARIS SD 5L0098 @ MM.YY ASTM/ASME ASA106 API5L CSA Z245.1-ED 2002 B/X42P5L1290 C1 SS S 114,3 X 11,1 19,02 4 SCH 120 3000PSI PO G1609215 58143.02 MADE IN ARGENTINA HN000000			
Terjeta / Card : SIDERCA MADE IN ARGENTINA P.O.: G1609215 OF: 58143-02 PIECES: LENGTH: WEIGHT(KG): LIFT: SIZE: 114,30 X 11,10 GDO:B/X42+280SS SPEC: API-ASTM HEAT: CL-COMCO PIPE & SUPPLY COMPANY		Q.C.I. N.D.		ACCEPTED/REVIEWED/RELEASED for and on behalf of: <u>S.P.M. OFF SHEETS</u> Print Name: <u>G.P. FRESH SAHII</u> Signature: <u>[Signature]</u> Date: <u>July 16/13</u>		046 Applus® VELOSI Velosi America LLC			
FABRICADO POR SIDERCA		*MANUFACTURED BY SIDERCA*		*ACIERAGE PROCESS*		*MANUFACTURING PROCESS*			
PROCESO DE ACERACIÓN		FABRICACIÓN DE ACERO: FUNDICIÓN POR ARCO ELECTRICO Y COLADO CONTINUO - ACERO CALMADO AL ALUMINIO.		STEEL MAKING PROCESS: E.A.F.A.F. AND CONTINUOUS CASTING - FULL ALUMINIUM KILLED AND FINE GRAIN PRACTICE.		-THE LF PRACTICE INCLUDES A FINAL INJECTION OF CALCIUM SILICIDE WIRE FOR MICROINCLUSION SHAPE CONTROL			
-LA PRÁCTICA DE AFINO EN EL HORNO - CUCHARA INCLUYE UNA INYECCIÓN FINAL DE UNA VARILLA DE SILICIO DE CALCIO PARA OBTENER UNA FORMA GLOBULAR DE EVENTUALES MICROINCLUSIONES.		-MATERIAL LIBRE DE CONTAMINACIÓN DE MERCURIO.		-MATERIAL FREE FROM MERCURY CONTAMINATION.		*ROLLING PROCESS*			
PROCESO DE LAMINACIÓN		-FABRICACIÓN DE TUBO: LAMINADO EN CALIENTE Y SIN COSTURA.		-MANUFACTURING PROCESS : SEAMLESS HOT ROLLED.					

CALL 17004



APR 17 2013



INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

SIDERCA S.A.I.C.
Dr. Jorge A. Sirtini 250
B2604MHA Campana
Buenos Aires, Argentina
(54) 3489 433100 tel.
(54) 3489 433405 fax

Cliente / Customer COMCO PIPE & SUPPLY CO.		Expediental / Manufacturing Order 5/0143.02	Número / Number 205419	Fecha / Date 24/08/2005	Pág./Page 4 / 5
Producto / Product SMILS LINE PIPE		Orden de Compra / Purchase Order G1809215	Item 00008	Referencia del Cliente / Customer Reference	
Norma / Standard API 5L/ASTM A-106/ASME SA-106 + CSAZ245.1-PA.17		Grado / Grade B7K43+280SS	Extremo / Ends ASMEB16.25FZA/ANSIB16.25		
Dimensiones / Dimensions 114.30 x 11.10 mm 4 1/2 x 0.438 inches	Schedule 120	Peso Nominal / Nominal Weight 28.25 KG/MT 19.02 LB/FT	Longitud / Length 11,813,4 m	Cantidades / Quantities 27 Pz 326.02 m 27 Pcs 1069.62 Ft	9169 Kg 20214 Lb
CONTROLES -CONTROL VISUAL Y DIMENSIONAL: SATISFACTORIO. -TRATAMIENTO TÉRMICO DE TUBOS. -DIRECTO DE LAMINACIÓN.		*CONTROLS* -VISUAL AND DIMENSIONAL INSPECTION : SATISFACTORY. HEAT TREATING PROCESS: -AS ROLLED.			
CONDICIONES DEL MATERIAL -NO REPARADO POR SOLDADURA.		*MATERIAL CONDITIONS* -NO REPAIR BY WELDING.			
PROPIEDADES DEL MATERIAL -EL MATERIAL CUMPLE CON LA NORMA NACE MR 01-75 ULTIMA EDICION -EL MATERIAL CUMPLE CON LOS REQUERIMIENTOS CSA Z245.1 GR 241/290 CAT 1 -EL MATERIAL CUMPLE CON LOS REQUERIMIENTOS DE MICRODUREZA HV500 MAXIMO 248 VICKERS SEGÚN CSA Z245.1.02.		*MATERIAL PROPERTIES* -MATERIAL ACCORDING TO NACE MR-01-75 LATEST EDITION -MATERIAL COMPLIES WITH CSA Z245.1 GR 241/290 CAT 1 -MATERIAL COMPLIES WITH HARDNESS HV500 MAXIMUM 248 VICKERS ACCORDING TO CSA Z245.1.02 REQUIREMENTS.			
NORMAS -EDICION DE LA NORMA : ASME SA 106/01. -EDICION DE LA NORMA: CSA Z245.1/02. -EDICION DE LA NORMA: API 5L, 43° Edition 2004. -EDICION DE LA NORMA : ASTM A106/04b.		*STANDARDS* -EDITION OF REGULATION: ASME SA 106/01. -EDITION OF REGULATION: CSA Z245.1/02 -EDITION OF REGULATION: API 5L, 43° Edition 2004. -EDITION OF REGULATION: ASTM A106/04b.			
Observaciones / Remarks NON DESTRUCTIVE TEST: SATISFACTORY. INSPECTION METHODS: E.M.I. LONG.(EXT.) NOTCH 5% E.M.I. LONG.(INT.) NOTCH 10% E.M.I. TRANS.(EXT./INT.) NOTCH 10% ONE LONGITUDINAL BLUE BAND.		<div style="text-align: center;"> <div style="display: flex; justify-content: space-around;"> APR 17 2013 APR 17 2013 </div> </div>			

ACCEPTED/REVIEWED/RELEASED

for use on behalf of: SRM OFFSHORE

Print Name: GAVESLI SPH
Signature: [Signature]
Date: 2007 10 13

Applus®
VELOSI
Velosi America LU

CALL 17884



INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

SIDERCA S.A.L.C.
 Dr. Jorge A. Simini 250
 (02804)MHA) Carrizosa
 Buenos Aires, Argentina
 (54) 3489 433100 tel.
 (54) 3489 433405 fax

Cliente / Customer COMCO PIPE & SUPPLY CO.		Expedient / Manufacturing Order 58143.02		Número / Number 205419		Fecha / Date 24/06/2005		Pág./Page 5 / 5	
Producto / Product SMRLS LINE PIPE		Orden de Compra / Purchase Order G1000215		Item 00008		Referencia del Cliente / Customer Reference			
Norma / Standard API 5L/ASTM A-106/ASME SA-106 + CSAZ245.1-P4.17		Grado / Grade B/X42-Y280SS		Extremo / Ends ASMEB16.25FZA(ANSIB16.25)		Caridades / Quantities 27 Pz 323.02 m 9169 Kg 27 Pcs 1069.02 Ft 20214 Lb			
Dimensiones / Dimensions 114.30 x 11.10 mm 4 1/2 x 0.438 Inches		Peso Nominal / Nominal Weight 28.25 KG/MT 19.02 LB/FT		Longitud / Length 11,013,4 m		Superficie Externa / External Surface VARNISHED			

END MARKING: ONE GREEN BAND.

Protectores / End Protectors:
 NON LIFTABLE CLOSED PLASTIC PROTECTOR FOR FLAT / BEVELED PIPE. SUPPLIER METAL CENTRO.

046

ACCEPTED/REVIEWED/RELEASED

for and on behalf of: SOM OFF SHEAR

Print Name: GAMZSI SAH H

Signature: [Signature]

Date: July 10/13

APPLUS®
VELOSI

Velosi America LLC

<p>Por la presente certificamos que el material aquí descrito ha sido fabricado de acuerdo con las normas y especificaciones solicitadas en vuestra orden y satisfacen los correspondientes requerimientos.</p> <p>Este certificado se emite mediante un sistema computarizado y es válido con firma electrónica. El certificado original presenta el logo Tenaris (verde claro), impreso en la parte inferior de la hoja. En caso que el poseedor del certificado entregue una copia del mismo, deberá garantizar la conformidad con el original, haciéndose responsable por cualquier uso ilegal o indebido.</p> <p>Cualquier alteración y / o falsificación estará sujeta a la ley.</p> <p>Si necesita asegurar la autenticidad de este certificado, contactarse con Siderca SAC, e-mail: eye@siderca.com</p>	<p>We hereby certify that material herein described has been manufactured in accordance with the standards and specifications required in your order and satisfies the corresponding requirements.</p> <p>This certificate is issued by a computerized system and it is valid with electronic signature.</p> <p>On the original certificate the trade-mark Tenaris light-green coloured at the bottom of the page is stamped. In case the owner of the certificate would release a copy of it, he must assure its conformity to the original one taking upon himself the responsibility for any unlawful or not allowed use.</p> <p>Any alteration and / or falsification will be subject to the law.</p> <p>If you need to ensure the authenticity of this certificate, please do not hesitate to contact Siderca SAC through this e-address: eye@siderca.com</p>
<p>QUALITY CERTIFICATION DEPT. DTO CERTIFICACION DE CALIDAD EDUARDO A. AYERBE</p>	

CAJ 17504



Benteler Steel/Tube GmbH
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 33043 Paderborn
 Deutschland
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ABNAHMEPRÜFZEUGNIS EN 10204-3.1
 INSPECTION CERTIFICATE EN 10204-3.1
 CERTIFICAT DE RECEPTION EN 10204-3.1
 EN 10204:2005-01

Benteler Steel/Tube GmbH - Postfach 1340 - 33043 Paderborn - Deutschland
 COMCO PIPE & SUPPLY CO.
 R.R. # 3
 GUELPH, ON N1H 6H9
 KANADA

Dokument-Nr.: 65-615576/001/P

Prüf-Nr.:
 Inspection No.:
 No. du certificat:

Hersteller:
 Manufacturer:
 Producteur:

Herstellerzeichen:
 Manufacturer's brand:
 Marque du producteur:

Kunden-Bestell-Nr.:
 Purchase Order No.:
 No. de commande du client:

Benteler Auftrags-Nr.:
 Benteler Order No.:
 No. de commande Benteler:

Versandanzeigen-Nr.:
 Dispatch Note No.:
 No. d'avis d'expédition:

Produkt: NAHTLOSE STAHLROHRE
 Product: SEAMLESS STEEL TUBES
 Produit: TUBES D'ACIER SANS SOUDURE

Stahlschmelzungsverfahren:
 Steelmaking process:
 Procédé d'élaboration de l'acier:

Lieferbedingungen:
 Terms of delivery:
 Conditions de livraison:

ASME SA-106, ASME Section II Part A Edition 2007 Addenda 2009b, S5, API Specification 5L
 Forty-Fourth Edition, October 2007, ISO 3183:2007, PSL 1, incl/ADDENDUM 2, ASTM-A 106-2008, S6, CSA
 Standard Z245.1-07 Category 1, Sour Service, NACE MR0175/ISO 15156-1:2001, NACE MR0175/ISO
 15156-2:2003

Maße - Toleranzen:
 Dimensions-tolerances:
 Dimensions-tolérances:

ASME B36.10M-2004, ASME SA-530, ASME Section II Part A Edition 2010, ASTM-A 530-2004a

Stahlsorte:
 Steel grade:
 Nuance d'acier:

GRADE 290, GRADE B, GRADE X 42

Lieferzustand:
 Delivery condition:
 État de livraison:

Hot rolled

Produktkennzeichnung:
 Product marking:
 Marquage du produit:

see attachment product marking

Pos.	Stück Item Poste	Maße Dimensions Dimensions	Länge Length Longueur	Gewicht Weight Poids	Schmelzen-Nr. Heat No. No. de coulée	Prüfdruck Test pressure Pression d'épreuve	Rohr-Nr.-Gruppe Tube number group Série de no. des tubes	Vielfachlängen Multiple lengths Longueurs multiples
0009	19	2" NPS * Sched. 160 38 FT - 42 FT	755,09 feet	5728 lbs	562541	3000 PSI	5	5



Personnel
 April 5, 2013
 APR 0 6 2013



APR 05 2013



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Dokument-Nr.: 65-615576/001/P
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ABNAHMEPRÜFZEUGNIS EN 10204-3.1
 INSPECTION CERTIFICATE EN 10204-3.1
 CERTIFICAT DE RECEPTION EN 10204-3.1

Pos.	Stück	Maße	Länge	Gewicht	Schmelzen-Nr.	Prüfdruck	Rohr-Nr.-Gruppe	Vierfachlänger
Item	Number	Dimensions	Length	Weight	Heat No.	Test pressure	Tube number group	Multiple lengths
Poste	Nombre	Dimensions	Longueur	Poids	No. de coulée	Pression d'épreuve	Série de no. des tubes	Longueurs multiples
			feet	lbs		PSI		
0012	168	2" NPS * Sched. 80 38 FT - 42 FT	6867,55	34736	562617	3000	5	
0017	30	3" NPS * Sched. 80 38 FT - 42 FT	1223,46	12699	562651	3000	5	
0019	13	3" NPS * XXS 38 FT - 42 FT	537,96	10042	562541	3000	5	
0020	18	3 1/2" NPS * Sched. 40 38 FT - 42 FT	732,61	6753	562651	2860	5	
0021	8	4" NPS * Sched. 160 38 FT - 42 FT	329,76	7507	561984	3000	5	



APR 05 2013

Schmelzenanalyse [%] / Heat analysis [%] / Analyse sur coulée [%]

Pos.	Schmelzen-Nr.	C	SI	MN	P	S	CR	MO	NI	CU	V	NB	TI	B
Item	Heat No.													
Poste	No. de coulée													
0009	562541	0,130	0,230	0,84	0,009	0,001	0,09	0,02	0,08	0,14	0,002	0,001	0,003	0,0001
0012	562617	0,140	0,180	0,80	0,015	0,001	0,16	0,03	0,09	0,15	0,002	0,010	0,001	0,0001
0017	562651	0,130	0,200	0,82	0,010	0,002	0,10	0,03	0,08	0,15	0,002	0,010	0,001	0,0001
0019	562541	0,130	0,230	0,84	0,009	0,001	0,09	0,02	0,08	0,14	0,002	0,001	0,003	0,0001
0020	562651	0,130	0,200	0,82	0,010	0,002	0,10	0,03	0,08	0,15	0,002	0,010	0,001	0,0001
0021	561984	0,130	0,220	0,83	0,007	0,004	0,09	0,03	0,08	0,15	0,002	0,001	0,001	0,0002

1. Formel: $CE_{IIW} = C + (Mn/6) + ((Cr+Mo+V)/5) + ((Cu+Ni)/15) \leq 0,40 \%$
2. Formel: $CEV = C + F * ((Mn/6) + (Si/24) + (Cu/15) + (Ni/20) + ((Cr+Mo+V+Ni)/5) + (5 * B)) \leq 0,40$
3. Formel: $Mn/C \geq 3/1$
4. Formel: $Cr+Cu+Mo+Ni+V \leq 1,00 \%$



Certification of Material - Per ASME
 HT# 562541
 Qualifies to all requirements of SA 106-GRB per Sect. II 10 Edition II Addenda

W.O. # 11768
 M.S. # 24 (24)
 THK. # -624
 P.O. # 13-0249



APR 04 2013

Review
 April 5, 2013



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ABNAHMEPRÜFZEUGNIS EN 10204-3.1
 INSPECTION CERTIFICATE EN 10204-3.1
 CERTIFICAT DE RECEPTION EN 10204-3.1

Dokument-Nr.: 65-615576/001/P

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Augensichtkontrolle: PASSED Maßkontrolle: PASSED
 Visual inspection: PASSED Dimensions examination:
 Examen visuel: PASSED Vérification des dimensions:

Biegeversuch: PASSED
 Bending test:
 Essai de cintrage:
 POS. / Item / Poste: 0009, 0012

Ringfaltversuch: PASSED
 Flattening test:
 Essai d'aplatissement:
 POS. / Item / Poste: 0017, 0019, 0020, 0021

Ergebnisse der mechanischen Prüfung / Results of mechanical testing / Résultats des essais mécaniques
 Die Probenahme erfolgte an Vielfachlängen.
 The sampling was carried out on multiple lengths.
 L'echantillonage était réalisé aux longueurs multiples.

Zugversuch Streifenprobe / Tensile test Strip test specimen / Essai de traction Bande decoupee sur tube

Pos. Item Poste	Proben-Nr. Specimen No.	Schmelzen-Nr. Heat No.	Probenabmessung Specimen dimensions	Streckgrenze Yield strength	Zugfestigkeit Tensile strength	Dehnung Elongation	Einschnürung Area reduction	Re/Rm Re/Rm Re/Rm
			Dimensions de l'éprouv.	Limite élastique	Résistance à la traction	Allongement	Coefficient de striction	
Anforderungen Requirements Exigences	mm	ReH MPa MIN 290	ReH MPa MIN 290	Rm MPa 415-625	A2" % MIN 30	1. Formel 1. Formula 1. Formule		
0009	000001	562541	19,00 X 8,75	314	465	48		
0012	000001	562617	19,00 X 5,50	349	490	34		
0017	000001	562651	25,40 X 8,70	321	457	44		
0019	000001	562541	25,40 X 15,25	300	455	48		
0020	000001	562651	25,40 X 5,80	346	477	37		
0021	000001	561984	25,40 X 13,80	302	452	48		



APR 05 2013

Review
April 5, 2013



APR 04 2013





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ABNAHMEPRÜFZEUGNIS EN 10204-3.1
 INSPECTION CERTIFICATE EN 10204-3.1
 CERTIFICAT DE RECEPTION EN 10204-3.1

Pos.	Schmelzen-Nr	1. Formel	2. Formel	3. Formel	4. Formel
Item	Heat No.	1. Formula	2. Formula	3. Formula	4. Formula
Poste	No. de coulée	1. Formule	2. Formule	3. Formule	4. Formule
0009	562541	0,307	0,279	6,462	0,332
0012	562617	0,328	0,307	5,714	0,432
0017	562651	0,308	0,280	6,308	0,362
0019	562541	0,307	0,279	6,462	0,332
0020	562651	0,308	0,280	6,308	0,362
0021	561984	0,308	0,280	6,385	0,352

Formelergebnisse / Formula results / Résultats des formules

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 Inspection No.:
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Dokument-Nr.:
 Document No.:
 No. du document:

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Produktanalyse [%] / Product analysis [%] / Analyse sur produit [%]

Pos.	Schmelzen-Nr.	C	SI	MN	P	S	CR	MO	NI	CU	V	NB	TI	B
Item	Heat No.													
Poste	No. de coulée													
0009	562541	0,130	0,200	0,82	0,006	0,005	0,09	0,05	0,07	0,15	0,002	0,001	0,001	0,0001
0009	562541	0,130	0,210	0,82	0,007	0,004	0,09	0,04	0,07	0,14	0,001	0,001	0,001	0,0001
0012	562617	0,130	0,190	0,81	0,010	0,004	0,13	0,03	0,09	0,11	0,002	0,010	0,002	0,0001
0012	562617	0,130	0,200	0,80	0,010	0,004	0,13	0,02	0,09	0,12	0,001	0,010	0,002	0,0001
0017	562651	0,130	0,190	0,82	0,011	0,002	0,10	0,02	0,08	0,15	0,001	0,010	0,001	0,0001
0017	562651	0,130	0,200	0,82	0,012	0,003	0,11	0,03	0,08	0,14	0,001	0,010	0,001	0,0001
0019	562541	0,130	0,230	0,85	0,008	0,002	0,09	0,02	0,08	0,14	0,002	0,001	0,003	0,0001
0019	562541	0,130	0,230	0,85	0,008	0,002	0,10	0,02	0,08	0,14	0,002	0,001	0,003	0,0001
0020	562651	0,130	0,180	0,82	0,012	0,004	0,13	0,03	0,10	0,15	0,001	0,010	0,001	0,0002
0020	562651	0,130	0,170	0,81	0,013	0,004	0,12	0,02	0,09	0,16	0,002	0,010	0,001	0,0002
0021	561984	0,130	0,210	0,82	0,006	0,004	0,10	0,03	0,08	0,14	0,002	0,002	0,001	0,0001
0021	561984	0,130	0,220	0,83	0,007	0,004	0,09	0,04	0,08	0,15	0,001	0,001	0,001	0,0001

APR 04 2013



Benteler Steel/Tube GmbH
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ABNAHMEPRÜFZEUGNIS EN 10204-3.1
 INSPECTION CERTIFICATE EN 10204-3.1
 CERTIFICAT DE RECEPTION EN 10204-3.1

- 1. Formel: $CE_{IIW} = C + (Mn/6) + ((Cr+Mo+V)/5) + ((Cu+Ni)/15) \leq 0,40 \%$
- 2. Formel: $CEV = C + F * ((Mn/6) + (Si/24) + (Cu/15) + (Ni/20) + ((Cr+Mo+V+Nb)/5) + (5*B)) \leq 0,40$
- 3. Formel: $Mn/C \geq 3/1$
- 4. Formel: $Cr+Cu+Mo+Ni+V \leq 1,00 \%$

Formelerggebnisse / Formula results / Résultats des formules

Pos.	Schmelzen-Nr	1. Formel	2. Formel	3. Formel	4. Formel
Item	Heat No.	1. Formula	2. Formula	3. Formula	4. Formula
Poste	No. de coulée	1. Formule	2. Formule	3. Formule	4. Formule
0009	562541	0,309	0,280	6,307	0,362
0009	562541	0,306	0,278	6,307	0,341
0012	562617	0,310	0,282	6,230	0,362
0012	562617	0,307	0,279	6,153	0,361
0017	562651	0,306	0,278	6,307	0,351
0017	562651	0,309	0,281	6,307	0,361
0019	562541	0,308	0,280	6,538	0,332
0019	562541	0,310	0,282	6,538	0,342
0020	562651	0,315	0,285	6,307	0,411
0020	562651	0,310	0,281	6,230	0,392
0021	561984	0,307	0,279	6,307	0,352
0021	561984	0,309	0,281	6,384	0,361

Q.C.I.
E.V.

APR 05 2013

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 No. du certificat: 65-615576/001/P

Dokument-Nr.:
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 No. du document:

65-615576/001/P

Prüfergebnisse / Test results / Résultats des essais

Die Rohre sind auf Dichtheit geprüft durch:
 The tubes have been submitted to a leak tightness test by:
 Les tubes ont passé un contrôle d'étanchéité par:

Hydrostatic test: acc. to CSA Z245.1, holding time min 5 seconds, Test pressure/Time-record

PASSED

Die Rohre wurden zerstörungsfrei geprüft:
 The tubes are non destructive tested:
 Les tubes ont passé un essai non destructif:

ET-test: acc. to CSA Z245.1; for imperfections; drilled hole: 3,20 mm

PASSED



Benteler Steel/Tube GmbH
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ABNAHMEPRÜFZEUGNIS EN 10204-3.1
 INSPECTION CERTIFICATE EN 10204-3.1
 CERTIFICAT DE RECEPTION EN 10204-3.1

Härteprüfung / Hardness test / Essai de dureté

65-615576/001/P

Prüf-Nr.:
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Pos. Item Poste	Proben-Nr. Specimen No. No. de l'éprouv.	Schmelzen-Nr. Heat No. No. de coulée	Härte Hardness Dureté	HRC	HB	HV	HRB	HBW
Anforderungen Requirements Exigences								
					MAX 200			
0009	000001	562541			136			
0009	000002	562541			136			
0009	000003	562541			136			
0012	000001	562617			135			
0012	000002	562617			135			
0012	000003	562617			135			
0012	000004	562617			134			
0017	000001	562651			135			
0017	000002	562651			136			
0017	000003	562651			135			
0019	000001	562541			132			
0019	000002	562541			131			
0019	000003	562541			132			
0020	000001	562651			135			
0020	000002	562651			134			
0020	000003	562651			134			
0021	000001	561984			131			
0021	000002	561984			135			
0021	000003	561984			133			



APR 05 2013

Restmagnetismus / Demagnetize / Démagnétiser
 demagnetized tubes; 1 measurement per 4 hours on both tube ends Two readings 180° apart around the circumference. Average value
 max 3.0 Millitesla (24 A/cm), individual value max 3.5 Millitesla (28 A/cm)



Steel/Tube

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

ABNAHMEPRÜFZEUGNIS EN 10204-3.1
 INSPECTION CERTIFICATE EN 10204-3.1
 CERTIFICAT DE RECEPTION EN 10204-3.1

Dokument-Nr.: 65-615576/001/P
 Document No.:
 No. du document:

Prüf-Nr.:
 Inspection No.:
 No. du certificat:

Blatt: 7 /
 Page:
 Page:

Vermerk / Remark / Remarque

Pos. / Item / Poste: 0009, 0012, 0012, 0012, 0012
 NACE Standard: Hardness acc. to NACE MR0175/ISO 15156: HRC max 22., The material meets the requirements of NACE MR0103;
 Certificate remarks: The Material is Aluminium deoxidized and inclusion shape controlled with Calcium-Silicon treatment, This is to confirm that the seamless linepipe supplied by Benteler and verified to CSA Standard Z245.1-07 meets the requirement for micro hardness of max. 248 HV 500 gf., No weld repair has been carried out; Bend test: mandrel diameter 12D; Bending angle: 90 °

Pos. / Item / Poste: 0017, 0019, 0021, 0020, 0019, 0020, 0021, 0019
 NACE Standard: Hardness acc. to NACE MR0175/ISO 15156: HRC max 22., The material meets the requirements of NACE MR0103;
 Certificate remarks: The Material is Aluminium deoxidized and inclusion shape controlled with Calcium-Silicon treatment, This is to confirm that the seamless linepipe supplied by Benteler and verified to CSA Standard Z245.1-07 meets the requirement for micro hardness of max. 248 HV 500 gf., No weld repair has been carried out

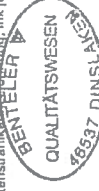
Beiblatt Produktkennzeichnung / Attachment product marking / Supplément marquage du produit

Pos. Produktkennzeichnung
 Item Produktkennzeichnung
 Poste Marquage du produit

- 0009, 0012, 0017, 0020
 FS: BENTELER Z.245.1-07 - ISO 3183 - A 106-S6 - SA-106-S5 5L-0151 API SIGN 1110 PSL1 B/X42/290 SS HEAT-NO. TEST
 PRESSURE NDE DIMENSIONS TUBES-LENGTH FEET WA GERMANY P.O. G1-1346
- 0019
 FS: BENTELER Z.245.1-07 - ISO 3183 - A 106-S6 - SA-106-S5 5L-0151 API SIGN 1110 PSL1 B/X42/290 SS HEAT-NO. TEST
 PRESSURE NDE WEIGHT CLASS TUBES-LENGTH FEET WA GERMANY P.O. G1-1346
- 0021
 FS: BENTELER Z.245.1-07 - ISO 3183 - A 106-S6 - SA-106-S5 5L-0151 API SIGN 1010 PSL1 B/X42/290 SS HEAT-NO. TEST
 PRESSURE NDE DIMENSIONS TUBES-LENGTH FEET WA GERMANY P.O. G1-1346

AEZ = Ätzintendenbeschriftung, Etching ink marking, Gravure à l'encre | FK = Farbmarkenzeichnung, colour marking, marquage par couleur | FS = Farbschablonierung, paint stencilling, marquage par peinture | SD = Farbschablondrucker, Colour jet printer, imprimante à jet d'encre de c
 | LK = Laserkennzeichnung, Laser marking, Marquage laser | PKE = Etikettenkennzeichnung, tag marking, marquage sur étiquette | PS = Prägestempel, die stamp, marquage par poinçonnage | TS = Tintenstrahlkennzeichnung, ink jet spray marking, imprimante à jet d'encre

Verkäufer(in) / Salesman/woman in charge / Personne chargée : Mr Pottmeier, Tel.: 05254/81-4265, Fax: 4289



Dinslaken, 02.12.2010, TEL.: 02064.623-537 FAX: 02064.623-539

Abnahmebeauftragter
 Inspection representative
 Contrôleur
 DR. BASEL KENTA / Thei

Es wird bestätigt, daß die gelieferten Erzeugnisse den techn. Lieferbedingungen des Auftrages entsprechen. Dieses Dokument wurde mittels EDV erstellt und ist ohne Unterschrift rechtsgültig.
 We certify that the supplied products comply with the order specification. This document was prepared by means of electronic data processing and is valid without signature.
 Nous attestons que les produits livrés sont conformes aux stipulations de la commande. Ce document a été établi par traitement électronique de l'information et est valide sans signature.

Contact: HELENE/BRIAN

QUALITY PLATES & PROFILES LIMITED
 20 Nicholas Beaver Road, R.R.#3 (Aberfoyle), Guelph, ON N1H 6H9
 ALL WELD COMPANY LIMITED PO/Rel: 13-0220
 PLATE CPL 516N 1/2" x DWG# 1176-4-4 TAG 1176-26

ESSAR STEEL ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

0005751

SO No., Item & Date:	8003926 000020 2012/10/18	Shipment No. & Date:	1000011159 2012/10/18	TC No., Date & Time:	ESA-19141 2012/10/19 - 07:59:10
Sold to Customer Name and Address:	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE, Ontario, Canada N1H 6H9	Ship to Customer Name and Address:	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE, Ontario, Canada N1H 6H9	Customer PO NO./Item:	P007192 / 2 1000011159
Customer Specification:	HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (11A) / ASME SA516 GR 70 (11A) Meets NACE MR 0175 latest Ed., BHN < 200, D.O.CEQ .43 max. Inclusion Shape Control Calcium Treated Normalized Temp 1670 °F 17 min CVNL Req. 15 / 12 FT-LBF at -50.0 °F Sid Thickness Tol PVC Top and Bottom Standard Surface No Weld Repair Flatness 1/2 A20 Latest Ed. + Addenda of ASME Niobium max 0.015 Sum-Nb+V max 0.030 Vanadium max 0.020			Cust. Part No.:	NATIONAL TRANSPORTATION - 0695(1009) REV
Supplementary Instructions:	Test Cert 1:519-837-2227			Carrier:	
Insp T/R:	Test Report As Per Spec			Cust Use:	PVC

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. 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)945-4095 FOR INSTRUCTIONS ON METHOD OF DISPOSAL.

MEETS EN 10204:2004 TYPE 3.1
 ISO QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM

Dimensions (T x W x L)	Batch No.	Heat No-MS	Quantity	No. of Pcs	Dimensions (T x W x L)	Batch No.	Heat No-MS	Quantity	No. of Pcs
0.5000" x 120.000" x 384.00"	AA5660	8520M-05	6,534 LB	1	0.5000" x 120.000" x 384.00"	AA5421	8952M3-56	13,068 LB	2
0.5000" x 120.000" x 384.00"	AA5422	8952M3-56	13,068 LB	2	0.5000" x 120.000" x 384.00"	AA5423	9339M3-03	13,068 LB	2

Heat No. (wt%)	CHEMICAL PROPERTIES										MECHANICAL PROPERTIES			
	C	Mn	P	S	Si	Cr	Ni	Cu	Mo	Al	Nb	B	Ti	DO
8520M	0.20	1.18	0.013	0.003	0.340	0.03	0.15	0.03	0.00	0.029	0.000	0.015	0.003	4.0400
8952M3	0.19	1.07	0.014	0.005	0.330	0.03	0.15	0.04	0.00	0.029	0.000	0.014	0.003	0.3900
9339M3	0.19	1.12	0.016	0.005	0.350	0.02	0.15	0.04	0.00	0.027	0.000	0.015	0.003	0.4000

HARDNESS TESTS

Heat No.	Batch No.	SRCE	LAB	GAUGE	COND	LOC	MTHD	HARDNESS
9339M3	AA5423	166"	ALG	0.5000	NORM	B	HBW	158
8952M3	AA5421	166"	ALG	0.5000	NORM	B	HBW	153
8952M3	AA5422	166"	ALG	0.5000	NORM	B	HBW	153

W.O. # 11760
M.S. # 26
THK. # .517
P.O. # 13-0220

Q.C.I. N.D.

Q.C.I. E.V.

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
CU + Ni + CR + MO = .27
CR + MO = .03

Certification of Material - Per ASME HT# 8952M-56
 Qualifies to all requirements of SA 516-GR70 per Sect. II, Edition II, Addenda

MANAGER METALLURGICAL SERVICES
 K. UGHADPAGAP.O.

MILL TEST REPORTS APPROVED BY Q.C.

Weld America Review
 MAR 27 2013 279
 1, 2013

****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 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.

Date: 2012/10/19 Time: 07:59:10 Page no: 1 of 3 **APR 03 2013**

Inv: I055184 Date: 03/19/2013
 Heat: 8952M3

Contact: HELENE/BRIAN

ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4



SO No., Item & Date:	8003926 000020 2012/10/18	Shipment No. & Date:	1000011159 2012/10/18	TC No., Date & Time:	ESA-19141 2012/10/19 - 07:59:10
Sold to Customer Name and Address:	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE, Ontario, Canada N1H 6H9	Ship to Customer Name and Address:	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE, Ontario, Canada N1H 6H9	Customer PO NO./Item:	P007192 / 2
Customer Specification:	HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (10) / ASME SA516 GR 70 (11A) Meets NACE MR 0175 latest Ed. BHN < 200, D.O.CEQ .43 max. Inclusion Shape Control Calcium Treated Normalized Temp 1670 °F-17 min CVNL Req. 15/12 FT.-LBF at -50.0 °F Std Thickness Tol PVQ Top and Bottom Standard Surface No Weld Repair Flatness 1/2 A20 Latest Ed. +Addenda of ASME Niobium max 0.015 Sum-Nb+V max 0.030 Vanadium max 0.020			BOL NO.:	1000011159
Supplementary Instructions:	Test Cert 1:519-837-2227			Cust.Part No.:	
Insp T/R:	Test Report As Per Spec			Carrier:	NATIONAL TRANSPORTATION - 0695(1009) REV
					Cust Use: PVQ

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. 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)945-1095 FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.

MEETS EN 10204:2004 TYPE 3.1
 ISO QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM

Hardness Tests		MECHANICAL PROPERTIES									
Heat No.	Batch No.	SRCE	LAB	GAUGE	COND	LOC	LOC	MTHD	HARDNESS		
Heat No.	Batch No.	SRCE	LAB	GAUGE	COND	METH	DIR	LOC	SIZE	TEMP(°F)	ENERGY(ft.-lbf)
8520M	AA5660	166"	ALG	0.5000	NORM	B		HBW	164		
9339M3	AA5423	166"	ALG	0.5000	NORM	CVN	L	B	FULL	-50	74 89 95
8952M3	AA5421	166"	ALG	0.5000	NORM	CVN	L	B	FULL	-50	79 79 63
8952M3	AA5422	166"	ALG	0.5000	NORM	CVN	L	B	FULL	-50	90 92 88
8520M	AA5660	166"	ALG	0.5000	NORM	CVN	L	B	FULL	-50	80 70 93

Tensile Tests		TENSILE(KSI)						ELONG(%)			
Heat No.	Batch No.	SRCE	LAB	GAUGE	COND	METH	DIR	LOC	YIELD(KSI)	EL SCALE	ELONG(%)
Heat No.	Batch No.	SRCE	LAB	GAUGE	COND	METH	DIR	LOC	YIELD(KSI)	EL SCALE	ELONG(%)
9339M3	AA5423	166"	ALG	0.5000	NORM	.2	T	B	52	75	8"
8952M3	AA5421	166"	ALG	0.5000	NORM	.2	T	B	50	75	8"



Handwritten signature and date: April 1, 2013

APR 03 2013

K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

***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 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 CALCULATION) AS REPRESENTING THE ACTUAL STRENGTH OF SUCH STEEL.

20 Nicholas Beaver Road, R.R.#3 (Aberfoyle), Guelph, ON N1H 6H9
 ALL-WELD COMPANY LIMITED PO/Rel: 13-0220
 PLATE CPL 516N 1/2" x DWG# 1176-4 TAG 1176-26

Contact: HELENE/BRIAN Inv: I055184 Date: 03/19/2013
 Heat: 8952M3



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

SO No., Item & Date:	8003926 000020 2012/10/18	Shipment No. & Date:	1000011159 2012/10/18	TC No., Date & Time:	ESA-19141 2012/10/19 - 07:59:10						
Sold to Customer Name and Address:	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE, Ontario, Canada N1H 6H9	Ship to Customer Name and Address:	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE, Ontario, Canada N1H 6H9	Customer PO NO./Item:	P007192 / 2						
Customer Specification:	HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (10) / ASME SA516 GR 70 (11A) Meets NACE MR 0103 latest Ed., BHN < 200, D.O.CEQ .43 max, Inclusion Shape Control Calcium Treated Normalized Temp 1670 °F 17 min CVNL Req. 15 / 12 FT-LBF at -50.0 F Sid Thickness Tol PVQ Top and Bottom Standard Surface No Weld Repair Flatness 1/2 A20 Latest Ed. +Addenda of ASME Niobium max 0.015 Sum-Nb+V max 0.030 Vanadium max 0.020	BOL NO.:	1000011159	Carrier:	NATIONAL TRANSPORTATION - 0695(1009) REV						
Supplementary Instructions:	Test Cert 1:519-837-2227	Cust.Part No.:									
Insp T/R:	Test Report As Per Spec	Cust Use:	PVQ								
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. 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)945-4085 FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.											
MEETS EN 10204:2004 TYPE 3.1 ISO QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM											
. MECHANICAL PROPERTIES											
Tensile Tests	SRCE	LAB	GAUGE	COND	METH	DIR	LOC	YIELD(KSI)	TENSILE(KSI)	EL SCALE	ELONG(%)
Heat No.	Batch No.	166*	ALG	0.5000	NORM	.2	T	B	51	8"	27
8952M3	AA5422	166*	ALG	0.5000	NORM	.2	T	B	55	8"	25
8520M	AA5660										

K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

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14527 Smith Rd.
Humble, Texas 77396
TEL: (281) 441-4088
FAX: (281) 441-8899

REPORT NUMBER 73175

DATE 3/25/2013

FCI ORDER NUMBER 59801

Processed I.A.W. EN10204 3.1
I.A.W. NACE MR0175

CUSTOMER ORDER NUMBER 13-0216
SOLD/SHIPPED TO ALL-WELD CO., LTD.
49 PASSMORE AVE.

SCARBOROUGH ONT MIV 4T1 CANADA

Item Quantity Description

1 2 2" X 900 X 11.75" LG RTJ LWN

ITEM# 1176-34

HEAT NUMBER: G820

MATERIAL TYPE: SA350LF2CL1

Manufactured in USA

I.A.W. ASME 2010 ED 11AD.

CHEMICAL ANALYSIS

PHYSICAL PROPERTIES

C .191 ✓
Mn .993 ✓
P .0270 ✓
S .0240 ✓
Si .243 ✓
Cr .131 ✓
Mo .007 ✓
V .002 ✓
Cu .048 ✓
Ni .035 ✓
C .001 ✓

Yield PSI 49,366 ✓
Tensile PSI 71,634 ✓
Elongation 32 ✓
Reduction of Area 67 ✓
Hardness 144/150 HBW ✓
CVN @ -58 °F FT LBS 28/27/29 ✓
% Shear
MLE

^{NS}
Certification of Material - Per ASME
HT# G820
Qualifies to all requirements of
SA350-LF2 CL1 per
Sect. II 10 Edition 11 Addenda

W.O. # 11760
M.L. # 34(6/2)
THK. # 1.097
P.O. # 13-0216

Q.C.I.
N.D.

APR 03 2013

Q.C.I.
E.Y.

CE .39 ✓

Heat Treatment NORMALIZED ✓
Temperature 1670 °F
Time at Temperature 1/2 HR/IN THK MIN
Cooling Media AIR

LIMITS OF UNSPECIFIED
ELEMENTS PER ASME
SECTION II (SA-20)
CU + NI + CR + MO = .227
CR + MO = .138

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

Prepared by

Name: Helen Fielder

Title: QA Representative

Reviewed
Apr 15, 2013
Vitali America
279

CERTIFICADO DE INSPECCION
Inspection Certificate - Certificat de Réception

CLIENTE / Customer / Client:
COMCO PIPE&SUPPLY COMPANY-ONTAR
 A DIVISION OF RUSSELL METALS
 14 KERR CRESCENT
 PUSLINC, ONTARIO
 NOB 2J0 - CANADA

SGI 197164
 SGI 6000236
 SGI 6009987



PRODUCTO / Article / Produit:
FLANGES
 SU PEDIDO N° / Your Order N° / Votre Cde N°:
G1-3363
 ASME B16.5-09

FECHA / Date:
 25/02/2013
 N° / No.:
 155342
 HOJA / Page:
 1

DEFECCIONES / Remarks / Observations:
 07/06/2012

CLIENTE / Customer / Client:
 25/02/2013

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 HOJA / Page:
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DEFECCIONES / Remarks / Observations:
 07/06/2012

CLIENTE / Customer / Client:
 25/02/2013

ITEM	DESCRIPTION	REMARKS	TESTS	RESULTS	ACCEPTANCE																																																																													
16	SO 8 150LB RF A350LF2		ASME B16.5-09																																																																															
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APR 17 2013

Observations:
 - Las dimensiones en la condición superficial se hallaron satisfactorias.
 - Dimension and surface condition were found acceptable.
 - Les dimensions et état de surface sont satisfaisants.
 - Las mediciones aladas cumplen las normas aplicables.
 - Measuring equipments are checked.
 - Les mesures aladées sont satisfaisantes.

EL INSPECTOR / Works Inspector - L'inspecteur:
ULMA FORJAS, S.COOP.
 Dept. de Ingeniería de Calidad / Quality Assurance Dept.

ACCEPTED/REVIEWED/RELEASÉ
 for and on behalf of: SAM OFFSHORE
 Print Name: ANVESH SAHA
 Signature: [Signature]
 Date: July 10/13

W.O. # 11768009A
 M.L. # 39061
 THK. #
 P.O. # 13-0293-REV1

Certification of Material - Per ASME
 HT# A3943
 Qualifies to all requirements of SA350 LF2 CL1 per ASME B16.5-09 Edition 11 Addenda



**NIPPON STEEL &
 SUMITOMO METAL
 CORPORATION**

NIPPON STEEL & SUMITOMO METAL CORPORATION
 WAKAYAMA WORKS
 1850, MINATO, WAKAYAMA, JAPAN

INSPECTION CERTIFICATE

CERTIFICATE NO. :WYYK1969-02 PAGE : 1/2 DATE : 2012-11-04

CUSTOMER : COMCO PIPE AND SUPPLY LTD.
 ORDER NO. : E1-3125 ITEM NO. 18
 SHIPPER : SUMITOMO CORPORATION 057 KEQ 0809/2 2P17S243710
 COMMODITY : SEAMLESS HOT FINISHED CARBON STEEL PIPE WITH BEVELED ENDS
 STANDARD : ASTM A333M-10 / ASME 2010 (A11) SA-333M GR 6 CSA Z245.1-07 CAT. II GR 359
 SPECIFICATION :
 MILL WORK NO. : WYYK1969 O. D. : NPS8 W. T. : STD LENGTH: 40feet QUANTITY: 3pcs. MASS: 1554kg

HEAT NO. : J2KA102 J2L9676
 PRODUCTS PCS. : 1 2
 HEAT TREATMENT : QUENCHED & TEMPERED (950° C X 5min. W. Q. & 650° C X 30min. A. C.)
 MELTING : BASIC OXYGEN
 DEOXIDATION : KILLED

W.O. # 1176
 M.L. # 40 (76) 2/12
 THK. # 342
 P.O. # 13-0249

CHEMICAL COMPOSITION (%)

		*1	C	Si	Mn	P	S	Cu	Cr	Ni	Mo	Ti	V	Nb	B *CEQ
						#3	#3			#2					#3
SPEC. MIN.	L		-	10	29	-	-	-	-	-	-	-	-	-	-
MAX.	L		26	50	106	25	25	-	-	10	-	11	11	11	1 40
MIN.	P		-	-	-	-	-	-	-	-	-	-	-	-	-
MAX.	P		26	50	200	30	35	-	-	10	-	11	11	11	1 40
HEAT NO. J2KA102	L		6	26	130	10	2	2	9	0	3	1	0	0	0 20
J2L9676	P		7	28	129	10	2	2	10	0	3	1	0	0	0 21
	L		7	25	125	9	2	1	9	0	1	1	0	0	0 20
	P		7	25	125	9	2	1	9	0	1	1	0	0	0 21
	P		7	25	125	9	2	1	9	0	1	1	0	0	0 21

APR 04 2013

Q.C.I.
 N.D.

*1 L:LADLE ANALYSIS P:PRODUCT ANALYSIS *2:X10 *3:X1000 OTHER:X100
 *CEQ: C+F (Mn/6+Si/24+Cu/15+Ni/20+(Cr+Mo+V+Nb)/5+5B) F=COEFFICIENT BY CSA STANDARD

"FOR EACH REDUCTION OF 0.01% CARBON BELOW 0.30%, AN INCREASE OF 0.05% MANGANESE ABOVE 1.06% IS PERMITTED TO A MAXIMUM OF 1.35% MANGANESE."

TENSILE TEST

		*1	*2	YS	TS	EL
				#3	#3	%
SPEC. MIN.	L B			M 359	M 455	30
MAX.	L B			M 530	M 625	-
HEAT NO. J2KA102	L B			M 485	M 552	33
J2L9676	L B			M 428	M 515	40
	L B			M 419	M 506	40

Certification of Material - Per ASME
 HT# J2L9676
 Qualifies to all requirements of
 SA333-GR 6 per
 Sect. II 10 Edition II Addenda

APR 05 2013

Q.C.I.
 E.Y.

TYPE OF SPECIMEN: STRIP 38mm WIDTH *1 SAMPLING DIRECTION L: LONGITUDINAL *2 SAMPLING POSITION B: BASE METAL
 *3 UNIT M: MPa GAUGE LENGTH: 50.0mm KIND OF YS: 0.5% EXTENSION UNDER LOAD

Handwritten signature and stamp: "All reviewed April 5 2013" and "Velosi America V 279"

WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREIN HAS BEEN MADE IN ACCORDANCE WITH THE RULES OF THE CONTRACT.

T. Kondo

HEAD OF DEPARTMENT
 QUALITY ASSURANCE DEPARTMENT

<An Important Message To Our Customers>
 This certification is intended only for products listed. Modification to or unauthorized use of this certification is strictly prohibited. Offences may be regarded as forgery of documents and be subject to criminal prosecution. If you have any questions on this certification, you can contact us by facsimile or e-mail as shown below:
 Fax. No. : +81-3-6867-4926 E-mail: pipe-ipp@jp.nssmc.com NO. 173609W12



**NIPPON STEEL &
 SUMITOMO METAL
 CORPORATION**

NIPPON STEEL & SUMITOMO METAL CORPORATION
 WAKAYAMA WORKS
 1850, MINATO, WAKAYAMA, JAPAN

INSPECTION CERTIFICATE

CERTIFICATE NO. : WYYK1969-02 PAGE : 2/2 DATE : 2012-11-04

HARDNESS TEST (HBW)

	#1 #2	#3			
SPEC. MIN.	B C	-			
MAX.	B C	200			
HEAT NO.		(1) (2) (3)			
J2KA102	B C	169 172 174			
J2L9676	B C	158 157 158			
	B C	157 158 158			
*1 SAMPLING POSITION B:BASE METAL *2 LOCATION C:CROSS SECTION *3 EACH					

IMPACT TEST (-50.0°C 2mm V-Notch 10X6.67)

	#1 #2	#3 #4	AVG		
SPEC. MIN.	L B	E J *5 9/12	12		
MAX.	L B	E J -/-	-		
		[1] [2] [3]			
HEAT NO.					
J2KA102	L B	E J 267 270 270 269			
J2L9676	L B	E J 270 270 270 270			
[1] [2] [3] : SPECIMEN NO. TYPE OF SPECIMEN:NONFLATTENED ABSORBED ENERGY *5:VALUE OF ONE PIECE/EACH VALUE OF TWO PIECES AVG:AVERAGE VALUE OF ONE SET (3 PIECES) *1 SAMPLING DIRECTION L:LONGITUDINAL *2 SAMPLING POSITION B:BASE METAL *3 E:ABSORBED ENERGY *4 UNIT J:Joule					

IMPACT TEST (-45.0°C 2mm V-Notch 10X6.70)

	#1 #2	#3 #4	AVG			#3 #4	AVG		
SPEC. MIN.	T B	E J *5 -	18			S % *6 50	60		
MAX.	T B	E J -	-			S % -	-		
		[1] [2] [3]				[1] [2] [3]			
HEAT NO.									
J2KA102	T B	E J 260 260 260 260	S % 100 100 100 100						
J2L9676	T B	E J 255 252 258 255	S % 100 100 100 100						
[1] [2] [3] : SPECIMEN NO. TYPE OF SPECIMEN:NONFLATTENED ABSORBED ENERGY *5:VALUE OF ONE PIECE AVG:AVERAGE VALUE OF ONE SET (3 PIECES) SHEAR AREA *6:VALUE OF ONE PIECE AVG:AVERAGE VALUE OF ONE SET (3 PIECES) *1 SAMPLING DIRECTION T:TRANSVERSE *2 SAMPLING POSITION B:BASE METAL *3 E:ABSORBED ENERGY S:SHEAR AREA *4 UNIT J:Joule %:									

FLATTENING TEST: ACCEPTABLE
 VISUAL & DIMENSIONS: ACCEPTABLE
 HYDROSTATIC TEST 20. IMPaX5sec. : ACCEPTABLE
 ULTRASONIC EXAMINATION: ACCEPTABLE
 RESIDUAL MAGNETISM (EACH READING MAX. 3.5mT / AVG. OF 4 READINGS MAX. 3.0mT) : ACCEPTABLE
 EN 10204 3.1
 SOUR SERVICE (PSA)
 NACE MR0175/ISO 15156-2 (2009) ANNEX A. 2 REGION 3 AND NACE MR0103 (2010) SEC. 2. 1: ACCEPTABLE



APR 05 2013

APR 04 2013

WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREIN HAS BEEN MADE IN ACCORDANCE WITH THE RULES OF THE CONTRACT.

Reviewed
Apr 15 2013



T. Kondo

HEAD OF DEPARTMENT
 QUALITY ASSURANCE DEPARTMENT

<An Important Message To Our Customers>
 This certification is intended only for products listed. Modification to or unauthorized use of this certification is strictly prohibited. Offences may be regarded as forgery of documents and be subject to criminal prosecution. If you have any questions on this certification, you can contact us by facsimile or e-mail as shown below;
 Fax. No. : +81-3-6867-4926 E-mail: pipe-ipp@jp.nssmc.com

NO. 173609W12



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

ABNAHMEPRÜFZEUGNIS EN 10204-3.1
 INSPECTION CERTIFICATE EN 10204-3.1
 CERTIFICAT DE RECEPTION EN 10204-3.1
 EN 10204:2005-01

Benteler Steel/Tube GmbH - Postfach 1340 - 33043 Paderborn - Deutschland
 BENTELER STEEL & TUBE CORP.
 2121 ARGENTIA ROAD, SUITE # 101
 MISSISSAUGA ON L5N 2X4
 CANADA

Dokument-Nr.: 65-689506/001/P
 Document No.:
 No. du document:

Kunden-Bestell-Nr.: BST 12-5492 / Comco G1-2943
 Purchase Order No.:
 No. de commande du client:

Benteler Auftrags-Nr.: 1572951
 Benteler Order No.:
 No. de commande Benteler:

Versandanzeigen-Nr.: 6555571
 Dispatch Note No.:
 No. d'avis d'expédition:

Produkt: NAHTLOSE STAHLROHRE
 Product: SEAMLESS STEEL TUBES
 Produit: TUBES D'ACIER SANS SOUDURE

Lieferbedingungen: ASME SA-106, ASME Section II Part A Edition 2010 Addenda 2011a, S6, ASTM-A 106-2010, S6, ASTM-A 333-2010-HF, ASME SA-333-HF, ASME Section II Part A Edition 2010 Addenda 2011a, CSA Standard Z245.1-07 Category II, Sour Service, ANSI/NACE MR0175/ISO 15156-1: 2009, ANSI/NACE MR0175/ISO 15156-2: 2009

Maße - Toleranzen: ASME B36.10M-2004, ASME SA-999 ASME Section II Part A Edition 2010, ASTM-A 999-2011
 Dimensions-tolerances:
 Dimensions-tolérances:

Stahlsorte: GRADE 6, GRADE B, GRADE C, GRADE 359
 Steel grade:
 Nuance d'acier:

Lieferzustand: Normalized
 Delivery condition:
 État de livraison:

Produktkennzeichnung: FS: BENTELER Z.245.1 - A/SA-333 - A/SA 106 6/359/B/C CATEGORIE 2 HEAT-NO. M45C SS SMLS HN
 Product marking: DIMENSIONS WEIGHT CLASS WA GERMANY PO NO G1-2943

Marquage du produit:
 AEZ = Ätzlinienbeschriftung, Etching ink marking, Grävure à l'encre, couleur, PK = Farbblanzzeichnung, colour marking, marquage par couleur, FS = Farbschablonierung, paint stencilling, marquage par peinture, FSD = Farbstrahldrucker, Colour jet printer, imprimante à jet d'encre de couleur, LK = Laserkennzeichnung, Laser marking, Marquage laser, PKE = Etikettenkennzeichnung, tag marking, marquage sur étiquette, PS = Prägestempel, die stamp, marquage par poinçonnage, TS = Tintenstrahlkennzeichnung, ink jet spray marking, imprimante à jet d'encre

Prüf-Nr.:
 Inspection No.:
 No. du certificat:

Hersteller: Warmrohrwerk Dinslaken
 Manufacturer: DIN EN 9001: 2008 TÜV CERT 44100090381-003
 Producteur: PED 9723/EC TÜV CERT 07-202-14111-Z-1193/8/D

Herstellerzeichen:
 Manufacturer's brand:
 Marque du producteur:

Stempel des Abnahmebeauftragten: WA
 Stamp of the inspection representative:
 Poinçon du contrôleur:

Stahlerschmelzungsverfahren: ELEKTROSTAHL
 Steelmaking process: ELECTRIC FURNACE
 Procédé d'élaboration de l'acier: FOUR ELECTRIQUE

Benjamin
279
2013
 APR 05 2013
 APR 04 2013
 Q.C.I. E.Y.
 Q.C.I. N.D.



Benteler Steel/Tube GmbH
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Pos.	Stück	Maße	Länge	Gewicht	Schmelzen-Nr.	Prüfdruck	Rohr-Nr.-Gruppe	Vielfachlängen
Item	Number	Dimensions	Length	Weight	Heat No.	Test pressure	Tube number group	Multiple lengths
Poste	Nombre	Dimensions	Longueur	Poids	No. de coulée	Pression d'épreuve	Série de no. des tubes	Longueurs multiples
			feet	lbs		bar		
0020	105	2" NPS * XS 20 FT - 22 FT	2305,35	11579	570747	172	5	
0030	56	2" NPS * XS 38 FT - 42 FT	2296,82	11616	570747	172	5	

Schmelzenanalyse [%] / Heat analysis [%] / Analyse sur coulée [%]

Pos.	Schmelzen-Nr.	C	SI	MN	P	S	CR	MO	NI	CU	V	NB	TI	B
Item	Heat No.													
Poste	No. de coulée													
0020	570747	0,120	0,320	1,23	0,008	0,002	0,17	0,07	0,19	0,08	0,064	0,031	0,003	0,0002
0030	570747	0,120	0,320	1,23	0,008	0,002	0,17	0,07	0,19	0,08	0,064	0,031	0,003	0,0002

- Formel: $CE\ IIV = C + (Mn/6) + ((Cr + Mo + V)/5) + ((Cr + Ni)/15) <= 0,45\ %$
- Formel: $CEV = C + F * ((Mn/6) + (Si/24) + (Cu/15) + (Ni/20) + ((Cr + Mo + V + Nb)/5) + (5 * B)) <= 0,40$
- Formel: $Mn/C >= 3/1$
- Formel: $Cr + Cu + Mo + Ni + V <= 1,00\ %$

Formelergebnisse / Formula results / Résultats des formules

Pos.	Schmelzen-Nr.	1. Formel	2. Formel	3. Formel	4. Formel
Item	Heat No.	1. Formula	2. Formula	3. Formula	4. Formula
Poste	No. de coulée	1. Formule	2. Formule	3. Formule	4. Formule
0020	570747	0,404	0,346	10,250	0,574
0030	570747	0,404	0,346	10,250	0,574

Produktanalyse [%] / Product analysis [%] / Analyse sur produit [%]

Pos.	Schmelzen-Nr.	C	SI	MN	P	S	CR	MO	NI	CU	V	NB	TI	B
Item	Heat No.													
Poste	No. de coulée													
0020	570747	0,120	0,310	1,23	0,008	0,002	0,17	0,07	0,19	0,07	0,064	0,031	0,003	0,0002
0030	570747	0,120	0,310	1,23	0,008	0,002	0,17	0,07	0,19	0,07	0,064	0,031	0,003	0,0002

Certification of Material - Per ASMB
 HT# 570747
 Qualifies to all requirements of
 SA333 GR6
 Sect. II Edition II Addenda

Q.C.I.
 N.D.

APR 0 4 2013

W.O. # 11769
 M.L. # 41(3/16, 4/6)
 THK. # 219
 P.O. # 13-0249
 5, 2013

Q.C.I.
 E.Y.

APR 0 5 2013



Benteler Steel/Tube GmbH
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1. Formel: $CE_{IIW} = C + (Mn/6) + ((Cr + Mo + V)/5) + ((Cu + Ni)/15) < = 0.45 \%$
 2. Formel: $CEV = C + F * ((Mn/6) + (Si/24) + (Cu/15) + (Ni/20) + ((Cr + Mo + V + Nb)/5) + (5 * B)) < = 0.40$
 3. Formel: $Mn/C > = 3/1$
 4. Formel: $Cr + Cu + Mo + Ni + V < = 1,00 \%$

Formelerggebnisse / Formula results / Résultats des formules

Pos.	Schmelzen-Nr	1. Formel	2. Formel	3. Formel	4. Formel
0020	570747	0,403	0,345	10,250	0,564
0030	570747	0,403	0,345	10,250	0,564



Ben Award
APR 5 2013

APR 05 2013

Prüfergebnisse / Test results / Résultats des essais

Die Rohre sind auf Dichtheit geprüft durch:
 The tubes have been submitted to a leak tightness test by:
 Les tubes ont passé un contrôle d'étanchéité par:

Hydrostatic test: acc. to CSA Z245.1, holding time min 5 seconds, Test pressure/Time-record

PASSED

Die Rohre wurden zerstörungsfrei geprüft:

The tubes are non destructive tested:
 Les tubes ont passé un essai non destructif:

ET-test: acc. to CSA Z245.1; for imperfections; drilled hole: 3,20 mm

PASSED

Augensichtkontrolle:

Visual inspection:
 Examen visuel:

PASSED

Biegeversuch:
 Bending test:
 Essai de cintrage:

PASSED

Maßkontrolle:
 Dimensions examination:
 Vérification des dimensions:

PASSED

Ringfaltversuch:

Flattening test:
 Essai d'aplatissement:

PASSED

Ergebnisse der mechanischen Prüfung / Results of mechanical testing / Résultats des essais mécaniques

Die Probenahme erfolgte an Vielfachlängen.
 The sampling was carried out on multiple lengths.
 L'échantillonnage était réalisé aux longueurs multiples.



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 No. du certificat:

Zugversuch längs Streifenprobe / Tensile test longitudinal Strip test specimen / Essai de traction longitudinale Bande decoupee sur tube

Pos. Item	Proben-Nr. Specimen No.	Schmelzen-Nr. Heat No.	Probenabmessung Specimen dimensions	Streckgrenze Yield strength	Zugfestigkeit Tensile strength	Dehnung Elongation	Einschnürung Area reduction
Poste	No. de l'éprouvette	No. de coulée	Dimensions de l'éprouv.	Limite élastique	Résistance à la traction	Allongement	Coefficient de striction
Anforderungen Requirements Exigences			mm	ReH MPa	Rm MPa	A2"	1. Formel 1. Formula 1. Formule
0020	000001	570747	19,00 X	5,55 458	582	34	34
0020	000002	570747	19,00 X	5,55 460	585	34	34
0030	000001	570747	19,00 X	5,50 458	585	34	34
0030	000002	570747	19,00 X	5,80 461	582	34	34

Härteprüfung / Hardness test / Essai de dureté

Pos. Item	Proben-Nr. Specimen No.	Schmelzen-Nr. Heat No.	Härte Hardness	HRC	HB	HV	HRB	HBW
Poste	No. de l'éprouv.	No. de coulée	Dureté					
Anforderungen Requirements Exigences			MAX 200					
0020	000001	570747	170					
0020	000002	570747	169					
0020	000003	570747	168					
0030	000001	570747	170					
0030	000002	570747	168					
0030	000003	570747	168					

Handwritten signature: *Barlow*
 Q.C.I. E.Y. (diamond stamp)
 APR 05 2013 2013
 Valosi America (circular stamp)
 279

APR 04 2013

Q.C.I. N.D. (diamond stamp)



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

Blatt: 5 / 6
 Page: Page:
 Prf-Nr.: 65-689506/001/P
 Inspection No.:
 No. du certificat:
 Dokument-Nr.: 65-689506/001/P
 Document No.:
 No. du document:
 ABNAHMEPRÜFZEUGNIS EN 10204-3.1
 INSPECTION CERTIFICATE EN 10204-3.1
 CERTIFICAT DE RECEPTION EN 10204-3.1

Kerbschlagbiegeversuch Notched bar impact test / Essai de flexion par choc (résilience) [1 CHARPY_V]

Pos. Proben-Nr. Schmelzen-Nr. Heat No.	Probenabmessung	Probenlage	Prüftemperatur	Kerbschlagarbeit	Kerbschlagzähigkeit	Verf.-Bruchanteil
Item Specimen No. Heat No.	Specimen dimensions	Specimen position	Test temperature	Absorbed energy	Impact strength	Shear fracture
Poste No. de l'éprouv. No. de coulée	Dimensions de l'éprouvette	Position de l'éprouvette	Température d'essai	Energie absorbée	Résistance au choc	Rupture ductile
Anforderungen	Länge Breite Höhe	längs (L)		einzel mittel	einzel mittel	single average
Requirements	Length Width Height	longitudinal (L)	GRAD	single average	single average	single average
Exigences	Longueur Largeur Hauteur	longitudinal (L)	°C	individuelle moyenne	individuelle moyenne	single average
0020 000001 570747	mm mm mm	quer (Q)	-54	J MIN 011	J/cm²	%
	55 4,00 10,00	transversal (Q)	-54	64	85	85
	4,00 10,00	transversal (Q)		70	85	85
	4,00 10,00	L		68 67	85	85
0030 000001 570747	mm mm mm	L	-54	J	J/cm²	%
	55 4,00 10,00	L		68	85	85
	4,00 10,00			72	85	85
	4,00 10,00			71 70	85	85

Wärmebehandlung / Heat treatment / Traitement thermique
 Rolling temperature: 870°C - 1000°C / Cooling: air

Restmagnetismus / Demagnetize / Démagnétiser

demagnetized tubes; 1 measurement per 4 hours on both tube ends Two readings 180° apart around the circumference. Average value
 max 3.0 Millitesla (24 A/cm), individual value max 3.5 Millitesla (28 A/cm)

Vermerk / Remark / Remarque

NACE Standard: Hardness acc. to ANSI/NACE MR0175/ISO 15156: HRC max 22., The material meets the requirements of NACE MR0103;
 Certificate remarks: Sour Service, The Material is Aluminium deoxidized and inclusion shape controlled with Calcium-Silicon
 treatment, This is to confirm that the seamless linepipe supplied by Benteler and verified to CSA Standard Z245.1-07 meets the
 requirement for micro hardness of max. 248 HV 500 gf., No weld repair has been carried out; Bend test: mandrel diameter 12D
 Bending angle: 90°

Grain size determination: acc. to ASTM-E 112, Grain size 6 and finer

Verkäufer(in) / Salesman/ woman in charge / Personne chargée : Mrs Schöneweis, Tel.: 05254/81-4234, Fax: 4289

Q.C.I. E.Y.
 APR 05 2013
 Q.C.I. N.D.
 APR 06 2013
 BENTELER
 QUALITÄTSMESSEN
 18537 DIN EN 10101

ACCEPTED FOR REVIEW/RELEASED
 for and on behalf of: SGM O.F.F. S.p.A.
 Print Name: G. ARSINI S.A.H.
 Signature: [Signature]
 Date: [Date]
 046
 Appius VELOSI
 Velosi America LLC

BENTELER
Steel/Tube

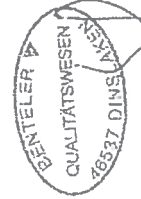
Benteler Steel/Tube GmbH
Postfach 13 40
33043 Paderborn
Deutschland
Tel.: +49.5254.81-0 Fax: +49.5254.13666

ABNAHMEPRÜFZEUGNIS EN 10204-3.1
INSPECTION CERTIFICATE EN 10204-3.1
CERTIFICAT DE RECEPTION EN 10204-3.1

Dokument-Nr.: 65-689506/001/P
Document No.:
No. du document:

Prüf-Nr.:
Inspection No.:
No. du certificat:

Blatt: 6 / 6
Page:
Page:



Abnahmebeauftragter
Inspection representative
Contrôleur

DR. BASEL KEITA / Thei

Dinslaken, 17.04.2012, TEL.: 02064.623-537 FAX: 02064.623-539

Es wird bestätigt, daß die gelieferten Erzeugnisse den techn. Lieferbedingungen des Auftrages entsprechen. Dieses Dokument wurde mittels EDV erstellt und ist ohne Unterschrift rechtsgültig.
We certify that the supplied products comply with the order specification. This document was prepared by means of electronic data processing and is valid without signature.
Nous attestons que les produits livrés sont conformes aux stipulations de la commande. Ce document a été établi par traitement électronique de l'information et est valide sans signature.



Manufacturer of Piping and Pressure Vessel Components
 4404 Haygood St - Houston, TX 77022
 Phone: 713-695-3633 Fax: 713-695-3528
 A Bonney Forge Company

Sold To: COMCO PIPE & SUPPLY
 (PUSLINCH)
 14 KERR CRESCENT
 PUSLINCH ON NOB 210

MTR #: 250,800
 PO #: G1-269324-GK

Sales Order #: C001305091 Date: 04/04/2013

This product has not come in direct contact with mercury or any of its compounds, nor with any mercury-containing device employing a single boundary of containment. No welding performed.

We certify that the contents of this report are correct and accurate, and that all test results and operations performed by WFI or its subcontractors are in compliance with the material specification and requirements of the referenced code or standard, and that the material conforms to the dimensional requirements of the order. This document is in accordance with EN10204 3.1.

Certified Material Test Report

Heat Code: 58494

Material: A/SAS350 00a LF2 CL1

Item	Quantity	Description
1	16	36 - 8 X 2 3M THP SA350LF2 CL1 IAW NACE MR0175,2009

Chemical Composition

Ladle	C	CR	CU	MN	MO	NB	NI	P
	0.200	0.04	0.070	1.02	0.000	0.015	0.02	0.008
	S	SI	V					
	0.022	0.19	0.004					

Carbon Equivalency: Ladle 0.39

Product	Tensile PSI	Yield PSI	Elong %	RA %	Hardness
	72,500	48,750	30.10	64.70	130 BHN
Charpy V-Notch Properties:			Test Temperature:		+50 F
	FJ LBS: 17/21/45	% Shear: NB/NB/NB			MLE: NB/NB/NB
	Normalized				132 BHN

Certification of Material - Per ASME
 HT# 58494
 Qualifies to all requirements of
 SA350-LF2CL1 per
 Sect. II TC Edition 11 Addenda

W.O. # 11760
 M.L. # 42(5/6)
 THK. #
 P.O. # 13-0293

ACCEPTED/REVIEWED/RELEASED 046
 for and on behalf of: SBM OFFSHORE
 Print Name: GRACE SAHA
 Signature: [Signature]
 Date: July 10/13
 Q.C.I. Applied VELOSI
 Velosi America LLC
 APR 25 2013

Q.C.I. N.D.

Marie Dehmer
 Marie Dehmer
 Quality Assurance Representative

ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

0006010



SO No. Item & Date	8005968 000010 2013/01/15	Shipment No & Date	1000025416 2013/01/15	TC No., Date & Time	ESA 41597 2013/01/15 22:23:45																																					
Sold to Customer Name and Address	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE Ontario Canada N1H 6H9	Ship to Customer Name and Address	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE Ontario Canada N1H 6H9	Customer PO NO. Item	P007612-1 1000025416																																					
Customer Specification	HR STEEL PLATE Carbon MILD Inclus on Snap Control Calc Int. treated Normalized Normal Temp 1670 F 8 min CVN Req 15/12 FT LB at 50 F Std Thickness Tol PVO Top and Bottom Standard Surface Flatness 1/2 A20 Latest Ed - Addenda of ASME Code section II part A applies Fine Grain Fully Killed No Weld Repair			Cur Part No	NATIONAL TRANSPORTATION - 1213 1127																																					
Customer Specification	HR STEEL PLATE Carbon MILD Inclus on Snap Control Calc Int. treated Normalized Normal Temp 1670 F 8 min CVN Req 15/12 FT LB at 50 F Std Thickness Tol PVO Top and Bottom Standard Surface Flatness 1/2 A20 Latest Ed - Addenda of ASME Code section II part A applies Fine Grain Fully Killed No Weld Repair			Carrier																																						
Supplementary Instructions	Test Cert 1519-837-2227			Cust Use	PVO																																					
Inspection Report As Per Spec																																										
<p>ESSAR STEEL ALGOMA INC. HEREBY CERTIFIES THAT THE MATERIAL DESCRIBED WAS MANUFACTURED AND TESTED IN ACCORDANCE WITH THE REQUIREMENTS OF THE SPECIFICATION AND ALL REQUIREMENTS ARE MET. THE MANUFACTURER'S MARKING IS AS FOLLOWS: 2259P3-56. THE TEST REPORT MAY NOT BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM. ALL RIGHTS ARE RESERVED. CONTACT: SALES@ESSARSTEEL.COM</p>																																										
Dimensions (T x W x L)	Batch No	Heat No-MS	No of PCS	Quantity	Heat No-MS	Quantity	No of PCS																																			
0.2500" x 95.000" x 288.00"	AB8626	2259P3-56	3	5.880 LB	2259P3-56	5.880 LB	3																																			
0.2500" x 95.000" x 288.00"	AB8631	2259P3-56	3	5.880 LB																																						
<p>MECHANICAL PROPERTIES</p> <table border="1"> <tr> <td>Heat No. (wt%)</td> <td>C</td> <td>Min</td> <td>P</td> <td>S</td> <td>Si</td> <td>Cr</td> <td>Ni</td> <td>Cu</td> <td>Mn</td> <td>Al</td> <td>Nb</td> <td>V</td> <td>B</td> <td>Ti</td> <td>DO</td> </tr> <tr> <td>2259P3</td> <td>0.19</td> <td>1.10</td> <td>0.009</td> <td>0.005</td> <td>0.330</td> <td>0.04</td> <td>0.15</td> <td>0.04</td> <td>0.01</td> <td>0.034</td> <td>0.000</td> <td>0.015</td> <td>0.0002</td> <td>0.003</td> <td>0.4000</td> </tr> </table>								Heat No. (wt%)	C	Min	P	S	Si	Cr	Ni	Cu	Mn	Al	Nb	V	B	Ti	DO	2259P3	0.19	1.10	0.009	0.005	0.330	0.04	0.15	0.04	0.01	0.034	0.000	0.015	0.0002	0.003	0.4000			
Heat No. (wt%)	C	Min	P	S	Si	Cr	Ni	Cu	Mn	Al	Nb	V	B	Ti	DO																											
2259P3	0.19	1.10	0.009	0.005	0.330	0.04	0.15	0.04	0.01	0.034	0.000	0.015	0.0002	0.003	0.4000																											
<p>HARDNESS TESTS</p> <table border="1"> <tr> <td>Heat No</td> <td>SRCE</td> <td>LAB</td> <td>GAUGE</td> <td>COND</td> <td>LOC</td> <td>MTHD</td> <td>HARDNESS</td> </tr> <tr> <td>2259P3</td> <td>AB8626</td> <td>166"</td> <td>ALG</td> <td>0.2500</td> <td>N</td> <td>B</td> <td>HBW</td> <td>151</td> </tr> <tr> <td>2259P3</td> <td>AB8631</td> <td>166"</td> <td>ALG</td> <td>0.2500</td> <td>N</td> <td>B</td> <td>HBW</td> <td>153</td> </tr> <tr> <td>2259P3</td> <td>AB8631</td> <td>166"</td> <td>ALG</td> <td>0.2500</td> <td>N</td> <td>B</td> <td>HBW</td> <td>151</td> </tr> </table>								Heat No	SRCE	LAB	GAUGE	COND	LOC	MTHD	HARDNESS	2259P3	AB8626	166"	ALG	0.2500	N	B	HBW	151	2259P3	AB8631	166"	ALG	0.2500	N	B	HBW	153	2259P3	AB8631	166"	ALG	0.2500	N	B	HBW	151
Heat No	SRCE	LAB	GAUGE	COND	LOC	MTHD	HARDNESS																																			
2259P3	AB8626	166"	ALG	0.2500	N	B	HBW	151																																		
2259P3	AB8631	166"	ALG	0.2500	N	B	HBW	153																																		
2259P3	AB8631	166"	ALG	0.2500	N	B	HBW	151																																		

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
CU + Ni + CR + MO = .05
CR + MO = .05

CERTIFICATION OF MATERIAL - Per ASME HT# 2259P3-56
Qualifies to all requirements of SAS 16 GR 70 N per Sect. II 10 Edition 11 Addenda

W.O. # 11760
 M.L. # 43 (5/16)
 THK. # - 256
 P.O. # 13-00259

MILL TEST REPORTS APPROVED BY Q.C. P.O. _____

Velocity America 279
 Approved
 April 11, 2013
 K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

MAR 27 2013



APR 03 2013

WARNING: THE TEST RESULTS AND VALUES REPORTED HEREIN INDICATE ONLY THAT THE PARTICULAR STEEL FULFILLS THE MINIMUM SPECIFIED YIELD STRENGTH AND TENSILE STRENGTH AND PHYSICAL PROPERTIES OF SUCH STEEL AS SPECIFIED IN THE SPECIFICATION INDICATED. THESE VALUES REPORTED HEREIN CAN NOT BE USED TO QUALIFY THE STEEL FOR ANY OTHER APPLICATIONS. THE USER SHALL BE RESPONSIBLE FOR THE PROPER SELECTION AND USE OF THE MATERIAL AS INTENDED. THE ACTUAL STRENGTH OF SUCH STEEL WILL BE DETERMINED BY THE USER'S OWN TESTING.



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

SO No. Item & Date	8059568 000010 2013/01/15	Shipment No. & Date	1000025416 2013/01/15	Tc No., Date & Time	ESA 41597 2013/01/15 22:23:45
Sold to Customer Name and Address	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE Ontario Canada N1H 6H9	Ship to Customer Name and Address	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE Ontario Canada N1H 6H9	Customer PO NO Item	P007612 11
Customer Specification	HR STEEL PLATE Carbon Mild Cert ASTM A516 GR 70 (11A) Meets NACE MR 0103 latest Ed. BHN < 200 D.O.CEQ. 43 max Inclusion Shape Control Calcium Treated Normalized Temp. 1670 F 8 min CVN. Req. 15 1/2 FT. LBT at -50.0 F Std Thickness Tol PVQ Top and Bottom Standard Surface Flatness 1/2 AGO Latest Ed + Addenda of ASME Code section II part A applies Fine Grain fully killed No Weld Repair			BOL NO.	1000025416
Supplementary Instructions	Test Cert 1519 637/222			Cust Part No	
Insp T/R	Test Report As Per Spec			Carrier	NATIONAL TRANSPORTATION - 1213 1127
<p>ESSAR STEEL IS PROVIDING THESE CERTIFICATES THAT THE MATERIALS DESCRIBED WERE MADE AND TESTED IN ACCORDANCE WITH THE COMPANY'S STANDARD REQUIREMENTS. THIS SMALL TEST REPORT MAY NOT BE REPRODUCED OR DISTRIBUTED WITHOUT WRITTEN APPROVAL OF ESSAR STEEL. ALL INFORMATION ON THIS DOCUMENT IS SUBJECT TO OUR METHOD OF DISPOSAL OR DESTRUCTION.</p> <p>MEETS EN 10204 2004 PART 31 REGULATORY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM</p>					

MAR 27 2013

Q.C.I. N.D.

Received
April 1, 2013
279
Kings America

K. UGHINDPAGA
MANAGER METALURGICAL SERVICES

WARNING: THE TEST RESULTS AND VALUES REPORTED HEREIN INDICATE ONLY THAT THE MATERIALS DESCRIBED WERE MADE AND TESTED IN ACCORDANCE WITH THE COMPANY'S STANDARD REQUIREMENTS. THIS SMALL TEST REPORT MAY NOT BE REPRODUCED OR DISTRIBUTED WITHOUT WRITTEN APPROVAL OF ESSAR STEEL. ALL INFORMATION ON THIS DOCUMENT IS SUBJECT TO OUR METHOD OF DISPOSAL OR DESTRUCTION.

Certificate of Mill Test Results

QUALITY PLATES & PROFILES LIMITED
 20 Nicholas Blvd, R.R.#3 (Aberfoyle), Guelph, ON N1H 6H9
 ALL-WELD COMPANY LIMITED
 PO/Rel: 13-0239
 PLATE CPL 516N 1/4" x 2-3/16" DIA.

Contact: BRIAN WEEDON Inv: 1055234 Date: 03/25/2013 Heat: 8888L

ESSAR Steel Algoma Inc. 105 West St., Sault Ste. Marie, Ontario, Canada, P6A 7B4 0005097

CUSTOMER PURCHASE ORDER NUMBER: P005643 ENTRY DATE: 2011/08/29 CREATE DATE: 2011/10/17 TALLY NUMBER: 246425 SHIPPERS NUMBER: - CARRIER: W.J. DEANS TRANSPORTATION -2221 A/B MILL ORDER: 10816

SHIP TO CUSTOMER NAME & ADDRESS:
 QUALITY PLATES & PROFILES LTD
 20 NICHOLAS BEAVER ROAD
 RR#3
 ABERFOYLE, ON
 NIH 6H9

CHARGE TO CUSTOMER NAME & ADDRESS:
 QUALITY PLATES & PROFILES LTD
 20 NICHOLAS BEAVER ROAD RR#3
 ABERFOYLE, ON
 NIH 6H9

CUSTOMER SPECIFICATION:
 HR PLATE - CARBON - ASME SA516 GR 70 (10) - CVNL 15/12 FT LBS AT -50 F - C .23
 MAX, DO CE 0.43 MAX, V 0.02% MAX, NB 0.02% MAX, V+NB 0.03% MAX - FINE GRAIN
 - MEETS ASME SECTION II LATEST ADDENDA - PVQ - NORMALIZED - FLATNESS 1/2 A-20

SUPPLEMENTARY INSTRUCTIONS:
 TEST CERT 1: MICHELLE CRAVEIRO 519-837-2227 TEST CERT 2: PLAT
 E TEST COUPON:
 INSP T/R TEST REPORTS REQUIRED 2000200546 PF
 CUST USE RESALE 2011/10/17 18:27

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

CUSTOMER ITEM 00001 OUR ITEM 002 DIMENSIONS .250 X 96 X 288 " S H I P E D * * * * *
 PLATE NUMBER HEAT-MS NO. WEIGHT PLATE NUMBER HEAT-MS NO. WEIGHT P R O P E R T I E S * * * * *
 38621 8888L-04 3 5880 38622 8888L-04 3 5880 8888L-04 5880
 38623 8888L-04 3 5880 38624 8888L-04 3 5880 8888L-05 5880
 38625 8888L-04 3 5880 38627 8888L-05 3 5880 8888L-05 5880

TENSILE TESTS:
 PLATE NUMBER SRCE SAMPLE GAUGE COND METH TEST DIR YIELD KSI TENSILE KSI % ELONG
 8888L 38621 166" .2500 N .2 TT 54.0 74.0 26 (8")
 8388L 38622 166" .2500 N .2 TT 51.0 74.0 24 (8")
 8888L 38623 166" .2500 N .2 TT 53.2 74.0 26 (8")
 8888L 38624 166" .2500 N .2 TT 54.2 74.4 25 (8")
 8888L 38625 166" .2500 N .2 TT 54.0 74.4 27 (8")
 8888L 38627 166" .2500 N .2 TT 54.4 75.0 25 (8")

MILL TEST REPORTS
 ESSAR STEEL ALGOMA INC. HEREBY CERTIFIES THAT THE MATERIAL 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.

MANAGER METALLURGICAL SERVICES
 K. UGHADPAGA
 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)945-2624 COLLECT FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.

Q.C.I. E.Y. APR 03 2013
 Velsco America
 MILL TEST REPORTS APPROVED BY Q.C.
 P.O. _____
 PAGE 1 OF 2

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.

Certificate of Mill Test Results

QUALITY PLATES & PROFILES LIMITED
 20 Nicholas B... Road, R.R.#3 (Aberfoyle), Guelph, ON N1H 6H9
 ALL-WELD COMPANY LIMITED
 PO/Rel: 13-0239
 PLATE CBL-516N-1/4" x 2-3/16" DIA.

Contact: BRIAN WEEDON
 Inv: 1055234 Date: 03/25/2013
 Heat: 8888

ESSAR Steel Algoma Inc. 105 West St., Sault Ste. Marie, Ontario, Canada, P6A 7B4
 CUSTOMER PURCHASE ORDER NUMBER: P005643
 ENTRY DATE: 2011/08/29
 CREATE DATE: 2011/10/17
 TALLY NUMBER: 246425
 SHIPPERS NUMBER: -
 CARRIER: W.J. DEANS TRANSPORTATION - 2221 A/B
 MILL ORDER: 10816

SHIP TO CUSTOMER NAME & ADDRESS:
 QUALITY PLATES & PROFILES LTD
 20 NICHOLAS BEAVER ROAD RR#3
 ABERFOYLE, ON N1H 6H9

CUSTOMER SPECIFICATION:
 HR PLATE - CARBON - ASME SA516 GR 70 (10) - CVNL 15/12 FT LBS AT -50 F - C .23
 MAX, DO CE 0.43 MAX, V 0.02% MAX, NB 0.02% MAX, V+NB 0.03% MAX - FINE GRAIN
 - MEETS ASME SECTION II LATEST ADDENDA - PVQ - NORMALIZED - FLATNESS 1/2 A-20

SHIP TO CUSTOMER NAME & ADDRESS:
 QUALITY PLATES & PROFILES LTD
 20 NICHOLAS BEAVER ROAD RR#3
 ABERFOYLE, ON N1H 6H9

TEST CERT 1: MICHELLE CRAVEIRO 519-837-2227 TEST CERT 2: PLAT
 E TEST COUPON:
 TEST REPORTS REQUIRED
 RESALE

INSPT/R: 2000200546 PF
 2011/10/17 18:27

IMPACT TESTS:
 PLATE NUMBER: 8888L 38621, 8888L 38622, 8888L 38623, 8888L 38624, 8888L 38625, 8888L 38627

HEAT (WT %): 8888L**
 SRCE: 166", 166", 166", 166", 166"
 GAUGE IN: .2500, .2500, .2500, .2500, .2500
 COND: N, N, N, N, N
 METH: CVN, CVN, CVN, CVN, CVN
 TEST DIR: L, L, L, L, L
 SIZE: 1 1/2, 1 1/2, 1 1/2, 1 1/2, 1 1/2
 TEMP: -50F, -50F, -50F, -50F, -50F
 FULLSIZE ENERGY: FTLB 104, 112, 110, 90, 77; AVG* 108, 108, 108, 88, 84

PROPERTIES: P, S, AS, ZR, SI, CR, NI, CU, MO, AL, CB, B, DO
 Values: P .011, S .007, AS .007, ZR .31, SI .31, CR .02, NI .02, CU .03, MO .01, AL .044, CB .000, B .002, DO .38

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)945-2624 COLLECT FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.

Q.C.I. E.Y.
 APR 03 2013



LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
 CU + Ni + CR + MO = 6.68
 CR + MO = 0.3

Certification of Material - Per ASME
 HT# 8888L-38623
 Qualifies to all requirements of SA516-GR70 per Sect. II Edition 4 Addenda

W.O. # 11760
 M.L. # 43676
 THK. # 2546
 P.O. # 13-0237

****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.



Cambridge

materials testing limited

1177 Franklin Boulevard,
Cambridge, Ontario N1R 7W4
Tel: (519) 621-6600 Fax: (519) 621-6082
www.cambridgematerials.com

ISO17025 Accredited

Report for: Quality Plates & Profiles Ltd.
20 Nicholas Beaver Road
R. R. # 3
ABERFOYLE, Ontario
N1H 6H9
Phone: 1-800-268-2853
Fax: 1-519-837-2224

Laboratory No. 598087-2012
Report Date: January 24, 2012
Received Date: January 19, 2012
Customer P.O.#: P006311

Attention: Dave Braga

Specimen: Material: ASME SA516 - 70 Normalized
.25" Thick x 3" x 3", Algoma Heat # 8888L-38625

ROCKWELL HARDNESS TEST REPORT

80,79,79 HRBW

ACCEPTED/REVIEWED/RELEASED 046
for and on behalf of: SBM OFFSHORE
Print Name: GRANESH SAH
Signature: [Signature]
Date: APR 15 2013
Applus® VELOSI
Velosi America LLC

NACE MR0175/ISO 15156-2 (A.2.1.2) Rockwell Hardness Requirement:
22 HRC maximum

Conclusion: Pass

Testing performed according to
NACE MR0175/ISO 15156-2:2009/Cir.1:2011(E), ISO 6508-1:1999(E),
ASME Boiler and Pressure Vessel Code Section II, Part A, SA-370
(2010 Edition, 2011 Addenda) and ASTM E18-08b.

Q.C.I. E.Y.
APR 03 2013
Q.C.I. N.D.

This report is subject to the following terms and conditions: 1. This report relates only to the specimen provided and there is no representation or warranty that it applies to similar substances or materials or the bulk of which the specimen is a part. 2. The content of this report is for the information of the customer identified above only and it shall not be reprinted, published or disclosed to any other party except in full. Prior written consent from Cambridge Materials Testing Limited is required. 3. The name Cambridge Materials Testing Limited shall not be used in connection with the specimen reported on or any substance or materials similar to that specimen without the prior written consent of Cambridge Materials Testing Limited. 4. Neither Cambridge Materials Testing Limited nor any of its employees shall be responsible or hold liable for any claims, loss or damages arising in consequence of reliance on this report or any default, error or omission in its preparation or the tests conducted. 5. Specimens are retained 6 months, test reports and test data are retained 7 years from date of final test report and then disposed of, unless instructed otherwise in writing.

Cambridge Materials Testing Limited

Per [Signature]
Per Matthew Link Quality Assurance
Technician

Contact: BRIAN WEEDON
 Inv: I055234
 Date: 03/25/2013
 Heat: 2797P3



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

0005981

SO No. Item & Date:	8006515 000020 2013/01/05	Shipment No. & Date:	1000023647 2013/01/06	TC No., Date & Time:	ESA-38932 2013/01/07 - 10:15:07
Sold to Customer Name and Address:	NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE, Ontario, Canada N1H 6H9	Ship to Customer Name and Address:	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE, Ontario, Canada N1H 6H9	Customer PO NO./Item:	P007755 / 2
BOL NO.:	1000023647	Cust. Part No.:		Carrier:	ROBINSON TRANSPORT LTD - 205(661)

Customer Specification: HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (10) ASME SA516 GR 70 (11A) Meets NACE MR 0103 latest Ed. NACE MR 0175 latest Ed. BHN < 200. DO CEO 43 max. Inclusion Shape Control Calcium Treated Normalized Temp 1670 - F 34 min CVNL Req. 15/12 FT. LBF at 0 - 50.0 F Sid Thickness Tol. PQV Top and Bottom Standard Surface Flatness 1/2 A20 Latest Ed + Addenda of ASME Code section II part A applies Fine Grain Fully Killed No Weld Repair

Supplementary Instructions: Test Cert 1519-837-2227

Inspr T/R: Test Report As Per Spec

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. 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) 945-4095 FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.

ALL HEATS FULLY KILLED
 HEATS INDICATED WITH (*) ARE GRAINED
 HEATS INDICATED WITH (+) MADE IN CANADA WITH DOMESTIC AND NORTH AMERICAN MATERIALS

Dimensions (T x W x L)	Heat No.-MS	Quantity	No. of Pcs	Dimensions (T x W x L)	Batch No.	Heat No.-MS	Quantity	No. of Pcs
1.0000" x 120.000" x 384.00"	AB8769	13.068 LB	1	1.0000" x 120.000" x 384.00"	AB8770	2606P3-56	13.068 LB	1
1.0000" x 120.000" x 384.00"	AB8771	13.068 LB	1					

Heat No. (wt.%)	C	Mn	P	S	Si	Cr	Ni	Cu	Mo	Al	Nb	V	TI	DO
2606P3*	0.20	1.06	0.012	0.004	0.340	0.02	0.15	0.02	0.01	0.027	0.000	0.014	0.0003	0.4000
2797P3*	0.19	1.09	0.009	0.005	0.310	0.02	0.15	0.03	0.00	0.024	0.000	0.015	0.0002	0.3900

Hardness Tests	Heat No.	Batch No.	SRCE	LAB	GAUGE	COND	LOC	MTHD	HARDNESS
	2606P3	AB8769	166"	ALG	1.0000	NORM	B	HBW	153
	2606P3	AB8770	166"	ALG	1.0000	NORM	B	HBW	153
	2797P3	AB8771	166"	ALG	1.0000	NORM	B	HBW	150

W.O. # 11768
 M.L. # 46(272)45(19/2)
 THK. # 1-027
 P.O. # 13-0239

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
 CU + NI + CR + MO = 0.02
 CR + MO = 0.02

Certification of Material - Per ASME
 HT# 2797P3-05
 Qualifies to all requirements of
 SASIBERSON per
 Sect. II 10 Edition II Addenda



K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

MILL TEST REPORTS APPROVED BY Q.C. P.O.
 WARNING THE TEST RESULTS AND VALUES REPORTED HEREON ARE ONLY THAT (1) THE PART/PLATE/STEEL AND (2) THE TEST METHOD USED TO OBTAIN THEM. THE RESULTS CAN ONLY BE USED TO QUALIFY THE STEEL FOR ANY SPECIFICATION OTHER THAN THE ONE INDICATED AND CAN NOT BE RELIED UPON FOR ANY PURPOSES INCLUDING DESIGN OR CONSTRUCTION OF STRUCTURAL STEEL.

MAR 27 2013

APR 03 2013



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

SO No./Item & Date:	8006515 000020 2013/01/05	Shipment No & Date:	1000023647 2013/01/06	TC No., Date & Time:	ESA-38932 2013/01/07 - 10:15:07
Sold to Customer Name and Address:	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE, Ontario, Canada N1H 6H9	Ship to Customer Name and Address:	QUALITY PLATES & PROFILES LTD NICHOLAS BEAVER ROAD RR#3 20 ABERFOYLE, Ontario, Canada N1H 6H9	Customer PO NO./Item:	P007755 / 2
Customer Specification:	HR STEEL PLATE Carbon Mils Cert ASTM A516 GR 70 (11A) Meets NACE MR 0175 latest Ed., BHN < 200, D.O.CEQ 43 max. Inclusion Shape Control Calcium Treated Normalized Temp 1670-1734 min CVNL Req. 15/12 FT-LBF at 0-50 F Std Thickness Tol PVQ Top and Bottom Standard Surface Flatness 1/2 A20 Latest Ed + Addenda of ASME Code section II part A applies Fine Grain Fully Killed No Weld Repair	BOL NO.:	1000023647	Cust.Part No.:	ROBINSON TRANSPORT LTD - 205(661)
Supplementary Instructions:	Test Cert 1:519-837:2227	Carrier:			

Customer: ROBINSON TRANSPORT LTD - 205(661)
 Carrier: ROBINSON TRANSPORT LTD - 205(661)
 Insp TR: Test Report As Per Spec
 Cust Use: PVO

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.
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MEETS EN 10204 2004 TYPE 3.1
 ISO QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM

Heat No.	Batch No.	SRCE	LAB	GAUGE	COND	METH	DIR	LOC	SIZE	TEMP(°F)	ENERGY(ft-lbf)	ENERGY AVG(ft-lbf)
2606P3	AB8760	166"	ALG	1.0000	NORM	CVN	L	B	FULL	-50	71.6977	72
2606P3	AB8770	166"	ALG	1.0000	NORM	CVN	L	B	FULL	-50	59.6173	64
2797P3	AB8771	166"	ALG	1.0000	NORM	CVN	L	B	FULL	-50	84.8665	79
TENSILE TESTS												
Heat No.	Batch No.	SRCE	LAB	GAUGE	COND	METH	DIR	LOC	YIELD(KSI)	TENSILE(KSI)	EL SCALE	ELONG(%)
2606P3	AB8769	166"	ALG	1.0000	NORM	2	T	B	49.5	78.2	2"	33
2606P3	AB8770	166"	ALG	1.0000	NORM	2	T	B	49.0	77.1	2"	32
2797P3	AB8771	166"	ALG	1.0000	NORM	2	T	B	50.7	77.2	2"	31



APR 03 2013

Amber
PL
April 11, 2013
 Velocity America
 279



MAR 27 2013

K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

WARNING THE TEST RESULTS AND VALUES INDICATED HEREIN INDICATE ONLY THAT (1) THE PARTICULAR STEEL FOR WHICH THIS CERTIFICATE IS ISSUED MEETS THE MINIMUM SPECIFIED YIELD STRENGTH AND (2) THE ANALYSIS AND PHYSICAL PROPERTIES OF SUCH STEEL ARE IN COMPLIANCE WITH THE REQUIREMENTS OF THE SPECIFICATION INDICATED. THESE STATISTICAL 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.



14527 Smith Rd.
Humble, Texas 77396
TEL: (281) 441-4088
FAX: (281) 441-8899

REPORT NUMBER 73595

DATE 4/5/2013

FCI ORDER NUMBER 60029

Processed I.A.W. EN10204 3.1
I.A.W. NACE MR0175

CUSTOMER ORDER NUMBER 13-0279 ADD
SOLD/SHIPPED TO ALL-WELD CO., LTD.
49 PASSMORE AVE.

SCARBOROUGH ONT MIV 4T1 CANADA

Item Quantity Description

2 2 2" X 900 RTJ WN S/160

ITEM# 1176-7

HEAT NUMBER:
B859

MATERIAL TYPE:
SA350LF2CL1

Material Origin: USA
Manufactured in USA
I.A.W. ASME 2010 ED 11AD.

CHEMICAL ANALYSIS

PHYSICAL PROPERTIES

PRODUCT

C	.180	.181
Mn	1.160	1.176
P	.0080	.0000
S	.0030	.0000
Si	.220	.232
Cr	.070	.076
Mo	.020	.022
V	.020	.014
Cu	.130	.140
Ni	.060	.063
	.001	.002
	.0103	
Sn	.008	
Ti	.0010	
Al	.029	.030
B	.0002	
CE	.41	.410

Yield PSI 46,300
Tensile PSI 73,900
Elongation 27
Reduction of Area 70
Hardness 149 HBW
CVN @ -50 °F FT LBS 58/55/54
% Shear
MLE

MAY 27 2013



NI
Certification of Material - Per ASME
HT# B859
Qualifies to all requirements of
SA350 LF2CL1 per
Sect. II 10 Edition 11 Addenda

W.O. # 1176Q
M.L. # 47(1/2)
THK. # 460
P.O. # 13-0279

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
CU + Ni + CR + MO = .28
CR+MO = .09

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

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

Prepared by

Name: Helen Fielder

Title: QA Representative

ACCEPTED/REVIEWED/RELEASED
for and on behalf of: SBM OFF STORE
Print Name: CHAMBESH SAHA
Signature: [Signature]
Date: July 10/13
046
Applus[®] VELOSI
Velosi America LLC



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

SO No., Item & Date:	8010079 000010 2013/04/30	Shipment No. & Date:	1000045592 2013/05/06	TC No., Date & Time:	ESA-71132 2013/05/08 - 22:33:08
Sold to Customer Name and Address:	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	Ship to Customer Name and Address:	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	Customer PO NO./Item:	19748-STK / 1 1000045592
Customer Specification:	HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (10) / ASME SA516 GR 70 (11A) MEETS NACE MR 0103 LATEST ED., NACE MR 0175 LATEST ED., BHN < 200, ISO 15156, PER EN 10204 3.1, SULPHIDE SHAPE CONTROL, CALCIUM TREATED, NO WELDREPAIR HAS BEEN PERFORMED ON THIS MATERIAL Normalized Normalize Temp 1670 °F 17 min CVNL Req. 15 / 12 FT-LBF at -50.0 F Std Thickness Tol PVQ Top and Bottom Standard Surface Flatness 1/2 A20 Latest Ed.+Addenda of ASME Fine Grain Fully Killed			Cust.Part No.:	LOCOMOTE SYSTEM INC - RTA341 (891030)
Supplementary Instructions:	Test Cert 1:drafting@canadianplate.com Test Cert 2: 905-206-1370			Carrier:	

Insp T/R : Test Report As Per Spec Cust Use : PVQ

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. 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)945-4095 FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.

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.

Dimensions (T x W x L)	0.5000" x 96.000" x 480.00"	Batch No.	AD7572	Heat No.-MS	6396P3-01	Quantity	13,068 LB	Pcs	2
Heat No. (wt%)	6396P3*	C	0.20	Mn	1.06	P	0.012	S	0.005
		Si	0.340	Cr	0.01	Ni	0.14	Mo	0.00
		Al	0.030	Nb	0.000	V	0.015	B	0.0002
		TI	0.003	DO	0.39				

CHEMICAL PROPERTIES									
MECHANICAL PROPERTIES									
HARDNESS									
Heat No.	Batch No.	SRCE	LAB	GAUGE	COND	LOC	MTHD	HBW	158
6396P3	AD7572	166"	ALG	0.5000	N	B	HBW		

Impact Tests												
Heat No.	Batch No.	SRCE	LAB	GAUGE	COND	METH	DIR	LOC	SIZE	TEMP(°F)	FULLENERGY(ft-lbf)	FULL AVG(ft-lbf)
6396P3	AD7572	166"	ALG	0.5000	N	CVN	L	B	FULL	-50	82 81 87	83
6396P3	AD7572	166"	ALG	0.5000	N	CVN	L	B	FULL	-50	88 79 67	78

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
CU + Ni + CR + MO = .17
CR+MO = .01

Certification of Material - Per ASME
 HT# 6396P3-01
 Qualifies all requirements of SA 516-GR 70 N per Sect. II 10 Edition 4 Addenda

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 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.

ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: S.M. OFFSHORE 046
 Print Name: CIARLES SAMI **Applus®**
 Signature: [Signature]
 Date: Aug 2013 **Velosi America LLC**

Q.C.I. E.Y.

Q.C.I. N.D.

W.O. # 11768
 M.L. # 53(2372)54(2442)57(114)
 THK. # 510
 P.O. # 13-0720

K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

SO No., Item & Date:	8010079 000010 2013/04/30	Shipment No. & Date:	1000045592 2013/05/06	TC No., Date & Time :	ESA-71132 2013/05/08 - 22:33:08							
Sold to Customer Name and Address :	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	Ship to Customer Name and Address:	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	Customer PO NO./Item:	19748-STK / 1							
Customer Specification :	HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (10) / ASME SA516 GR 70 (11A) MEETS NACE MR 0103 LATEST ED., NACE MR 0175 LATEST ED., BHN < 200, ISO 15156, PER EN 10204 3.1, SULPHIDE SHAPE CONTROL CALCIUM TREATED, NO WELD REPAIR HAS BEEN PERFORMED ON THIS MATERIAL Normalized Temp 1670 °F 17 min CVNL Req. 15/12 FT-LBF at -50.0 F Sid Thickness Tol PVQ Top and Bottom Standard Surface Flatness 1/2 A20 Latest Ed. + Addenda of ASME Fine Grain Fully Killed											
Supplementary Instructions :	Test Cert 1:drafting@canadianplate.com Test Cert 2: 905-206-1370											
Insp TIR :	Test Report As Per Spec											
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. 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)945-4095 FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.												
MEETS EN 10204:2004 TYPE 3.1 ISO QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM												
***** MECHANICAL PROPERTIES *****												
Tensile Tests												
Heat No.	Batch No.	SRCE	LAB	GAUGE	COND	METH	DIR	LOC	YIELD(KSI)	TENSILE(KSI)	EL SCALE	ELONG(%)
6396P3	AD7572	166"	ALG	0.5000	N	.2	T	B	53.0	77.0	8"	24
6396P3	AD7572	166"	ALG	0.5000	N	.2	T	B	54.0	78.0	8"	24



046

ACCEPTED/REVIEWED/RELEASED
for and on behalf of: SBM OFF SHORE
GARESH SAH
Print Name: _____
Signature: [Signature]
Date: Aug 25/13
Applus®
VELOSI
Velosi America LLC

K. UGHADPAGA
MANAGER METALLURGICAL SERVICES

****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 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.



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

SO No., Item & Date:	8007677 000021 2013/02/22	Shipment No. & Date:	1000033668 2013/03/05	TC No., Date & Time:	ESA-53909 2013/03/06 - 06:21:28
Sold to Customer Name and Address:	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	Ship to Customer Name and Address:	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	Customer PO NO./Item:	19396-STK / 2
				BOL NO.:	1000033668
				Cust Part No.:	LOCOMOTE SYSTEM INC - rts341 (89103) rev

Customer Specification: HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (10) / ASME SA516 CR 70 (11A) Meets NACE MR 0103 latest Ed., NACE MR 0175 latest Ed., BHN < 200, Calcium Treated for Sulphide Shape Control Normalize Temp 1670 °F 8 min CVNL Req. 15 / 12 FT-LBF at -50.0 F Std Thickness Tol PVQ Top and Bottom Standard Surface Finish 1/2 A20 Latest Ed. + Addenda of ASME Fine Grain Fully Killed No Weld Repair

Supplementary Instructions: Test Cert 1: drafting@canadianplate.com Test Cert 2: 905-206-1370

Insp TIR: Test Report As Per Spec

Cust Use: PVQ

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. THIS WILL 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) 945-4095 FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.

MEETS EN 10204-2004 TYPE 3.1
ISO QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM

Dimensions (T x W x L)	Batch No.	Heat No-MS	Quantity	No. of Pcs	Dimensions (T x W x L)	Batch No.	Heat No-MS	Quantity	No. of Pcs
0 2500 " x 120 000 " x 480 00 "	AC5976	4019P3-52	4,084 LB	1	0 2500 " x 120 000 " x 480 00 "	AC5977	4019P3-52	4,084 LB	1

Heat No. (wt%)	C	Mn	P	S	Si	Cr	Ni	Cu	Mo	Al	Nb	B	TI	DO
4019P3*	0.19	1.07	0.011	0.004	0.310	0.02	0.15	0.02	0.00	0.026	0.000	0.014	0.0002	0.3900

Hardness Tests	SRCE	LAB	GAUGE	COND	LOC	MTHD	HARDNESS
Heat No.	Batch No.	168"	ALG	0.2500	N	B	161
4019P3	AC5976	168"	ALG	0.2500	N	B	162

W.O. # 11769
M.L. # 55 (25/3, 26/1)
THK. # 259
P.O. # 13-072e

Q.C.I. N.D.

Limitation of Material - Per ASME
 HT# 4019P3-52
 Qualifies to all requirements of SA 516 GR 70 per Sect. II Edition II Addenda

ML# 65 (13/2)

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
 CU + Ni + CR + MO = 19
 CR + MO = 0.02

AUG 20 2013

K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

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 MECHANICAL PROPERTIES INDICATED IN THIS CERTIFICATE COMPLY WITH THE REQUIREMENTS OF THE SPECIFICATION INDICATED. THE RESULTS ON VALUES REPORTED HEREIN CAN NOT BE USED TO QUALIFY THE STEEL FOR ANY OTHER PURPOSES 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.

Date: 2013/03/06 Time: 08:05:31 Page no: 1 of 2

ACCEPTED/REVIEWED/TESTED BY: SAM OFFSHORE

for and on behalf of: SAM OFFSHORE

Print Name: KAARELL SAH **Applus**
 Signature: [Signature] **VELOSI**
 Date: Aug 22/13 **Velosi America LLC**



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

SO No., Item & Date:	8007677 000021 2013/02/22	Shipment No. & Date:	1000033668 2013/03/05	TC No., Date & Time:	ESA-53909 2013/03/06 - 06:21:28
Sold to Customer Name and Address:	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada	Ship to Customer Name and Address:	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada	Customer PO NO./Item:	19396-STK / 2
	L4W 2R6		L4W 2R6	BOL NO.:	1000033668
				Cust. Part No.:	
				Carrier:	LOCOMOTE SYSTEM INC - rta341 (89103) rev
Customer Specification:	HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (10) / ASME SA516 GR 70 (11A) Meets NACE MR 0103 latest Ed., NACE MR 0175 latest Ed., BHN < 200, Calcium Treated for Sulphide Stress Corrosion Normalized Temp 1670 °F 8 min CVNL Req. 15 / 12 FT-LBF at -50 °F Sid Thickness Tol PVQ Top and Bottom Standard Surface Flatness 1/2 A20 Latest Ed. - Addenda of ASME Fine Grain Fully Killed No Weld Repair				

Supplementary Instructions : Test Cert 1:drafting@canadianplate.com Test Cert 2: 905-206-1370


Insp TIR : Test Report As Per Spec

Customer Use : PVQ

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. 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)945-4095 FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.

MEETS EN 10204-2004 TYPE 3.1
ISO QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM

MECHANICAL PROPERTIES												
Impact Test	Batch No.	SRCE	LAB	GAUGE	COND	METH	DIR	LOC	SIZE	TEMP(°F)	FULLENERGY(ft·lbf)	FULL AVG(ft·lbf)
	4019P3	166"	ALG	0.2500	N	CVN	L	B	1/2	-50	75 73 68	72
	4019P3	166"	ALG	0.2500	N	CVN	L	B	1/2	-50	71 67 63	67
Tensile Test												
Batch No.	SRCE	LAB	GAUGE	COND	METH	DIR	LOC	YIELD(KSI)	TENSILE(KSI)	EL SCALE	ELONG(%)	
4019P3	166"	ALG	0.2500	N	2	T	B	56.0	77.0	8"	21	
4019P3	166"	ALG	0.2500	N	2	T	B	56.0	76.0	8"	23	



 AUG 20 2013

ACCEPTED/REVIEWED/RELEASED 046
 for and on behalf of: SRM OFF SHORE
 CLARESI SAHA
 Signature: *Clare Sah*
 Date: *July 23/13*
 Affplus®
 VELDOSI
 Velost America LLC



K. UGHADPAGA
MANAGER METALLURGICAL SERVICES

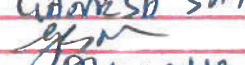
****WARNING**** THE TEST RESULTS AND VALUES REPORTED HEREIN INDICATE ONLY THAT (1) THE PARTICULAR STEEL FOR WHICH THIS CERTIFICATE IS ISSUED MEETS THE MINIMUM SPECIFIED YIELD STRENGTH AND (2) THE ANALYSIS AND PHYSICAL PROPERTIES OF SUCH STEEL ARE IN CONFORMANCE WITH THE REQUIREMENTS OF THE SPECIFICATION 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.

HI-TECH NDE INC

160-2 County Court Blvd. Suite # 205, Brampton, ON, L6W 4V1
 Tel: 416-473-8207 Fax-905-455-7844
 Email: n@hitechnde.com

ULTRASONIC INSPECTION REPORT

Client: Canadian Plate & Profiles Inc				Report No: 05/13			
PO #: 19945				Part Description: Plate			
WO #: 2427				Procedure: UT/GP/101			
Heat No: See below				Client Specifications: ASME Sec. V Art - 23, 2010 addenda 2011, SA578, Level- 'C'			
Material: SA516, Gr 70MT, NACE				Technique: 'A' Scan contact			
Thickness: See below				Cal. Block: IIW-1 & BW itself		SI. # -	
Surface: As Rolled/Rough				Couplant: Water		Batch # -	
Type of Fabrication: Plate				Time Base: As required			
Dwg. No: -				Gain: As Required			
Work Location: Kamato Road, Mississauga				Scanning Speed: 6" per sec.			
Customer: -				Test Date: Apr 24, 2013			
UT EQUIPMENT				TRANSDUCER			
Make		Model		Sl. #		CALIBRATION	
				Date		Valid	
Panametrics		Epoch-IV		03155409		Nov, 2012	
						Nov 2013	
						Angle	
						0°	
						Size	
						1"	
						Frequency	
						2.25 Mhz	
						Sl. #	
						43629	
Scope: To inspect the following plate for lamination scan before flame cut:							
QTY		SIZE				HEAT #	
1 Plate		0.2500" X 48" X 120" D/L 102" X 129"				4019P3-AC5977	
1 Plate		0.3750" X 120" X 304"				4582P3-AC7419	
1 Plate		0.5000" X 120" X 191"				4927P3-AD0156	
1 Plate		0.6250" X 120" X 289"				2259P3-AB6514	
1 Plate		0.7500" X 96" X 94" D/L 43"X179"				4582P3-AC7352	
1 Plate		1.0000" X 96" X 171" D/L 70"X79"				4582P3-AC7350	
1 Plate		1.2500" X 120" X 240"				1966P3-AB5386	
1 Plate		1.5000" X 120" X 288"				5441P3-AD1562	
1 Plate		2.0000" X 120" X 151"				5441P3-AD1559	
Results:							
1. 100% plate area scanned with normal probe.							
2. No reject able indication detected during inspection.							
3. The plates inspected meet the requirement of ASTM SA578, Level- 'C'.							
Total Parts Examined		Parts Accepted			Parts Rejected		
9		9			0		
Name & Signature of Inspector		Certification		Representative		Dated	
N. WRAICH 		CGSB Level-II- [√] SNT - Level-II [√] ACCP- Level-III [√]		Hi-Tech NDE Inc		Apr. 24, 2013	
CLIENT REPRESENTATIVE: 				Signature		Date	

ACCEPTED/REVIEWED/RELEASED		046
for and on behalf of: <u>SRM OFF SHORE</u>		
Print Name:	<u>CHANDRA SAHA</u>	Applus[®] VELOSI Velosi America LLC
Signature:		
Date:	<u>July 23/13</u>	

SO No., Item & Date: 8004571 000010 2012/10/27		Shipment No. & Date: 1000012968 2012/10/29		TC No., Date & Time: ESA-22183 2012/10/30 - 20:30:57					
Sold to Customer Name and Address: CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6		Ship to Customer Name and Address: CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6		Customer PO NO./Item: 18651-STK / 1 1000012968					
Customer Specification: HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (11A) / ASME SA516 GR 70 (11A) Meets NACE MR 0103 latest Ed., NACE MR 0175 latest Ed., BHN < 200, Calcium Treated for Sulphide Shape Control Normalized Temp 1670 °F 34 min CVNL Req. 15/12 FT-LBF at -50.0 F Sid Thickness Tol PVQ Top and Bottom Standard Surface Flatness 1/2 A20 Latest Ed. - Addenda of ASME Code section II part A applies Fine Grain Fully Killed No Weld Repair		Carrier: TRIPLE K TRANSPORT LTD - 35099 (250)							
Supplementary Instructions: Test Cert 1: drafting@canadianplate.com Test Cert 2: 905-206-1370									
Insp TR: Test Report As Per Spec									
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. 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)945-4095 FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.									
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.									
Dimensions (T x W x L)	Batch No.	Heat No-MS	Quantity	No. of Pcs	Dimensions (T x W x L)	Batch No.	Heat No-MS	Quantity	No. of Pcs
1,0000" x 120,000" x 480,00"	AB0907	0811P3-02	16,335 LB	1	1,0000" x 120,000" x 480,00"	AB0908	0811P3-54	16,335 LB	1
CHEMICAL PROPERTIES									
C	0.19	Mn	1.08	P	0.009	S	0.004	Si	0.330
Gr	0.05	Ni	0.16	Cu	0.04	Mo	0.01	Al	0.030
Nb	0.000	0.000	0.015	0.002	0.003	0.000	0.000	0.000	0.000
MECHANICAL PROPERTIES									
HARDNESS									
Heat No.	Batch No.	SRCE	LAB	GAUGE	COND	LOC	MTHD	HARDNESS	
0811P3	AB0907	166"	ALG	1,0000	N	B	HBW	153	
0811P3	AB0908	166"	ALG	1,0000	N	B	HBW	150	

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
 CU + Ni + CR + MO = 2.6
 CR + MO = 0.06

Certification of Material - Per ASME
 III # 0811P3-02
 Qualities to all requirements per SA516-GR 70
 Sect. II Edition II Addenda

W.O. # 11769
 M.L. # 36 (7/3)
 TRK. # 1
 P.O. # 13-0720

Q.C.I. N.D.

AUG 20 2013

K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

ACCEPTANCE OF THIS REPORT AND VALUES REPORTED HEREIN IMPLIES THAT (1) THE PARTICULAR STEEL FOR WHICH THIS CERTIFICATE IS ISSUED MEETS THE MINIMUM SPECIFIED YIELD STRENGTH AND (2) THE RESULTS OR VALUES REPORTED HEREIN CAN NOT BE USED TO QUALIFY THE STEEL FOR ANY SPECIFICATION OTHER THAN THE ONE SPECIFIED IN THIS CERTIFICATE. ANY SPECIFICATION OTHER THAN THE ONE SPECIFIED IN THIS CERTIFICATE SHALL NOT BE RELIED UPON FOR ANY PURPOSE (INCLUDING DESIGN OR CALCULATIONS) AS REPRESENTING THE ACTUAL STRENGTH OF SUCH STEEL.

Print Name: S B M O F S H
 Signature: [Signature]
 Date: Aug 23 2013
Appius
 VELOSI
 Velosi America LLC



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

SO No., Item & Date:	8004571 000010 2012/10/27	Shipment No. & Date:	1000012968 2012/10/29	TC No., Date & Time :	ESA-22183 2012/10/30 - 20:30:57								
Sold to Customer Name and Address :	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	Ship to Customer Name and Address:	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	Customer PO NO./Item:	18651-STK / 1								
				BOL NO.:	1000012968								
				Cust.Part No.:									
				Carrier :	TRIPLE K TRANSPORT LTD - 350999 (250								
Customer Specification :	HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (10) / ASME SA516 GR 70 (11A) Meets NACE MR 0103 latest Ed., NACE MR 0175 latest Ed., BHN < 200, Calcium Treated for Sulphide Shape Control Normalized Temp 1670 °F 34 min CVN1 Req 15 1/2 FT LBF at -50.0 F Std Thickness Tol PVQ, Top and Bottom Standard Surface Flatness 1/2 A20 Latest Ed. - Addenda of ASME Code section II part A applies Fine Grain Fully Killed No Weld Repair												
Supplementary Instructions :	Test Cert 1: drafting@canadianplate.com Test Cert 2: 905-206-1370												
Insp T/R :	Test Report As Per Spec												
	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.												
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	MEETS EN 10204 2004 TYPE 3.1												
	ISO QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM												
..... MECHANICAL PROPERTIES													
Impact Tests	Batch No.	SRCE	LAB	GAUGE	COND	METH	DIR	LOC	SIZE	TEMP(°F)	FULLENERGY(lb-ft)	FULL AVG(lb-ft)	
	0811P3	AB0907	166"	ALG	1.0000	N	CVN	L	B	FULL	-50	101 74 89	88
	0811P3	AB0908	166"	ALG	1.0000	N	CVN	L	B	FULL	-50	89 108 107	101
Tensile Tests	Batch No.	SRCE	LAB	GAUGE	COND	METH	DIR	LOC	YIELD(KSI)	TENSILE(KSI)	ELSCALE	ELONG(%)	
	0811P3	AB0907	166"	ALG	1.0000	N	.2	T	B	50.5	75.5	2"	36
	0811P3	AB0908	166"	ALG	1.0000	N	.2	T	B	50.0	77.0	2"	37

ACCBY P.D/R REVIEWED/RELEASED 046
 for and on behalf of: SBM OFF STORE
 Print Name: CA MESH SAKH
 Signature: [Signature]
 Date: Aug 23/13
Applus®
VELOSI
 Velosi America LLC

AUG 20 2013



K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

****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 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 RELEAED UPON FOR ANY PURPOSE (INCLUDING DESIGN OR CALCULATIONS) AS REPRESENTING THE ACTUAL STRENGTH OF SUCH STEEL.



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

SO No., Item & Date.: 8008924 000020 2013/03/15	Shipment No. & Date.: 1000038482 2013/03/29	TC No., Date & Time : ESA-60867 2013/03/30 - 08:47:26
Sold to Customer Name and Address : CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada	Ship to Customer Name and Address : CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada	Customer PO NO./Item: 19609-STK / 2 BOL NO.: 1000038482 CusLPart No.: Carrier : GBS & SONS TRUCKING LTD. - 413(1034)
Customer Specification : HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (11A) Meets NACE MR 0103 latest Ed., NACE MR 0175 latest Ed., BHN < 200, D.O.CEQ .43 max, Inclusion Shape Control Calcium Treated Normalized Temp 1670 °F 12 min CVNL Req. 15 / 12 FT-LBF at -50.0 °F Std Thickness Tol PVQ Top and Bottom Standard Surface Flatness 1/2 A20 Fine Grain Fully Killed L4W 2R6		

Supplementary Instructions : Test Cert 1: drafting@canadianplate.com Test Cert 2: 905-206-1370

Insp TIR : Test Report As Per Spec

Cust Use : PVQ

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. 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)945-4095 FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.

MEETS EN 10204:2004 TYPE 3.1
ISO QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM

Dimensions (T x W x L)	Batch No.	Heat No.-MS	Quantity	No. of Pcs	Dimensions (T x W x L)	Batch No.	Heat No.-MS	Quantity	No. of Pcs
0.3750" x 120.000" x 480.00"	AD0158	4927P3-04	12,252 LB	2	0.3750" x 120.000" x 480.00"	AD0159	4927P3-04	12,252 LB	2
0.3750" x 120.000" x 480.00"	AD0160	4927P3-52	12,252 LB	2					

Heat No. (wt%)	C	Mn	P	S	Si	Cr	Ni	Mo	Cu	Al	Nb	V	B	TI	DO
4927P3*	0.20	1.07	0.009	0.003	0.330	0.01	0.15	0.02	0.025	0.025	0.000	0.015	0.0002	0.003	0.39

..... MECHANICAL PROPERTIES

Heat No.	Batch No.	SRCE	LAB	GAUGE	COND	LOC	MTHD	HARDNESS
4927P3	AD0160	166"	ALG	0.3750	N	B	HBW	155
4927P3	AD0159	166"	ALG	0.3750	N	B	HBW	156
4927P3	AD0158	166"	ALG	0.3750	N	B	HBW	157

W.O. # 1176Q

M.L. # 57

THK. # 378

P.O. # 13-0720

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)

CU + Ni + CR + MO = 0.18

CR + MO = 0.1

Q.C.I. N.D.

Q.C.I. E.Y.

Certification of Material - Per ASME
 Hit # 4927P3-04
 Qualifies to all requirements of SASIBGRTON per Sect. II 10 Edition 11 Addenda

AUG 20 2013
 K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

SO No., Item & Date.: 8008924 000020 2013/03/15	Shipment No. & Date.: 1000038482 2013/03/29	TC No., Date & Time : ESA-60867 2013/03/30 - 08:47:26	Customer PO NO./Item: 19609-STK / 2
Sold to Customer Name and Address : CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6		Customer Name and Address: CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	
Customer Specification : HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (10) / ASME SA516 GR 70 (11A) Meets NACE MR 0103 latest Ed., NACE MR 0175 latest Ed., BHN < 200, D.O.CEQ. 43 max, Inclusion Shape Control Calcium Treated Normalized Temp 1670 F 12 min CVNL Req. 15 / 12 FT-LBF at -50.0 F Std Thickness Tol PVQ Top and Bottom Standard Surface Flatness 1/2 A20 Fine Grain Fully Killed		BOL NO.: 1000038482 Cust. Part No.: Carrier : GBS & SONS TRUCKING LTD. - 413(1034)	
Supplementary Instructions : Test Cert 1: drafting@canadianplate.com Test Cert 2: 905-206-1370			
Insp T/R : Test Report As Per Spec			
Cust Use : PVQ			
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. 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)945-4095 FOR INSTRUCTIONS ON METHOD OF DISPOSAL OF DOCUMENT.			
MEETS EN 10204:2004 TYPE 3.1 ISO QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM ***** MECHANICAL PROPERTIES *****			
Impact Tests			
Heat No.	Batch No.	SRCE LAB GAUGE COND METH DIR LOC SIZE	TEMP (°F) FULL ENERGY (ft-lbf) FULL AVG (ft-lbf)
4927P3	AD0160	166" ALG 0.3750 N CVN L B 3/4	-50 82 145 94 107
4927P3	AD0159	166" ALG 0.3750 N CVN L B 3/4	-50 89 87 89 88
4927P3	AD0158	166" ALG 0.3750 N CVN L B 3/4	-50 88 112 87 95
Tensile Tests			
Heat No.	Batch No.	SRCE LAB GAUGE COND METH DIR LOC YIELD(KSI) TENSILE(KSI) EL SCALE	ELONG(%)
4927P3	AD0160	166" ALG 0.3750 N .2 T B 55.0 77.0 8"	26
4927P3	AD0159	166" ALG 0.3750 N .2 T B 55.0 76.0 8"	24
4927P3	AD0158	166" ALG 0.3750 N .2 T B 53.0 75.0 8"	23

ACCEPTED REVIEWED/RELEASED
for and on behalf of: SBM OFF SHORE
Print Name: GANESH SAHA
Signature: [Signature]
Date: Aug 23/13

Applus®
VELOSI
Velosi America LLC



AUG 20 2013

K. UGHADPAGA
MANAGER METALLURGICAL SERVICES

****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 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.



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

SO No. Item & Date:	8005805 000020 2012/12/17	Shipment No. & Date:	1000021035 2012/12/17	TC No., Date & Time:	ESA-34474 2012/12/17 - 10:18:00
Sold to Customer Name and Address:	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	Ship to Customer Name and Address:	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	Customer PO NO./Item:	18926-STK/2 12729abc
Customer Specification:	HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (10) ASME SA516 GR 70 (11A) Meets NACE MR 0103, latest Ed. BHN < 200, Calcium Treated for Sulphide Shape Control Normalized Temp 1670 °F - 30 min per inch CVNL Req 13/12 F FLBF at -50.0 F Std Thickness 101 PVQ Top and Bottom Standard Surface Flatness 1/2 A20 Fine Grain Fully Killed No Weld Repair	Carrier:	LOCOMOTE SYSTEM INC -		

Supplementary Instructions: Test Cert 1: drafting@canadianplate.com Test Cert 2: 905-206-1370

Insp T/R: Test Report As Per Spec

Cust Use: PVQ

MEETS EN 10204 2004 TYPE 31
 ISO QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM

ALL HEATS FULLY KILLED
 HEATS INDICATED WITH (C) FINE GRAINED
 HEATS INDICATED WITH (L) MADE IN CANADA WITH DOMESTIC AND NORTH AMERICAN MATERIALS

Dimensions (I x W x L)	Batch No.	Heat No.-MS	Quantity	Pcs
1 5000" x 120 000" x 480 00"	AB5383	1966P3-04	24,503 LB	1

Heat No. (wt.%)	C	Mn	P	S	Si	Cr	Ni	Cu	Mo	Al	Nb	V	B	Ti	DD
1966P3	0.20	1.10	0.010	0.006	0.330	0.03	0.15	0.03	0.01	0.039	0.000	0.014	0.0003	0.002	0.4100

Heat No.	SRCE	LAB	GAUGE	COND	LOC	MTHD	HARDNESS
1966P3	AB5383	166"	ALG	1.5000	NORM	B	HBW

Heat No.	SRCE	LAB	GAUGE	COND	METH	DIR	LOC	SIZE	TEMP (°F)	ENERGY (ft-lbf)	ENERGY AVG (ft-lbf)	
1966P3	AB5383	166"	ALG	1.5000	NORM	CVN	L	B	FULL	-50	83.79	83

LIMITS OF UNSPECIFIED ELEMENTS PER ASME SECTION II (SA-20)
 CU + Ni + CR + MO = **0.22**
 CR + MO = **0.04**

W.O. # **11769**
 M.L. # **58(9/13)**
 THK. # **1 1/2"**
 P.O. # **13-0720**

Q.C.I. E.Y.
 Q.C.I. N.D.

K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

AUG 20 2012

WARNING: THE TEST RESULTS AND VALUES INDICATED HEREIN INDICATE ONLY THAT (1) THE PARTICULAR STEEL FOR WHICH THE CERTIFICATE IS ISSUED MEETS THE MINIMUM SPECIFIED YIELD STRENGTH AND (2) THE ANALYSIS AND PHYSICAL PROPERTIES OF SAAS STEEL MEET THE REQUIREMENTS OF THE SPECIFICATION. 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 ALTERED FOR ANY OTHER USE (INCLUDING DESIGN OR CALCULATION) AS REPRESENTING THE ACTUAL STRENGTH OF SUCH STEEL.

for and on behalf of: **SBM OFFSHORE**
CHANDRESH SAHA
 Signature: *[Signature]*
 Date: **12/17/13**

Print Name: **Applus® VELOSI**
 Signature: *[Signature]*
 Date: **12/17/13**

CR + MO = **0.04**

Page no.1 of 2



ESSAR STEEL ALGOMA INC., 105 West Street, Sault Ste. Marie, Ontario, Canada P6A 7B4

SO No., Item & Date:	8005805 000020 2012/12/17	Shipment No. & Date:	1000021035 2012/12/17	TC No., Date & Time:	ESA-34474 2012/12/17 - 10:18:00						
Sold to Customer Name and Address:	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	Ship to Customer Name and Address:	CANADIAN PLATE AND PROFILES IN KAMATO ROAD 920 MISSISSAUGA, Ontario, Canada L4W 2R6	Customer PO NO./Item:	18926-STK / 2						
Customer Specification:	HR STEEL PLATE Carbon Multi Cert ASTM A516 GR 70 (11A) Meets NACE MR 0175 latest Ed., NACE MR 0175 latest Ed., BHN < 200, Calcium Treated for Sulfides Sulfide Control, Normalized, Flatness 1/2 A20 Fine Grain Fully Killed No Weld Repair			BOL NO.:	12729abc						
				Cust. Part No.:	LOCOMOTE SYSTEM INC.						
				Carrier:							
Supplementary Instructions:	Test Cert 1: draft@canadianplate.com Test Cert 2: 905-206-1370										
Insp T/R:	Test Report As Per Spec			Cust Use:	PVQ						
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 RESULT IS ARE RETAINED IN ACCORDANCE WITH THE COMPANY'S STANDARD RECORD KEEPING PRACTICES. 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)945-4095 FOR INSTRUCTIONS ON METHOD OF DISPOSAL.											
MEETS EN 10204 2004 TYPE 3.1 ISO QUALITY AND ENVIRONMENTAL CERTIFICATES AVAILABLE AT WWW.ESSARSTEELALGOMA.COM											
MECHANICAL PROPERTIES											
Tensile Tests	SRCE	LAB	GAUGE	COND	METH	DIR	LOC	YIELD(KSI)	TENSILE(KSI)	EL SCALE	ELONG(%)
1966P3	166"	ALG	1.5000	NORM	2	T	B	48	77	2"	33

ACCEPTED / REVIEWED / RELEASED 046
 for and on behalf of: SBM OFF SHORE
 Print Name: WALTER SHAMH
 Signature: [Signature]
 Date: Aug 23/13
APPLIUS®
VELOSI
 Velosi America LLC

Q.C.I. E.Y.
 AUG 20 2013
 Q.C.I. N.D.

K. UGHADPAGA
 MANAGER METALLURGICAL SERVICES

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

Benteler Steel/Tube GmbH
 Postfach 13 40
 33043 Paderborn
 Deutschland
 Tel.: + 49.5254.61-0 Fax: + 49.5254.13666

BENTELER
 Steel/Tube

ABNAHMEPRÜFZEUGNIS EN 10204-3.1
 INSPECTION CERTIFICATE EN 10204-3.1
 CERTIFICAT DE RECEPTION EN 10204-3.1
 EN 10204:2005-01

Benteler Steel/Tube GmbH - Postfach 1340 - 33043 Paderborn - Deutschland
 COMCO PIPE & SUPPLY CO.
 R.R. # 3
 GUELPH, ON N1H 6H9
 CANADA

Dokument-Nr.: 65-714417/001/P

Document No.:
 No. du document:

Kunden-Bestell-Nr.:
 Purchase Order No.:
 No. de commande du client:

Benteler Auftrags-Nr.: 1577798
 Benteler Order No.:
 No. de commande Benteler:

Versandanzeigen-Nr.: 6570440
 Dispatch Note No.:
 No. d'avis d'expédition:

Produkt: NAHTLOSE STAHLROHRE
 Product: SEAMLESS STEEL TUBES
 Product: TUBES D'ACIER SANS SOUDURE

Prüf-Nr.:
 Inspection No.:
 No. du certificat:

Hersteller:
 Manufacturer:
 Producteur:
 Warmrohrwerk Dinslaken
 (DIN EN ISO 9001, ISO/TS-16949 CERTIFIED BY TÜV NORD CERT)
 (PED 37/23/EC CERTIFIED BY TÜV NORD SYSTEMS)

Herstellerzeichen:
 Manufacturer's brand:
 Marque du producteur:

Stempel des Abnahmebeauftragten: WA
 Stamp of the inspection representative:
 Poignon du contrôleur:

Stahlschmelzungsverfahren:
 Steelmaking process:
 Procédé d'élaboration de l'acier: ELKTROSTAHL
 ELECTRIC FURNACE
 FOUR ELECTRIQUE

Lieferbedingungen:
 Terms of delivery:
 Conditions de livraison:

ASME SA-106, ASME Section II Part A Edition 2010 Addenda 2011a, S6, ASTM-A 106-2011, S6, ASTM-A 333-2010-HF, ASME SA-333-HF, ASME Section II Part A Edition 2010 Addenda 2011a, CSA Standard Z245.1-07 Category II, Sour Service, ANSI/NACE MR0175/ISO 15156-1: 2009, ANSI/NACE MR0175/ISO 15156-2: 2009

Maße - Toleranzen:
 Dimensions-tolerances:
 Dimensions-tolerances:

ASME B36.10M-2004, ASME SA-999 ASME Section II Part A Edition 2010, ASTM-A 999-2011

Stahlsorte:
 Steel grade:
 Nuance d'acier:

GRADE 6, GRADE B, GRADE C, GRADE 359

Lieferzustand:
 Delivery condition:
 État de livraison:

Normalized

Produktkennzeichnung:
 Product marking:

FS: BENTELER Z.245.1 - A/SA-333 - A/SA 106 6/359/B/C CATEGORIE 2 HEAT-NO. M45C SS SMLS HN
 DIMENSIONS SCHEDULE WA GERMANY PO NO G1-3426

Marquage du produit:
 AEZ = Ätzmitrbeschriftung, Etching ink marking, Gravure à l'encre · FK = Farbkennzeichnung, colour marking, marquage par couleur · FS = Farbschablonierung, paint stencilling, marquage par poitrine · FSD = Farbstrahldrucker, Colour jet printer, imprimante à jet d'encre de couleur · LK = Laserkennzeichnung, Laser marking, Marquage laser · PKE = Etikettenkennzeichnung, tag marking, marquage sur étiquette · PS = Prägestempel, die stamp, marquage par polychromage · TS = Tintenstrahlkennzeichnung, ink jet spray marking, imprimante à jet d'encre

Pos. / Item / Poste	Stück / Number / Nombre	Maße / Dimensions / Dimensions	Länge / Length / Longueur	Gewicht / Weight / Poids	Schmelzen-Nr. / Heat No. / No. de coulée	Prüfdruck / Test pressure / Pression d'épreuve	Rohr-Nr.-Gruppe / Tube number group / Série de no. des tubes	Vielfachlängen / Multiple lengths / Longueurs multiples
			feet	lbs	PSI			
0004 66		2" NPS * Sched. 160 20 FT - 22 FT	1444,88	10935	573636	3000	5	5

ACCEPTED/RECEIVED/RELEASED
 for and on behalf of:
 BENTELER SA
 GERMANY
 Date: 08/20/13
 Signature: [Handwritten]
 Print Name: [Handwritten]
 Velos America LLC

Q.C.I.
 E.Y.
 Q.C.I.
 N.D.

AUG 20 2013

BENTELER
 Steel/Tube

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

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Schmelzenanalyse [%] / Heat analysis [%] / Analyse sur coulée [%]

Pos.	Schmelzen-Nr.	C	SI	MN	P	S	CR	MO	NI	CU	V	NB	TI	B
0004	573636	0,150	0,220	1,17	0,008	0,002	0,09	0,02	0,07	0,09	0,038	0,013	0,002	0,0001

1. Formel: $CE_{IIV} = C + (Mn/6) + ((Cr + Mo + V)/5) + ((Cu + Ni)/15) < = 0,45 \%$
2. Formel: $CE_V = C + F^* ((Mn/6) + (Si/24) + (Cu/15) + (Ni/20) + ((Cr + Mo + V + Nb)/5) + (5 * B)) < = 0,40$
3. Formel: $Mn/C > = 3/1$
4. Formel: $Cr + Cu + Mo + Ni + V < = 1,00 \%$

W.O. # 11760
 M.L. # 64(10/2)
 THK. # 342
 P.O. # 13-6798

Formelergbnisse / Formula results / Résultats des formules

Pos.	Schmelzen-Nr.	1. Formel	2. Formel	3. Formel	4. Formel
0004	573636	0,385	0,367	7,800	0,308

Produktanalyse [%] / Product analysis [%] / Analyse sur produit [%]

Pos.	Schmelzen-Nr.	C	SI	MN	P	S	CR	MO	NI	CU	V	NB	TI	B
0004	573636	0,150	0,210	1,17	0,008	0,003	0,08	0,02	0,08	0,08	0,038	0,014	0,002	0,0001

1. Formel: $CE_{IIV} = C + (Mn/6) + ((Cr + Mo + V)/5) + ((Cu + Ni)/15) < = 0,45 \%$
2. Formel: $CE_V = C + F^* ((Mn/6) + (Si/24) + (Cu/15) + (Ni/20) + ((Cr + Mo + V + Nb)/5) + (5 * B)) < = 0,40$
3. Formel: $Mn/C > = 3/1$
4. Formel: $Cr + Cu + Mo + Ni + V < = 1,00 \%$

Certification of Material Per ASME
 HT# 573636
 Qualified to all requirements of
 SA 333-GR6
 Sect. II 16 Edition II Addenda

AUG 24 2013

Q.C.I. Exp.

Q.C.I. N.D.

Formelergbnisse / Formula results / Résultats des formules

Pos.	Schmelzen-Nr.	1. Formel	2. Formel	3. Formel	4. Formel
0004	573636	0,383	0,365	7,800	0,298

ACCEPTED/REVIEWED/RELEASED 046
 for and on behalf of: SIZM OFFSHORE
 Print Name: GAMBESH SAH A
 Signature: [Signature]
 Date: 08/23/13
Applus
 VELOSI
 Velosi America LLC



Steel/Tube

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

Prüfergebnisse / Test results / Résultats des essais

PASSED

Die Röhre sind auf Dichtheit geprüft durch:
 The tubes have been submitted to a leak tightness test by:
 Les tubes ont passé un contrôle d'étanchéité par:

PASSED

Die Röhre wurden zerstörungsfrei geprüft:
 The tubes are non destructive tested:
 Les tubes ont passé un essai non destructif:

PASSED

Augensichtkontrolle:
 Visual inspection:
 Examen visuel:
 Biegeversuch:
 Bending test:
 Essai de cintrage:
 Maßkontrolle:
 Dimensions examination:
 Vérification des dimensions:

PASSED

Q.C.I.
 N.D.

PASSED

Ringfaltversuch:
 Flattening test:
 Essai d'aplatissement:

Ergebnisse der mechanischen Prüfung / Results of mechanical testing / Résultats des essais mécaniques

Die Probenahme erfolgte an Vielfachlängen.
 The sampling was carried out on multiple lengths.
 L'échantillonnage était réalisé aux longueurs multiples.

Zugversuch längs Streifenprobe / Tensile test longitudinal Strip test specimen / Essai de traction longitudinale Bande découpée sur tube

Pos.	Proben-Nr.	Schmelzen-Nr.	Probenabmessung	Streckgrenze	Zugfestigkeit	Dehnung	Einschnürung
Item	Specimen No.	Heat No.	Specimen dimensions	Yield strength	Tensile strength	Elongation	Area reduction
Poste	No. de l'éprouvette	No. de coulée	Dimensions de l'éprouv.	Limite élastique	Résistance à la traction	Allongement	Coefficient de striction
Anforderungen			ReH	Rm		1. Formel	
Requirements			PSI	PSI	%	1. Formula	
Exigences			52069-76870	65992-90649	MIN 30	1. Formule	
0004	000001	573636	19,00 X 9,30	53664	73389	40	
0004	000002	573636	19,00 X 8,40	52939	74114	38	
0004	000003	573636	19,00 X 8,40	52939	73534	38	
0004	000004	573636	19,00 X 8,70	52359	72519	40	

Q.C.I.
 E.Y.

AUG 20 2013

046
 ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SBM OFFSHORE
 Print Name: GRANESH SAHA
 Signature: [Signature]
 Date: Aug 23/13
APIUS®
VELOSI
 Velosi America LLC

AUG 20 2013



Steel/Tube

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ABNAHMEPRÜFZEUGNIS EN 10204-3.1
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Benteler Steel/Tube GmbH
 Postfach 13 40
 33043 Paderborn
 Deutschland
 Tel.: + 49.5254.81-0 Fax: + 49.5254.13666

Härteprüfung / Hardness test / Essai de dureté

Pos.	Proben-Nr.	Schmelzen-Nr.	Härte	HB	HV	HRB	HBW
Item	Specimen No.	Heat No.	Hardness				
Poste	No. de l'éprouv.	No. de coulée	Dureté				
Anforderungen				HRC			
Requirements							
Exigences				MAX 200			
0004	000001	573636		144			
0004	000002	573636		146			
0004	000003	573636		143			
0004	000004	573636		145			

Kerbschlagbiegeversuch Notched bar impact test / Essai de flexion par choc (résilience) [1 CHARPY_V]

Pos.	Proben-Nr.	Schmelzen-Nr.	Probenabmessung	Probenlage	Prüftemperatur	Kerbschlagarbeit	Laterale Breitung	Verf.-Bruchanteil
Item	Specimen No.	Heat No.	Specimen dimensions	Specimen position	Test temperature	Absorbed energy	Lateral expansion	Shear fracture
Poste	No. de l'éprouv.	No. de coulée	Dimensions de l'éprouvette	Position de l'éprouvette	Température d'essai	Energie absorbée	Expansion latérale	Rupture ductile
Anforderungen	Länge	Breite	Höhe	längs (L)	einzel	mittel	single	average
Requirements	Length	Width	Height	longitudinal (L)	single	average	single	average
Exigences	Longueur	Largueur	Hauteur	longitudinal (L)	individuelle	moyenne	individuelle	moyenne
0004	000001	573636	55	7,50	10,00	1,83	1,42	80
			55	7,50	10,00	1,91	1,42	80
			55	7,50	10,00	1,83	1,42	80

Wärmebehandlung / Heat treatment / Traitement thermique

Rolling temperature: 870°C - 1.000°C / Cooling: Air

Restmagnetismus / Demagnetize / Démagnétiser

demagnetized tubes; 1 measurement per 4 hours on both tube ends Two readings 180° apart around the circumference. Average value
 max 3.0 Millitesla (24 A/cm), individual value max 3.5 Millitesla (28 A/cm)

ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SAM OF SAHARA
 Print Name: WABRESII SAHA
 Signature: [Signature]
 Date: Aug 23/13

APPLIUS® VELOS!
 Velosi America LLC

BENTELER
 Steel/Tube

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ABNAHMEPRÜFZEUGNIS EN 10204-3.1
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Benteler Steel/Tube GmbH
 Postfach 13 40
 33043 Paderborn
 Deutschland
 Tel.: + 49-5254-81-0 Fax: + 49-5254-13666

Vermerk / Remark / Remarque

NACE Standard: Hardness acc. to ANSI/NACE MR0175/ISO 15156: HRC max 22., The material meets the requirements of NACE MR0103, Region 3, in accordance to Figure 1 and Appendix A.2, ANSI/NACE MR0175/ISO 15156-2:2009; Certificate remarks: Sour Service, The Material is Aluminium deoxidized and inclusion shape controlled with Calcium-Silicon treatment, it is the end user's responsibility to ensure that all environmental requirements as well as the requirements regarding engineering, construction and operation of facilities are fulfilled in the country of use. Fit for purpose of the parts as well as homologation is not the scope of this contract., This is to confirm that the seamless linepipe supplied by Benteler and verified to CSA Standard Z245.1-07 meets the requirement for micro hardness of max. 248 HV 500 gf., No weld repair has been carried out; Bend test: mandrel diameter 12D; Bending angle: 90°
 Grain size: acc. to ASTM-E 112, Grain size 6 and finer

Verkäufer(in) / Salesman/ woman in charge / Personne chargée : Mrs Schöneweis, Tel.: 05254/81-4234, Fax: 4289

046
 ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SBM OFFSHORE
 Print Name: GABRIEL SAHIT **Applus®**
 Signature: [Signature] **VELOSI**
 Date: Aug 23/13 **Velosi America LLC**



Abnahmebeauftragter
 Inspection representative

Contrôleur

DR. BASEL KEITA / Thei

Dinslaken, 17.09.2012, TEL.: 02064.623-537 FAX: 02064.623-539

Es wird bestätigt, daß die gelieferten Erzeugnisse den techn. Lieferbedingungen des Auftrages entsprechen. Dieses Dokument wurde mittels EDV erstellt und ist ohne Unterschrift rechtsgültig.
 We certify that the supplied products comply with the order specification. This document was prepared by means of electronic data processing and is valid without signature.
 Nous attestons que les produits livrés sont conformes aux stipulations de la commande. Ce document a été établi par traitement électronique de l'information et est valide sans signature.

Sold To: SALIT STEEL SERVICE CENTRE
 DIVISION OF MYER SALIT LTD
 PO BOX 837
 NIAGARA FALLS ON L2E 6V6
 CANADA
 (905) 354-5691

Ship To: SALIT STEEL PP - NF
 7771 STANLEY AVE
 NIAGARA FALLS ON L2E 6V6
 CANADA
 (905) 354-5691
 Fax: (905) 356-0809

Customer P.O.	46911	Sales Order	296351.5
Product Group	Merchant Bar Quality	Part Number	2020025024004W0
Grade	A36/A529gr50/CSA44W/50W	Lot #	AU1310159402
Size	2x2x1/4 Angle	Heat #	AU13101594
Product	2x2x1/4 Angle 20' A36/A52950/CSA44W/50W	B.L. Number	Y1-423553
Description	A36/A529gr50/CSA44W/50W	Load Number	Y1-170457
Customer Spec		Customer Part #	

I hereby certify that the material described herein has been manufactured in accordance with the specifications and standards listed above and that it satisfies those requirements.

Roll Date: 4/5/2013 Melt Date: 3/18/2013 Qty Shipped LBS: 15,504 Qty Shipped Pcs: 243

ASTM A36/A36M-08, A709/709M-11 GR36, ASME SA36-10 Ed '11 Ad.
 ASME SA36-2007 EDITION-2011 ADDENDA
 ASTM A709/A709M-11 GR 36 [250]

C	Mn	P	S	Si	Cu	Ni	Cr	Mo
0.14%	0.91%	0.016%	0.032%	0.13%	0.32%	0.10%	0.13%	0.022%

Yield 1: 54,500psi (376MPa) Tensile 1: 75,800psi (523MPa) Elongation: 30.1% in 8"(% in 203.3mm)
 Yield 2: 53,900psi (372MPa) Tensile 2: 75,800psi (523MPa) Elongation 30.9% in 8"(% in 203.3mm)

Specification Comments: MEETS OR EXCEEDS THE REQUIREMENTS OF ASTM A36/A36M-08, A529/A529-05 GR50(345), A709/A709M-10 GR36(250), A709 GR50(345) CSA G40.21-04 GR44W(300W)&GR50W(350W) AASHTO M270/270M-10 GR36(270) ASME SA36/SA36M-10

ALL MANUFACTURING PROCESSES OF THE STEEL MATERIALS IN THIS PRODUCT, INCLUDING MELTING, HAVE OCCURRED WITHIN THE UNITED STATES. ALL PRODUCTS PRODUCED ARE WELD FREE. MERCURY, IN ANY FORM, HAS NOT BEEN USED IN THE PRODUCTION OR TESTING OF THIS MATERIAL.

W.O. # 11760
 M.L. # 67(37,47,9,17,17)
 THK. # 250
 P.O. # 13-0768

Certification of Material - Per ASME
 HT# AU13101594
 Qualifies to all requirements of
 SA 36 per
 Sect. II 10 Edition 11 Addenda

Q.C.I.
 N.D.

AUG 24 2013

ACCEPTED/REVIEWED/RELEASED
 for and on behalf of: SBM OFFSHORE 046
 Print Name: GARRETT SAHJ
 Signature: [Signature]
 Date: Aug 23/13
 Applus® VELOSI
 Velosi America LLC

[Signature]

Jim Blernat
 Division Metallurgist

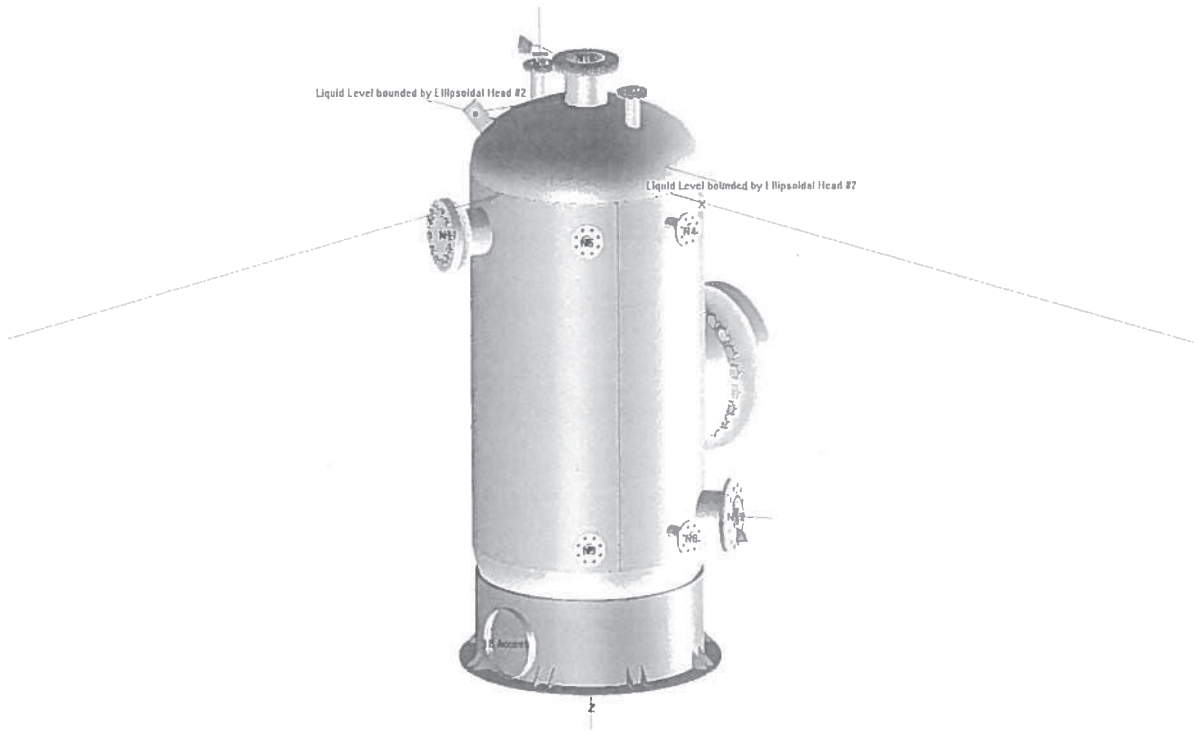
ALL-WELD COMPANY LIMITED

49 Passmore Avenue,

Toronto, Ontario,

Canada M1V 4T1

www.allweld.ca



COMPRESS Pressure Vessel Design Calculations

Item: 60" ID Vertical Carbon Steel H₂S Contactor
Vessel No: 772-VECO-102 and 202
Customer: Ultrafab Industries Limited
Designer: Todd Clark, P. Eng.
Date: Tuesday, July 16, 2013



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26. Diff press Low (N8)
27. Inspection Nozzle (N11)
28. Inlet Nozzle (N12)
29. Manway (N13)
30. Straight Flange on 60 ID BOTTOM SE HEAD
31. 60 ID BOTTOM SE HEAD
32. Bottom Drain (N1)
33. 63-1/4" OD Skirt
34. Tail lug
35. Skirt Base Ring
36. Liquid Level bounded by Ellipsoidal Head #2



Nozzle Schedule

Nozzle mark	Service	Size	Materials		Impact Tested	Normalized	Fine Grain	Flange	Blind
<u>N1</u>	Bottom Drain	NPS 2 Sch 160	Nozzle	SA-333 1 Wld & smts pipe	No	No	No	NPS 2 Class 900 WN A350 LF2	No
<u>N10</u>	Outlet	11.75 OD x 1.875	Nozzle	SA-350 LF2 Cl 1	No	No	No	NPS 8 Class 900 LWN A350 LF2 Cl.1	No
<u>N11</u>	Inspection Nozzle	11.75 OD x 1.875	Nozzle	SA-350 LF2 Cl 1	No	No	No	NPS 8 Class 900 LWN A350 LF2 Cl.1	NPS 8 Class 900 A350 LF2 Cl.1
<u>N12</u>	Inlet Nozzle	11.75 OD x 1.875	Nozzle	SA-350 LF2 Cl 1	No	No	No	NPS 8 Class 900 LWN A350 LF2 Cl.1	No
<u>N13</u>	Manway	35 OD x 5.5	Nozzle	SA-350 LF2 Cl 1	No	No	No	NPS 24 Class 900 V2 A350 LF2 Cl.1	NPS 24 Class 900 A350 LF2 Cl.1
<u>N2</u>	Purge	4.12 OD x 1.06	Nozzle	SA-350 LF2 Cl 1	No	No	No	NPS 2 Class 900 LWN A350 LF2 Cl.1	No
<u>N3</u>	Level Bridal Low	4.12 OD x 1.06	Nozzle	SA-350 LF2 Cl 1	No	No	No	NPS 2 Class 900 LWN A350 LF2 Cl.1	No
<u>N4</u>	Diff Press High	4.12 OD x 1.06	Nozzle	SA-350 LF2 Cl 1	No	No	No	NPS 2 Class 900 LWN A350 LF2 Cl.1	No
<u>N5</u>	Level Bridal High	4.12 OD x 1.06	Nozzle	SA-350 LF2 Cl 1	No	No	No	NPS 2 Class 900 LWN A350 LF2 Cl.1	No
<u>N6</u>	Fill/ Water Flush	4.12 OD x 1.06	Nozzle	SA-350 LF2 Cl 1	No	No	No	NPS 2 Class 900 LWN A350 LF2 Cl.1	No
<u>N7</u>	Vent	4.12 OD x 1.06	Nozzle	SA-350 LF2 Cl 1	No	No	No	NPS 2 Class 900 LWN A350 LF2 Cl.1	No
<u>N8</u>	Diff press Low	4.12 OD x 1.06	Nozzle	SA-350 LF2 Cl 1	No	No	No	NPS 2 Class 900 LWN A350 LF2 Cl.1	No
<u>N9</u>	Corrosion Coupon	5 OD x 1	Nozzle	SA-350 LF2 Cl 1	No	No	No	NPS 3 Class 900 LWN A350 LF2 Cl.1	No

Nozzle Summary

Nozzle mark	OD (In)	t _n (In)	Req t _n (In)	A ₁ ?	A ₂ ?	Shell			Reinforcement Pad		Corr (In)	A / A _r (%)
						Nom t (In)	Design t (In)	User t (In)	Width (In)	t _{pad} (In)		
<u>N1</u>	2.375	0.344	0.2969	Yes	Yes	2.491*	N/A		N/A	N/A	0.125	Exempt
<u>N10</u>	11.75	1.875	0.5057	Yes	Yes	2.491*	1.9983		N/A	N/A	0.125	109.5
<u>N11</u>	11.75	1.875	0.5501	Yes	Yes	2.5	2.2916		N/A	N/A	0.125	101.6
<u>N12</u>	11.75	1.875	0.5501	Yes	Yes	2.5	2.2965		N/A	N/A	0.125	101.1
<u>N13</u>	35	5.5	1.3828	Yes	Yes	2.5	2.2952		N/A	N/A	0.125	110.3
<u>N2</u>	4.12	1.06	0.3324	Yes	Yes	2.5	N/A		N/A	N/A	0.125	Exempt
<u>N3</u>	4.12	1.06	0.3324	Yes	Yes	2.5	N/A		N/A	N/A	0.125	Exempt
<u>N4</u>	4.12	1.06	0.3324	Yes	Yes	2.5	N/A		N/A	N/A	0.125	Exempt
<u>N5</u>	4.12	1.06	0.3324	Yes	Yes	2.5	N/A		N/A	N/A	0.125	Exempt
<u>N6</u>	4.12	1.06	0.3324	Yes	Yes	2.5	N/A		N/A	N/A	0.125	Exempt
<u>N7</u>	4.12	1.06	0.3324	Yes	Yes	2.491*	2.491		N/A	N/A	0.125	136.5
<u>N8</u>	4.12	1.06	0.3324	Yes	Yes	2.5	N/A		N/A	N/A	0.125	Exempt
<u>N9</u>	5	1	0.3508	Yes	Yes	2.491*	2.3917		N/A	N/A	0.125	100.0

t_n: Nozzle thickness

Req t_n: Nozzle thickness required per UG-45/UG-16

Nom t: Vessel wall thickness

Design t: Required vessel wall thickness due to pressure + corrosion allowance per UG-37

User t: Local vessel wall thickness (near opening)

A_a: Area available per UG-37, governing condition

A_r: Area required per UG-37, governing condition

Corr: Corrosion allowance on nozzle wall

* Head minimum thickness after forming

Pressure Summary

Pressure Summary for Chamber bounded by 60 ID BOTTOM SE HEAD and 60 ID TOP SE HEAD

Identifier	P Design (psi)	T Design (°F)	MAWP (psi)	MAEP (psi)	T _e external (°F)	MDMT (°F)	MDMT Exemption	Impact Tested
<u>60 ID TOP SE HEAD</u>	1,378	140	1,566.92	750.1	140	-32.9	Note 1	Yes
<u>Straight Flange on 60 ID TOP SE HEAD</u>	1,378	140	1,572.94	876.28	140	-32.9	Note 2	Yes
<u>60 ID SHELL</u>	1,378	140	1,501.48	838.94	140	-28.6	Note 3	Yes
<u>Straight Flange on 60 ID BOTTOM SE HEAD</u>	1,378	140	1,569.04	876.28	140	-32.7	Note 5	Yes
<u>60 ID BOTTOM SE HEAD</u>	1,378	140	1,562.35	750.1	140	-32.7	Note 4	Yes
<u>Bottom Drain (N1)</u>	1,378	140	1,378	750.1	140	-55	Note 6	No
<u>Outlet (N10)</u>	1,378	140	1,378	750.1	140	-55	Note 7	No
<u>Inspection Nozzle (N11)</u>	1,378	140	1,378	838.94	140	-55	Note 7	No
<u>Inlet Nozzle (N12)</u>	1,378	140	1,378	838.94	140	-55	Note 7	No
<u>Manway (N13)</u>	1,378	140	1,378	838.94	140	-55	Note 8	No
<u>Purge (N2)</u>	1,378	140	1,378	838.94	140	-55	Note 7	No
<u>Level Bridal Low (N3)</u>	1,378	140	1,378	838.94	140	-55	Note 7	No
<u>Diff Press High (N4)</u>	1,378	140	1,378	838.94	140	-55	Note 7	No
<u>Level Bridal High (N5)</u>	1,378	140	1,378	838.94	140	-55	Note 7	No
<u>Fill Water Flush (N6)</u>	1,378	140	1,378	838.94	140	-55	Note 7	No
<u>Vent (N7)</u>	1,378	140	1,378	750.1	140	-55	Note 7	No
<u>Diff press Low (N8)</u>	1,378	140	1,378	838.94	140	-55	Note 7	No
<u>Corrosion Coupon (N9)</u>	1,378	140	1,378	718.17	140	-55	Note 7	No

Chamber design MDMT is -20 °F

Chamber rated MDMT is -28.6 °F @ 1,378 psi

Chamber MAWP hot & corroded is 1,378 psi @ 140 °F

This is due to the MAWP limit set in the Calculations tab of the Set Mode dialog.

Chamber MAEP is 718.17 psi @ 140 °F

Vacuum rings did not govern the external pressure rating.

Notes for Maximum Pressure Rating:

Note #	Details
1.	Option to calculate MAP was not selected. See the Calculation->General tab of the Set Mode dialog.

Notes for MDMT Rating:

Note #	Exemption	Details
1.	<u>Straight Flange</u> governs MDMT	
2.	Material is impact tested per UG-84 to -20 °F	UCS-66(i) reduction of 12.9 °F applied (ratio = 0.8707).
3.	Material is impact tested per UG-84 to -20 °F	UCS-66(i) reduction of 8.6 °F applied (ratio = 0.9144).
4.	<u>Straight Flange</u> governs MDMT	
5.	Material is impact tested per UG-84 to -20 °F	UCS-66(i) reduction of 12.7 °F applied (ratio = 0.8733).
6.	Nozzle is impact tested to -50 °F with an additional 5 °F reduction per UCS-66(g)	UCS-66 governing thickness = 0.301 in.
7.	Flange rating governs:	UCS-66(b)(1)(b)
8.	Nozzle is impact tested to -50 °F with an additional 5 °F reduction per UCS-66(g)	UCS-66 governing thickness = 2.5 in.

Design notes are available on the [Settings Summary](#) page.

Settings Summary

COMPRESS 2013 Build 7320

Units: U.S. Customary

Datum Line Location: 0.00" from top seam

Design

ASME Section VIII Division 1, 2010 Edition, A11 Addenda

Design or Rating:	Get Thickness from Pressure
Minimum thickness:	0.0625" per UG-16(b)
Design for cold shut down only:	No
Design for lethal service (full radiography required):	Yes
User has limited MAWP to:	1,378 psi
Design nozzles for:	Vessel MAWP
Corrosion weight loss:	100% of theoretical loss
UG-23 Stress Increase:	1.20
Skirt/legs stress increase:	1.3
Minimum nozzle projection:	4"
Juncture calculations for $\alpha > 30$ only:	Yes
Preheat P-No 1 Materials $> 1.25"$ and $\leq 1.50"$ thick:	No
UG-37(a) shell tr calculation considers longitudinal stress:	No
Butt welds are tapered per Figure UCS-66.3(a).	

Hydro/Pneumatic Test

Shop Hydrotest Pressure:	1.3 times vessel MAWP
Test liquid specific gravity:	1.00
Maximum stress during test:	90% of yield

Required Marking - UG-116

UG-116(e) Radiography:	RT1
UG-116(f) Postweld heat treatment:	HT

Code Cases/Interpretations

Use Code Case 2547:	No
Apply interpretation VIII-1-83-66:	Yes
Apply interpretation VIII-1-86-175:	Yes
Apply interpretation VIII-1-01-37:	Yes
No UCS-66.1 MDMT reduction:	No
No UCS-68(c) MDMT reduction:	No
Disallow UG-20(f) exemptions:	No

UG-22 Loadings

UG-22(a) Internal or External Design Pressure :	Yes
UG-22(b) Weight of the vessel and normal contents under operating or test conditions:	Yes
UG-22(c) Superimposed static reactions from weight of attached equipment (external loads):	No
UG-22(d)(2) Vessel supports such as lugs, rings, skirts, saddles and legs:	Yes
UG-22(f) Wind reactions:	Yes
UG-22(f) Seismic reactions:	Yes
UG-22(j) Test pressure and coincident static head acting during the test:	No
Note: UG-22(b),(c) and (f) loads only considered when supports are present.	

Thickness Summary

Component Identifier	Material	Diameter (In)	Length (In)	Nominal t (In)	Design t (In)	Total Corrosion (In)	Joint E	Load
<u>60 ID TOP SE HEAD</u>	SA-516 70	60 ID	17.491	2.491*	2.2038	0.125	1.00	Internal
<u>Straight Flange on 60 ID TOP SE HEAD</u>	SA-516 70	60 ID	2	2.612	2.2906	0.125	1.00	Internal
<u>60 ID SHELL</u>	SA-516 70	60 ID	96	2.5	2.2968	0.125	1.00	Internal
<u>Straight Flange on 60 ID BOTTOM SE HEAD</u>	SA-516 70	60 ID	2	2.612	2.297	0.125	1.00	Internal
<u>60 ID BOTTOM SE HEAD</u>	SA-516 70	60 ID	17.491	2.491*	2.2108	0.125	1.00	Internal
<u>63-1/4" OD Skirt</u>	SA-516 70	63.25 OD	23.25	0.75	0.0557	0	0.55	Seismic

Nominal t: Vessel wall nominal thickness

Design t: Required vessel thickness due to governing loading + corrosion

Joint E: Longitudinal seam joint efficiency

* Head minimum thickness after forming

Load

internal: Circumferential stress due to internal pressure governs

external: External pressure governs

Wind: Combined longitudinal stress of pressure + weight + wind governs

Seismic: Combined longitudinal stress of pressure + weight + seismic governs

Weight Summary

Component	Weight (lb) Contributed by Vessel Elements										Surface Area ft ²
	Metal New*	Metal Corroded*	Insulation	Insulation Supports	Lining	Piping + Liquid	Operating Liquid		Test Liquid		
							New	Corroded	New	Corroded	
60 ID TOP SE HEAD	3,428	3,272.2	0	0	0	0	714.6	720.8	1,239.6	1,259.7	37
60 ID SHELL	12,445.3	11,848.4	0	0	0	0	10,913.1	11,008.3	9,921	10,007.5	127
60 ID BOTTOM SE HEAD	3,524.5	3,363.9	0	0	0	0	1,347.6	1,368.4	1,225.1	1,244	38
63-1 4" OD Skirt	927.3	927.3	0	0	0	0	0	0	0	0	64
Skirt Base Ring	451	451	0	0	0	0	0	0	0	0	27
TOTAL:	20,776.2	19,862.7	0	0	0	0	12,975.3	13,097.5	12,385.7	12,511.2	294

* Shells with attached nozzles have weight reduced by material cut out for opening.

Component	Weight (lb) Contributed by Attachments										Surface Area ft ²
	Body Flanges		Nozzles & Flanges		Packed Beds	Ladders & Platforms	Trays	Tray Supports	Rings & Clips	Vertical Loads	
	New	Corroded	New	Corroded							
60 ID TOP SE HEAD	0	0	452.8	435.8	0	0	0	0	32.3	0	7
60 ID SHELL	0	0	7,439.9	7,333.4	0	0	0	0	0	0	52
60 ID BOTTOM SE HEAD	0	0	29	27.7	0	0	0	0	0	0	1
63-1/4" OD Skirt	0	0	85.3	85.3	0	0	0	0	15.8	0	1
TOTAL:	0	0	8,007.1	7,882.2	0	0	0	0	48.1	0	61

Vessel operating weight, Corroded: 40,891 lb
Vessel operating weight, New: 41,807 lb
Vessel empty weight, Corroded: 27,793 lb
Vessel empty weight, New: 28,831 lb
Vessel test weight, New: 41,217 lb
Vessel test weight, Corroded: 40,304 lb
Vessel surface area: 355 ft²

Vessel center of gravity location - from datum - lift condition

Vessel Lift Weight, New: 28,831 lb
Center of Gravity: 52.5931"

Vessel Capacity

Vessel Capacity** (New): 1,469 US gal
Vessel Capacity** (Corroded): 1,483 US gal

**The vessel capacity does not include volume of nozzle, piping or other attachments.

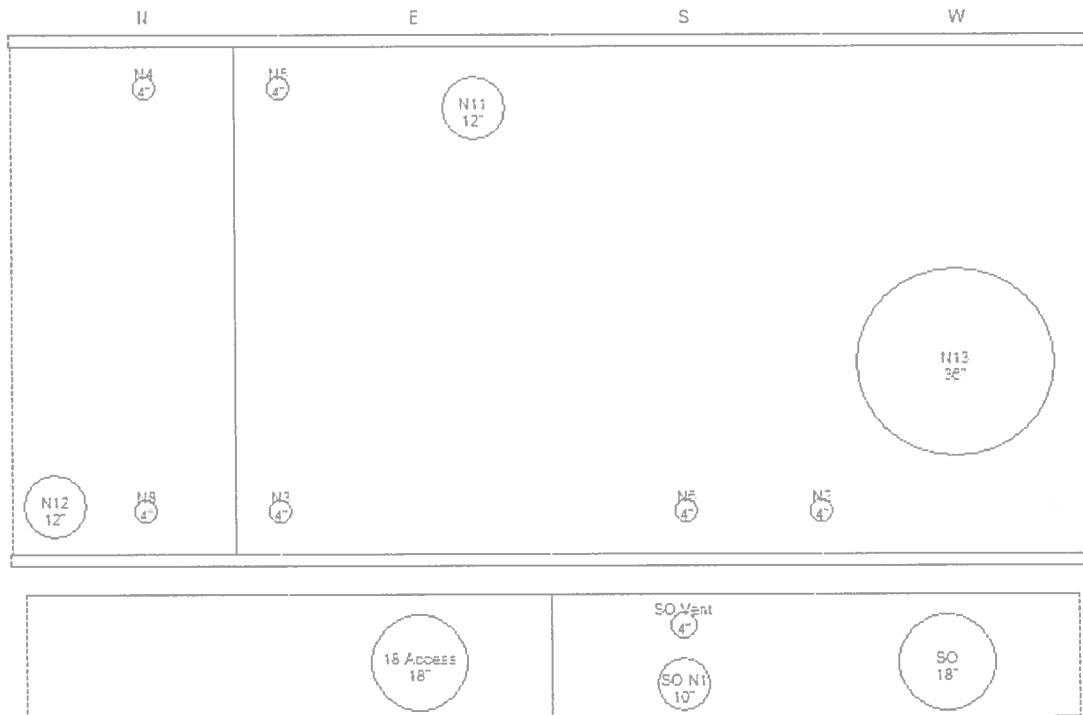
Long Seam Summary

Shell Long Seam Angles	
Component	Seam 1
60 ID SHELL	30°
63 1/4" OD Skirt	135°

Shell Plate Lengths		
Component	Starting Angle	Plate 1
60 ID SHELL	30°	196.3495"
63 1/4" OD Skirt	135°	196.3495"

*North is located at 0°

*Plate Lengths use the circumference of the vessel based on the mid diameter of the components



Shell Rollout



Hydrostatic Test

Shop test pressure determination for Chamber bounded by 60 ID BOTTOM SE HEAD and 60 ID TOP SE HEAD based on MAWP per UG-99(b)

Shop hydrostatic test gauge pressure is 1,791.4 psi at 50 °F (the chamber MAWP = 1,378 psi)

The shop test is performed with the vessel in the horizontal position.

Identifier	Local test pressure psi	Test liquid static head psi	UG-99(b) stress ratio	UG-99(b) pressure factor
60 ID TOP SE HEAD (1)	1,793.945	2.545	1	1.30
Straight Flange on 60 ID TOP SE HEAD	1,793.945	2.545	1	1.30
60 ID SHELL	1,793.945	2.545	1	1.30
Straight Flange on 60 ID BOTTOM SE HEAD	1,793.945	2.545	1	1.30
60 ID BOTTOM SE HEAD	1,793.945	2.545	1	1.30
Bottom Drain (N1)	1,792.892	1.492	1	1.30
Corrosion Coupon (N9)	1,793.566	2.166	1	1.30
Diff Press High (N4)	1,791.689	0.289	1	1.30
Diff press Low (N8)	1,791.689	0.289	1	1.30
Fill/ Water Flush (N6)	1,794.324	2.924	1	1.30
Inlet Nozzle (N12)	1,791.918	0.518	1	1.30
Inspection Nozzle (N11)	1,793.522	2.122	1	1.30
Level Bridal High (N5)	1,792.058	0.658	1	1.30
Level Bridal Low (N3)	1,792.058	0.658	1	1.30
Manway (N13)	1,793.295	1.895	1	1.30
Outlet (N10)	1,793.006	1.606	1	1.30
Purge (N2)	1,793.921	2.521	1	1.30
Vent (N7)	1,792.248	0.848	1	1.30

Notes:

- (1) 60 ID TOP SE HEAD limits the UG-99(b) stress ratio.
- (2) The zero degree angular position is assumed to be up, and the test liquid height is assumed to the top-most flange.

The field test condition has not been investigated for the Chamber bounded by 60 ID BOTTOM SE HEAD and 60 ID TOP SE HEAD.

The test temperature of 50 °F is warmer than the minimum recommended temperature of 1.4 °F so the brittle fracture provision of UG-99(h) has been met.

Vacuum Summary

Component	Line of Support	Elevation above Datum (In)	Length Le (In)
<u>60 ID TOP SE HEAD</u>	-	-19.491	N/A
-	<u>1.3 depth of 60 ID TOP SE HEAD</u>	-7.0417	N/A
<u>Straight Flange on 60 ID TOP SE HEAD Top</u>	-	-2	110.0833
<u>Straight Flange on 60 ID TOP SE HEAD Bottom</u>	-	0	110.0833
<u>60 ID SHELL Top</u>	-	0	110.0833
<u>60 ID SHELL Bottom</u>	-	96	110.0833
<u>Straight Flange on 60 ID BOTTOM SE HEAD Top</u>	-	96	110.0833
<u>Straight Flange on 60 ID BOTTOM SE HEAD Bottom</u>	-	98	110.0833
-	<u>1.3 depth of 60 ID BOTTOM SE HEAD</u>	103.0417	N/A
<u>60 ID BOTTOM SE HEAD</u>	-	115.491	N/A

Note
For main components, the listed value of 'Le' is the largest unsupported length for the component.

Engineering Notes

1. External loads have not been considered in the flange pressure rating.
2. The minimum thickness of the top and bottom heads are from the readings taken by KV Inspection Services. Reports dated February 26, 2013.
3. The style of lifting lug analysed here is only analysed for vertical lifting only. The software will not complete a "rigging analyses" on this style of lifting lug.
4. The Compress software does not analyse the seismic and wind loads simultaneously so this information is not contained within this report. The magnitude of the wind loading in comparison to the motion "seismic" loads is miniscule when compared to the motion loads. The total wind load on this vessel equates to a force of 660 pounds acting on one side of the vessel.

Seismic Code

Method of seismic analysis:	User-defined
Base Shear Multiplier	0.5000
Portion at Top	0.0700
Vertical Accelerations Considered:	Yes
Force Multiplier:	= 1.4738
Minimum Weight Multiplier:	= 1.0000

Vessel Characteristics

Vessel height: 12.1832 ft

Vessel Weight:

Operating, Corroded: 40,891 lb

Empty, Corroded: 27,793 lb

Vacuum, Corroded: 40,891 lb

Period of Vibration Calculation

Fundamental Period, T:

Operating, Corroded: 0.018 sec (f = 56.5 Hz)

Empty, Corroded: 0.015 sec (f = 68.3 Hz)

Vacuum, Corroded: 0.018 sec (f = 57.0 Hz)

The fundamental period of vibration T (above) is calculated using the Rayleigh method of approximation:

$T = 2 * \text{PI} * \text{Sqr}(\{\text{Sum}(W_i * y_i^2)\} / \{g * \text{Sum}(W_i * y_i)\})$, where

W_i is the weight of the i^{th} lumped mass, and
 y_i is its deflection when the system is treated as a cantilever beam.

Seismic Shear Reports:

Operating, Corroded

Empty, Corroded

Vacuum, Corroded

Base Shear Calculations

Seismic Shear Report: Operating, Corroded

Component	Elevation of bottom above base (In)	Elastic modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Seismic shear at Bottom (lbf)	Bending Moment at Bottom (lbf-ft)
60 ID TOP SE HEAD	126.7075	29.1	*	5,197	5,392
60 ID SHELL	30.7075	29.1	11.0628	19,545	135,547
60 ID BOTTOM SE HEAD (top)	23.25	29.1	*	19,897	147,809
63-1/4" OD Skirt	0	29.1	3.468	20,445	187,180

*Moment of Inertia I varies over the length of the component

Seismic Shear Report: Empty, Corroded

Component	Elevation of bottom above base (In)	Elastic modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Seismic shear at Bottom (lbf)	Bending Moment at Bottom (lbf-ft)
60 ID TOP SE HEAD	126.7075	29.4	*	4,178	4,509
60 ID SHELL	30.7075	29.4	11.0628	13,220	101,019
60 ID BOTTOM SE HEAD (top)	23.25	29.4	*	13,437	109,306
63-1/4" OD Skirt	0	29.4	3.468	13,897	136,015

*Moment of Inertia I varies over the length of the component

Seismic Shear Report: Vacuum, Corroded

Component	Elevation of bottom above base (In)	Elastic modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Seismic shear at Bottom (lbf)	Bending Moment at Bottom (lbf-ft)
60 ID TOP SE HEAD	126.7075	29.1	*	5,197	5,392
60 ID SHELL	30.7075	29.1	11.0628	19,545	135,547
60 ID BOTTOM SE HEAD (top)	23.25	29.1	*	19,897	147,809
63-1/4" OD Skirt	0	29.8	3.468	20,445	187,180

*Moment of Inertia I varies over the length of the component

Vertical Acceleration Term, V_{Accel}

Factor is applied to dead load.

Compressive Side: = $1.0 + V_{Accel}$

V_{Accel} Term is: greater of (Force Mult * Base Shear / Weight) or (Min. Weight Mult.)				
Force multiplier = 1.4738		Minimum Weight Multiplier = 1.0000		
Condition	Base Shear (lbf)	Weight (lb)	Force Mult * Shear Weight	V_{Accel}
Operating, Corroded	20,445	40,890.5	0.7369	1
Operating, New	20,903	41,806.6	0.7369	1
Empty, Corroded	13,897	27,793	0.7369	1
Empty, New	14,416	28,831.4	0.7369	1
Vacuum, Corroded	20,445	40,890.5	0.7369	1

Base Shear Calculations

Operating, Corroded

Empty, Corroded

Vacuum, Corroded

Base Shear Calculations: Operating, Corroded

$$\begin{aligned} V &= \text{Base Shear Multiplier} * W \\ &= 0.5000 * 40,890.5156 \\ &= 20,445.26 \text{ lb} \end{aligned}$$

Base Shear Calculations: Empty, Corroded

$$\begin{aligned} V &= \text{Base Shear Multiplier} * W \\ &= 0.5000 * 27,793.0352 \\ &= 13,896.52 \text{ lb} \end{aligned}$$

Base Shear Calculations: Vacuum, Corroded

$$\begin{aligned} V &= \text{Base Shear Multiplier} * W \\ &= 0.5000 * 40,890.5156 \\ &= 20,445.26 \text{ lb} \end{aligned}$$

Wind Code

Building Code: **User Defined**
 Elevation of base above grade: 0.0000 ft
 Increase effective outer diameter by: 0.0000 ft
 Wind Force Coefficient Cf: 0.8000

Vessel Characteristics

Vessel height, h: 12.1832 ft
 Vessel Minimum Diameter
 Operating, Corroded: 5.4167 ft
 Empty, Corroded: 5.4167 ft
 Fundamental Frequency, n_1
 Operating, Corroded: 56.4765 Hz
 Empty, Corroded: 68.3053 Hz
 Damping coefficient, β
 Operating, Corroded: 0.0250
 Empty, Corroded: 0.0200

Wind Deflection Reports:

[Operating, Corroded](#)
[Empty, Corroded](#)
[Vacuum, Corroded](#)
[Wind Pressure Table](#)

Wind Deflection Report: Operating, Corroded

Component	Elevation of bottom above base (In)	Effective OD (ft)	Elastic modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Platform wind shear at Bottom (lbf)	Total wind shear at Bottom (lbf)	bending moment at Bottom (lbf-ft)	Deflection at top (In)
60 ID TOP SE HEAD	126.7075	5.43	29.1	*	0	88	79	0.0007
60 ID SHELL	30.7075	5.42	29.1	11.06	0	625	25,969	0.0006
60 ID BOTTOM SE HEAD (top)	23.25	5.43	29.1	*	0	667	26,371	0.0001
63-1/4" OD Skirt	0	5.27	29.1	3.468	0	793	27,785	0
*Moment of Inertia I varies over the length of the component								

Wind Deflection Report: Empty, Corroded

Component	Elevation of bottom above base (In)	Effective OD (ft)	Elastic modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Platform wind shear at Bottom (lbf)	Total wind shear at Bottom (lbf)	bending moment at Bottom (lbf-ft)	Deflection at top (In)
60 ID TOP SE HEAD	126.7075	5.43	29.4	*	0	88	79	0.0007
60 ID SHELL	30.7075	5.42	29.4	11.06	0	625	25,969	0.0006
60 ID BOTTOM SE HEAD (top)	23.25	5.43	29.4	*	0	667	26,371	0.0001
63-1/4" OD Skirt	0	5.27	29.4	3.468	0	793	27,785	0

*Moment of Inertia I varies over the length of the component

Wind Deflection Report: Vacuum, Corroded

Component	Elevation of bottom above base (In)	Effective OD (ft)	Elastic modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Platform wind shear at Bottom (lbf)	Total wind shear at Bottom (lbf)	bending moment at Bottom (lbf-ft)	Deflection at top (In)
60 ID TOP SE HEAD	126.7075	5.43	29.1	*	0	88	79	0.0007
60 ID SHELL	30.7075	5.42	29.1	11.06	0	625	25,969	0.0006
60 ID BOTTOM SE HEAD (top)	23.25	5.43	29.1	*	0	667	26,371	0.0001
63-1/4" OD Skirt	0	5.27	29.8	3.468	0	793	27,785	0

*Moment of Inertia I varies over the length of the component

Wind Pressure (WP) table

Wind Force Coefficient Cf: 0.8000

Design Wind Pressures

To Height Z (')	Wind Pressure (psf)	Adjusted by Cf (psf)
15.00	15.5000	12.4000

Design Wind Force determined from: $F = \text{Pressure} * A_f$, where A_f is the projected area.

60 ID TOP SE HEAD

ASME Section VIII, Division 1, 2010 Edition, A11 Addenda

Component: Ellipsoidal Head
Material Specification: SA-516 70 (II-D p.18, In. 19)
Straight Flange governs MDMT

Internal design pressure: $P = 1,378$ psi @ 140 °F
External design pressure: $P_e = 15$ psi @ 140 °F

Static liquid head:

$P_s = 0.18$ psi (SG=1.1, $H_s=4.5$ " Operating head)
 $P_{th} = 2.54$ psi (SG=1, $H_s=70.5$ " Horizontal test head)

Corrosion allowance: Inner C = 0.125" Outer C = 0"

Design MDMT = -20°F Impact test performed
Rated MDMT = -32.9°F Material is normalized
Material is not produced to fine grain practice
PWHT is performed
Do not Optimize MDMT / Find MAWP

Radiography: Category A joints - Seamless No RT
Head to shell seam - Full UW-11(a) Type 1

Estimated weight*: new = 3,428 lb corr = 3,272.2 lb
Capacity*: new = 146.9 US gal corr = 149.1 US gal
* includes straight flange

Inner diameter = 60"
Minimum head thickness = 2.491"
Head ratio D/2h = 2 (new)
Head ratio D/2h = 1.9917 (corroded)
Straight flange length L_{sf} = 2"
Nominal straight flange thickness t_{sf} = 2.612"

Results Summary

The governing condition is internal pressure.
Minimum thickness per UG-16 = $0.0625" + 0.125" = 0.1875"$
Design thickness due to internal pressure (t) = 2.2038"
Design thickness due to external pressure (t_e) = 0.2819"
Maximum allowable working pressure (MAWP) = 1,566.92 psi
Maximum allowable external pressure (MAEP) = 750.1 psi

K (Corroded)

$$K = (1/6) * [2 + (D / (2*h))^2] = (1/6) * [2 + (60.25 / (2*15.125))^2] = 0.994502$$

K (New)

$$K = (1/6) * [2 + (D / (2*h))^2] = (1/6) * [2 + (60 / (2*15))^2] = 1$$

Design thickness for internal pressure, (Corroded at 140 °F) Appendix 1-4(c)

$$\begin{aligned}t &= P \cdot D \cdot K / (2 \cdot S \cdot E - 0.2 \cdot P) + \text{Corrosion} \\&= 1,378.18 \cdot 60.25 \cdot 0.994502 / (2 \cdot 20,000 \cdot 1 - 0.2 \cdot 1,378.18) + 0.125 \\&= 2.2038''\end{aligned}$$

The head internal pressure design thickness is 2.2038".

Maximum allowable working pressure, (Corroded at 140 °F) Appendix 1-4(c)

$$\begin{aligned}P &= 2 \cdot S \cdot E \cdot t / (K \cdot D + 0.2 \cdot t) - P_s \\&= 2 \cdot 20,000 \cdot 1 \cdot 2.366 / (0.994502 \cdot 60.25 + 0.2 \cdot 2.366) - 0.18 \\&= 1,566.92 \text{ psi}\end{aligned}$$

The maximum allowable working pressure (MAWP) is 1.566.92 psi.

Design thickness for external pressure, (Corroded at 140 °F) UG-33(d)

Equivalent outside spherical radius (R_o)

$$\begin{aligned}R_o &= K_o \cdot D_o \\&= 0.8359 \cdot 64.982 \\&= 54.3193 \text{ in}\end{aligned}$$

$$\begin{aligned}A &= 0.125 / (R_o / t) \\&= 0.125 / (54.3193 / 0.156888) \\&= 0.000361\end{aligned}$$

From Table CS-2: $B = 5,193.454$ psi

$$\begin{aligned}P_a &= B / (R_o / t) \\&= 5,193.454 / (54.3193 / 0.1569) \\&= 15 \text{ psi}\end{aligned}$$

$$t = 0.1569'' + \text{Corrosion} = 0.1569'' + 0.125'' = 0.2819''$$

Check the external pressure per UG-33(a)(1) Appendix 1-4(c)

$$\begin{aligned}t &= 1.67 \cdot P_e \cdot D \cdot K / (2 \cdot S \cdot E - 0.2 \cdot 1.67 \cdot P_e) + \text{Corrosion} \\&= 1.67 \cdot 15 \cdot 60.25 \cdot 0.994502 / (2 \cdot 20,000 \cdot 1 - 0.2 \cdot 1.67 \cdot 15) + 0.125 \\&= 0.1625''\end{aligned}$$

The head external pressure design thickness (t_e) is 0.2819".

Maximum Allowable External Pressure, (Corroded at 140 °F) UG-33(d)

Equivalent outside spherical radius (R_o)

$$\begin{aligned}R_o &= K_o \cdot D_o \\&= 0.8359 \cdot 64.982 \\&= 54.3193 \text{ in}\end{aligned}$$

$$\begin{aligned}A &= 0.125 / (R_o / t) \\&= 0.125 / (54.3193 / 2.366) \\&= 0.005445\end{aligned}$$

From Table CS-2: $B = 17,220.94$ psi

$$\begin{aligned}
 P_a &= B / (R_o / t) \\
 &= 17,220.94 / (54.3193 / 2.366) \\
 &= 750.0974 \text{ psi}
 \end{aligned}$$

Check the Maximum External Pressure, UG-33(a)(1) Appendix 1-4(c)

$$\begin{aligned}
 P &= 2 * S * E * t / ((K * D + 0.2 * t) * 1.67) - P_{s2} \\
 &= 2 * 20,000 * 1 * 2.366 / ((0.994502 * 60.25 + 0.2 * 2.366) * 1.67) - 0 \\
 &= 938.38 \text{ psi}
 \end{aligned}$$

The maximum allowable external pressure (MAEP) is 750.1 psi.

% Extreme fiber elongation - UCS-79(d)

$$\begin{aligned}
 EFE &= (75 * t / R_i) * (1 - R_i / R_o) \\
 &= (75 * 2.612 / 11.506) * (1 - 11.506 / \infty) \\
 &= 17.0259\%
 \end{aligned}$$

Straight Flange on 60 ID TOP SE HEAD

ASME Section VIII Division 1, 2010 Edition, A11 Addenda

Component: Straight Flange
Material specification: SA-516 70 (II-D p. 18, In. 19)
Material is impact tested per UG-84 to -20 °F
UCS-66(i) reduction of 12.9 °F applied (ratio = 0.8707).

Internal design pressure: $P = 1,378$ psi @ 140 °F
External design pressure: $P_e = 15$ psi @ 140 °F

Static liquid head:

$P_s = 0.26$ psi (SG = 1.1, $H_s = 6.5$ ", Operating head)
 $P_{th} = 2.54$ psi (SG = 1, $H_s = 70.5$ ", Horizontal test head)

Corrosion allowance Inner C = 0.125" Outer C = 0"

Design MDMT = -20 °F Impact test performed
Rated MDMT = -32.9 °F Material is normalized
Material is not produced to Fine Grain Practice
PWHT is performed

Radiography: Longitudinal joint - Seamless No RT
Circumferential joint - Full UW-11(a) Type 1

Estimated weight New = 290.8 lb corr = 277.4 lb
Capacity New = 24.48 US gal corr = 24.68 US gal

ID = 60"
Length = 2"
 L_c
t = 2.612"

Design thickness, (at 140 °F) UG-27(c)(1)

t = $P \cdot R / (S \cdot E - 0.60 \cdot P) + \text{Corrosion}$
= $1,378.26 \cdot 30.125 / (20,000 \cdot 1.00 - 0.60 \cdot 1,378.26) + 0.125$
= 2.2906"

Maximum allowable working pressure, (at 140 °F) UG-27(c)(1)

P = $S \cdot E \cdot t / (R + 0.60 \cdot t) - P_s$
= $20,000 \cdot 1.00 \cdot 2.487 / (30.125 + 0.60 \cdot 2.487) - 0.26$
= 1,572.94 psi

External Pressure, (Corroded & at 140 °F) UG-28(c)

$L / D_o = 110.0833 / 65.224 = 1.6878$
 $D_o / t = 65.224 / 0.2616 = 249.3220$
From table G: A = 0.000195
From table CS-2: B = 2,804.8786 psi

$P_a = 4 \cdot B / (3 \cdot (D_o / t))$

$$= 4 * 2,804.88 / (3 * (65.224 / 0.2616))$$

$$= 15 \text{ psi}$$

Design thickness for external pressure $P_a = 15$ psi

$$t_a = t + \text{Corrosion} = 0.2616 + 0.125 = 0.3866''$$

Maximum Allowable External Pressure, (Corroded & at 140 °F) UG-28(c)

$$L / D_o = 110.0833 / 65.224 = 1.6878$$

$$D_o / t = 65.224 / 2.487 = 26.2260$$

From table G: A = 0.005788

From table CS-2: B = 17,236.009 psi

$$P_a = 4 * B / (3 * (D_o / t))$$

$$= 4 * 17,236.01 / (3 * (65.224 / 2.487))$$

$$= 876.28 \text{ psi}$$

% Extreme fiber elongation - UCS-79(d)

$$\text{EFE} = (50 * t / R_i) * (1 - R_i / R_o)$$

$$= (50 * 2.612 / 31.306) * (1 - 31.306 / \infty)$$

$$= 4.1717\%$$

The extreme fiber elongation does not exceed 5%.

Design thickness = 2.2906''

The governing condition is due to internal pressure.

The cylinder thickness of 2.612'' is adequate.

Thickness Required Due to Pressure + External Loads

Condition	Pressure P (psi)	Allowable Stress Before UG-23 Stress Increase (psi)		Temperature (°F)	Corrosion C (in)	Load	Req'd Thk Due to Tension (in)	Req'd Thk Due to Compression (in)
		S _t	S _c					
<u>Operating, Hot & Corroded</u>	1,378	20,000	<u>17,359</u>	140	0.125	Wind	<u>0.8542</u>	<u>0.8542</u>
						Seismic	<u>0.8551</u>	<u>0.8526</u>
<u>Operating, Hot & New</u>	1,378	20,000	<u>17,371</u>	140	0	Wind	<u>0.8507</u>	<u>0.8506</u>
						Seismic	<u>0.8515</u>	<u>0.8489</u>
<u>Hot Shut Down, Corroded</u>	0	20,000	<u>17,359</u>	140	0.125	Wind	<u>0.0009</u>	<u>0.0009</u>
						Seismic	<u>0.0001</u>	<u>0.0028</u>
<u>Hot Shut Down, New</u>	0	20,000	<u>17,371</u>	140	0	Wind	<u>0.0009</u>	<u>0.001</u>
						Seismic	<u>0.0001</u>	<u>0.0029</u>
<u>Empty, Corroded</u>	0	20,000	<u>17,359</u>	70	0.125	Wind	<u>0.0009</u>	<u>0.0009</u>
						Seismic	<u>0.0001</u>	<u>0.0027</u>
<u>Empty, New</u>	0	20,000	<u>17,371</u>	70	0	Wind	<u>0.0009</u>	<u>0.001</u>
						Seismic	<u>0.0001</u>	<u>0.0028</u>
<u>Vacuum</u>	-15	20,000	<u>17,359</u>	140	0.125	Wind	<u>0.0117</u>	<u>0.0116</u>
						Seismic	<u>0.0108</u>	<u>0.0137</u>
<u>Hot Shut Down, Corroded, Weight & Eccentric Moments Only</u>	0	20,000	<u>17,359</u>	140	0.125	Weight	<u>0.0011</u>	<u>0.0011</u>

Allowable Compressive Stress, Hot and Corroded- S_{CHC}, (table CS-2)

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (32.612 / 2.487) \\
 &= 0.009533 \\
 B &= 17,359 \text{ psi} \\
 S &= 20,000 / 1.00 = 20,000 \text{ psi} \\
 S_{CHC} &= \min(B, S) = \underline{17,359 \text{ psi}}
 \end{aligned}$$

Allowable Compressive Stress, Hot and New- S_{CHN}, (table CS-2)

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (32.612 / 2.612) \\
 &= 0.010012 \\
 B &= 17,371 \text{ psi} \\
 S &= 20,000 / 1.00 = 20,000 \text{ psi} \\
 S_{CHN} &= \min(B, S) = \underline{17,371 \text{ psi}}
 \end{aligned}$$

Allowable Compressive Stress, Cold and New- S_{cCN}, (table CS-2)

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (32.612 / 2.612) \\
 &= 0.010012 \\
 B &= 17,371 \text{ psi} \\
 S &= 20,000 / 1.00 = 20,000 \text{ psi} \\
 S_{cCN} &= \min(B, S) = \underline{17,371 \text{ psi}}
 \end{aligned}$$

Allowable Compressive Stress, Cold and Corroded- S_{cCC} , (table CS-2)

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (32.612 / 2.487) \\
 &= 0.009533 \\
 B &= 17,359 \text{ psi} \\
 S &= 20,000 / 1.00 = 20,000 \text{ psi} \\
 S_{cCC} &= \min(B, S) = \underline{17.359 \text{ psi}}
 \end{aligned}$$

Allowable Compressive Stress, Vacuum and Corroded- S_{cVC} , (table CS-2)

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (32.612 / 2.487) \\
 &= 0.009533 \\
 B &= 17,359 \text{ psi} \\
 S &= 20,000 / 1.00 = 20,000 \text{ psi} \\
 S_{cVC} &= \min(B, S) = \underline{17.359 \text{ psi}}
 \end{aligned}$$

Operating, Hot & Corroded, Wind, Bottom Seam

$$\begin{aligned}
 t_p &= P \cdot R / (2 \cdot S_t \cdot K_s \cdot E_c + 0.40 \cdot |P|) && \text{(Pressure)} \\
 &= 1,378 \cdot 30.125 / (2 \cdot 20,000 \cdot 1.20 \cdot 1.00 + 0.40 \cdot |1,378|) \\
 &= 0.855" \\
 t_m &= M / (\pi \cdot R_m^2 \cdot S_t \cdot K_s \cdot E_c) && \text{(bending)} \\
 &= 949 / (\pi \cdot 31.3685^2 \cdot 20,000 \cdot 1.20 \cdot 1.00) \\
 &= 0" \\
 t_w &= W / (2 \cdot \pi \cdot R_m \cdot S_t \cdot K_s \cdot E_c) && \text{(Weight)} \\
 &= 3,740.2 / (2 \cdot \pi \cdot 31.3685 \cdot 20,000 \cdot 1.20 \cdot 1.00) \\
 &= 0.0008" \\
 t_t &= t_p + t_m - t_w && \text{(total required, tensile)} \\
 &= 0.855 + 0 - (0.0008) \\
 &= \underline{0.8542"} \\
 t_c &= |t_{mc} + t_{wc} - t_{pc}| && \text{(total, net tensile)} \\
 &= |0 + (0.0008) - (0.855)| \\
 &= \underline{0.8542"}
 \end{aligned}$$

Maximum allowable working pressure, Longitudinal Stress

$$\begin{aligned}
 P &= 2 \cdot S_t \cdot K_s \cdot E_c \cdot (t - t_m + t_w) / (R - 0.40 \cdot (t - t_m + t_w)) \\
 &= 2 \cdot 20,000 \cdot 1.20 \cdot 1.00 \cdot (2.487 - 0 + (0.0008)) / (30.125 - 0.40 \cdot (2.487 - 0 + (0.0008))) \\
 &= 4,099.34 \text{ psi}
 \end{aligned}$$

Operating, Hot & New, Wind, Bottom Seam

$$\begin{aligned}
 t_p &= P \cdot R / (2 \cdot S_t \cdot K_s \cdot E_c + 0.40 \cdot |P|) && \text{(Pressure)} \\
 &= 1,378 \cdot 30 / (2 \cdot 20,000 \cdot 1.20 \cdot 1.00 + 0.40 \cdot |1,378|) \\
 &= 0.8515"
 \end{aligned}$$

$$t_m = M / (\pi R_m^2 S_t K_s E_c) \quad (\text{bending})$$

$$= 970 / (\pi 31.306^2 20,000 1.20 1.00)$$

$$= 0''$$

$$t_w = W / (2 \pi R_m S_t K_s E_c) \quad (\text{Weight})$$

$$= 3,913.1 / (2 \pi 31.306 20,000 1.20 1.00)$$

$$= 0.0008''$$

$$t_t = t_p + t_m - t_w \quad (\text{total required, tensile})$$

$$= 0.8515 + 0 - (0.0008)$$

$$= \underline{0.8507''}$$

$$t_c = |t_{mc} + t_{wc} - t_{pc}| \quad (\text{total, net tensile})$$

$$= |0 + (0.0008) - (0.8515)|$$

$$= \underline{0.8506''}$$

Maximum allowable working pressure, Longitudinal Stress

$$P = 2 S_t K_s E_c (t - t_m + t_w) / (R - 0.40 (t - t_m + t_w))$$

$$= 2 20,000 1.20 1.00 (2.612 - 0 + (0.0008)) / (30 - 0.40 (2.612 - 0 + (0.0008)))$$

$$= 4,331.4 \text{ psi}$$

Hot Shut Down, Corroded, Wind, Bottom Seam

$$t_p = 0'' \quad (\text{Pressure})$$

$$t_m = M / (\pi R_m^2 S_c K_s) \quad (\text{bending})$$

$$= 949 / (\pi 31.3685^2 17,359.27 1.20)$$

$$= 0''$$

$$t_w = W / (2 \pi R_m S_c K_s) \quad (\text{Weight})$$

$$= 3,740.2 / (2 \pi 31.3685 17,359.27 1.20)$$

$$= 0.0009''$$

$$t_t = |t_p + t_m - t_w| \quad (\text{total, net compressive})$$

$$= |0 + 0 - (0.0009)|$$

$$= \underline{0.0009''}$$

$$t_c = t_{mc} + t_{wc} - t_{pc} \quad (\text{total required, compressive})$$

$$= 0 + (0.0009) - (0)$$

$$= \underline{0.0009''}$$

Hot Shut Down, New, Wind, Bottom Seam

$$t_p = 0'' \quad (\text{Pressure})$$

$$t_m = M / (\pi R_m^2 S_c K_s) \quad (\text{bending})$$

$$= 970 / (\pi 31.306^2 17,371.43 1.20)$$

$$= 0''$$

$$t_w = W / (2 \pi R_m S_c K_s) \quad (\text{Weight})$$

$$= 3,913.1 / (2 \pi 31.306 17,371.43 1.20)$$

$$= 0.001''$$

$$t_t = |t_p + t_m - t_w| \quad (\text{total, net compressive})$$

$$= |0 + 0 - (0.001)|$$

$$= \underline{0.0009''}$$

$$\begin{aligned}
 t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\
 &= 0 + (0.001) - (0) \\
 &= \underline{0.001"}
 \end{aligned}$$

Empty, Corroded, Wind, Bottom Seam

$$\begin{aligned}
 t_p &= 0" && \text{(Pressure)} \\
 t_m &= M / (\pi R_m^2 S_c K_s) && \text{(bending)} \\
 &= 949 / (\pi 31.3685^2 17,359.27 1.20) \\
 &= 0"
 \end{aligned}$$

$$\begin{aligned}
 t_w &= W / (2 \pi R_m S_c K_s) && \text{(Weight)} \\
 &= 3,740.2 / (2 \pi 31.3685 17,359.27 1.20) \\
 &= 0.0009"
 \end{aligned}$$

$$\begin{aligned}
 t_t &= |t_p + t_m - t_w| && \text{(total, net compressive)} \\
 &= |0 + 0 - (0.0009)| \\
 &= \underline{0.0009"}
 \end{aligned}$$

$$\begin{aligned}
 t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\
 &= 0 + (0.0009) - (0) \\
 &= \underline{0.0009"}
 \end{aligned}$$

Empty, New, Wind, Bottom Seam

$$\begin{aligned}
 t_p &= 0" && \text{(Pressure)} \\
 t_m &= M / (\pi R_m^2 S_c K_s) && \text{(bending)} \\
 &= 970 / (\pi 31.306^2 17,371.43 1.20) \\
 &= 0"
 \end{aligned}$$

$$\begin{aligned}
 t_w &= W / (2 \pi R_m S_c K_s) && \text{(Weight)} \\
 &= 3,913.1 / (2 \pi 31.306 17,371.43 1.20) \\
 &= 0.001"
 \end{aligned}$$

$$\begin{aligned}
 t_t &= |t_p + t_m - t_w| && \text{(total, net compressive)} \\
 &= |0 + 0 - (0.001)| \\
 &= \underline{0.0009"}
 \end{aligned}$$

$$\begin{aligned}
 t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\
 &= 0 + (0.001) - (0) \\
 &= \underline{0.001"}
 \end{aligned}$$

Vacuum, Wind, Bottom Seam

$$\begin{aligned}
 t_p &= P R / (2 S_c K_s + 0.40 |P|) && \text{(Pressure)} \\
 &= -15 \cdot 30.125 / (2 \cdot 17,359.27 \cdot 1.20 + 0.40 \cdot |15|) \\
 &= -0.0108"
 \end{aligned}$$

$$\begin{aligned}
 t_m &= M / (\pi R_m^2 S_c K_s) && \text{(bending)} \\
 &= 949 / (\pi 31.3685^2 17,359.27 1.20) \\
 &= 0"
 \end{aligned}$$

$$\begin{aligned}
 t_w &= W / (2 \pi R_m S_c K_s) && \text{(Weight)} \\
 &= 3,740.2 / (2 \pi 31.3685 17,359.27 1.20) \\
 &= 0.0009"
 \end{aligned}$$

$$t_t = |t_p + t_m - t_w| \quad (\text{total, net compressive})$$

$$= |-0.0108 + 0 - (0.0009)|$$

$$= \underline{0.0117''}$$

$$t_c = t_{mc} + t_{wc} - t_{pc} \quad (\text{total required, compressive})$$

$$= 0 + (0.0009) - (-0.0108)$$

$$= \underline{0.0118''}$$

Maximum Allowable External Pressure, Longitudinal Stress

$$P = 2 * S_c * K_s * (t - t_{mc} - t_{wc}) / (R - 0.40 * (t - t_{mc} - t_{wc}))$$

$$= 2 * 17,359.27 * 1.20 * (2.487 - 0 - 0.0009) / (30.125 - 0.40 * (2.487 - 0 - 0.0009))$$

$$= 3,555.56 \text{ psi}$$

Hot Shut Down, Corroded, Weight & Eccentric Moments Only, Bottom Seam

$$t_p = 0'' \quad (\text{Pressure})$$

$$t_m = M / (\pi * R_m^2 * S_c * K_s) \quad (\text{bending})$$

$$= 213 / (\pi * 31.3685^2 * 17,359.27 * 1.00)$$

$$= 0''$$

$$t_w = W / (2 * \pi * R_m * S_c * K_s) \quad (\text{Weight})$$

$$= 3,740.2 / (2 * \pi * 31.3685 * 17,359.27 * 1.00)$$

$$= 0.0011''$$

$$t_t = |t_p + t_m - t_w| \quad (\text{total, net compressive})$$

$$= |0 + 0 - (0.0011)|$$

$$= \underline{0.0011''}$$

$$t_c = t_{mc} + t_{wc} - t_{pc} \quad (\text{total required, compressive})$$

$$= 0 + (0.0011) - (0)$$

$$= \underline{0.0011''}$$

Operating, Hot & Corroded, Seismic, Bottom Seam

$$t_p = P * R / (2 * S_t * K_s * E_c + 0.40 * |P|) \quad (\text{Pressure})$$

$$= 1,378 * 30.125 / (2 * 20,000 * 1.20 * 1.00 + 0.40 * |1,378|)$$

$$= 0.855''$$

$$t_m = M / (\pi * R_m^2 * S_t * K_s * E_c) \quad (\text{bending})$$

$$= 64,702 / (\pi * 31.3685^2 * 20,000 * 1.20 * 1.00)$$

$$= 0.0009''$$

$$t_w = W / (2 * \pi * R_m * S_t * K_s * E_c) \quad (\text{Weight})$$

$$= 3,740.2 / (2 * \pi * 31.3685 * 20,000 * 1.20 * 1.00)$$

$$= 0.0008''$$

$$t_t = t_p + t_m - t_w \quad (\text{total required, tensile})$$

$$= 0.855 + 0.0009 - (0.0008)$$

$$= \underline{0.8551''}$$

$$t_{wc} = (1 + V_{\text{Accel}}) * W / (2 * \pi * R_m * S_t * K_s * E_c) \quad (\text{Weight})$$

$$= 2.00 * 3,740.2 / (2 * \pi * 31.3685 * 20,000 * 1.20 * 1.00)$$

$$= 0.0016''$$

$$t_c = |t_{mc} + t_{wc} - t_{pc}| \quad (\text{total, net tensile})$$

$$= |0.0009 + (0.0016) - (0.855)|$$

$$= \underline{0.8526''}$$

Maximum allowable working pressure, Longitudinal Stress

$$P = 2*S_t*K_s*E_c*(t - t_m + t_w) / (R - 0.40*(t - t_m + t_w))$$

$$= 2*20,000*1.20*1.00*(2.487 - 0.0009 + (0.0008)) / (30.125 - 0.40*(2.487 - 0.0009 + (0.0008)))$$

$$= 4,097.88 \text{ psi}$$

Operating, Hot & New, Seismic, Bottom Seam

$$t_p = P*R / (2*S_t*K_s*E_c + 0.40*|P|) \quad (\text{Pressure})$$

$$= 1,378*30 / (2*20,000*1.20*1.00 + 0.40*|1,378|)$$

$$= 0.8515''$$

$$t_m = M / (\pi*R_m^2*S_t*K_s*E_c) \quad (\text{bending})$$

$$= 66,830 / (\pi*31.306^2*20,000*1.20*1.00)$$

$$= 0.0009''$$

$$t_w = W / (2*\pi*R_m*S_t*K_s*E_c) \quad (\text{Weight})$$

$$= 3,913.1 / (2*\pi*31.306*20,000*1.20*1.00)$$

$$= 0.0008''$$

$$t_t = t_p + t_m - t_w \quad (\text{total required, tensile})$$

$$= 0.8515 + 0.0009 - (0.0008)$$

$$= \underline{0.8515''}$$

$$t_{wc} = (1 + V\text{Accel})*W / (2*\pi*R_m*S_t*K_s*E_c) \quad (\text{Weight})$$

$$= 2.00*3,913.1 / (2*\pi*31.306*20,000*1.20*1.00)$$

$$= 0.0017''$$

$$t_c = |t_{mc} + t_{wc} - t_{pc}| \quad (\text{total, net tensile})$$

$$= |0.0009 + (0.0017) - (0.8515)|$$

$$= \underline{0.8489''}$$

Maximum allowable working pressure, Longitudinal Stress

$$P = 2*S_t*K_s*E_c*(t - t_m + t_w) / (R - 0.40*(t - t_m + t_w))$$

$$= 2*20,000*1.20*1.00*(2.612 - 0.0009 + (0.0008)) / (30 - 0.40*(2.612 - 0.0009 + (0.0008)))$$

$$= 4,329.87 \text{ psi}$$

Hot Shut Down, Corroded, Seismic, Bottom Seam

$$t_p = 0'' \quad (\text{Pressure})$$

$$t_m = M / (\pi*R_m^2*S_t*K_s*E_c) \quad (\text{bending})$$

$$= 64,702 / (\pi*31.3685^2*20,000*1.20*1.00)$$

$$= 0.0009''$$

$$t_w = W / (2*\pi*R_m*S_t*K_s*E_c) \quad (\text{Weight})$$

$$= 3,740.2 / (2*\pi*31.3685*20,000*1.20*1.00)$$

$$= 0.0008''$$

$$t_t = t_p + t_m - t_w \quad (\text{total required, tensile})$$

$$= 0 + 0.0009 - (0.0008)$$

$$= \underline{0.0001''}$$

$$\begin{aligned} t_{mc} &= M / (\pi^2 R_m^2 S_c K_s) && \text{(bending)} \\ &= 64,702 / (\pi^2 31.3685^2 17,359.27 * 1.20) \\ &= 0.001'' \end{aligned}$$

$$\begin{aligned} t_{wc} &= (1 + V_{Accel}) * W / (2 * \pi^2 R_m^2 S_c K_s) && \text{(Weight)} \\ &= 2.00 * 3,740.2 / (2 * \pi^2 31.3685^2 17,359.27 * 1.20) \\ &= 0.0018'' \end{aligned}$$

$$\begin{aligned} t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\ &= 0.001 + (0.0018) - (0) \\ &= \underline{0.0028''} \end{aligned}$$

Hot Shut Down, New, Seismic, Bottom Seam

$$t_p = 0'' \quad \text{(Pressure)}$$

$$\begin{aligned} t_m &= M / (\pi^2 R_m^2 S_t K_s E_c) && \text{(bending)} \\ &= 66,830 / (\pi^2 31.306^2 20,000 * 1.20 * 1.00) \\ &= 0.0009'' \end{aligned}$$

$$\begin{aligned} t_w &= W / (2 * \pi^2 R_m^2 S_t K_s E_c) && \text{(Weight)} \\ &= 3,913.1 / (2 * \pi^2 31.306^2 20,000 * 1.20 * 1.00) \\ &= 0.0008'' \end{aligned}$$

$$\begin{aligned} t_t &= t_p + t_m - t_w && \text{(total required, tensile)} \\ &= 0 + 0.0009 - (0.0008) \\ &= \underline{0.0001''} \end{aligned}$$

$$\begin{aligned} t_{mc} &= M / (\pi^2 R_m^2 S_c K_s) && \text{(bending)} \\ &= 66,830 / (\pi^2 31.306^2 17,371.43 * 1.20) \\ &= 0.001'' \end{aligned}$$

$$\begin{aligned} t_{wc} &= (1 + V_{Accel}) * W / (2 * \pi^2 R_m^2 S_c K_s) && \text{(Weight)} \\ &= 2.00 * 3,913.1 / (2 * \pi^2 31.306^2 17,371.43 * 1.20) \\ &= 0.0019'' \end{aligned}$$

$$\begin{aligned} t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\ &= 0.001 + (0.0019) - (0) \\ &= \underline{0.0029''} \end{aligned}$$

Empty, Corroded, Seismic, Bottom Seam

$$t_p = 0'' \quad \text{(Pressure)}$$

$$\begin{aligned} t_m &= M / (\pi^2 R_m^2 S_c K_s) && \text{(bending)} \\ &= 54,112 / (\pi^2 31.3685^2 17,359.27 * 1.20) \\ &= 0.0008'' \end{aligned}$$

$$\begin{aligned} t_w &= W / (2 * \pi^2 R_m^2 S_c K_s) && \text{(Weight)} \\ &= 3,740.2 / (2 * \pi^2 31.3685^2 17,359.27 * 1.20) \\ &= 0.0009'' \end{aligned}$$

$$\begin{aligned} t_t &= |t_p + t_m - t_w| && \text{(total, net compressive)} \\ &= |0 + 0.0008 - (0.0009)| \\ &= \underline{0.0001''} \end{aligned}$$

$$t_{wc} = (1 + V_{Accel}) * W / (2 * \pi * R_m * S_c * K_s) \quad (\text{Weight})$$

$$= 2.00 * 3,740.2 / (2 * \pi * 31.3685 * 17,359.27 * 1.20)$$

$$= 0.0018''$$

$$t_c = t_{mc} + t_{wc} - t_{pc} \quad (\text{total required, compressive})$$

$$= 0.0008 + (0.0018) - (0)$$

$$= \underline{0.0027''}$$

Empty, New, Seismic, Bottom Seam

$$t_p = 0'' \quad (\text{Pressure})$$

$$t_m = M / (\pi * R_m^2 * S_c * K_s) \quad (\text{bending})$$

$$= 56,321 / (\pi * 31.306^2 * 17,371.43 * 1.20)$$

$$= 0.0009''$$

$$t_w = W / (2 * \pi * R_m * S_c * K_s) \quad (\text{Weight})$$

$$= 3,913.1 / (2 * \pi * 31.306 * 17,371.43 * 1.20)$$

$$= 0.001''$$

$$t_t = |t_p + t_m - t_w| \quad (\text{total, net compressive})$$

$$= |0 + 0.0009 - (0.001)|$$

$$= \underline{0.0001''}$$

$$t_{wc} = (1 + V_{Accel}) * W / (2 * \pi * R_m * S_c * K_s) \quad (\text{Weight})$$

$$= 2.00 * 3,913.1 / (2 * \pi * 31.306 * 17,371.43 * 1.20)$$

$$= 0.0019''$$

$$t_c = t_{mc} + t_{wc} - t_{pc} \quad (\text{total required, compressive})$$

$$= 0.0009 + (0.0019) - (0)$$

$$= \underline{0.0028''}$$

Vacuum, Seismic, Bottom Seam

$$t_p = P * R / (2 * S_c * K_s + 0.40 * |P|) \quad (\text{Pressure})$$

$$= -15 * 30.125 / (2 * 17,359.27 * 1.20 + 0.40 * |15|)$$

$$= -0.0108''$$

$$t_m = M / (\pi * R_m^2 * S_c * K_s) \quad (\text{bending})$$

$$= 64,702 / (\pi * 31.3685^2 * 17,359.27 * 1.20)$$

$$= 0.001''$$

$$t_w = W / (2 * \pi * R_m * S_c * K_s) \quad (\text{Weight})$$

$$= 3,740.2 / (2 * \pi * 31.3685 * 17,359.27 * 1.20)$$

$$= 0.0009''$$

$$t_t = |t_p + t_m - t_w| \quad (\text{total, net compressive})$$

$$= |-0.0108 + 0.001 - (0.0009)|$$

$$= \underline{0.0108''}$$

$$t_{wc} = (1 + V_{Accel}) * W / (2 * \pi * R_m * S_c * K_s) \quad (\text{Weight})$$

$$= 2.00 * 3,740.2 / (2 * \pi * 31.3685 * 17,359.27 * 1.20)$$

$$= 0.0018''$$

$$t_c = t_{mc} + t_{wc} - t_{pc} \quad (\text{total required, compressive})$$

$$= 0.001 + (0.0018) - (-0.0108)$$

$$= \underline{0.0137''}$$

Maximum Allowable External Pressure, Longitudinal Stress

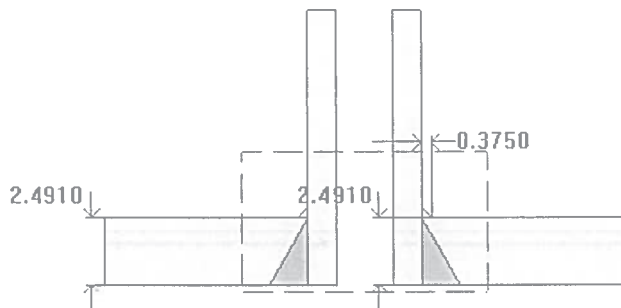
$$\begin{aligned} P &= 2 * S_c * K_s * (t - t_{mc} - t_{wc}) / (R - 0.40 * (t - t_{mc} - t_{wc})) \\ &= 2 * 17,359.27 * 1.20 * (2.487 - 0.001 - 0.0018) / (30.125 - 0.40 * (2.487 - 0.001 - 0.0018)) \\ &= 3,552.75 \text{ psi} \end{aligned}$$

Vent (N7)

ASME Section VIII Division 1, 2010 Edition, A11 Addenda

$$t_{w(\text{lower})} = 2.491 \text{ in}$$

$$\text{Leg}_{41} = 0.375 \text{ in}$$



Note: round inside edges per UG-76 c)

Location and Orientation

Located on:	60 ID TOP SE HEAD
Orientation:	0°
End of nozzle to datum line:	-24.5 in
Calculated as hillside:	Yes
Distance to head center, R:	18 in
Passes through a Category A joint:	No

Nozzle

Access opening:	No
Material specification:	SA-350 LF2 Cl 1 (II-D p. 18, In. 10)
Inside diameter, new:	2 in
Nominal wall thickness:	1.06 in
Corrosion allowance:	0.125 in
Opening chord length:	2.3928 in
Projection available outside vessel, Lpr:	5.5086 in
Projection available outside vessel to flange face, Lf:	7.2586 in
Local vessel minimum thickness:	2.491 in
Liquid static head included:	0 psi
Longitudinal joint efficiency:	1

ASME B16.5-2009 Flange

Description:	NPS 2 Class 900 LWN A350 LF2 Cl.1
Bolt Material:	SA-193 B7 Bolt <= 2 1/2 (II-D p. 334, In. 32)
Blind included:	No
Rated MDMT:	-55°F per UCS-66(b)(1)(b)
Liquid static head:	0 psi
MAWP rating:	2,146 psi @ 140°F
MAP rating:	2,220 psi @ 50°F
Hydrotest rating:	3,350 psi @ 50°F

PWHT performed:

Yes



Reinforcement Calculations for Chamber MAWP

UG-37 Area Calculation Summary (in²) For P = 1,378 psi @ 140 °F The opening is adequately reinforced							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
4.4824	7.3864	3.2529	3.9929	--	--	0.1406	0.3324	1.06

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(1)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	<u>0.25</u>	0.2625	weld size is adequate

Calculations for internal pressure 1,378 psi @ 140 °F

Nozzle is impact test exempt to -155 °F per UCS-66(b)(3) (coincident ratio = 0.0865).

Nozzle UCS-66 governing thk: 1.06 in

Nozzle rated MDMT: -155 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(2.3928, 1.1964 + (1.06 - 0.125) + (2.491 - 0.125)) \\
 &= 4.4974 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.491 - 0.125), 2.5*(1.06 - 0.125) + 0) \\
 &= 2.3375 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-27(c)(1)

$$\begin{aligned}
 t_{rn} &= P * R_n / (S_n * E - 0.6 * P) \\
 &= 1,378 * 1.125 / (20,000 * 1 - 0.6 * 1,378) \\
 &= 0.0809 \text{ in}
 \end{aligned}$$

Required thickness t_r from UG-37(a)(c)

$$\begin{aligned}
 t_r &= P * K_1 * D / (2 * S * E - 0.2 * P) \\
 &= 1,378 * 0.8963 * 60.25 / (2 * 20,000 * 1 - 0.2 * 1,378)
 \end{aligned}$$

$$= 1.8733 \text{ in}$$

Area required per UG-37(c)

Allowable stresses: $S_n = 20,000$, $S_v = 20,000$ psi

$$f_{r1} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$f_{r2} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$\begin{aligned} A &= d \cdot t_r \cdot F + 2 \cdot t_n \cdot t_r \cdot F \cdot (1 - f_{r1}) \\ &= 2.3928 \cdot 1.8733 \cdot 1 + 2 \cdot 0.935 \cdot 1.8733 \cdot 1 \cdot (1 - 1) \\ &= \underline{4.4824} \text{ in}^2 \end{aligned}$$

Area available from FIG. UG-37.1

$$A_1 = \text{larger of the following} = \underline{3.2529} \text{ in}^2$$

$$\begin{aligned} &= d \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1}) \\ &= 2.3928 \cdot (1 \cdot 2.366 - 1 \cdot 1.8733) - 2 \cdot 0.935 \cdot (1 \cdot 2.366 - 1 \cdot 1.8733) \cdot (1 - 1) \\ &= 1.179 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} &= 2 \cdot (t + t_n) \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1}) \\ &= 2 \cdot (2.366 + 0.935) \cdot (1 \cdot 2.366 - 1 \cdot 1.8733) - 2 \cdot 0.935 \cdot (1 \cdot 2.366 - 1 \cdot 1.8733) \cdot (1 - 1) \\ &= 3.2529 \text{ in}^2 \end{aligned}$$

$$A_2 = \text{smaller of the following} = \underline{3.9929} \text{ in}^2$$

$$\begin{aligned} &= 2 \cdot (t_n - t_m) \cdot f_{r2} \cdot L_{pr} \\ &= 2 \cdot (0.935 - 0.0809) \cdot 1 \cdot 5.5086 \\ &= 9.4098 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} &= 5 \cdot (t_n - t_m) \cdot f_{r2} \cdot t_n \\ &= 5 \cdot (0.935 - 0.0809) \cdot 1 \cdot 0.935 \\ &= 3.9929 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} A_{41} &= \text{Leg}^2 \cdot f_{r2} \\ &= 0.375^2 \cdot 1 \\ &= \underline{0.1406} \text{ in}^2 \end{aligned}$$

$$\begin{aligned} \text{Area} &= A_1 + A_2 + A_{41} \\ &= 3.2529 + 3.9929 + 0.1406 \\ &= \underline{7.3864} \text{ in}^2 \end{aligned}$$

As Area \geq A the reinforcement is adequate.

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \text{lesser of } 0.75 \text{ or } t_n \text{ or } t = 0.75 \text{ in}$

$t_{c(\min)} = \text{lesser of } 0.25 \text{ or } 0.7 * t_{\min} = 0.25 \text{ in}$

$t_{c(\text{actual})} = 0.7 * \text{Leg} = 0.7 * 0.375 = 0.2625 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$\begin{aligned} t_{a \text{ UG-27}} &= P * R / (S * E - 0.6 * P) + \text{Corrosion} \\ &= 1,378 * 1.125 / (20,000 * 1 - 0.6 * 1,378) + 0.125 \\ &= 0.2059 \text{ in} \end{aligned}$$

$$\begin{aligned} t_a &= \max[t_{a \text{ UG-27}}, t_{a \text{ UG-22}}] \\ &= \max[0.2059, 0] \\ &= 0.2059 \text{ in} \end{aligned}$$

$$t_{b1} = 2.2035 \text{ in}$$

$$\begin{aligned} t_{b1} &= \max[t_{b1}, t_{b \text{ UG16}}] \\ &= \max[2.2035, 0.1875] \\ &= 2.2035 \text{ in} \end{aligned}$$

$$\begin{aligned} t_b &= \min[t_{b3}, t_{b1}] \\ &= \min[0.3324, 2.2035] \\ &= 0.3324 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{\text{UG-45}} &= \max[t_a, t_b] \\ &= \max[0.2059, 0.3324] \\ &= 0.3324 \text{ in} \end{aligned}$$

Available nozzle wall thickness new, $t_n = 1.06 \text{ in}$

The nozzle neck thickness is adequate.

Reinforcement Calculations for MAEP

UG-37 Area Calculation Summary (in²) For Pe = 750.1 psi @ 140 °F The opening is adequately reinforced							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
<u>2.8278</u>	<u>3.8609</u>	--	<u>3.7203</u>	--	--	<u>0.1406</u>	<u>0.3324</u>	1.06

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (In)	Actual weld throat size (In)	Status
Nozzle to shell fillet (Leg ₄₁)	<u>0.25</u>	0.2625	weld size is adequate

Calculations for external pressure 750.1 psi @ 140 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(2.3904, 1.1952 + (1.06 - 0.125) + (2.491 - 0.125)) \\
 &= 4.4962 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.491 - 0.125), 2.5*(1.06 - 0.125) + 0) \\
 &= 2.3375 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-28 t_{rn} = 0.1392 in

From UG-37(d)(1) required thickness t_r = 2.366 in

Area required per UG-37(d)(1)

Allowable stresses: S_n = 20,000, S_v = 20,000 psi

$$f_{r1} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$f_{r2} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$A = 0.5*(d*t_r*F + 2*t_n*t_r*F*(1 - f_{r1}))$$

$$= 0.5*(2.3904*2.366*1 + 2*0.935*2.366*1*(1 - 1))$$

$$= \underline{2.8278} \text{ in}^2$$

Area available from FIG. UG-37.1

$$A_1 = \text{larger of the following} = \underline{0} \text{ in}^2$$

$$= d*(E_1*t - F*t_r) - 2*t_n*(E_1*t - F*t_r)*(1 - f_{r1})$$

$$= 2.3904*(1*2.366 - 1*2.366) - 2*0.935*(1*2.366 - 1*2.366)*(1 - 1)$$

$$= 0 \text{ in}^2$$

$$= 2*(t + t_n)*(E_1*t - F*t_r) - 2*t_n*(E_1*t - F*t_r)*(1 - f_{r1})$$

$$= 2*(2.366 + 0.935)*(1*2.366 - 1*2.366) - 2*0.935*(1*2.366 - 1*2.366)*(1 - 1)$$

$$= 0 \text{ in}^2$$

$$A_2 = \text{smaller of the following} = \underline{3.7203} \text{ in}^2$$

$$= 2*(t_n - t_{rn})*f_{r2}*L_{pr}$$

$$= 2*(0.935 - 0.1392)*1*5.5086$$

$$= 8.7672 \text{ in}^2$$

$$= 5*(t_n - t_{rn})*f_{r2}*t_n$$

$$= 5*(0.935 - 0.1392)*1*0.935$$

$$= 3.7203 \text{ in}^2$$

$$A_{41} = \text{Leg}^2*f_{r2}$$

$$= 0.375^2*1$$

$$= \underline{0.1406} \text{ in}^2$$

$$\text{Area} = A_1 + A_2 + A_{41}$$

$$= 0 + 3.7203 + 0.1406$$

$$= \underline{3.8609} \text{ in}^2$$

As Area \geq A the reinforcement is adequate.

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \text{lesser of } 0.75 \text{ or } t_n \text{ or } t = 0.75 \text{ in}$

$t_{c(\min)} = \text{lesser of } 0.25 \text{ or } 0.7*t_{\min} = \underline{0.25} \text{ in}$

$t_{c(\text{actual})} = 0.7*\text{Leg} = 0.7*0.375 = 0.2625 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$t_{a \text{ UG-28}} = 0.2642 \text{ in}$$

$$\begin{aligned} t_a &= \max[t_{a \text{ UG-28}}, t_{a \text{ UG-22}}] \\ &= \max[0.2642, 0] \\ &= 0.2642 \text{ in} \end{aligned}$$

$$t_{b2} = 1.2529 \text{ in}$$

$$\begin{aligned} t_{b2} &= \max[t_{b2}, t_{b \text{ UG16}}] \\ &= \max[1.2529, 0.1875] \\ &= 1.2529 \text{ in} \end{aligned}$$

$$\begin{aligned} t_b &= \min[t_{b3}, t_{b2}] \\ &= \min[0.3324, 1.2529] \\ &= 0.3324 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{\text{UG-45}} &= \max[t_a, t_b] \\ &= \max[0.2642, 0.3324] \\ &= 0.3324 \text{ in} \end{aligned}$$

Available nozzle wall thickness new, $t_n = 1.06$ in

The nozzle neck thickness is adequate.

External Pressure, (Corroded & at 140 °F) UG-28(c)

$$L / D_o = 8.7407 / 4.12 = 2.1215$$

$$D_o / t = 4.12 / 0.1392 = 29.5928$$

From table G: $A = 0.003723$

From table
CS-2: $B = 16,648.1137$ psi

$$\begin{aligned} P_a &= 4 * B / (3 * (D_o / t)) \\ &= 4 * 16,648.11 / (3 * (4.12 / 0.1392)) \\ &= 750.1 \text{ psi} \end{aligned}$$

Design thickness for external pressure $P_a = 750.1$ psi

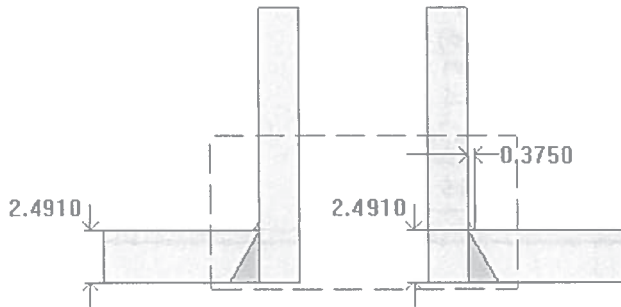
$$t_a = t + \text{Corrosion} = 0.1392 + 0.125 = 0.2642''$$

Outlet (N10)

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$$t_{w(\text{lower})} = 2.491 \text{ in}$$

$$\text{Leg}_{41} = 0.375 \text{ in}$$



Note: round inside edges per UG-76(c)

Location and Orientation

Located on:	60 ID TOP SE HEAD
Orientation:	0°
End of nozzle to datum line:	-29.1875 in
Calculated as hillside:	No
Distance to head center, R:	0 in
Passes through a Category A joint:	No

Nozzle

Access opening:	No
Material specification:	SA-350 LF2 Cl 1 (II-D p. 18, In. 10)
Inside diameter, new:	8 in
Nominal wall thickness:	1.875 in
Corrosion allowance:	0.125 in
Projection available outside vessel, Lpr:	7.2348 in
Projection available outside vessel to flange face, Lf:	9.9848 in
Local vessel minimum thickness:	2.491 in
Liquid static head included:	0 psi
Longitudinal joint efficiency:	1

ASME B16.5-2009 Flange

Description:	NPS 8 Class 900 LWN A350 LF2 Cl.1
Bolt Material:	SA-193 B7 Bolt <= 2 1/2 (II-D p. 334, In. 32)
Blind included:	No
Rated MDMT:	-55°F per UCS-66(b)(1)(b)
Liquid static head:	0 psi
MAWP rating:	2,146 psi @ 140°F
MAP rating:	2,220 psi @ 50°F
Hydrotest rating:	3,350 psi @ 50°F
PWHT performed:	Yes

Reinforcement Calculations for Chamber MAWP

UG-37 Area Calculation Summary (in ²) For P = 1,378 psi @ 140 °F The opening is adequately reinforced							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
15.4546	16.9236	4.0649	12.7181	--	--	0.1406	0.4531	1.875

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(1)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (In)	Actual weld throat size (In)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for internal pressure 1,378 psi @ 140 °F

Nozzle is impact test exempt to -155 °F per UCS-66(b)(3) (coincident ratio = 0.1694).

Nozzle UCS-66 governing thk: 1.875 in

Nozzle rated MDMT: -155 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(8.25, 4.125 + (1.875 - 0.125) + (2.491 - 0.125)) \\
 &= 8.25 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.491 - 0.125), 2.5*(1.875 - 0.125) + 0) \\
 &= 4.375 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-27(c)(1)

$$\begin{aligned}
 t_{rn} &= P \cdot R_n / (S_n \cdot E - 0.6 \cdot P) \\
 &= 1,378 \cdot 4.125 / (20,000 \cdot 1 - 0.6 \cdot 1,378) \\
 &= 0.2965 \text{ in}
 \end{aligned}$$

Required thickness t_r from UG-37(a)(c)

$$\begin{aligned}
 t_r &= P \cdot K_1 \cdot D / (2 \cdot S \cdot E - 0.2 \cdot P) \\
 &= 1,378 \cdot 0.8963 \cdot 60.25 / (2 \cdot 20,000 \cdot 1 - 0.2 \cdot 1,378) \\
 &= 1.8733 \text{ in}
 \end{aligned}$$

Area required per UG-37(c)

Allowable stresses: $S_n = 20,000$, $S_v = 20,000$ psi

$$f_{r1} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$f_{r2} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$\begin{aligned} A &= d \cdot t_r \cdot F + 2 \cdot t_n \cdot t_r \cdot F \cdot (1 - f_{r1}) \\ &= 8.25 \cdot 1.8733 \cdot 1 + 2 \cdot 1.75 \cdot 1.8733 \cdot 1 \cdot (1 - 1) \\ &= \underline{15.4546} \text{ in}^2 \end{aligned}$$

Area available from FIG. UG-37.1

$A_1 = \text{larger of the following} = \underline{4.0649} \text{ in}^2$

$$\begin{aligned} &= d \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1}) \\ &= 8.25 \cdot (1 \cdot 2.366 - 1 \cdot 1.8733) - 2 \cdot 1.75 \cdot (1 \cdot 2.366 - 1 \cdot 1.8733) \cdot (1 - 1) \\ &= 4.0649 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} &= 2 \cdot (t + t_n) \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1}) \\ &= 2 \cdot (2.366 + 1.75) \cdot (1 \cdot 2.366 - 1 \cdot 1.8733) - 2 \cdot 1.75 \cdot (1 \cdot 2.366 - 1 \cdot 1.8733) \cdot (1 - 1) \\ &= 4.0561 \text{ in}^2 \end{aligned}$$

$A_2 = \text{smaller of the following} = \underline{12.7181} \text{ in}^2$

$$\begin{aligned} &= 5 \cdot (t_n - t_m) \cdot f_{r2} \cdot t \\ &= 5 \cdot (1.75 - 0.2965) \cdot 1 \cdot 2.366 \\ &= 17.1949 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} &= 5 \cdot (t_n - t_m) \cdot f_{r2} \cdot t_n \\ &= 5 \cdot (1.75 - 0.2965) \cdot 1 \cdot 1.75 \\ &= 12.7181 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} A_{41} &= \text{Leg}^2 \cdot f_{r2} \\ &= 0.375^2 \cdot 1 \\ &= \underline{0.1406} \text{ in}^2 \end{aligned}$$

$$\begin{aligned} \text{Area} &= A_1 + A_2 + A_{41} \\ &= 4.0649 + 12.7181 + 0.1406 \\ &= \underline{16.9236} \text{ in}^2 \end{aligned}$$

As Area \geq A the reinforcement is adequate.

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \text{lesser of } 0.75 \text{ or } t_n \text{ or } t = 0.75 \text{ in}$

$t_{c(\min)} = \text{lesser of } 0.25 \text{ or } 0.7*t_{\min} = \underline{0.25} \text{ in}$

$t_{c(\text{actual})} = 0.7*\text{Leg} = 0.7*0.375 = 0.2625 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$\begin{aligned}t_{a \text{ UG-27}} &= P*R / (S*E - 0.6*P) + \text{Corrosion} \\ &= 1,378*4.125 / (20,000*1 - 0.6*1,378) + 0.125 \\ &= 0.4215 \text{ in}\end{aligned}$$

$$\begin{aligned}t_a &= \max[t_{a \text{ UG-27}}, t_{a \text{ UG-22}}] \\ &= \max[0.4215, 0] \\ &= 0.4215 \text{ in}\end{aligned}$$

$$t_{b1} = 2.2035 \text{ in}$$

$$\begin{aligned}t_{b1} &= \max[t_{b1}, t_{b \text{ UG16}}] \\ &= \max[2.2035, 0.1875] \\ &= 2.2035 \text{ in}\end{aligned}$$

$$\begin{aligned}t_b &= \min[t_{b3}, t_{b1}] \\ &= \min[0.4531, 2.2035] \\ &= 0.4531 \text{ in}\end{aligned}$$

$$\begin{aligned}t_{\text{UG-45}} &= \max[t_a, t_b] \\ &= \max[0.4215, 0.4531] \\ &= 0.4531 \text{ in}\end{aligned}$$

Available nozzle wall thickness new, $t_n = 1.875 \text{ in}$

The nozzle neck thickness is adequate.

Reinforcement Calculations for MAEP

<p align="center">UG-37 Area Calculation Summary (in²) For $P_e = 750.1 \text{ psi @ } 140 \text{ }^\circ\text{F}$ The opening is adequately reinforced</p>							<p align="center">UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45</p>	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
9.7598	12.1224	--	11.9818	--	--	0.1406	0.5057	1.875

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for external pressure 750.1 psi @ 140 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(8.25, 4.125 + (1.875 - 0.125) + (2.491 - 0.125)) \\
 &= 8.25 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.491 - 0.125), 2.5*(1.875 - 0.125) + 0) \\
 &= 4.375 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-28 $t_{rn} = 0.3807 \text{ in}$

From UG-37(d)(1) required thickness $t_r = 2.366 \text{ in}$

Area required per UG-37(d)(1)

Allowable stresses: $S_n = 20,000, S_v = 20,000 \text{ psi}$

$$f_{r1} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$f_{r2} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$\begin{aligned}
 A &= 0.5*(d*t_r*F + 2*t_n*t_r*F*(1 - f_{r1})) \\
 &= 0.5*(8.25*2.366*1 + 2*1.75*2.366*1*(1 - 1))
 \end{aligned}$$

$$= 9.7598 \text{ in}^2$$

Area available from FIG. UG-37.1

$$A_1 = \text{larger of the following} = 0 \text{ in}^2$$

$$\begin{aligned} &= d(E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}) \\ &= 8.25 (1 * 2.366 - 1 * 2.366) - 2 * 1.75 (1 * 2.366 - 1 * 2.366) (1 - 1) \\ &= 0 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} &= 2 (t + t_n) (E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}) \\ &= 2 (2.366 + 1.75) (1 * 2.366 - 1 * 2.366) - 2 * 1.75 (1 * 2.366 - 1 * 2.366) (1 - 1) \\ &= 0 \text{ in}^2 \end{aligned}$$

$$A_2 = \text{smaller of the following} = 11.9818 \text{ in}^2$$

$$\begin{aligned} &= 5 (t_n - t_m) f_{r2} t \\ &= 5 (1.75 - 0.3807) * 1 * 2.366 \\ &= 16.1993 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} &= 5 (t_n - t_m) f_{r2} t_n \\ &= 5 (1.75 - 0.3807) * 1 * 1.75 \\ &= 11.9818 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} A_{41} &= \text{Leg}^2 f_{r2} \\ &= 0.375^2 * 1 \\ &= 0.1406 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} \text{Area} &= A_1 + A_2 + A_{41} \\ &= 0 + 11.9818 + 0.1406 \\ &= 12.1224 \text{ in}^2 \end{aligned}$$

As Area \geq A the reinforcement is adequate.

UW-16(c) Weld Check

Fillet weld: t_{\min} = lesser of 0.75 or t_n or $t = 0.75$ in

$t_{c(\min)}$ = lesser of 0.25 or $0.7 * t_{\min} = 0.25$ in

$t_{c(\text{actual})}$ = $0.7 * \text{Leg} = 0.7 * 0.375 = 0.2625$ in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$t_{a \text{ UG-28}} = 0.5057 \text{ in}$$

$$\begin{aligned} t_a &= \max[t_{a \text{ UG-28}}, t_{a \text{ UG-22}}] \\ &= \max[0.5057, 0] \\ &= 0.5057 \text{ in} \end{aligned}$$

$$t_{b2} = 1.2529 \text{ in}$$

$$\begin{aligned} t_{b2} &= \max[t_{b2}, t_{b \text{ UG16}}] \\ &= \max[1.2529, 0.1875] \\ &= 1.2529 \text{ in} \end{aligned}$$

$$\begin{aligned} t_b &= \min[t_{b3}, t_{b2}] \\ &= \min[0.4531, 1.2529] \\ &= 0.4531 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{\text{UG-45}} &= \max[t_a, t_b] \\ &= \max[0.5057, 0.4531] \\ &= 0.5057 \text{ in} \end{aligned}$$

Available nozzle wall thickness new, $t_n = 1.875$ in

The nozzle neck thickness is adequate.

External Pressure, (Corroded & at 140 °F) UG-28(c)

$$L / D_o = 9.9848 / 11.75 = 0.8498$$

$$D_o / t = 11.75 / 0.3807 = 30.8677$$

From table G: $A = 0.009769$

From table
CS-2: $B = 17,365.3559$ psi

$$\begin{aligned} P_a &= 4*B / (3*(D_o / t)) \\ &= 4*17,365.36 / (3*(11.75 / 0.3807)) \\ &= 750.1 \text{ psi} \end{aligned}$$

Design thickness for external pressure $P_a = 750.1$ psi

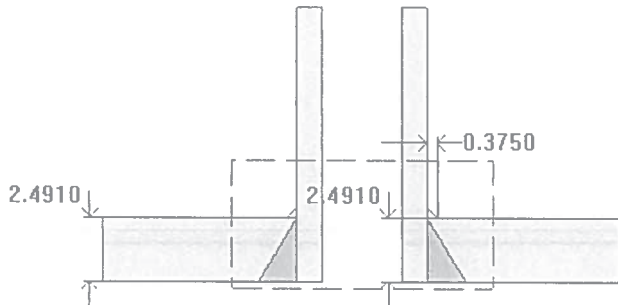
$$t_a = t + \text{Corrosion} = 0.3807 + 0.125 = 0.5057''$$

Corrosion Coupon (N9)

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$$t_{w(\text{lower})} = 2.491 \text{ in}$$

$$\text{Leg}_{41} = 0.375 \text{ in}$$



Note: round inside edges per UG-76(c)

Location and Orientation

Located on:	60 ID TOP SE HEAD
Orientation:	180°
End of nozzle to datum line:	-24.5 in
Calculated as hillside:	Yes
Distance to head center, R:	18 in
Passes through a Category A joint:	No

Nozzle

Access opening:	No
Material specification:	SA-350 LF2 Cl 1 (II-D p. 18, In. 10)
Inside diameter, new:	3 in
Nominal wall thickness:	1 in
Corrosion allowance:	0.125 in
Opening chord length:	3.4569 in
Projection available outside vessel, Lpr:	5.3776 in
Projection available outside vessel to flange face, Lf:	7.1276 in
Local vessel minimum thickness:	2.491 in
Liquid static head included:	0 psi
Longitudinal joint efficiency:	1

ASME B16.5-2009 Flange

Description:	NPS 3 Class 900 LWN A350 LF2 Cl.1
Bolt Material:	SA-193 B7 Bolt <= 2 1/2 (II-D p. 334, In. 32)
Blind included:	No
Rated MDMT:	-55 °F per UCS-66(b)(1)(b)
Liquid static head:	0 psi
MAWP rating:	2,146 psi @ 140 °F
MAP rating:	2,220 psi @ 50 °F
Hydrotest rating:	3,350 psi @ 50 °F

PWHT performed:

Yes



Reinforcement Calculations for Chamber MAWP

UG-37 Area Calculation Summary (in ²) For P = 1,378 psi @ 140 °F The opening is adequately reinforced							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
6.4757	6.6515	3.1938	3.3171	--	--	0.1406	0.3508	1

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(1)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (In)	Actual weld throat size (In)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for internal pressure 1,378 psi @ 140 °F

Nozzle is impact test exempt to -155 °F per UCS-66(b)(3) (coincident ratio = 0.1335).

Nozzle UCS-66 governing thk: 1 in

Nozzle rated MDMT: -155 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(3.4569, 1.7285 + (1 - 0.125) + (2.491 - 0.125)) \\
 &= 4.9695 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.491 - 0.125), 2.5*(1 - 0.125) + 0) \\
 &= 2.1875 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-27(c)(1)

$$\begin{aligned}
 t_{rn} &= P \cdot R_n / (S_n \cdot E - 0.6 \cdot P) \\
 &= 1,378 \cdot 1.625 / (20,000 \cdot 1 - 0.6 \cdot 1,378) \\
 &= 0.1168 \text{ in}
 \end{aligned}$$

Required thickness t_r from UG-37(a)(c)

$$\begin{aligned}
 t_r &= P \cdot K_1 \cdot D / (2 \cdot S \cdot E - 0.2 \cdot P) \\
 &= 1,378 \cdot 0.8963 \cdot 60.25 / (2 \cdot 20,000 \cdot 1 - 0.2 \cdot 1,378)
 \end{aligned}$$

$$= 1.8733 \text{ in}$$

Area required per UG-37(c)

Allowable stresses: $S_n = 20,000$, $S_v = 20,000$ psi

$$f_{r1} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$f_{r2} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$\begin{aligned} A &= d \cdot t_r \cdot F + 2 \cdot t_n \cdot t_r \cdot F \cdot (1 - f_{r1}) \\ &= 3.4569 \cdot 1.8733 \cdot 1 + 2 \cdot 0.875 \cdot 1.8733 \cdot 1 \cdot (1 - 1) \\ &= \underline{6.4757} \text{ in}^2 \end{aligned}$$

Area available from FIG. UG-37.1

$A_1 = \text{larger of the following} = \underline{3.1938} \text{ in}^2$

$$\begin{aligned} &= d \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1}) \\ &= 3.4569 \cdot (1 \cdot 2.366 - 1 \cdot 1.8733) - 2 \cdot 0.875 \cdot (1 \cdot 2.366 - 1 \cdot 1.8733) \cdot (1 - 1) \\ &= 1.7033 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} &= 2 \cdot (t + t_n) \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1}) \\ &= 2 \cdot (2.366 + 0.875) \cdot (1 \cdot 2.366 - 1 \cdot 1.8733) - 2 \cdot 0.875 \cdot (1 \cdot 2.366 - 1 \cdot 1.8733) \cdot (1 - 1) \\ &= 3.1938 \text{ in}^2 \end{aligned}$$

$A_2 = \text{smaller of the following} = \underline{3.3171} \text{ in}^2$

$$\begin{aligned} &= 2 \cdot (t_n - t_m) \cdot f_{r2} \cdot L_{pr} \\ &= 2 \cdot (0.875 - 0.1168) \cdot 1 \cdot 5.3776 \\ &= 8.1546 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} &= 5 \cdot (t_n - t_m) \cdot f_{r2} \cdot t_n \\ &= 5 \cdot (0.875 - 0.1168) \cdot 1 \cdot 0.875 \\ &= 3.3171 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} A_{41} &= \text{Leg}^2 \cdot f_{r2} \\ &= 0.375^2 \cdot 1 \\ &= \underline{0.1406} \text{ in}^2 \end{aligned}$$

$$\begin{aligned} \text{Area} &= A_1 + A_2 + A_{41} \\ &= 3.1938 + 3.3171 + 0.1406 \\ &= \underline{6.6515} \text{ in}^2 \end{aligned}$$

As Area \geq A the reinforcement is adequate.

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \text{lesser of } 0.75 \text{ or } t_n \text{ or } t = 0.75 \text{ in}$

$t_{c(\min)} = \text{lesser of } 0.25 \text{ or } 0.7*t_{\min} = 0.25 \text{ in}$

$t_{c(\text{actual})} = 0.7*\text{Leg} = 0.7*0.375 = 0.2625 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$\begin{aligned}t_{a \text{ UG-27}} &= P*R / (S*E - 0.6*P) + \text{Corrosion} \\ &= 1,378*1.625 / (20,000*1 - 0.6*1,378) + 0.125 \\ &= 0.2418 \text{ in}\end{aligned}$$

$$t_{a \text{ UG-22}} = 0.2384 \text{ in}$$

$$\begin{aligned}t_a &= \max[t_{a \text{ UG-27}}, t_{a \text{ UG-22}}] \\ &= \max[0.2418, 0.2384] \\ &= 0.2418 \text{ in}\end{aligned}$$

$$t_{b1} = 2.2035 \text{ in}$$

$$\begin{aligned}t_{b1} &= \max[t_{b1}, t_{b \text{ UG16}}] \\ &= \max[2.2035, 0.1875] \\ &= 2.2035 \text{ in}\end{aligned}$$

$$\begin{aligned}t_b &= \min[t_{b3}, t_{b1}] \\ &= \min[0.3508, 2.2035] \\ &= 0.3508 \text{ in}\end{aligned}$$

$$\begin{aligned}t_{\text{UG-45}} &= \max[t_a, t_b] \\ &= \max[0.2418, 0.3508] \\ &= 0.3508 \text{ in}\end{aligned}$$

Available nozzle wall thickness new, $t_n = 1 \text{ in}$

The nozzle neck thickness is adequate.

Applied Loads

Radial load: $P_r = 642 \text{ lb}_f$
Circumferential moment: $M_1 = 8,629 \text{ lb}_f\text{-in}$
Circumferential shear: $V_2 = 787 \text{ lb}_f$
Longitudinal moment: $M_2 = 8,629 \text{ lb}_f\text{-in}$
Longitudinal shear: $V_1 = 787 \text{ lb}_f$
Torsion moment: $M_t = 12,214 \text{ lb}_f\text{-in}$
Internal pressure: $P = 1,378 \text{ psi}$
Head yield stress: $S_y = 36,200 \text{ psi}$

Maximum stresses due to the applied loads at the nozzle OD (includes pressure)

Mean dish radius $R_m = 55.578 \text{ in}$

$$U = r_o / \text{Sqr}(R_m * t) = 0.218$$

Pressure stress intensity factor, $I = 1$ (derived from PVP-Vol. 399, pages 77-82)

$$\text{Local pressure stress} = I * P * R_i / (2 * t) = 15,840 \text{ psi}$$

$$\text{Maximum combined stress } (P_L + P_b + Q) = 16,538 \text{ psi}$$

$$\text{Allowable combined stress } (P_L + P_b + Q) = +-3 * S = +-60,000 \text{ psi}$$

The maximum combined stress $(P_L + P_b + Q)$ is within allowable limits.

$$\text{Maximum local primary membrane stress } (P_L) = 15,839 \text{ psi}$$

$$\text{Allowable local primary membrane stress } (P_L) = +-1.5 * S = +-30,000 \text{ psi}$$

The maximum local primary membrane stress (P_L) is within allowable limits.

Stresses at the nozzle OD per WRC Bulletin 107									
Figure	value	A _u	A _i	B _u	B _i	C _u	C _i	D _u	D _i
SR-2*	0.2178	-25	-25	-25	-25	-25	-25	-25	-25
SR-2	0.1824	-126	126	-126	126	-126	126	-126	126
SR-3*	0.1614	0	0	0	0	-22	-22	22	22
SR-3	0.6952	0	0	0	0	-561	561	561	-561
SR-3*	0.1614	-22	-22	22	22	0	0	0	0
SR-3	0.6952	-561	561	561	-561	0	0	0	0
Pressure stress*		15,840	15,840	15,840	15,840	15,840	15,840	15,840	15,840
Total O _x stress		15,106	16,480	16,272	15,402	15,106	16,480	16,272	15,402
Membrane O _x stress*		15,793	15,793	15,837	15,837	15,793	15,793	15,837	15,837
SR-2*	0.0675	-8	-8	-8	-8	-8	-8	-8	-8
SR-2	0.0544	-37	37	-37	37	-37	37	-37	37
SR-3*	0.0487	0	0	0	0	-7	-7	7	7
SR-3	0.202	0	0	0	0	-163	163	163	-163
SR-3*	0.0487	-7	-7	7	7	0	0	0	0
SR-3	0.202	-163	163	163	-163	0	0	0	0
Pressure stress*		15,840	15,840	15,840	15,840	15,840	15,840	15,840	15,840
Total O _y stress		15,625	16,025	15,965	15,713	15,625	16,025	15,965	15,713
Membrane O _y stress*		15,825	15,825	15,839	15,839	15,825	15,825	15,839	15,839
Shear from M _t		131	131	131	131	131	131	131	131
Shear from V ₁		0	0	0	0	-42	-42	42	42
Shear from V ₂		42	42	-42	-42	0	0	0	0
Total Shear stress		173	173	89	89	89	89	173	173
Combined stress (P _L +P _b +Q)		15,677	16,538	16,296	15,737	15,640	16,497	16,350	15,790

Notes: (1) * denotes primary stress.

(2) The nozzle is assumed to be a rigid (solid) attachment.

Longitudinal stress in the nozzle wall due to internal pressure + external loads

$$\begin{aligned}\sigma_{n(P_m)} &= P \cdot R_i / (2 \cdot t_n) - P_r / (\pi \cdot (R_o^2 - R_i^2)) + M \cdot R_o / I \\ &= 1,378 \cdot 1.625 / (2 \cdot 0.875) - 642 / (\pi \cdot (2.5^2 - 1.625^2)) + 12,203.2 \cdot 2.5 / 25.2031 \\ &= 2,433 \text{ psi}\end{aligned}$$

The average primary stress P_m (see Division 2 5.6.a.1) across the nozzle wall due to internal pressure + external loads is acceptable ($\leq S = 20,000$ psi)

Shear stress in the nozzle wall due to external loads

$$\begin{aligned}\sigma_{\text{shear}} &= (V_L^2 + V_c^2)^{0.5} / (\pi \cdot R_i \cdot t_n) \\ &= (787^2 + 787^2)^{0.5} / (\pi \cdot 1.625 \cdot 0.875) \\ &= 249 \text{ psi}\end{aligned}$$

$$\begin{aligned}\sigma_{\text{torsion}} &= M_t / (2 \cdot \pi \cdot R_i^2 \cdot t_n) \\ &= 12,214 / (2 \cdot \pi \cdot 1.625^2 \cdot 0.875) \\ &= 841 \text{ psi}\end{aligned}$$

$$\begin{aligned}\sigma_{\text{total}} &= \sigma_{\text{shear}} + \sigma_{\text{torsion}} \\ &= 249 + 841 \\ &= 1,090 \text{ psi}\end{aligned}$$

UG-45: The total combined shear stress (1,090 psi) is below than the allowable ($0.7 \cdot S_n = 0.7 \cdot 20,000 = 14,000$ psi)

Reinforcement Calculations for MAEP

UG-37 Area Calculation Summary (in ²) For Pe = 718.17 psi @ 140 °F The opening is adequately reinforced							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
3.9146	3.9146	0.6438	3.1302	--	--	0.1406	0.3508	1

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for external pressure 718.17 psi @ 140 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(3.454, 1.727 + (1 - 0.125) + (2.491 - 0.125)) \\
 &= 4.968 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.491 - 0.125), 2.5*(1 - 0.125) + 0) \\
 &= 2.1875 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-28 $t_{rn} = 0.1595$ in

From UG-37(d)(1) required thickness $t_r = 2.2667$ in

Area required per UG-37(d)(1)

Allowable stresses: $S_n = 20,000$, $S_v = 20,000$ psi

$$f_{r1} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$f_{r2} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$A = 0.5*(d*t_r*F + 2*t_n*t_r*F*(1 - f_{r1}))$$

$$= 0.5(3.454 \cdot 2.2667 \cdot 1 + 2 \cdot 0.875 \cdot 2.2667 \cdot 1 \cdot (1 - 1))$$

$$= \underline{3.9146} \text{ in}^2$$

Area available from FIG. UG-37.1

$$A_1 = \text{larger of the following} = \underline{0.6438} \text{ in}^2$$

$$= d(E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1})$$

$$= 3.454(1 \cdot 2.366 - 1 \cdot 2.2667) - 2 \cdot 0.875(1 \cdot 2.366 - 1 \cdot 2.2667)(1 - 1)$$

$$= 0.3431 \text{ in}^2$$

$$= 2(t + t_n)(E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1})$$

$$= 2(2.366 + 0.875)(1 \cdot 2.366 - 1 \cdot 2.2667) - 2 \cdot 0.875(1 \cdot 2.366 - 1 \cdot 2.2667)(1 - 1)$$

$$= 0.6438 \text{ in}^2$$

$$A_2 = \text{smaller of the following} = \underline{3.1302} \text{ in}^2$$

$$= 2(t_n - t_{rn}) f_{r2} L_{pr}$$

$$= 2(0.875 - 0.1595) \cdot 1 \cdot 5.3776$$

$$= 7.6951 \text{ in}^2$$

$$= 5(t_n - t_{rn}) f_{r2} t_n$$

$$= 5(0.875 - 0.1595) \cdot 1 \cdot 0.875$$

$$= 3.1302 \text{ in}^2$$

$$A_{41} = \text{Leg}^2 f_{r2}$$

$$= 0.375^2 \cdot 1$$

$$= \underline{0.1406} \text{ in}^2$$

$$\text{Area} = A_1 + A_2 + A_{41}$$

$$= 0.6438 + 3.1302 + 0.1406$$

$$= \underline{3.9146} \text{ in}^2$$

As Area \geq A the reinforcement is adequate.

UW-16(c) Weld Check

Fillet weld: t_{\min} = lesser of 0.75 or t_n or $t = 0.75$ in

$t_{c(\min)}$ = lesser of 0.25 or $0.7 \cdot t_{\min} = \underline{0.25}$ in

$t_{c(\text{actual})} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.375 = 0.2625$ in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$t_{a \text{ UG-28}} = 0.2845 \text{ in}$$

$$t_{a \text{ UG-22}} = 0.2031 \text{ in}$$

$$\begin{aligned} t_a &= \max[t_{a \text{ UG-28}}, t_{a \text{ UG-22}}] \\ &= \max[0.2845, 0.2031] \\ &= 0.2845 \text{ in} \end{aligned}$$

$$t_{b2} = 1.2047 \text{ in}$$

$$\begin{aligned} t_{b2} &= \max[t_{b2}, t_{b \text{ UG16}}] \\ &= \max[1.2047, 0.1875] \\ &= 1.2047 \text{ in} \end{aligned}$$

$$\begin{aligned} t_b &= \min[t_{b3}, t_{b2}] \\ &= \min[0.3508, 1.2047] \\ &= 0.3508 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{\text{UG-45}} &= \max[t_a, t_b] \\ &= \max[0.2845, 0.3508] \\ &= 0.3508 \text{ in} \end{aligned}$$

Available nozzle wall thickness new, $t_n = 1 \text{ in}$

The nozzle neck thickness is adequate.

External Pressure, (Corroded & at 140 °F) UG-28(c)

$$L / D_o = 8.93 / 5 = 1.7860$$

$$D_o / t = 5 / 0.1595 = 31.3435$$

From table G: A = 0.004190

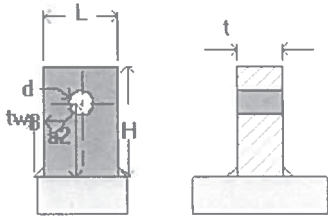
From table CS-2: B = 16,882.5165 psi

$$\begin{aligned} P_a &= 4 * B / (3 * (D_o / t)) \\ &= 4 * 16,882.52 / (3 * (5 / 0.1595)) \\ &= 718.17 \text{ psi} \end{aligned}$$

Design thickness for external pressure $P_a = 718.17 \text{ psi}$

$$t_a = t + \text{Corrosion} = 0.1595 + 0.125 = 0.2845 \text{ in}$$

Lifting Lug #1



Geometry Inputs

Attached To	60 ID TOP SE HEAD
Material	A36
Orientation	Longitudinal
Distance of Lift Point From Datum	-15"
Angular Position	135.00°
Length of Lug, L	5"
Height of Lug, H	7.5"
Thickness of Lug, t	1.5"
Hole Diameter, d	1.5625"
Pin Diameter, Dp	1.5"
Load Eccentricity, a_1	0"
Distance from Load to Shell or Pad, a_2	5"
Weld Size, t_w	0.75"
Load Angle Normal to Vessel, β	139.0635 °
Load Angle from Vertical, ϕ	98.1270 °

Intermediate Values

Load Factor	1.5000
Vessel Weight (new, incl. Load Factor), W	43247 lb
Lug Weight (new), W_{lug}	16 lb
Distance from Center of Gravity to Top Lug, l_1	67.5931"
Distance from Center of Gravity to Tail Lug, l_2	70.6144"
Distance from Vessel Center Line to Tail Lug, l_3	36.625"
Allowable Stress, Tensile, σ_t	19980 psi
Allowable Stress, Shear, σ_s	13320 psi
Allowable Stress, Bearing, σ_p	29970 psi
Allowable Stress, Bending, σ_b	22201 psi
Allowable Stress, Weld Shear, $\tau_{allowable}$	13320 psi
Allowable Stress set to 1/3 Sy per ASME B30.20	No

Summary Values

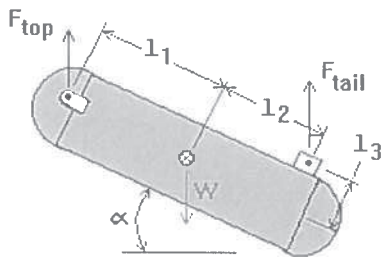
Required Lift Pin Diameter, d_{reqd}	1.0166"
Required Lug Thickness, t_{reqd}	0.481"
Lug Stress Ratio, σ_{ratio}	0.4
Weld Shear Stress Ratio, τ_{ratio}	0.48
Lug Design	Acceptable
Local Stresses	Acceptable

Lift Forces

Lift force on lugs during rotational lift ($0^\circ \leq \alpha \leq 90^\circ$):

$$2 * F_{top} = W * (l_2 * \cos(\alpha) + l_3 * \sin(\alpha)) / (l_1 * \cos(\alpha) + l_2 * \cos(\alpha) + l_3 * \sin(\alpha))$$

$$F_{tail} = W - (2 * F)$$



α [°]	F_{top} [lbf]	F_{tail} [lbf]
0	11,048	21,151
15	11,749	19,749
30	12,451	18,344
45	13,264	16,720
60	14,375	14,497
75	16,307	10,634
90	21,624	0
90 ¹	21,624	0
90 ²	21,624	0
¹ Lift angle at maximum lug stress.		
² Lift angle at maximum weld stress.		
Shell angle at lift lug	229.06°	

Lug Pin Diameter - Shear stress

$$d_{reqd} = (2F_r / (\pi \sigma_s))^{0.5}$$

$$= (2 \cdot 21,624 / (\pi \cdot 13,320))^{0.5} = \underline{1.0166"}$$

$$d_{reqd} / D_p = 1.0166 / 1.5 = 0.68 \quad \text{Acceptable}$$

$$\sigma = F_r / A$$

$$= F_r / (2 \cdot (0.25 \cdot \pi \cdot D_p^2))$$

$$= 21,624 / (2 \cdot (0.25 \cdot \pi \cdot 1.5^2)) = 6,118 \text{ psi}$$

$$\sigma / \sigma_s = 6,118 / 13,320 = 0.46 \quad \text{Acceptable}$$

Lug Thickness - Tensile stress

$$t_{reqd} = F_r / ((L - d) \cdot \sigma_t)$$

$$= 21,624 / ((5 - 1.5625) \cdot 19,980) = 0.3148"$$

$$t_{reqd} / t = 0.3148 / 1.5 = 0.21 \quad \text{Acceptable}$$

$$\sigma = F_r / A$$

$$= F_r / ((L - d) \cdot t)$$

$$= 21,624 / ((5 - 1.5625) \cdot 1.5) = 4,194 \text{ psi}$$

$$\sigma / \sigma_t = 4,194 / 19,980 = 0.21 \quad \text{Acceptable}$$

Lug Thickness - Bearing stress

$$t_{reqd} = F_v / (D_p \cdot \sigma_p)$$

$$= 21,624 / (1.5 \cdot 29,970) = \underline{0.481"}$$

$$t_{\text{reqd}} / t = 0.481 / 1.5 = 0.32 \quad \text{Acceptable}$$

$$\begin{aligned} \sigma &= F_v / A_{\text{bearing}} \\ &= F_v / (D_p * t) \\ &= 21,624 / (1.5 * 1.5) = 9,610 \text{ psi} \end{aligned}$$

$$\sigma / \sigma_p = 9,610 / 29,970 = 0.32 \quad \text{Acceptable}$$

Lug Thickness - Shear stress

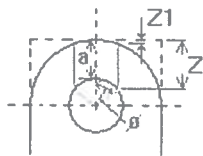
$$\begin{aligned} t_{\text{reqd}} &= [F_v / \sigma_s] / (2 * L_{\text{shear}}) \\ &= (21,624 / 13,320) / (2 * 2.0153) = \underline{0.4028"} \end{aligned}$$

$$t_{\text{reqd}} / t = 0.4028 / 1.5 = 0.27 \quad \text{Acceptable}$$

$$\begin{aligned} \tau &= F_v / A_{\text{shear}} \\ &= F_v / (2 * t * L_{\text{shear}}) \\ &= 21,624 / (2 * 1.5 * 2.0153) = 3,577 \text{ psi} \end{aligned}$$

$$\tau / \sigma_s = 3,577 / 13,320 = 0.27 \quad \text{Acceptable}$$

Shear stress length (per Pressure Vessel and Stacks, A. Keith Escoe)



$$\begin{aligned} \phi &= 55 * D_p / d \\ &= 55 * 1.5 / 1.5625 \\ &= 52.8^\circ \end{aligned}$$

$$\begin{aligned} L_{\text{shear}} &= (H - a_2 - 0.5 * d) + 0.5 * D_p * (1 - \cos(\phi)) \\ &= (7.5 - 5 - 0.5 * 1.5625) + 0.5 * 1.5 * (1 - \cos(52.8)) \\ &= 2.0153" \end{aligned}$$

Lug Plate Stress

Lug stress tensile + bending during lift:

$$\begin{aligned} \sigma_{\text{ratio}} &= [F_{\text{ten}} / (A_{\text{ten}} * \sigma_t)] + [M_{\text{bend}} / (Z_{\text{bend}} * \sigma_b)] \leq 1 \\ &= [(F_r * \cos(\alpha)) / (t * L * \sigma_t)] + [(6 * \text{abs}(F_r * \sin(\alpha) * \text{Hght} - F_r * \cos(\alpha) * a_1)) / (t * L^2 * \sigma_b)] \leq 1 \\ &= (21,624 * \cos(139.1)) / (1.5 * 5 * 19,980) + (6 * \text{abs}(21,624 * \sin(139.1) * 5 - 21,624 * \cos(139.1) * 0)) / (1.5 * 5^2 * 22,201) \\ &= \underline{0.40} \quad \text{Acceptable} \end{aligned}$$

Weld Stress

Weld stress, tensile, bending and shear during lift:

Direct shear:

Shear stress at lift angle 139.06°; lift force = 21,624 lbf

$$A_{\text{weld}} = 2 \cdot (0.707) \cdot t_w \cdot (L + t)$$

$$= 2 \cdot (0.707) \cdot 0.75 \cdot (5 + 1.5) = 6.8933 \text{ in}^2$$

$$\tau_t = F_r \cdot \cos(\alpha) / A_{\text{weld}}$$

$$= 21,624 \cdot \cos(139.1) / 6.8933 = -2,370 \text{ psi}$$

$$\tau_s = F_r \cdot \sin(\alpha) / A_{\text{weld}}$$

$$= 21,624 \cdot \sin(139.1) / 6.8933 = 2,055 \text{ psi}$$

$$\tau_b = \frac{M \cdot c}{I}$$

$$= \frac{3 \cdot (F_r \cdot \sin(\alpha) \cdot \text{Hght} - F_r \cdot \cos(\alpha) \cdot a_1)}{(0.707 \cdot h \cdot L \cdot (3 \cdot t + L))}$$

$$= \frac{3 \cdot \text{abs}(21,624 \cdot \sin(139.1) \cdot 5 - 21,624 \cdot \cos(139.1) \cdot (0))}{(25.1869)}$$

$$= 8,438 \text{ psi}$$

$$\tau_{\text{ratio}} = \frac{\text{sqr}((\tau_t + \tau_b)^2 + \tau_s^2)}{\tau_{\text{allowable}}} \leq 1$$

$$= \frac{\text{sqr}((-2,370 + 8,438)^2 + (2,055)^2)}{13,320}$$

$$= \underline{0.48} \quad \text{Acceptable}$$

EN 13445 Lift Lug Procedure

Geometry Inputs - EN13445

Nominal Vessel Thickness, e_n	2.491"
Pad Thickness, e_2	0"
Length of Lug, b_1	5"
Width of Pad, b_2	0"
Length of Pad, b_3	0"

Intermediate Values - EN13445

Equivalent Diameter of Vessel at Lug, ID_{eq}	<u>36.2456"</u>
Shell Allowable Stress, f	20000 psi
Pad Allowable Stress, f_2	N/A
Design Factor, K_2	1.2500

Summary Values - EN13445

Force on Vessel, F_r	<u>21,624 lbf</u>
Maximum Allowable Load, F_{Rmax}	<u>135,388 lbf</u>
Load Acceptance Ratio, F_R / F_{Rmax}	0.1597
Lug Design	Acceptable

Equivalent Inner Diameter

$$ID_{eq} = D_i \sqrt{1 - 3 \cdot (x / D_i)^2}$$

$$ID_{eq} = 60 \sqrt{1 - 3 \cdot (27.6059 / 60)^2}$$

$$ID_{eq} = 36.2456''$$

where 'x' is the distance between the axis of semi-ellipsoidal head and the center of the lug

Applied Force

$$F_r = \text{force on vessel at lug}$$

$$F_r = [W / \cos(\phi_1)] \cdot (1 - x_1 / (x_1 + x_2))$$

$$= (43,247) / \cos(98.1270) \cdot (1 - 0 / (0 + 0))$$

$$= \underline{21,624 \text{ lbf}}$$

where 'x₁' is the distance between this lug and the center of gravity

'x₂' is the distance between the second lift lug and the center of gravity

Lug factors

$$\lambda = \text{line load factor}$$

$$\lambda = b / \sqrt{ID_{eq} \cdot e_n}$$

$$= 5 / \sqrt{36.2456 \cdot 2.491}$$

$$= 0.526$$

$$v_1 = \text{ratio between local membrane stress and local bending stress}$$

$$v_1 = \min(0.08 \cdot \lambda, 0.2)$$

$$= 0.042$$

$$\sigma_m = \text{global membrane stress}$$

$$\sigma_m = P \cdot ID_{eq} / (2 \cdot e_n)$$

$$= 0 \cdot 36.2456 / (2 \cdot 2.491)$$

$$= 0.0000 \text{ psi}$$

$$v_2 = \text{ratio between global membrane stress and allowable stress}$$

$$v_2 = \sigma_m / (K_2 \cdot f)$$

$$= 0 / (1.25 \cdot 20,000)$$

$$= 0$$

$$K_{13} = 1 / (1.2 \cdot \sqrt{1 + 0.06 \cdot \lambda^2})$$

$$= 1 / (1.2 \cdot \sqrt{1 + 0.06 \cdot 0.526^2})$$

$$= 0.8265$$

$$\begin{aligned} K_{14} &= 1 / (0.6 * \text{sqr}(1 + 0.03 * \lambda^2)) \\ &= 1 / (0.6 * \text{sqr}(1 + 0.03 * 0.5262^2)) \\ &= 1.6598 \end{aligned}$$

Bending Limit Stress

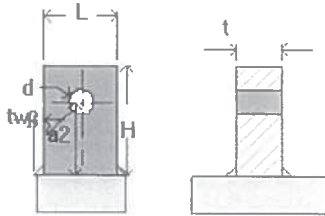
$$\begin{aligned} K_1 &= (1 - \nu_2^2) / ((1/3 + \nu_1 * \nu_2) + \text{sqr}((1/3 + \nu_1 * \nu_2)^2 + (1 - \nu_2^2) * \nu_1^2)) \\ &= (1 - 0^2) / ((1/3 + 0.0421 * 0) + \text{sqr}((1/3 + 0.0421 * 0)^2 + (1 - 0^2) * 0.0421^2)) \\ &= 1.4941 \end{aligned}$$

$$\begin{aligned} \sigma_b &= K_1 * K_2 * f \\ &= 1.4941 * 1.25 * 20,000 \\ &= 37,352 \text{ psi} \end{aligned}$$

Maximum Allowable Load

$$\begin{aligned} F_{Rmax} &= \sigma_b * e_n^2 / (K_{13} * |\cos(\beta)| + K_{14} * |a_2 * \sin(\beta) - a_1 * \cos(\beta)| / b_1) \\ &= 37,352 * (2.491)^2 / (0.8265 * |\cos(139.0635)| + 1.6598 * |5 * \sin(139.0635) - 0 * \cos(139.0635)| / 5) \\ &= \underline{135,388 \text{ lbf}} \end{aligned}$$

Lifting Lug #2



Geometry Inputs

Attached To	60 ID TOP SE HEAD
Material	A36
Orientation	Longitudinal
Distance of Lift Point From Datum	-13.5"
Angular Position	225.00°
Length of Lug, L	5"
Height of Lug, H	7.5"
Thickness of Lug, t	1.5"
Hole Diameter, d	1.5625"
Pin Diameter, Dp	1.5"
Load Eccentricity, a_1	0"
Distance from Load to Shell or Pad, a_2	5"
Weld Size, t_w	0.75"
Load Angle Normal to Vessel, β	133.8604 °
Load Angle from Vertical, ϕ	87.7207 °

Intermediate Values

Load Factor	1.5000
Vessel Weight (new, incl. Load Factor), W	43247 lb
Lug Weight (new), W_{lug}	16 lb
Distance from Center of Gravity to Top Lug, l_1	67.5931"
Distance from Center of Gravity to Tail Lug, l_2	70.6144"
Distance from Vessel Center Line to Tail Lug, l_3	36.625"
Allowable Stress, Tensile, σ_t	19980 psi
Allowable Stress, Shear, σ_s	13320 psi
Allowable Stress, Bearing, σ_p	29970 psi
Allowable Stress, Bending, σ_b	22201 psi
Allowable Stress, Weld Shear, $\tau_{allowable}$	13320 psi
Allowable Stress set to 1/3 Sy per ASME B30.20	No

Summary Values

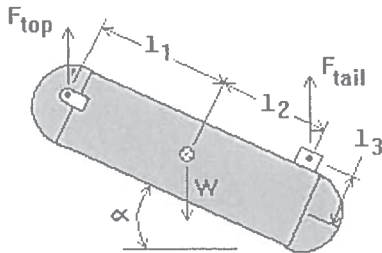
Required Lift Pin Diameter, d_{reqd}	1.0166"
Required Lug Thickness, t_{reqd}	0.481"
Lug Stress Ratio, σ_{ratio}	0.46
Weld Shear Stress Ratio, τ_{ratio}	0.56
Lug Design	Acceptable
Local Stresses	Acceptable

Lift Forces

Lift force on lugs during rotational lift ($0^\circ \leq \alpha \leq 90^\circ$):

$$2 * F_{top} = W * (l_2 * \cos(\alpha) + l_3 * \sin(\alpha)) / (l_1 * \cos(\alpha) + l_2 * \cos(\alpha) + l_3 * \sin(\alpha))$$

$$F_{tail} = W - (2 * F)$$



α [°]	F_{top} [lbf]	F_{tail} [lbf]
0	11,048	21,151
15	11,749	19,749
30	12,451	18,344
45	13,264	16,720
60	14,375	14,497
75	16,307	10,634
90	21,624	0
90 ¹	21,624	0
90 ²	21,624	0
¹ Lift angle at maximum lug stress.		
² Lift angle at maximum weld stress.		
Shell angle at lift lug	223.86°	

Lug Pin Diameter - Shear stress

$$d_{reqd} = (2 \cdot F_r / (\pi \cdot \sigma_s))^{0.5}$$

$$= (2 \cdot 21,624 / (\pi \cdot 13,320))^{0.5} = \underline{1.0166''}$$

$$d_{reqd} / D_p = 1.0166 / 1.5 = 0.68 \quad \text{Acceptable}$$

$$\sigma = F_r / A$$

$$= F_r / (2 \cdot (0.25 \cdot \pi \cdot D_p^2))$$

$$= 21,624 / (2 \cdot (0.25 \cdot \pi \cdot 1.5^2)) = 6,118 \text{ psi}$$

$$\sigma / \sigma_s = 6,118 / 13,320 = 0.46 \quad \text{Acceptable}$$

Lug Thickness - Tensile stress

$$t_{reqd} = F_r / ((L - d) \cdot \sigma_t)$$

$$= 21,624 / ((5 - 1.5625) \cdot 19,980) = 0.3148''$$

$$t_{reqd} / t = 0.3148 / 1.5 = 0.21 \quad \text{Acceptable}$$

$$\sigma = F_r / A$$

$$= F_r / ((L - d) \cdot t)$$

$$= 21,624 / ((5 - 1.5625) \cdot 1.5) = 4,194 \text{ psi}$$

$$\sigma / \sigma_t = 4,194 / 19,980 = 0.21 \quad \text{Acceptable}$$

Lug Thickness - Bearing stress

$$t_{reqd} = F_v / (D_p \cdot \sigma_p)$$

$$= 21,624 / (1.5 \cdot 29,970) = \underline{0.481''}$$

$$t_{\text{reqd}} / t = 0.481 / 1.5 = 0.32 \quad \text{Acceptable}$$

$$\begin{aligned} \sigma &= F_v / A_{\text{bearing}} \\ &= F_v / (D_p * t) \\ &= 21,624 / (1.5 * (1.5)) = 9,610 \text{ psi} \end{aligned}$$

$$\sigma / \sigma_p = 9,610 / 29,970 = 0.32 \quad \text{Acceptable}$$

Lug Thickness - Shear stress

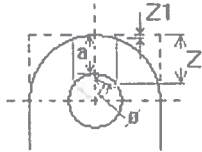
$$\begin{aligned} t_{\text{reqd}} &= [F_v / \sigma_s] / (2 * L_{\text{shear}}) \\ &= (21,624 / 13,320) / (2 * 2.0153) = \underline{0.4028"} \end{aligned}$$

$$t_{\text{reqd}} / t = 0.4028 / 1.5 = 0.27 \quad \text{Acceptable}$$

$$\begin{aligned} \tau &= F_v / A_{\text{shear}} \\ &= F_v / (2 * t * L_{\text{shear}}) \\ &= 21,624 / (2 * 1.5 * 2.0153) = 3,577 \text{ psi} \end{aligned}$$

$$\tau / \sigma_s = 3,577 / 13,320 = 0.27 \quad \text{Acceptable}$$

Shear stress length (per Pressure Vessel and Stacks, A. Keith Escoe)



$$\begin{aligned} \phi &= 55 * D_p / d \\ &= 55 * 1.5 / 1.5625 \\ &= 52.8^\circ \end{aligned}$$

$$\begin{aligned} L_{\text{shear}} &= (H - a_2 - 0.5 * d) + 0.5 * D_p * (1 - \cos(\phi)) \\ &= (7.5 - 5 - 0.5 * 1.5625) + 0.5 * 1.5 * (1 - \cos(52.8)) \\ &= 2.0153" \end{aligned}$$

Lug Plate Stress

Lug stress tensile + bending during lift:

$$\begin{aligned} \sigma_{\text{ratio}} &= [F_{\text{ten}} / (A_{\text{ten}} * \sigma_t)] + [M_{\text{bend}} / (Z_{\text{bend}} * \sigma_b)] \leq 1 \\ &= [(F_r * \cos(\alpha)) / (t * L * \sigma_t)] + [(6 * \text{abs}(F_r * \sin(\alpha) * \text{Hght} - F_r * \cos(\alpha) * a_1)) / (t * L^2 * \sigma_b)] \leq 1 \\ &= (21,624 * \cos(133.9)) / (1.5 * 5 * 19,980) + (6 * \text{abs}(21,624 * \sin(133.9) * 5 - 21,624 * \cos(133.9) * 0)) / (1.5 * 5^2 * 22,201) \\ &= \underline{0.46} \quad \text{Acceptable} \end{aligned}$$

Weld Stress

Weld stress, tensile, bending and shear during lift:

Direct shear:

Shear stress at lift angle 133.86°; lift force = 21,624 lbf

$$A_{\text{weld}} = 2 \cdot (0.707) \cdot t_w \cdot (L + t)$$

$$= 2 \cdot (0.707) \cdot 0.75 \cdot (5 + 1.5) = 6.8933 \text{ in}^2$$

$$\tau_t = F_r \cdot \cos(\alpha) / A_{\text{weld}}$$

$$= 21,624 \cdot \cos(133.9) / 6.8933 = -2,174 \text{ psi}$$

$$\tau_s = F_r \cdot \sin(\alpha) / A_{\text{weld}}$$

$$= 21,624 \cdot \sin(133.9) / 6.8933 = 2,262 \text{ psi}$$

$$\tau_b = \frac{M \cdot c}{I}$$

$$= \frac{3 \cdot (F_r \cdot \sin(\alpha) \cdot \text{Hght} - F_r \cdot \cos(\alpha) \cdot a_1)}{(0.707 \cdot h \cdot L \cdot (3 \cdot t + L))}$$

$$= \frac{3 \cdot \text{abs}(21,624 \cdot \sin(133.9) \cdot 5 - 21,624 \cdot \cos(133.9) \cdot (0))}{(25.1869)}$$

$$= 9,285 \text{ psi}$$

$$\tau_{\text{ratio}} = \frac{\text{sqr}((\tau_t + \tau_b)^2 + \tau_s^2)}{\tau_{\text{allowable}}} \leq 1$$

$$= \frac{\text{sqr}((-2,174 + 9,285)^2 + (2,262)^2)}{13,320}$$

$$= 0.56 \quad \text{Acceptable}$$

EN 13445 Lift Lug Procedure

Geometry Inputs - EN13445

Nominal Vessel Thickness, e_n	2.491"
Pad Thickness, e_2	0"
Length of Lug, b_1	5"
Width of Pad, b_2	0"
Length of Pad, b_3	0"

Intermediate Values - EN13445

Equivalent Diameter of Vessel at Lug, ID_{eq}	33.1911"
Shell Allowable Stress, f	20000 psi
Pad Allowable Stress, f_2	N/A
Design Factor, K_2	1.2500

Summary Values - EN13445

Force on Vessel, F_r	<u>21.624 lbf</u>
Maximum Allowable Load, F_{Rmax}	<u>131.003 lbf</u>
Load Acceptance Ratio, F_R / F_{Rmax}	0.1651
Lug Design	Acceptable

Equivalent Inner Diameter

$$ID_{eq} = D_i \cdot \sqrt{1 - 3 \cdot (x / D_i)^2}$$

$$ID_{eq} = 60 \cdot \sqrt{1 - 3 \cdot (28.858 / 60)^2}$$

$$ID_{eq} = 33.1911''$$

where 'x' is the distance between the axis of semi-ellipsoidal head and the center of the lug

Applied Force

$$F_r = \text{force on vessel at lug}$$

$$F_r = [W / \cos(\phi_1)] \cdot (1 - x_1 / (x_1 + x_2))$$

$$= (43,247) / \cos(87.7207) \cdot (1 - 0 / (0 + 0))$$

$$= \underline{21.624 \text{ lbf}}$$

where 'x₁' is the distance between this lug and the center of gravity

'x₂' is the distance between the second lift lug and the center of gravity

Lug factors

$$\lambda = \text{line load factor}$$

$$\lambda = b / \sqrt{ID_{eq} \cdot e_n}$$

$$= 5 / \sqrt{33.1911 \cdot 2.491}$$

$$= 0.55$$

$$v_1 = \text{ratio between local membrane stress and local bending stress}$$

$$v_1 = \min(0.08 \cdot \lambda, 0.2)$$

$$= 0.044$$

$$\sigma_m = \text{global membrane stress}$$

$$\sigma_m = P \cdot ID_{eq} / (2 \cdot e_n)$$

$$= 0 \cdot 33.1911 / (2 \cdot 2.491)$$

$$= 0.0000 \text{ psi}$$

$$v_2 = \text{ratio between global membrane stress and allowable stress}$$

$$v_2 = \sigma_m / (K_2 \cdot f)$$

$$= 0 / (1.25 \cdot 20,000)$$

$$= 0$$

$$K_{13} = 1 / (1.2 \cdot \sqrt{1 + 0.06 \cdot \lambda^2})$$

$$= 1 / (1.2 \cdot \sqrt{1 + 0.06 \cdot 0.5499^2})$$

$$= 0.8259$$

$$\begin{aligned} K_{14} &= 1 / (0.6 * \text{sqr}(1 + 0.03 * \lambda^2)) \\ &= 1 / (0.6 * \text{sqr}(1 + 0.03 * 0.5499^2)) \\ &= 1.6592 \end{aligned}$$

Bending Limit Stress

$$\begin{aligned} K_1 &= (1 - v_2^2) / ((1/3 + v_1 * v_2) + \text{sqr}((1/3 + v_1 * v_2)^2 + (1 - v_2^2) * v_1^2)) \\ &= (1 - 0^2) / ((1/3 + 0.044 * 0) + \text{sqr}((1/3 + 0.044 * 0)^2 + (1 - 0^2) * 0.044^2)) \\ &= 1.4935 \end{aligned}$$

$$\begin{aligned} \sigma_b &= K_1 * K_2 * f \\ &= 1.4935 * 1.25 * 20,000 \\ &= 37,338 \text{ psi} \end{aligned}$$

Maximum Allowable Load

$$\begin{aligned} F_{Rmax} &= \sigma_b * e_n^2 / (K_{13} * |\cos(\beta)| + K_{14} * |a_2 * \sin(\beta) - a_1 * \cos(\beta)| / b_1) \\ &= 37,338 * (2.491)^2 / (0.8259 * |\cos(133.8604)| + 1.6592 * |5 * \sin(133.8604) - 0 * \cos(133.8604)| / 5) \\ &= \underline{131,003 \text{ lbf}} \end{aligned}$$

60 ID SHELL

ASME Section VIII Division 1, 2010 Edition, A11 Addenda

Component: Cylinder
Material specification: SA-516 70 (II-D p. 18, ln. 19)
Material is impact tested per UG-84 to -20 °F
UCS-66(i) reduction of 8.6 °F applied (ratio = 0.9144).

Internal design pressure: $P = 1,378$ psi @ 140 °F
External design pressure: $P_e = 15$ psi @ 140 °F

Static liquid head:

$P_s = 4.07$ psi (SG = 1.1, $H_s = 102.5$ ", Operating head)
 $P_{th} = 2.54$ psi (SG = 1, $H_s = 70.5$ ", Horizontal test head)

Corrosion allowance Inner C = 0.125" Outer C = 0"

Design MDMT = -20 °F Impact test performed
Rated MDMT = -28.6 °F Material is normalized
Material is not produced to Fine Grain Practice
PWHT is performed

Radiography: Longitudinal joint - Full UW-11(a) Type 1
Top circumferential joint - Full UW-11(a) Type 1
Bottom circumferential joint - Full UW-11(a) Type 1

Estimated weight New = 12,445.3 lb corr = 11,848.4 lb
Capacity New = 1,175.04 US gal corr = 1,184.85 US gal

ID = 60"
Length = 96"
 L_c
t = 2.5"

Design thickness, (at 140 °F) UG-27(c)(1)

t = $P \cdot R / (S \cdot E - 0.60 \cdot P) + \text{Corrosion}$
= $1,382.07 \cdot 30.125 / (20,000 \cdot 1.00 - 0.60 \cdot 1,382.07) + 0.125$
= 2.2968"

Maximum allowable working pressure, (at 140 °F) UG-27(c)(1)

P = $S \cdot E \cdot t / (R + 0.60 \cdot t) - P_s$
= $20,000 \cdot 1.00 \cdot 2.375 / (30.125 + 0.60 \cdot 2.375) - 4.07$
= 1,501.48 psi

External Pressure, (Corroded & at 140 °F) UG-28(c)

$L / D_o = 110.0833 / 65 = 1.6936$
 $D_o / t = 65 / 0.261 = 249.0199$
From table G: A = 0.000195
From table CS-2: B = 2,801.4783 psi

$$\begin{aligned}
 P_a &= 4*B / (3*(D_o / t)) \\
 &= 4*2,801.48 / (3*(65 / 0.261)) \\
 &= 15 \text{ psi}
 \end{aligned}$$

Design thickness for external pressure $P_a = 15$ psi

$$t_a = t + \text{Corrosion} = 0.261 + 0.125 = 0.386''$$

Maximum Allowable External Pressure, (Corroded & at 140 °F) UG-28(c)

$$\begin{aligned}
 L / D_o &= 110.0833 / 65 = 1.6936 \\
 D_o / t &= 65 / 2.375 = 27.3684 \\
 \text{From table G: } A &= 0.005433 \\
 \text{From table CS-2: } B &= 17,220.3969 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 P_a &= 4*B / (3*(D_o / t)) \\
 &= 4*17,220.4 / (3*(65 / 2.375)) \\
 &= 838.94 \text{ psi}
 \end{aligned}$$

% Extreme fiber elongation - UCS-79(d)

$$\begin{aligned}
 \text{EFE} &= (50*t / R_f) * (1 - R_f / R_o) \\
 &= (50*2.5 / 31.25) * (1 - 31.25 / \infty) \\
 &= 4\%
 \end{aligned}$$

The extreme fiber elongation does not exceed 5%.

External Pressure + Weight + Wind Loading Check (Bergman, ASME paper 54-A-104)

$$\begin{aligned}
 P_v &= W / (2*\pi*R_m) + M / (\pi*R_m^2) \\
 &= 22,922.1 / (2*\pi*31.3125) + 311,627 / (\pi*31.3125^2) \\
 &= 217.6776 \text{ lb/in} \\
 \alpha &= P_v / (P_e*D_o) \\
 &= 217.6776 / (15*65) \\
 &= 0.2233 \\
 n &= 3 \\
 m &= 1.23 / (L / D_o)^2 \\
 &= 1.23 / (110.0833 / 65)^2 \\
 &= 0.4288 \\
 \text{Ratio } P_e &= (n^2 - 1 + m + m*\alpha) / (n^2 - 1 + m) \\
 &= (3^2 - 1 + 0.4288 + 0.4288*0.2233) / (3^2 - 1 + 0.4288) \\
 &= 1.0114
 \end{aligned}$$

Ratio $P_e * P_e \leq$ MAEP design cylinder thickness is satisfactory.

External Pressure + Weight + Seismic Loading Check (Bergman, ASME paper 54-A-104)

$$\begin{aligned}
 P_v &= (1 + V\text{Accel})*W / (2*\pi*R_m) + M / (\pi*R_m^2) \\
 &= 2.00*22,922.1 / (2*\pi*31.3125) + 1,626,562 / (\pi*31.3125^2) \\
 &= 761.0786 \text{ lb/in}
 \end{aligned}$$

$$\begin{aligned}
 \alpha &= P_v / (P_e * D_o) \\
 &= 761.0786 / (15 * 65) \\
 &= 0.7806 \\
 n &= 3 \\
 m &= 1.23 / (L / D_o)^2 \\
 &= 1.23 / (110.0833 / 65)^2 \\
 &= 0.4288 \\
 \text{Ratio } P_e &= (n^2 - 1 + m + m * \alpha) / (n^2 - 1 + m) \\
 &= (3^2 - 1 + 0.4288 + 0.4288 * 0.7806) / (3^2 - 1 + 0.4288) \\
 &= 1.0397
 \end{aligned}$$

Ratio $P_e * P_e \leq$ MAEP design cylinder thickness is satisfactory.

Design thickness = 2.2968"

The governing condition is due to internal pressure.

The cylinder thickness of 2.5" is adequate.

Thickness Required Due to Pressure + External Loads

Condition	Pressure P (psi)	Allowable Stress Before UG-23 Stress Increase (psi)		Temperature (°F)	Corrosion C (in)	Load	Req'd Thk Due to Tension (in)	Req'd Thk Due to Compression (in)
		S _t	S _c					
<u>Operating, Hot & Corroded</u>	1,378	20,000	<u>17,349</u>	140	0.125	Wind	<u>0.8544</u>	<u>0.846</u>
						Seismic	<u>0.8722</u>	<u>0.8233</u>
<u>Operating, Hot & New</u>	1,378	20,000	<u>17,361</u>	140	0	Wind	<u>0.8507</u>	<u>0.8422</u>
						Seismic	<u>0.869</u>	<u>0.8188</u>
<u>Hot Shut Down, Corroded</u>	0	20,000	<u>17,349</u>	140	0.125	Wind	<u>0.0007</u>	<u>0.0105</u>
						Seismic	<u>0.0171</u>	<u>0.0366</u>
<u>Hot Shut Down, New</u>	0	20,000	<u>17,361</u>	140	0	Wind	<u>0.0009</u>	<u>0.0107</u>
						Seismic	<u>0.0175</u>	<u>0.0377</u>
<u>Emptv. Corroded</u>	0	20,000	<u>17,349</u>	70	0.125	Wind	<u>0.0007</u>	<u>0.0105</u>
						Seismic	<u>0.0115</u>	<u>0.0301</u>
<u>Emptv. New</u>	0	20,000	<u>17,361</u>	70	0	Wind	<u>0.0009</u>	<u>0.0107</u>
						Seismic	<u>0.012</u>	<u>0.0312</u>
<u>Vacuum</u>	-15	20,000	<u>17,349</u>	140	0.125	Wind	<u>0.0116</u>	<u>0.0213</u>
						Seismic	<u>0.0077</u>	<u>0.0474</u>
<u>Hot Shut Down, Corroded, Weight & Eccentric Moments Only</u>	0	20,000	<u>17,349</u>	140	0.125	Weight	<u>0.0015</u>	<u>0.0119</u>

Allowable Compressive Stress, Hot and Corroded- S_{CHC}, (table CS-2)

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (32.5 / 2.375) \\
 &= 0.009135 \\
 B &= 17,349 \text{ psi} \\
 S &= 20,000 / 1.00 = 20,000 \text{ psi} \\
 S_{CHC} &= \min(B, S) = \underline{17,349 \text{ psi}}
 \end{aligned}$$

Allowable Compressive Stress, Hot and New- S_{CHN}, (table CS-2)

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (32.5 / 2.5) \\
 &= 0.009615 \\
 B &= 17,361 \text{ psi} \\
 S &= 20,000 / 1.00 = 20,000 \text{ psi} \\
 S_{CHN} &= \min(B, S) = \underline{17,361 \text{ psi}}
 \end{aligned}$$

Allowable Compressive Stress, Cold and New- S_{CCN}, (table CS-2)

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (32.5 / 2.5) \\
 &= 0.009615 \\
 B &= 17,361 \text{ psi} \\
 S &= 20,000 / 1.00 = 20,000 \text{ psi} \\
 S_{CCN} &= \min(B, S) = \underline{17,361 \text{ psi}}
 \end{aligned}$$

Allowable Compressive Stress, Cold and Corroded- S_{cCC} , (table CS-2)

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (32.5 / 2.375) \\
 &= 0.009135 \\
 B &= 17,349 \text{ psi} \\
 S &= 20,000 / 1.00 = 20,000 \text{ psi} \\
 S_{cCC} &= \min(B, S) = \underline{17.349 \text{ psi}}
 \end{aligned}$$

Allowable Compressive Stress, Vacuum and Corroded- S_{cVC} , (table CS-2)

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (32.5 / 2.375) \\
 &= 0.009135 \\
 B &= 17,349 \text{ psi} \\
 S &= 20,000 / 1.00 = 20,000 \text{ psi} \\
 S_{cVC} &= \min(B, S) = \underline{17.349 \text{ psi}}
 \end{aligned}$$

Operating, Hot & Corroded, Wind, Bottom Seam

$$\begin{aligned}
 t_p &= P \cdot R / (2 \cdot S_t \cdot K_s \cdot E_c + 0.40 \cdot |P|) && \text{(Pressure)} \\
 &= 1,378 \cdot 30.125 / (2 \cdot 20,000 \cdot 1.20 \cdot 1.00 + 0.40 \cdot |1,378|) \\
 &= 0.855"
 \end{aligned}$$

$$\begin{aligned}
 t_m &= M / (\pi \cdot R_m^2 \cdot S_t \cdot K_s \cdot E_c) && \text{(bending)} \\
 &= 311,627 / (\pi \cdot 31.3125^2 \cdot 20,000 \cdot 1.20 \cdot 1.00) \\
 &= 0.0042"
 \end{aligned}$$

$$\begin{aligned}
 t_w &= W / (2 \cdot \pi \cdot R_m \cdot S_t \cdot K_s \cdot E_c) && \text{(Weight)} \\
 &= 22,922.1 / (2 \cdot \pi \cdot 31.3125 \cdot 20,000 \cdot 1.20 \cdot 1.00) \\
 &= 0.0049"
 \end{aligned}$$

$$\begin{aligned}
 t_t &= t_p + t_m - t_w && \text{(total required, tensile)} \\
 &= 0.855 + 0.0042 - (0.0049) \\
 &= \underline{0.8544"}
 \end{aligned}$$

$$\begin{aligned}
 t_c &= |t_{mc} + t_{wc} - t_{pc}| && \text{(total, net tensile)} \\
 &= |0.0042 + (0.0049) - (0.855)| \\
 &= \underline{0.846"}
 \end{aligned}$$

Maximum allowable working pressure, Longitudinal Stress

$$\begin{aligned}
 P &= 2 \cdot S_t \cdot K_s \cdot E_c \cdot (t - t_m + t_w) / (R - 0.40 \cdot (t - t_m + t_w)) \\
 &= 2 \cdot 20,000 \cdot 1.20 \cdot 1.00 \cdot (2.375 - 0.0042 + (0.0049)) / (30.125 - 0.40 \cdot (2.375 - 0.0042 + (0.0049))) \\
 &= 3,908.54 \text{ psi}
 \end{aligned}$$

Operating, Hot & New, Wind, Bottom Seam

$$\begin{aligned}
 t_p &= P \cdot R / (2 \cdot S_t \cdot K_s \cdot E_c + 0.40 \cdot |P|) && \text{(Pressure)} \\
 &= 1,378 \cdot 30 / (2 \cdot 20,000 \cdot 1.20 \cdot 1.00 + 0.40 \cdot |1,378|) \\
 &= 0.8515"
 \end{aligned}$$

$$t_m = M / (\pi R_m^2 S_t K_s E_c) \quad (\text{bending})$$

$$= 314,448 / (\pi 31.25^2 20,000 1.20 1.00)$$

$$= 0.0043''$$

$$t_w = W / (2 \pi R_m S_t K_s E_c) \quad (\text{Weight})$$

$$= 23,798.4 / (2 \pi 31.25 20,000 1.20 1.00)$$

$$= 0.0051''$$

$$t_t = t_p + t_m - t_w \quad (\text{total required, tensile})$$

$$= 0.8515 + 0.0043 - (0.0051)$$

$$= \underline{0.8507''}$$

$$t_c = |t_{mc} + t_{wc} - t_{pc}| \quad (\text{total, net tensile})$$

$$= |0.0043 + (0.0051) - (0.8515)|$$

$$= \underline{0.8422''}$$

Maximum allowable working pressure, Longitudinal Stress

$$P = 2 S_t K_s E_c (t - t_m + t_w) / (R - 0.40 (t - t_m + t_w))$$

$$= 2 20,000 1.20 1.00 (2.5 - 0.0043 + (0.0051)) / (30 - 0.40 (2.5 - 0.0043 + (0.0051)))$$

$$= 4,139.27 \text{ psi}$$

Hot Shut Down, Corroded, Wind, Bottom Seam

$$t_p = 0'' \quad (\text{Pressure})$$

$$t_m = M / (\pi R_m^2 S_c K_s) \quad (\text{bending})$$

$$= 311,627 / (\pi 31.3125^2 17,348.7 1.20)$$

$$= 0.0049''$$

$$t_w = W / (2 \pi R_m S_c K_s) \quad (\text{Weight})$$

$$= 22,922.1 / (2 \pi 31.3125 17,348.7 1.20)$$

$$= 0.0056''$$

$$t_t = |t_p + t_m - t_w| \quad (\text{total, net compressive})$$

$$= |0 + 0.0049 - (0.0056)|$$

$$= \underline{0.0007''}$$

$$t_c = t_{mc} + t_{wc} - t_{pc} \quad (\text{total required, compressive})$$

$$= 0.0049 + (0.0056) - (0)$$

$$= \underline{0.0105''}$$

Hot Shut Down, New, Wind, Bottom Seam

$$t_p = 0'' \quad (\text{Pressure})$$

$$t_m = M / (\pi R_m^2 S_c K_s) \quad (\text{bending})$$

$$= 314,448 / (\pi 31.25^2 17,361.41 1.20)$$

$$= 0.0049''$$

$$t_w = W / (2 \pi R_m S_c K_s) \quad (\text{Weight})$$

$$= 23,798.4 / (2 \pi 31.25 17,361.41 1.20)$$

$$= 0.0058''$$

$$t_t = |t_p + t_m - t_w| \quad (\text{total, net compressive})$$

$$= |0 + 0.0049 - (0.0058)|$$

$$= \underline{0.0009''}$$

$$\begin{aligned}
 t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\
 &= 0.0049 + (0.0058) - (0) \\
 &= \underline{0.0107"}
 \end{aligned}$$

Empty, Corroded, Wind, Bottom Seam

$$\begin{aligned}
 t_p &= 0" && \text{(Pressure)} \\
 t_m &= M / (\pi * R_m^2 * S_c * K_s) && \text{(bending)} \\
 &= 311,627 / (\pi * 31.3125^2 * 17,348.7 * 1.20) \\
 &= 0.0049" \\
 t_w &= W / (2 * \pi * R_m * S_c * K_s) && \text{(Weight)} \\
 &= 22,922.1 / (2 * \pi * 31.3125 * 17,348.7 * 1.20) \\
 &= 0.0056" \\
 t_t &= |t_p + t_m - t_w| && \text{(total, net compressive)} \\
 &= |0 + 0.0049 - (0.0056)| \\
 &= \underline{0.0007"} \\
 t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\
 &= 0.0049 + (0.0056) - (0) \\
 &= \underline{0.0105"}
 \end{aligned}$$

Empty, New, Wind, Bottom Seam

$$\begin{aligned}
 t_p &= 0" && \text{(Pressure)} \\
 t_m &= M / (\pi * R_m^2 * S_c * K_s) && \text{(bending)} \\
 &= 314,448 / (\pi * 31.25^2 * 17,361.41 * 1.20) \\
 &= 0.0049" \\
 t_w &= W / (2 * \pi * R_m * S_c * K_s) && \text{(Weight)} \\
 &= 23,798.4 / (2 * \pi * 31.25 * 17,361.41 * 1.20) \\
 &= 0.0058" \\
 t_t &= |t_p + t_m - t_w| && \text{(total, net compressive)} \\
 &= |0 + 0.0049 - (0.0058)| \\
 &= \underline{0.0009"} \\
 t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\
 &= 0.0049 + (0.0058) - (0) \\
 &= \underline{0.0107"}
 \end{aligned}$$

Vacuum, Wind, Bottom Seam

$$\begin{aligned}
 t_p &= P * R / (2 * S_c * K_s + 0.40 * |P|) && \text{(Pressure)} \\
 &= -15 * 30.125 / (2 * 17,348.7 * 1.20 + 0.40 * |15|) \\
 &= -0.0109" \\
 t_m &= M / (\pi * R_m^2 * S_c * K_s) && \text{(bending)} \\
 &= 311,627 / (\pi * 31.3125^2 * 17,348.7 * 1.20) \\
 &= 0.0049" \\
 t_w &= W / (2 * \pi * R_m * S_c * K_s) && \text{(Weight)} \\
 &= 22,922.1 / (2 * \pi * 31.3125 * 17,348.7 * 1.20) \\
 &= 0.0056"
 \end{aligned}$$

$$\begin{aligned}
 t_t &= |t_p + t_m - t_w| && \text{(total, net compressive)} \\
 &= |-0.0109 + 0.0049 - (0.0056)| \\
 &= \underline{0.0116"}
 \end{aligned}$$

$$\begin{aligned}
 t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\
 &= 0.0049 + (0.0056) - (-0.0109) \\
 &= \underline{0.0213"}
 \end{aligned}$$

Maximum Allowable External Pressure, Longitudinal Stress

$$\begin{aligned}
 P &= 2*S_c*K_s*(t - t_{mc} - t_{wc}) / (R - 0.40*(t - t_{mc} - t_{wc})) \\
 &= 2*17,348.7*1.20*(2.375 - 0.0049 - 0.0056) / (30.125 - 0.40*(2.375 - 0.0049 - 0.0056)) \\
 &= 3,374.06 \text{ psi}
 \end{aligned}$$

Hot Shut Down, Corroded, Weight & Eccentric Moments Only, Bottom Seam

$$\begin{aligned}
 t_p &= 0" && \text{(Pressure)} \\
 t_m &= M / (\pi*R_m^2*S_c*K_s) && \text{(bending)} \\
 &= 276,644 / (\pi*31.3125^2*17,348.7*1.00) \\
 &= 0.0052"
 \end{aligned}$$

$$\begin{aligned}
 t_w &= W / (2*\pi*R_m*S_c*K_s) && \text{(Weight)} \\
 &= 22,922.1 / (2*\pi*31.3125*17,348.7*1.00) \\
 &= 0.0067"
 \end{aligned}$$

$$\begin{aligned}
 t_t &= |t_p + t_m - t_w| && \text{(total, net compressive)} \\
 &= |0 + 0.0052 - (0.0067)| \\
 &= \underline{0.0015"}
 \end{aligned}$$

$$\begin{aligned}
 t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\
 &= 0.0052 + (0.0067) - (0) \\
 &= \underline{0.0119"}
 \end{aligned}$$

Operating, Hot & Corroded, Seismic, Bottom Seam

$$\begin{aligned}
 t_p &= P*R / (2*S_t*K_s*E_c + 0.40*|P|) && \text{(Pressure)} \\
 &= 1,378*30.125 / (2*20,000*1.20*1.00 + 0.40*|1,378|) \\
 &= 0.855"
 \end{aligned}$$

$$\begin{aligned}
 t_m &= M / (\pi*R_m^2*S_t*K_s*E_c) && \text{(bending)} \\
 &= 1,626,562 / (\pi*31.3125^2*20,000*1.20*1.00) \\
 &= 0.022"
 \end{aligned}$$

$$\begin{aligned}
 t_w &= W / (2*\pi*R_m*S_t*K_s*E_c) && \text{(Weight)} \\
 &= 22,922.1 / (2*\pi*31.3125*20,000*1.20*1.00) \\
 &= 0.0049"
 \end{aligned}$$

$$\begin{aligned}
 t_t &= t_p + t_m - t_w && \text{(total required, tensile)} \\
 &= 0.855 + 0.022 - (0.0049) \\
 &= \underline{0.8722"}
 \end{aligned}$$

$$\begin{aligned}
 t_{wc} &= (1 + V\text{Accel})*W / (2*\pi*R_m*S_t*K_s*E_c) && \text{(Weight)} \\
 &= 2.00*22,922.1 / (2*\pi*31.3125*20,000*1.20*1.00) \\
 &= 0.0097"
 \end{aligned}$$

$$t_c = |t_{mc} + t_{wc} - t_{pc}| \quad \text{(total, net tensile)}$$

$$= |0.022 + (0.0097) - (0.855)|$$

$$= \underline{0.8233"}$$

Maximum allowable working pressure, Longitudinal Stress

$$P = 2*S_t*K_s*E_c*(t - t_m + t_w) / (R - 0.40*(t - t_m + t_w))$$

$$= 2*20,000*1.20*1.00*(2.375 - 0.022 + (0.0049)) / (30.125 - 0.40*(2.375 - 0.022 + (0.0049)))$$

$$= 3,878.33 \text{ psi}$$

Operating, Hot & New, Seismic, Bottom Seam

$$t_p = P*R / (2*S_t*K_s*E_c + 0.40*|P|) \quad (\text{Pressure})$$

$$= 1,378*30 / (2*20,000*1.20*1.00 + 0.40*|1,378|)$$

$$= 0.8515"$$

$$t_m = M / (\pi*R_m^2*S_t*K_s*E_c) \quad (\text{bending})$$

$$= 1,662,898 / (\pi*31.25^2*20,000*1.20*1.00)$$

$$= 0.0226"$$

$$t_w = W / (2*\pi*R_m*S_t*K_s*E_c) \quad (\text{Weight})$$

$$= 23,798.4 / (2*\pi*31.25*20,000*1.20*1.00)$$

$$= 0.0051"$$

$$t_t = t_p + t_m - t_w \quad (\text{total required, tensile})$$

$$= 0.8515 + 0.0226 - (0.0051)$$

$$= \underline{0.869"}$$

$$t_{wc} = (1 + V\text{Accel})*W / (2*\pi*R_m*S_t*K_s*E_c) \quad (\text{Weight})$$

$$= 2.00*23,798.4 / (2*\pi*31.25*20,000*1.20*1.00)$$

$$= 0.0101"$$

$$t_c = |t_{mc} + t_{wc} - t_{pc}| \quad (\text{total, net tensile})$$

$$= |0.0226 + (0.0101) - (0.8515)|$$

$$= \underline{0.8188"}$$

Maximum allowable working pressure, Longitudinal Stress

$$P = 2*S_t*K_s*E_c*(t - t_m + t_w) / (R - 0.40*(t - t_m + t_w))$$

$$= 2*20,000*1.20*1.00*(2.5 - 0.0226 + (0.0051)) / (30 - 0.40*(2.5 - 0.0226 + (0.0051)))$$

$$= 4,107.92 \text{ psi}$$

Hot Shut Down, Corroded, Seismic, Bottom Seam

$$t_p = 0" \quad (\text{Pressure})$$

$$t_m = M / (\pi*R_m^2*S_t*K_s*E_c) \quad (\text{bending})$$

$$= 1,626,562 / (\pi*31.3125^2*20,000*1.20*1.00)$$

$$= 0.022"$$

$$t_w = W / (2*\pi*R_m*S_t*K_s*E_c) \quad (\text{Weight})$$

$$= 22,922.1 / (2*\pi*31.3125*20,000*1.20*1.00)$$

$$= 0.0049"$$

$$t_t = t_p + t_m - t_w \quad (\text{total required, tensile})$$

$$= 0 + 0.022 - (0.0049)$$

$$= \underline{0.0171"}$$

$$\begin{aligned}
 t_{mc} &= M / (\pi R_m^2 S_c K_s) && \text{(bending)} \\
 &= 1,626,562 / (\pi 31.3125^2 17,348.7 1.20) \\
 &= 0.0254" \\
 t_{wc} &= (1 + V_{Accel}) W / (2 \pi R_m S_c K_s) && \text{(Weight)} \\
 &= 2.00 * 22,922.1 / (2 \pi 31.3125 17,348.7 1.20) \\
 &= 0.0112" \\
 t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\
 &= 0.0254 + (0.0112) - (0) \\
 &= \underline{0.0366"}
 \end{aligned}$$

Hot Shut Down, New, Seismic, Bottom Seam

$$\begin{aligned}
 t_p &= 0" && \text{(Pressure)} \\
 t_m &= M / (\pi R_m^2 S_t K_s E_c) && \text{(bending)} \\
 &= 1,662,898 / (\pi 31.25^2 20,000 1.20 1.00) \\
 &= 0.0226" \\
 t_w &= W / (2 \pi R_m S_t K_s E_c) && \text{(Weight)} \\
 &= 23,798.4 / (2 \pi 31.25 20,000 1.20 1.00) \\
 &= 0.0051" \\
 t_t &= t_p + t_m - t_w && \text{(total required, tensile)} \\
 &= 0 + 0.0226 - (0.0051) \\
 &= \underline{0.0175"} \\
 t_{mc} &= M / (\pi R_m^2 S_c K_s) && \text{(bending)} \\
 &= 1,662,898 / (\pi 31.25^2 17,361.41 1.20) \\
 &= 0.026" \\
 t_{wc} &= (1 + V_{Accel}) W / (2 \pi R_m S_c K_s) && \text{(Weight)} \\
 &= 2.00 * 23,798.4 / (2 \pi 31.25 17,361.41 1.20) \\
 &= 0.0116" \\
 t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\
 &= 0.026 + (0.0116) - (0) \\
 &= \underline{0.0377"}
 \end{aligned}$$

Empty, Corroded, Seismic, Bottom Seam

$$\begin{aligned}
 t_p &= 0" && \text{(Pressure)} \\
 t_m &= M / (\pi R_m^2 S_t K_s E_c) && \text{(bending)} \\
 &= 1,212,233 / (\pi 31.3125^2 20,000 1.20 1.00) \\
 &= 0.0164" \\
 t_w &= W / (2 \pi R_m S_t K_s E_c) && \text{(Weight)} \\
 &= 22,922.1 / (2 \pi 31.3125 20,000 1.20 1.00) \\
 &= 0.0049" \\
 t_t &= t_p + t_m - t_w && \text{(total required, tensile)} \\
 &= 0 + 0.0164 - (0.0049) \\
 &= \underline{0.0115"} \\
 t_{mc} &= M / (\pi R_m^2 S_c K_s) && \text{(bending)} \\
 &= 1,212,233 / (\pi 31.3125^2 17,348.7 1.20)
 \end{aligned}$$

$$= 0.0189''$$

$$\begin{aligned} t_{wc} &= (1 + V_{\text{Accel}}) * W / (2 * \pi * R_m * S_c * K_s) && \text{(Weight)} \\ &= 2.00 * 22,922.1 / (2 * \pi * 31.3125 * 17,348.7 * 1.20) \\ &= 0.0112'' \end{aligned}$$

$$\begin{aligned} t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\ &= 0.0189 + (0.0112) - (0) \\ &= \underline{0.0301''} \end{aligned}$$

Empty, New, Seismic, Bottom Seam

$$\begin{aligned} t_p &= 0'' && \text{(Pressure)} \\ t_m &= M / (\pi * R_m^2 * S_t * K_s * E_c) && \text{(bending)} \\ &= 1,252,311 / (\pi * 31.25^2 * 20,000 * 1.20 * 1.00) \\ &= 0.017'' \end{aligned}$$

$$\begin{aligned} t_w &= W / (2 * \pi * R_m * S_t * K_s * E_c) && \text{(Weight)} \\ &= 23,798.4 / (2 * \pi * 31.25 * 20,000 * 1.20 * 1.00) \\ &= 0.0051'' \end{aligned}$$

$$\begin{aligned} t_t &= t_p + t_m - t_w && \text{(total required, tensile)} \\ &= 0 + 0.017 - (0.0051) \\ &= \underline{0.012''} \end{aligned}$$

$$\begin{aligned} t_{mc} &= M / (\pi * R_m^2 * S_c * K_s) && \text{(bending)} \\ &= 1,252,311 / (\pi * 31.25^2 * 17,361.41 * 1.20) \\ &= 0.0196'' \end{aligned}$$

$$\begin{aligned} t_{wc} &= (1 + V_{\text{Accel}}) * W / (2 * \pi * R_m * S_c * K_s) && \text{(Weight)} \\ &= 2.00 * 23,798.4 / (2 * \pi * 31.25 * 17,361.41 * 1.20) \\ &= 0.0116'' \end{aligned}$$

$$\begin{aligned} t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\ &= 0.0196 + (0.0116) - (0) \\ &= \underline{0.0312''} \end{aligned}$$

Vacuum, Seismic, Bottom Seam

$$\begin{aligned} t_p &= P * R / (2 * S_t * K_s * E_c + 0.40 * |P|) && \text{(Pressure)} \\ &= -15 * 30.125 / (2 * 20,000 * 1.20 * 1.00 + 0.40 * |15|) \\ &= -0.0094'' \end{aligned}$$

$$\begin{aligned} t_m &= M / (\pi * R_m^2 * S_t * K_s * E_c) && \text{(bending)} \\ &= 1,626,562 / (\pi * 31.3125^2 * 20,000 * 1.20 * 1.00) \\ &= 0.022'' \end{aligned}$$

$$\begin{aligned} t_w &= W / (2 * \pi * R_m * S_t * K_s * E_c) && \text{(Weight)} \\ &= 22,922.1 / (2 * \pi * 31.3125 * 20,000 * 1.20 * 1.00) \\ &= 0.0049'' \end{aligned}$$

$$\begin{aligned} t_t &= t_p + t_m - t_w && \text{(total required, tensile)} \\ &= -0.0094 + 0.022 - (0.0049) \\ &= \underline{0.0077''} \end{aligned}$$

$$\begin{aligned} t_{pc} &= P * R / (2 * S_c * K_s + 0.40 * |P|) && \text{(Pressure)} \\ &= -15 * 30.125 / (2 * 17,348.7 * 1.20 + 0.40 * |15|) \end{aligned}$$

$$= -0.0109''$$

$$\begin{aligned} t_{mc} &= M / (\pi R_m^2 S_c K_s) && \text{(bending)} \\ &= 1,626,562 / (\pi 31.3125^2 17,348.7 1.20) \\ &= 0.0254'' \end{aligned}$$

$$\begin{aligned} t_{wc} &= (1 + V_{\text{Accel}}) W / (2 \pi R_m S_c K_s) && \text{(Weight)} \\ &= 2.00 22,922.1 / (2 \pi 31.3125 17,348.7 1.20) \\ &= 0.0112'' \end{aligned}$$

$$\begin{aligned} t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\ &= 0.0254 + (0.0112) - (-0.0109) \\ &= \underline{0.0474''} \end{aligned}$$

Maximum Allowable External Pressure, Longitudinal Stress

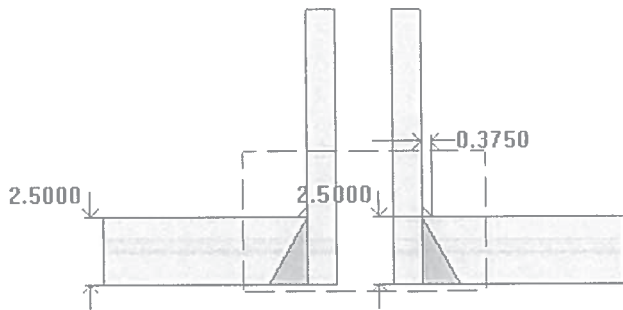
$$\begin{aligned} P &= 2 S_c K_s (t - t_{mc} - t_{wc}) / (R - 0.40(t - t_{mc} - t_{wc})) \\ &= 2 17,348.7 1.20 (2.375 - 0.0254 - 0.0112) / (30.125 - 0.40(2.375 - 0.0254 - 0.0112)) \\ &= 3,335.62 \text{ psi} \end{aligned}$$

Purge (N2)

ASME Section VIII Division 1, 2010 Edition, A11 Addenda

$$t_{w(\text{lower})} = 2.5 \text{ in}$$

$$\text{Leg}_{41} = 0.375 \text{ in}$$



Note: round inside edges per UG-76(c)

Location and Orientation

Located on:	60 ID SHELL
Orientation:	225°
Nozzle center line offset to datum line:	88 in
End of nozzle to shell center:	40.5 in
Passes through a Category A joint:	No

Nozzle

Access opening:	No
Material specification:	SA-350 LF2 Cl 1 (II-D p. 18, ln. 10)
Inside diameter, new:	2 in
Nominal wall thickness:	1.06 in
Corrosion allowance:	0.125 in
Projection available outside vessel, Lpr:	6.25 in
Projection available outside vessel to flange face, Lf:	8 in
Local vessel minimum thickness:	2.5 in
Liquid static head included:	3.792 psi
Longitudinal joint efficiency:	1

ASME B16.5-2009 Flange

Description:	NPS 2 Class 900 LWN A350 LF2 Cl.1
Bolt Material:	SA-193 B7 Bolt <= 2 1/2 (II-D p. 334, ln. 32)
Blind included:	No
Rated MDMT:	-55°F per UCS-66(b)(1)(b)
Liquid static head:	3.7523 psi
MAWP rating:	2,146 psi @ 140°F
MAP rating:	2,220 psi @ 50°F
Hydrotest rating:	3,350 psi @ 50°F
PWHT performed:	Yes

Reinforcement Calculations for Chamber MAWP

UG-37 Area Calculation Summary (in ²) For P = 1,381.79 psi @ 140 °F							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.3324	1.06

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for internal pressure 1,381.79 psi @ 140 °F

Nozzle is impact test exempt to -155 °F per UCS-66(b)(3) (coincident ratio = 0.0895). External nozzle loadings per UG-22 govern the coincident ratio used.

Nozzle UCS-66 governing thk: 1.06 in

Nozzle rated MDMT: -155 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(2.25, 1.125 + (1.06 - 0.125) + (2.5 - 0.125)) \\
 &= 4.435 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.06 - 0.125) + 0) \\
 &= 2.3375 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-27(c)(1)

$$\begin{aligned}
 t_m &= P*R_n / (S_n*E - 0.6*P) \\
 &= 1,381.792*1.125 / (20,000*1 - 0.6*1,381.792) \\
 &= 0.0811 \text{ in}
 \end{aligned}$$

Required thickness t_r from UG-37(a)

$$\begin{aligned}t_r &= P \cdot R / (S \cdot E - 0.6 \cdot P) \\&= 1,381.792 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 1,381.792) \\&= 2.1713 \text{ in}\end{aligned}$$

This opening does not require reinforcement per UG-36(c)(3)(a)

UW-16(c) Weld Check

Fillet weld: t_{\min} = lesser of 0.75 or t_n or $t = 0.75$ in

$t_{c(\min)}$ = lesser of 0.25 or $0.7 \cdot t_{\min} = 0.25$ in

$t_{c(\text{actual})} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.375 = 0.2625$ in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$\begin{aligned}t_{a \text{ UG-27}} &= P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion} \\&= 1,381.792 \cdot 1.125 / (20,000 \cdot 1 - 0.6 \cdot 1,381.792) + 0.125 \\&= 0.2061 \text{ in}\end{aligned}$$

$$t_{a \text{ UG-22}} = 0.2087 \text{ in}$$

$$\begin{aligned}t_a &= \max[t_{a \text{ UG-27}}, t_{a \text{ UG-22}}] \\&= \max[0.2061, 0.2087] \\&= 0.2087 \text{ in}\end{aligned}$$

$$\begin{aligned}t_{b1} &= P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion} \\&= 1,381.792 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 1,381.792) + 0.125 \\&= 2.2963 \text{ in}\end{aligned}$$

$$\begin{aligned}t_{b1} &= \max[t_{b1}, t_{b \text{ UG16}}] \\&= \max[2.2963, 0.1875] \\&= 2.2963 \text{ in}\end{aligned}$$

$$\begin{aligned}t_b &= \min[t_{b3}, t_{b1}] \\&= \min[0.3324, 2.2963] \\&= 0.3324 \text{ in}\end{aligned}$$

$$\begin{aligned}t_{\text{UG-45}} &= \max[t_a, t_b] \\&= \max[0.2087, 0.3324] \\&= 0.3324 \text{ in}\end{aligned}$$

Available nozzle wall thickness new, $t_n = 1.06$ in

The nozzle neck thickness is adequate.

Applied Loads

Radial load:	$P_r = 334$	lb _f
Circumferential moment:	$M_c = 2,965$	lb _f -in
Circumferential shear:	$V_c = 409$	lb _f
Longitudinal moment:	$M_L = 2,965$	lb _f -in
Longitudinal shear:	$V_L = 409$	lb _f
Torsion moment:	$M_t = 4,160$	lb _f -in
Internal pressure:	$P = 1,381.792$	psi
Mean shell radius:	$R_m = 31.3125$	in
Local shell thickness:	$t = 2.375$	in
Shell yield stress:	$S_y = 36,200$	psi

Maximum stresses due to the applied loads at the nozzle OD (includes pressure)

$$R_m / t = 31.3125 / 2.375 = 13.1842$$

Pressure stress intensity factor, $I = 1.08139$ (derived from PVP-Vol. 399, pages 77-82)

$$\text{Local circumferential pressure stress} = I * P * R_i / t = 18,954 \text{ psi}$$

$$\text{Local longitudinal pressure stress} = I * P * R_i / (2 * t) = 9,477 \text{ psi}$$

$$\text{Maximum combined stress } (P_L + P_b + Q) = 19,117 \text{ psi}$$

$$\text{Allowable combined stress } (P_L + P_b + Q) = \pm 3 * S = \pm 60,000 \text{ psi}$$

The maximum combined stress $(P_L + P_b + Q)$ is within allowable limits.

$$\text{Maximum local primary membrane stress } (P_L) = 18,952 \text{ psi}$$

$$\text{Allowable local primary membrane stress } (P_L) = \pm 1.5 * S = \pm 30,000 \text{ psi}$$

The maximum local primary membrane stress (P_L) is within allowable limits.

Stresses at the nozzle OD per WRC Bulletin 107										
Figure	value	β	A_u	A_l	B_u	B_l	C_u	C_l	D_u	D_l
3C*	2.6447	0.0576	0	0	0	0	-12	-12	-12	-12
4C*	2.6412	0.0576	-12	-12	-12	-12	0	0	0	0
1C	0.2321	0.0576	0	0	0	0	-82	82	-82	82
2C-1	0.1957	0.0576	-70	70	-70	70	0	0	0	0
3A*	0.1019	0.0576	0	0	0	0	-2	-2	2	2
1A	0.1082	0.0576	0	0	0	0	-189	189	189	-189
3B*	0.4471	0.0576	-10	-10	10	10	0	0	0	0
1B-1	0.0651	0.0576	-114	114	114	-114	0	0	0	0
Pressure stress*			18,954	18,954	18,954	18,954	17,527	17,527	17,527	17,527
Total circumferential stress			18,748	19,116	18,996	18,908	17,242	17,784	17,624	17,410
Primary membrane circumferential stress*			18,932	18,932	18,952	18,952	17,513	17,513	17,517	17,517
3C*	2.6447	0.0576	-12	-12	-12	-12	0	0	0	0
4C*	2.6412	0.0576	0	0	0	0	-12	-12	-12	-12
1C-1	0.2327	0.0576	-83	83	-83	83	0	0	0	0
2C	0.1925	0.0576	0	0	0	0	-68	68	-68	68
4A*	0.1414	0.0576	0	0	0	0	-3	-3	3	3
2A	0.0642	0.0576	0	0	0	0	-112	112	112	-112
4B*	0.1101	0.0576	-2	-2	2	2	0	0	0	0
2B-1	0.1039	0.0576	-182	182	182	-182	0	0	0	0
Pressure stress*			8,764	8,764	8,764	8,764	9,477	9,477	9,477	9,477
Total longitudinal stress			8,485	9,015	8,853	8,655	9,282	9,642	9,512	9,424
Primary membrane longitudinal stress*			8,750	8,750	8,754	8,754	9,462	9,462	9,468	9,468
Shear from M_t			66	66	66	66	66	66	66	66
Circ shear from V_c			27	27	-27	-27	0	0	0	0
Long shear from V_L			0	0	0	0	-27	-27	27	27
Total Shear stress			93	93	39	39	39	39	93	93
Combined stress (P_L+P_b+Q)			18,749	19,117	18,996	18,908	17,242	17,784	17,625	17,411

Note: * denotes primary stress.

Longitudinal stress in the nozzle wall due to internal pressure + external loads

$$\begin{aligned} \sigma_{n(P_m)} &= P \cdot R_i / (2 \cdot t_n) - P_r / (\pi \cdot (R_o^2 - R_i^2)) + M \cdot R_o / I \\ &= 1,381.79 \cdot 1.125 / (2 \cdot 0.935) - 334 / (\pi \cdot (2.06^2 - 1.125^2)) + 4,193.1 \cdot 2.06 / 12.8855 \\ &= 1,466 \text{ psi} \end{aligned}$$

The average primary stress P_m (see Division 2 5.6.a.1) across the nozzle wall due to internal pressure + external loads is acceptable ($\leq S = 20,000$ psi)

Shear stress in the nozzle wall due to external loads

$$\begin{aligned} \sigma_{\text{shear}} &= (V_L^2 + V_c^2)^{0.5} / (\pi \cdot R_i \cdot t_n) \\ &= (409^2 + 409^2)^{0.5} / (\pi \cdot 1.125 \cdot 0.935) \\ &= 175 \text{ psi} \end{aligned}$$

$$\begin{aligned} \sigma_{\text{torsion}} &= M_t / (2 \cdot \pi \cdot R_i^2 \cdot t_n) \\ &= 4,160 / (2 \cdot \pi \cdot 1.125^2 \cdot 0.935) \end{aligned}$$

= 560 psi

$$\begin{aligned}\sigma_{\text{total}} &= \sigma_{\text{shear}} + \sigma_{\text{torsion}} \\ &= 175 + 560 \\ &= 735 \text{ psi}\end{aligned}$$

UG-45: The total combined shear stress (735 psi) is below than the allowable ($0.7 \cdot S_n = 0.7 \cdot 20,000 = 14,000$ psi)

Reinforcement Calculations for MAEP

UG-37 Area Calculation Summary (in ²) For $P_e = 838.94$ psi @ 140 °F							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.3324	1.06

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (In)	Actual weld throat size (In)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for external pressure 838.94 psi @ 140 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(2.25, 1.125 + (1.06 - 0.125) + (2.5 - 0.125)) \\
 &= 4.435 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.06 - 0.125) + 0) \\
 &= 2.3375 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-28 $t_{rn} = 0.1518$ in

From UG-37(d)(1) required thickness $t_r = 2.375$ in

This opening does not require reinforcement per UG-36(c)(3)(a)

UW-16(c) Weld Check

$$\begin{aligned}
 \text{Fillet weld: } t_{\min} &= \text{lesser of } 0.75 \text{ or } t_n \text{ or } t = 0.75 \text{ in} \\
 t_{c(\min)} &= \text{lesser of } 0.25 \text{ or } 0.7*t_{\min} = 0.25 \text{ in} \\
 t_{c(\text{actual})} &= 0.7*\text{Leg} = 0.7*0.375 = 0.2625 \text{ in}
 \end{aligned}$$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a \text{ UG-28}} = 0.2768 \text{ in}$$

$$t_{a \text{ UG-22}} = 0.1847 \text{ in}$$

$$\begin{aligned} t_a &= \max[t_{a \text{ UG-28}}, t_{a \text{ UG-22}}] \\ &= \max[0.2768, 0.1847] \\ &= 0.2768 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{b2} &= P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion} \\ &= 838.9424 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 838.9424) + 0.125 \\ &= 1.4213 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{b2} &= \max[t_{b2}, t_{b \text{ UG16}}] \\ &= \max[1.4213, 0.1875] \\ &= 1.4213 \text{ in} \end{aligned}$$

$$\begin{aligned} t_b &= \min[t_{b3}, t_{b2}] \\ &= \min[0.3324, 1.4213] \\ &= 0.3324 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{\text{UG-45}} &= \max[t_a, t_b] \\ &= \max[0.2768, 0.3324] \\ &= 0.3324 \text{ in} \end{aligned}$$

Available nozzle wall thickness new, $t_n = 1.06 \text{ in}$

The nozzle neck thickness is adequate.

External Pressure, (Corroded & at 140 °F) UG-28(c)

$$L / D_o = 8.0654 / 4.12 = 1.9576$$

$$D_o / t = 4.12 / 0.1518 = 27.1437$$

From table G: $A = 0.004676$

From table
CS-2: $B = 17,078.9811 \text{ psi}$

$$\begin{aligned} P_a &= 4 \cdot B / (3 \cdot (D_o / t)) \\ &= 4 \cdot 17,078.98 / (3 \cdot (4.12 / 0.1518)) \\ &= 838.94 \text{ psi} \end{aligned}$$

Design thickness for external pressure $P_a = 838.94 \text{ psi}$

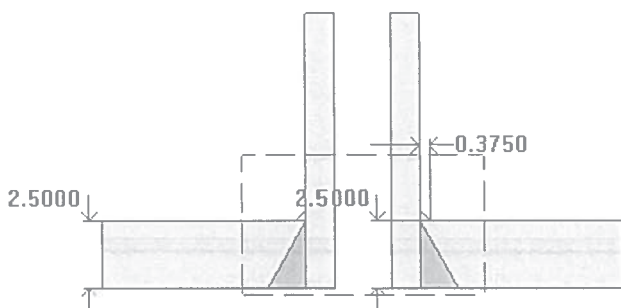
$$t_a = t + \text{Corrosion} = 0.1518 + 0.125 = 0.2768''$$

Level Bridal Low (N3)

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$$t_{w(\text{lower})} = 2.5 \text{ in}$$

$$\text{Leg}_{41} = 0.375 \text{ in}$$



Note: round inside edges per UG-76(c)

Location and Orientation

Located on:	60 ID SHELL
Orientation:	45°
Nozzle center line offset to datum line:	88 in
End of nozzle to shell center:	40.5 in
Passes through a Category A joint:	No

Nozzle

Access opening:	No
Material specification:	SA-350 LF2 Cl 1 (II-D p. 18, In. 10)
Inside diameter, new:	2 in
Nominal wall thickness:	1.06 in
Corrosion allowance:	0.125 in
Projection available outside vessel, L _{pr} :	6.25 in
Projection available outside vessel to flange face, L _f :	8 in
Local vessel minimum thickness:	2.5 in
Liquid static head included:	3.792 psi
Longitudinal joint efficiency:	1

ASME B16.5-2009 Flange

Description:	NPS 2 Class 900 LWN A350 LF2 Cl.1
Bolt Material:	SA-193 B7 Bolt <= 2 1/2 (II-D p. 334, In. 32)
Blind included:	No
Rated MDMT:	-55°F per UCS-66(b)(1)(b)
Liquid static head:	3.7523 psi
MAWP rating:	2,146 psi @ 140°F
MAP rating:	2,220 psi @ 50°F
Hydrotest rating:	3,350 psi @ 50°F
PWHT performed:	Yes

Reinforcement Calculations for Chamber MAWP

UG-37 Area Calculation Summary (in ²) For P = 1,381.79 psi @ 140 °F							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45		
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}	
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.3324	1.06	

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (In)	Actual weld throat size (In)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for internal pressure 1,381.79 psi @ 140 °F

Nozzle is impact test exempt to -155 °F per UCS-66(b)(3) (coincident ratio = 0.0867).

Nozzle UCS-66 governing thk: 1.06 in

Nozzle rated MDMT: -155 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(2.25, 1.125 + (1.06 - 0.125) + (2.5 - 0.125)) \\
 &= 4.435 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.06 - 0.125) + 0) \\
 &= 2.3375 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-27(c)(1)

$$\begin{aligned}
 t_{rn} &= P \cdot R_n / (S_n \cdot E - 0.6 \cdot P) \\
 &= 1,381.792 \cdot 1.125 / (20,000 \cdot 1 - 0.6 \cdot 1,381.792) \\
 &= 0.0811 \text{ in}
 \end{aligned}$$

Required thickness t_r from UG-37(a)

$$t_r = P \cdot R / (S \cdot E - 0.6 \cdot P)$$

$$= 1,381.792 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 1,381.792)$$

$$= 2.1713 \text{ in}$$

This opening does not require reinforcement per UG-36(c)(3)(a)

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \text{lesser of } 0.75 \text{ or } t_n \text{ or } t = 0.75 \text{ in}$

$t_{c(\min)} = \text{lesser of } 0.25 \text{ or } 0.7 \cdot t_{\min} = 0.25 \text{ in}$

$t_{c(\text{actual})} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.375 = 0.2625 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a \text{ UG-27}} = P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion}$$

$$= 1,381.792 \cdot 1.125 / (20,000 \cdot 1 - 0.6 \cdot 1,381.792) + 0.125$$

$$= 0.2061 \text{ in}$$

$$t_a = \max[t_{a \text{ UG-27}}, t_{a \text{ UG-22}}]$$

$$= \max[0.2061, 0]$$

$$= 0.2061 \text{ in}$$

$$t_{b1} = P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion}$$

$$= 1,381.792 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 1,381.792) + 0.125$$

$$= 2.2963 \text{ in}$$

$$t_{b1} = \max[t_{b1}, t_{b \text{ UG16}}]$$

$$= \max[2.2963, 0.1875]$$

$$= 2.2963 \text{ in}$$

$$t_b = \min[t_{b3}, t_{b1}]$$

$$= \min[0.3324, 2.2963]$$

$$= 0.3324 \text{ in}$$

$$t_{\text{UG-45}} = \max[t_a, t_b]$$

$$= \max[0.2061, 0.3324]$$

$$= 0.3324 \text{ in}$$

Available nozzle wall thickness new, $t_n = 1.06 \text{ in}$

The nozzle neck thickness is adequate.

Reinforcement Calculations for MAEP

UG-37 Area Calculation Summary (in ²) For Pe = 838.94 psl @ 140 °F							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.3324	1.06

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (In)	Actual weld throat size (In)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for external pressure 838.94 psi @ 140 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(2.25, 1.125 + (1.06 - 0.125) + (2.5 - 0.125)) \\
 &= 4.435 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.06 - 0.125) + 0) \\
 &= 2.3375 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-28 $t_{rn} = 0.1518$ in

From UG-37(d)(1) required thickness $t_r = 2.375$ in

This opening does not require reinforcement per UG-36(c)(3)(a)

UW-16(c) Weld Check

Fillet weld: $t_{min} = \text{lesser of } 0.75 \text{ or } t_n \text{ or } t = 0.75 \text{ in}$
 $t_{c(min)} = \text{lesser of } 0.25 \text{ or } 0.7*t_{min} = 0.25 \text{ in}$
 $t_{c(actual)} = 0.7*Leg = 0.7*0.375 = 0.2625 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a \text{ UG-28}} = 0.2768 \text{ in}$$

$$\begin{aligned} t_a &= \max[t_{a \text{ UG-28}}, t_{a \text{ UG-22}}] \\ &= \max[0.2768, 0] \\ &= 0.2768 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{b2} &= P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion} \\ &= 838.9424 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 838.9424) + 0.125 \\ &= 1.4213 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{b2} &= \max[t_{b2}, t_{b \text{ UG16}}] \\ &= \max[1.4213, 0.1875] \\ &= 1.4213 \text{ in} \end{aligned}$$

$$\begin{aligned} t_b &= \min[t_{b3}, t_{b2}] \\ &= \min[0.3324, 1.4213] \\ &= 0.3324 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{\text{UG-45}} &= \max[t_a, t_b] \\ &= \max[0.2768, 0.3324] \\ &= 0.3324 \text{ in} \end{aligned}$$

Available nozzle wall thickness new, $t_n = 1.06 \text{ in}$

The nozzle neck thickness is adequate.

External Pressure, (Corroded & at 140 °F) UG-28(c)

$$L / D_o = 8.0654 / 4.12 = 1.9576$$

$$D_o / t = 4.12 / 0.1518 = 27.1437$$

From table G: $A = 0.004676$

From table CS-2: $B = 17,078.9811 \text{ psi}$

$$\begin{aligned} P_a &= 4 \cdot B / (3 \cdot (D_o / t)) \\ &= 4 \cdot 17,078.98 / (3 \cdot (4.12 / 0.1518)) \\ &= 838.94 \text{ psi} \end{aligned}$$

Design thickness for external pressure $P_a = 838.94 \text{ psi}$

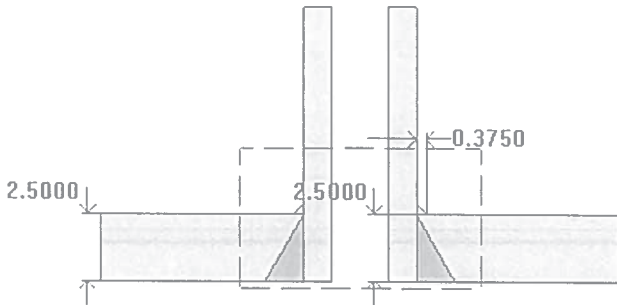
$$t_a = t + \text{Corrosion} = 0.1518 + 0.125 = 0.2768''$$

Diff Press High (N4)

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$$t_{w(\text{lower})} = 2.5 \text{ in}$$

$$\text{Leg}_{41} = 0.375 \text{ in}$$



Note: round inside edges per UG-76(c)

Location and Orientation

Located on:	60 ID SHELL
Orientation:	0°
Nozzle center line offset to datum line:	8 in
End of nozzle to shell center:	40.5 in
Passes through a Category A joint:	No

Nozzle

Access opening:	No
Material specification:	SA-350 LF2 Cl 1 (II-D p. 18, In. 10)
Inside diameter, new:	2 in
Nominal wall thickness:	1.06 in
Corrosion allowance:	0.125 in
Projection available outside vessel, L _{pr} :	6.25 in
Projection available outside vessel to flange face, L _f :	8 in
Local vessel minimum thickness:	2.5 in
Liquid static head included:	0.6155 psi
Longitudinal joint efficiency:	1

ASME B16.5-2009 Flange

Description:	NPS 2 Class 900 LWN A350 LF2 Cl.1
Bolt Material:	SA-193 B7 Bolt ≤ 2 1/2 (II-D p. 334, In. 32)
Blind included:	No
Rated MDMT:	-55 °F per UCS-66(b)(1)(b)
Liquid static head:	0.5757 psi
MAWP rating:	2,146 psi @ 140 °F
MAP rating:	2,220 psi @ 50 °F
Hydrotest rating:	3,350 psi @ 50 °F
PWHT performed:	Yes

Reinforcement Calculations for Chamber MAWP

UG-37 Area Calculation Summary (in ²) For P = 1,378.62 psi @ 140 °F							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45		
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}	
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							<u>0.3324</u>	1.06	

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	<u>0.25</u>	0.2625	weld size is adequate

Calculations for internal pressure 1,378.62 psi @ 140 °F

Nozzle is impact test exempt to -155 °F per UCS-66(b)(3) (coincident ratio = 0.0865).

Nozzle UCS-66 governing thk: 1.06 in

Nozzle rated MDMT: -155 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(2.25, 1.125 + (1.06 - 0.125) + (2.5 - 0.125)) \\
 &= 4.435 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.06 - 0.125) + 0) \\
 &= 2.3375 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-27(c)(1)

$$\begin{aligned}
 t_n &= P * R_n / (S_n * E - 0.6 * P) \\
 &= 1,378.6155 * 1.125 / (20,000 * 1 - 0.6 * 1,378.6155) \\
 &= 0.0809 \text{ in}
 \end{aligned}$$

Required thickness t_r from UG-37(a)

$$t_r = P * R / (S * E - 0.6 * P)$$

$$= 1,378.6155 \times 30.125 / (20,000 \times 1 - 0.6 \times 1,378.6155)$$

$$= 2.1661 \text{ in}$$

This opening does not require reinforcement per UG-36(c)(3)(a)

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \text{lesser of } 0.75 \text{ or } t_n \text{ or } t = 0.75 \text{ in}$

$t_{c(\min)} = \text{lesser of } 0.25 \text{ or } 0.7 \times t_{\min} = 0.25 \text{ in}$

$t_{c(\text{actual})} = 0.7 \times \text{Leg} = 0.7 \times 0.375 = 0.2625 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a \text{ UG-27}} = P \times R / (S \times E - 0.6 \times P) + \text{Corrosion}$$

$$= 1,378.6155 \times 1.125 / (20,000 \times 1 - 0.6 \times 1,378.6155) + 0.125$$

$$= 0.2059 \text{ in}$$

$$t_a = \max[t_{a \text{ UG-27}}, t_{a \text{ UG-22}}]$$

$$= \max[0.2059, 0]$$

$$= 0.2059 \text{ in}$$

$$t_{b1} = P \times R / (S \times E - 0.6 \times P) + \text{Corrosion}$$

$$= 1,378.6155 \times 30.125 / (20,000 \times 1 - 0.6 \times 1,378.6155) + 0.125$$

$$= 2.2911 \text{ in}$$

$$t_{b1} = \max[t_{b1}, t_{b \text{ UG16}}]$$

$$= \max[2.2911, 0.1875]$$

$$= 2.2911 \text{ in}$$

$$t_b = \min[t_{b3}, t_{b1}]$$

$$= \min[0.3324, 2.2911]$$

$$= 0.3324 \text{ in}$$

$$t_{\text{UG-45}} = \max[t_a, t_b]$$

$$= \max[0.2059, 0.3324]$$

$$= 0.3324 \text{ in}$$

Available nozzle wall thickness new, $t_n = 1.06 \text{ in}$

The nozzle neck thickness is adequate.

Reinforcement Calculations for MAEP

UG-37 Area Calculation Summary (in ²) For Pe = 838.94 psi @ 140 °F							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.3324	1.06

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg41)	0.25	0.2625	weld size is adequate

Calculations for external pressure 838.94 psi @ 140 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(2.25, 1.125 + (1.06 - 0.125) + (2.5 - 0.125)) \\
 &= 4.435 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.06 - 0.125) + 0) \\
 &= 2.3375 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-28 t_{rn} = 0.1518 in

From UG-37(d)(1) required thickness t_r = 2.375 in

This opening does not require reinforcement per UG-36(c)(3)(a)

UW-16(c) Weld Check

Fillet weld: t_{min} = lesser of 0.75 or t_n or t = 0.75 in
 t_{c(min)} = lesser of 0.25 or 0.7*t_{min} = 0.25 in
 t_{c(actual)} = 0.7*Leg = 0.7*0.375 = 0.2625 in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a \text{ UG-28}} = 0.2768 \text{ in}$$

$$\begin{aligned} t_a &= \max[t_{a \text{ UG-28}}, t_{a \text{ UG-22}}] \\ &= \max[0.2768, 0] \\ &= 0.2768 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{b2} &= P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion} \\ &= 838.9424 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 838.9424) + 0.125 \\ &= 1.4213 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{b2} &= \max[t_{b2}, t_{b \text{ UG16}}] \\ &= \max[1.4213, 0.1875] \\ &= 1.4213 \text{ in} \end{aligned}$$

$$\begin{aligned} t_b &= \min[t_{b3}, t_{b2}] \\ &= \min[0.3324, 1.4213] \\ &= 0.3324 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{\text{UG-45}} &= \max[t_a, t_b] \\ &= \max[0.2768, 0.3324] \\ &= 0.3324 \text{ in} \end{aligned}$$

Available nozzle wall thickness new, $t_n = 1.06 \text{ in}$

The nozzle neck thickness is adequate.

External Pressure, (Corroded & at 140 °F) UG-28(c)

$$L / D_o = 8.0654 / 4.12 = 1.9576$$

$$D_o / t = 4.12 / 0.1518 = 27.1437$$

From table G: $A = 0.004676$

From table CS-2: $B = 17,078.9811 \text{ psi}$

$$\begin{aligned} P_a &= 4 \cdot B / (3 \cdot (D_o / t)) \\ &= 4 \cdot 17,078.98 / (3 \cdot (4.12 / 0.1518)) \\ &= 838.94 \text{ psi} \end{aligned}$$

Design thickness for external pressure $P_a = 838.94 \text{ psi}$

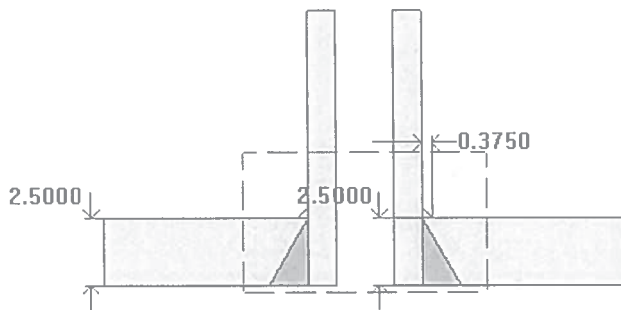
$$t_a = t + \text{Corrosion} = 0.1518 + 0.125 = 0.2768''$$

Level Bridal High (N5)

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$$t_{w(\text{lower})} = 2.5 \text{ in}$$

$$\text{Leg}_{41} = 0.375 \text{ in}$$



Note: round inside edges per UG-76(c)

Location and Orientation

Located on:	60 ID SHELL
Orientation:	45°
Nozzle center line offset to datum line:	8 in
End of nozzle to shell center:	40.5 in
Passes through a Category A joint:	No

Nozzle

Access opening:	No
Material specification:	SA-350 LF2 Cl 1 (II-D p. 18, In. 10)
Inside diameter, new:	2 in
Nominal wall thickness:	1.06 in
Corrosion allowance:	0.125 in
Projection available outside vessel, L _{pr} :	6.25 in
Projection available outside vessel to flange face, L _f :	8 in
Local vessel minimum thickness:	2.5 in
Liquid static head included:	0.6155 psi
Longitudinal joint efficiency:	1

ASME B16.5-2009 Flange

Description:	NPS 2 Class 900 LWN A350 LF2 Cl.1
Bolt Material:	SA-193 B7 Bolt <= 2 1/2 (II-D p. 334, In. 32)
Blind included:	No
Rated MDMT:	-55°F per UCS-66(b)(1)(b)
Liquid static head:	0.5757 psi
MAWP rating:	2,146 psi @ 140°F
MAP rating:	2,220 psi @ 50°F
Hydrotest rating:	3,350 psi @ 50°F
PWHT performed:	Yes

Reinforcement Calculations for Chamber MAWP

UG-37 Area Calculation Summary (in ²) For P = 1,378.62 psi @ 140 °F							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.3324	1.06

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (In)	Actual weld throat size (In)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for internal pressure 1,378.62 psi @ 140 °F

Nozzle is impact test exempt to -155 °F per UCS-66(b)(3) (coincident ratio = 0.0865).

Nozzle UCS-66 governing thk: 1.06 in

Nozzle rated MDMT: -155 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(2.25, 1.125 + (1.06 - 0.125) + (2.5 - 0.125)) \\
 &= 4.435 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.06 - 0.125) + 0) \\
 &= 2.3375 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-27(c)(1)

$$\begin{aligned}
 t_m &= P \cdot R_n / (S_n \cdot E - 0.6 \cdot P) \\
 &= 1,378.6155 \cdot 1.125 / (20,000 \cdot 1 - 0.6 \cdot 1,378.6155) \\
 &= 0.0809 \text{ in}
 \end{aligned}$$

Required thickness t_r from UG-37(a)

$$t_r = P \cdot R / (S \cdot E - 0.6 \cdot P)$$

$$= 1,378.6155 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 1,378.6155)$$

$$= 2.1661 \text{ in}$$

This opening does not require reinforcement per UG-36(c)(3)(a)

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \text{lesser of } 0.75 \text{ or } t_n \text{ or } t = 0.75 \text{ in}$

$t_{c(\min)} = \text{lesser of } 0.25 \text{ or } 0.7 \cdot t_{\min} = 0.25 \text{ in}$

$t_{c(\text{actual})} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.375 = 0.2625 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a \text{ UG-27}} = P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion}$$

$$= 1,378.6155 \cdot 1.125 / (20,000 \cdot 1 - 0.6 \cdot 1,378.6155) + 0.125$$

$$= 0.2059 \text{ in}$$

$$t_a = \max[t_{a \text{ UG-27}}, t_{a \text{ UG-22}}]$$

$$= \max[0.2059, 0]$$

$$= 0.2059 \text{ in}$$

$$t_{b1} = P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion}$$

$$= 1,378.6155 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 1,378.6155) + 0.125$$

$$= 2.2911 \text{ in}$$

$$t_{b1} = \max[t_{b1}, t_{b \text{ UG16}}]$$

$$= \max[2.2911, 0.1875]$$

$$= 2.2911 \text{ in}$$

$$t_b = \min[t_{b3}, t_{b1}]$$

$$= \min[0.3324, 2.2911]$$

$$= 0.3324 \text{ in}$$

$$t_{\text{UG-45}} = \max[t_a, t_b]$$

$$= \max[0.2059, 0.3324]$$

$$= 0.3324 \text{ in}$$

Available nozzle wall thickness new, $t_n = 1.06 \text{ in}$

The nozzle neck thickness is adequate.

Reinforcement Calculations for MAEP

UG-37 Area Calculation Summary (in ²) For Pe = 838.94 psi @ 140 °F							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.3324	1.06

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for external pressure 838.94 psi @ 140 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(2.25, 1.125 + (1.06 - 0.125) + (2.5 - 0.125)) \\
 &= 4.435 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.06 - 0.125) + 0) \\
 &= 2.3375 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-28 t_{rn} = 0.1518 in

From UG-37(d)(1) required thickness t_r = 2.375 in

This opening does not require reinforcement per UG-36(c)(3)(a)

UW-16(c) Weld Check

Fillet weld: t_{min} = lesser of 0.75 or t_n or t = 0.75 in
 t_{c(min)} = lesser of 0.25 or 0.7*t_{min} = 0.25 in
 t_{c(actual)} = 0.7*Leg = 0.7*0.375 = 0.2625 in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a \text{ UG-28}} = 0.2768 \text{ in}$$

$$\begin{aligned} t_a &= \max[t_{a \text{ UG-28}}, t_{a \text{ UG-22}}] \\ &= \max[0.2768, 0] \\ &= 0.2768 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{b2} &= P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion} \\ &= 838.9424 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 838.9424) + 0.125 \\ &= 1.4213 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{b2} &= \max[t_{b2}, t_{b \text{ UG16}}] \\ &= \max[1.4213, 0.1875] \\ &= 1.4213 \text{ in} \end{aligned}$$

$$\begin{aligned} t_b &= \min[t_{b3}, t_{b2}] \\ &= \min[0.3324, 1.4213] \\ &= 0.3324 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{\text{UG-45}} &= \max[t_a, t_b] \\ &= \max[0.2768, 0.3324] \\ &= 0.3324 \text{ in} \end{aligned}$$

Available nozzle wall thickness new, $t_n = 1.06 \text{ in}$

The nozzle neck thickness is adequate.

External Pressure, (Corroded & at 140 °F) UG-28(c)

$$L / D_o = 8.0654 / 4.12 = 1.9576$$

$$D_o / t = 4.12 / 0.1518 = 27.1437$$

From table G: $A = 0.004676$

From table CS-2: $B = 17,078.9811 \text{ psi}$

$$\begin{aligned} P_a &= 4 \cdot B / (3 \cdot (D_o / t)) \\ &= 4 \cdot 17,078.98 / (3 \cdot (4.12 / 0.1518)) \\ &= 838.94 \text{ psi} \end{aligned}$$

Design thickness for external pressure $P_a = 838.94 \text{ psi}$

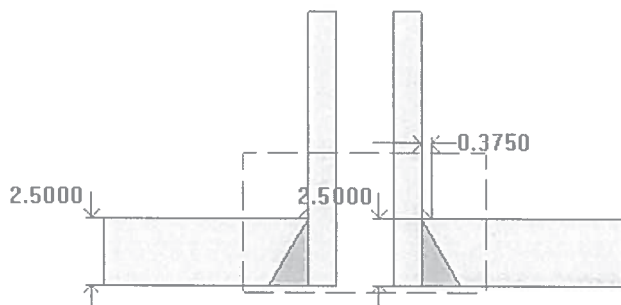
$$t_a = t + \text{Corrosion} = 0.1518 + 0.125 = 0.2768''$$

Fill/ Water Flush (N6)

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$$t_{w(\text{lower})} = 2.5 \text{ in}$$

$$\text{Leg}_{41} = 0.375 \text{ in}$$



Note: round inside edges per UG-76(c)

Location and Orientation

Located on:	60 ID SHELL
Orientation:	180°
Nozzle center line offset to datum line:	88 in
End of nozzle to shell center:	40.5 in
Passes through a Category A joint:	No

Nozzle

Access opening:	No
Material specification:	SA-350 LF2 Cl 1 (II-D p. 18, In. 10)
Inside diameter, new:	2 in
Nominal wall thickness:	1.06 in
Corrosion allowance:	0.125 in
Projection available outside vessel, L _{pr} :	6.25 in
Projection available outside vessel to flange face, L _f :	8 in
Local vessel minimum thickness:	2.5 in
Liquid static head included:	3.792 psi
Longitudinal joint efficiency:	1

ASME B16.5-2009 Flange

Description:	NPS 2 Class 900 LWN A350 LF2 Cl.1
Bolt Material:	SA-193 B7 Bolt ≤ 2 1/2 (II-D p. 334, In. 32)
Blind included:	No
Rated MDMT:	-55°F per UCS-66(b)(1)(b)
Liquid static head:	3.7523 psi
MAWP rating:	2,146 psi @ 140°F
MAP rating:	2,220 psi @ 50°F
Hydrotest rating:	3,350 psi @ 50°F
PWHT performed:	Yes

Reinforcement Calculations for Chamber MAWP

UG-37 Area Calculation Summary (in ²) For P = 1,381.79 psl @ 140 °F							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45		
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}	
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.3324	1.06	

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (In)	Actual weld throat size (In)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for internal pressure 1,381.79 psi @ 140 °F

Nozzle is impact test exempt to -155 °F per UCS-66(b)(3) (coincident ratio = 0.0867).

Nozzle UCS-66 governing thk: 1.06 in

Nozzle rated MDMT: -155 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(2.25, 1.125 + (1.06 - 0.125) + (2.5 - 0.125)) \\
 &= 4.435 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.06 - 0.125) + 0) \\
 &= 2.3375 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-27(c)(1)

$$\begin{aligned}
 t_n &= P \cdot R_n / (S_n \cdot E - 0.6 \cdot P) \\
 &= 1,381.792 \cdot 1.125 / (20,000 \cdot 1 - 0.6 \cdot 1,381.792) \\
 &= 0.0811 \text{ in}
 \end{aligned}$$

Required thickness t_r from UG-37(a)

$$t_r = P \cdot R / (S \cdot E - 0.6 \cdot P)$$

$$\begin{aligned}
 &= 1,381.792 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 1,381.792) \\
 &= 2.1713 \text{ in}
 \end{aligned}$$

This opening does not require reinforcement per UG-36(c)(3)(a)

UW-16(c) Weld Check

$$\begin{aligned}
 \text{Fillet weld: } t_{\min} &= \text{lesser of } 0.75 \text{ or } t_n \text{ or } t = 0.75 \text{ in} \\
 t_{c(\min)} &= \text{lesser of } 0.25 \text{ or } 0.7 \cdot t_{\min} = \underline{0.25} \text{ in} \\
 t_{c(\text{actual})} &= 0.7 \cdot \text{Leg} = 0.7 \cdot 0.375 = 0.2625 \text{ in}
 \end{aligned}$$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$\begin{aligned}
 t_{a \text{ UG-27}} &= P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion} \\
 &= 1,381.792 \cdot 1.125 / (20,000 \cdot 1 - 0.6 \cdot 1,381.792) + 0.125 \\
 &= 0.2061 \text{ in}
 \end{aligned}$$

$$\begin{aligned}
 t_a &= \max[t_{a \text{ UG-27}}, t_{a \text{ UG-22}}] \\
 &= \max[0.2061, 0] \\
 &= 0.2061 \text{ in}
 \end{aligned}$$

$$\begin{aligned}
 t_{b1} &= P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion} \\
 &= 1,381.792 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 1,381.792) + 0.125 \\
 &= 2.2963 \text{ in}
 \end{aligned}$$

$$\begin{aligned}
 t_{b1} &= \max[t_{b1}, t_{b \text{ UG16}}] \\
 &= \max[2.2963, 0.1875] \\
 &= 2.2963 \text{ in}
 \end{aligned}$$

$$\begin{aligned}
 t_b &= \min[t_{b3}, t_{b1}] \\
 &= \min[0.3324, 2.2963] \\
 &= 0.3324 \text{ in}
 \end{aligned}$$

$$\begin{aligned}
 t_{\text{UG-45}} &= \max[t_a, t_b] \\
 &= \max[0.2061, 0.3324] \\
 &= 0.3324 \text{ in}
 \end{aligned}$$

Available nozzle wall thickness new, $t_n = 1.06 \text{ in}$

The nozzle neck thickness is adequate.

Reinforcement Calculations for MAEP

UG-37 Area Calculation Summary (in ²) For Pe = 838.94 psi @ 140 °F							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.3324	1.06

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for external pressure 838.94 psi @ 140 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(2.25, 1.125 + (1.06 - 0.125) + (2.5 - 0.125)) \\
 &= 4.435 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.06 - 0.125) + 0) \\
 &= 2.3375 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-28 $t_m = 0.1518 \text{ in}$

From UG-37(d)(1) required thickness $t_r = 2.375 \text{ in}$

This opening does not require reinforcement per UG-36(c)(3)(a)

UW-16(c) Weld Check

$$\begin{aligned}
 \text{Fillet weld: } t_{\min} &= \text{lesser of } 0.75 \text{ or } t_n \text{ or } t = 0.75 \text{ in} \\
 t_{c(\min)} &= \text{lesser of } 0.25 \text{ or } 0.7*t_{\min} = 0.25 \text{ in} \\
 t_{c(\text{actual})} &= 0.7*\text{Leg} = 0.7*0.375 = 0.2625 \text{ in}
 \end{aligned}$$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a \text{ UG-28}} = 0.2768 \text{ in}$$

$$\begin{aligned} t_a &= \max[t_{a \text{ UG-28}}, t_{a \text{ UG-22}}] \\ &= \max[0.2768, 0] \\ &= 0.2768 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{b2} &= P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion} \\ &= 838.9424 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 838.9424) + 0.125 \\ &= 1.4213 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{b2} &= \max[t_{b2}, t_{b \text{ UG16}}] \\ &= \max[1.4213, 0.1875] \\ &= 1.4213 \text{ in} \end{aligned}$$

$$\begin{aligned} t_b &= \min[t_{b3}, t_{b2}] \\ &= \min[0.3324, 1.4213] \\ &= 0.3324 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{\text{UG-45}} &= \max[t_a, t_b] \\ &= \max[0.2768, 0.3324] \\ &= 0.3324 \text{ in} \end{aligned}$$

Available nozzle wall thickness new, $t_n = 1.06 \text{ in}$

The nozzle neck thickness is adequate.

External Pressure, (Corroded & at 140 °F) UG-28(c)

$$L / D_o = 8.0654 / 4.12 = 1.9576$$

$$D_o / t = 4.12 / 0.1518 = 27.1437$$

From table G: A = 0.004676

From table
CS-2: B = 17,078.9811 psi

$$\begin{aligned} P_a &= 4 \cdot B / (3 \cdot (D_o / t)) \\ &= 4 \cdot 17,078.98 / (3 \cdot (4.12 / 0.1518)) \\ &= 838.94 \text{ psi} \end{aligned}$$

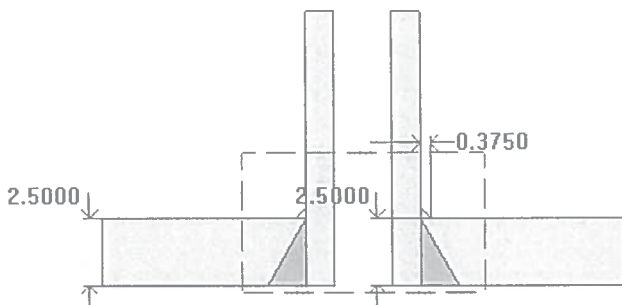
Design thickness for external pressure $P_a = 838.94 \text{ psi}$

$$t_a = t + \text{Corrosion} = 0.1518 + 0.125 = 0.2768''$$

Diff press Low (N8)

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$t_{w(lower)} = 2.5 \text{ in}$
 $Leg_{41} = 0.375 \text{ in}$



Note: round inside edges per UG-76(c)

Location and Orientation

Located on: 60 ID SHELL
 Orientation: 0°
 Nozzle center line offset to datum line: 88 in
 End of nozzle to shell center: 40.5 in
 Passes through a Category A joint: No

Nozzle

Access opening: No
 Material specification: SA-350 LF2 Cl 1 (II-D p. 18, In. 10)
 Inside diameter, new: 2 in
 Nominal wall thickness: 1.06 in
 Corrosion allowance: 0.125 in
 Projection available outside vessel, Lpr: 6.25 in
 Projection available outside vessel to flange face, Lf: 8 in
 Local vessel minimum thickness: 2.5 in
 Liquid static head included: 3.792 psi
 Longitudinal joint efficiency: 1

ASME B16.5-2009 Flange

Description: NPS 2 Class 900 LWN A350 LF2 Cl.1
 Bolt Material: SA-193 B7 Bolt <= 2 1/2 (II-D p. 334, In. 32)
 Blind included: No
 Rated MDMT: -55°F per UCS-66(b)(1)(b)
 Liquid static head: 3.7523 psi
 MAWP rating: 2,146 psi @ 140°F
 MAP rating: 2,220 psi @ 50°F
 Hydrotest rating: 3,350 psi @ 50°F
 PWHT performed: Yes

Reinforcement Calculations for Chamber MAWP

UG-37 Area Calculation Summary (in ²) For P = 1,381.79 psi @ 140 °F							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45		
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}	
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.3324	1.06	

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (In)	Actual weld throat size (In)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for internal pressure 1,381.79 psi @ 140 °F

Nozzle is impact test exempt to -155 °F per UCS-66(b)(3) (coincident ratio = 0.0867).

Nozzle UCS-66 governing thk: 1.06 in

Nozzle rated MDMT: -155 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(2.25, 1.125 + (1.06 - 0.125) + (2.5 - 0.125)) \\
 &= 4.435 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.06 - 0.125) + 0) \\
 &= 2.3375 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-27(c)(1)

$$\begin{aligned}
 t_{rn} &= P * R_n / (S_n * E - 0.6 * P) \\
 &= 1,381.792 * 1.125 / (20,000 * 1 - 0.6 * 1,381.792) \\
 &= 0.0811 \text{ in}
 \end{aligned}$$

Required thickness t_r from UG-37(a)

$$t_r = P * R / (S * E - 0.6 * P)$$

$$= 1,381.792 * 30.125 / (20,000 * 1 - 0.6 * 1,381.792)$$

$$= 2.1713 \text{ in}$$

This opening does not require reinforcement per UG-36(c)(3)(a)

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \text{lesser of } 0.75 \text{ or } t_n \text{ or } t = 0.75 \text{ in}$

$t_{c(\min)} = \text{lesser of } 0.25 \text{ or } 0.7 * t_{\min} = 0.25 \text{ in}$

$t_{c(\text{actual})} = 0.7 * \text{Leg} = 0.7 * 0.375 = 0.2625 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a \text{ UG-27}} = P * R / (S * E - 0.6 * P) + \text{Corrosion}$$

$$= 1,381.792 * 1.125 / (20,000 * 1 - 0.6 * 1,381.792) + 0.125$$

$$= 0.2061 \text{ in}$$

$$t_a = \max[t_{a \text{ UG-27}} , t_{a \text{ UG-22}}]$$

$$= \max[0.2061 , 0]$$

$$= 0.2061 \text{ in}$$

$$t_{b1} = P * R / (S * E - 0.6 * P) + \text{Corrosion}$$

$$= 1,381.792 * 30.125 / (20,000 * 1 - 0.6 * 1,381.792) + 0.125$$

$$= 2.2963 \text{ in}$$

$$t_{b1} = \max[t_{b1} , t_{b \text{ UG16}}]$$

$$= \max[2.2963 , 0.1875]$$

$$= 2.2963 \text{ in}$$

$$t_b = \min[t_{b3} , t_{b1}]$$

$$= \min[0.3324 , 2.2963]$$

$$= 0.3324 \text{ in}$$

$$t_{\text{UG-45}} = \max[t_a , t_b]$$

$$= \max[0.2061 , 0.3324]$$

$$= 0.3324 \text{ in}$$

Available nozzle wall thickness new, $t_n = 1.06 \text{ in}$

The nozzle neck thickness is adequate.

Reinforcement Calculations for MAEP

UG-37 Area Calculation Summary (in ²) For Pe = 838.94 psi @ 140 °F							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.3324	1.06

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (In)	Actual weld throat size (In)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for external pressure 838.94 psi @ 140 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(2.25, 1.125 + (1.06 - 0.125) + (2.5 - 0.125)) \\
 &= 4.435 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.06 - 0.125) + 0) \\
 &= 2.3375 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-28 $t_m = 0.1518 \text{ in}$

From UG-37(d)(1) required thickness $t_r = 2.375 \text{ in}$

This opening does not require reinforcement per UG-36(c)(3)(a)

UW-16(c) Weld Check

$$\begin{aligned}
 \text{Fillet weld: } t_{\min} &= \text{lesser of } 0.75 \text{ or } t_n \text{ or } t = 0.75 \text{ in} \\
 t_{c(\min)} &= \text{lesser of } 0.25 \text{ or } 0.7*t_{\min} = 0.25 \text{ in} \\
 t_{c(\text{actual})} &= 0.7*\text{Leg} = 0.7*0.375 = 0.2625 \text{ in}
 \end{aligned}$$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a \text{ UG-28}} = 0.2768 \text{ in}$$

$$\begin{aligned} t_a &= \max[t_{a \text{ UG-28}}, t_{a \text{ UG-22}}] \\ &= \max[0.2768, 0] \\ &= 0.2768 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{b2} &= P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion} \\ &= 838.9424 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 838.9424) + 0.125 \\ &= 1.4213 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{b2} &= \max[t_{b2}, t_{b \text{ UG16}}] \\ &= \max[1.4213, 0.1875] \\ &= 1.4213 \text{ in} \end{aligned}$$

$$\begin{aligned} t_b &= \min[t_{b3}, t_{b2}] \\ &= \min[0.3324, 1.4213] \\ &= 0.3324 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{\text{UG-45}} &= \max[t_a, t_b] \\ &= \max[0.2768, 0.3324] \\ &= 0.3324 \text{ in} \end{aligned}$$

Available nozzle wall thickness new, $t_n = 1.06 \text{ in}$

The nozzle neck thickness is adequate.

External Pressure, (Corroded & at 140 °F) UG-28(c)

$$\begin{aligned} L / D_o &= 8.0654 / 4.12 = 1.9576 \\ D_o / t &= 4.12 / 0.1518 = 27.1437 \\ \text{From table G: } A &= 0.004676 \\ \text{From table CS-2: } B &= 17,078.9811 \text{ psi} \end{aligned}$$

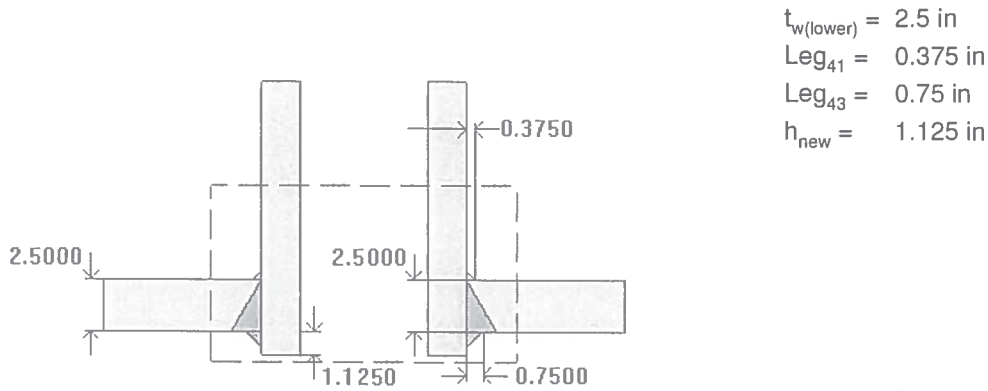
$$\begin{aligned} P_a &= 4 \cdot B / (3 \cdot (D_o / t)) \\ &= 4 \cdot 17,078.98 / (3 \cdot (4.12 / 0.1518)) \\ &= 838.94 \text{ psi} \end{aligned}$$

Design thickness for external pressure $P_a = 838.94 \text{ psi}$

$$t_a = t + \text{Corrosion} = 0.1518 + 0.125 = 0.2768''$$

Inspection Nozzle (N11)

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Note: round inside edges per UG-76(c)

Location and Orientation

Located on:	60 ID SHELL
Orientation:	110°
Nozzle center line offset to datum line:	12 in
End of nozzle to shell center:	42.5 in
Passes through a Category A joint:	No

Nozzle

Access opening:	No
Material specification:	SA-350 LF2 Cl 1 (II-D p. 18, In. 10)
Inside diameter, new:	8 in
Nominal wall thickness:	1.875 in
Corrosion allowance:	0.125 in
Projection available outside vessel, L _{pr} :	7.25 in
Internal projection, h_{new} :	1.125 in
Projection available outside vessel to flange face, L _f :	10 in
Local vessel minimum thickness:	2.5 in
Liquid static head included:	0.8934 psi
Longitudinal joint efficiency:	1

ASME B16.5-2009 Flange

Description:	NPS 8 Class 900 LWN A350 LF2 Cl.1
Bolt Material:	SA-193 B7 Bolt <= 2 1/2 (II-D p. 334, In. 32)
Blind included:	Yes
Rated MDMT:	-55°F per UCS-66(b)(1)(b)
Liquid static head:	0.7346 psi
MAWP rating:	2,146 psi @ 140°F
MAP rating:	2,220 psi @ 50°F
Hydrotest rating:	3,350 psi @ 50°F
PWHT performed:	Yes

Reinforcement Calculations for Chamber MAWP

UG-37 Area Calculation Summary (in²) For P = 1,378.89 psi @ 140 °F The opening is adequately reinforced							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
17.8743	18.153	1.7195	12.7164	3.25	--	0.4671	0.4531	1.875

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(1)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for internal pressure 1,378.89 psi @ 140 °F

Nozzle is impact test exempt to -155 °F per UCS-66(b)(3) (coincident ratio = 0.1695).

Nozzle UCS-66 governing thk: 1.875 in

Nozzle rated MDMT: -155 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(8.25, 4.125 + (1.875 - 0.125) + (2.5 - 0.125)) \\
 &= 8.25 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.875 - 0.125) + 0) \\
 &= 4.375 \text{ in}
 \end{aligned}$$

Inner Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_I &= \text{MIN}(2.5*(t - C), 2.5*(t_i - C_n - C)) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.875 - 0.125 - 0.125)) \\
 &= 4.0625 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-27(c)(1)

$$\begin{aligned}
 t_m &= P*R_n / (S_n*E - 0.6*P) \\
 &= 1,378.8934*4.125 / (20,000*1 - 0.6*1,378.8934) \\
 &= 0.2967 \text{ in}
 \end{aligned}$$

Required thickness t_r from UG-37(a)

$$\begin{aligned}t_r &= P \cdot R / (S \cdot E - 0.6 \cdot P) \\&= 1,378.8934 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 1,378.8934) \\&= 2.1666 \text{ in}\end{aligned}$$

Area required per UG-37(c)

Allowable stresses: $S_n = 20,000$, $S_v = 20,000$ psi

$$f_{r1} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$f_{r2} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$\begin{aligned}A &= d \cdot t_r \cdot F + 2 \cdot t_n \cdot t_r \cdot F \cdot (1 - f_{r1}) \\&= 8.25 \cdot 2.1666 \cdot 1 + 2 \cdot 1.75 \cdot 2.1666 \cdot 1 \cdot (1 - 1) \\&= \underline{17.8743} \text{ in}^2\end{aligned}$$

Area available from FIG. UG-37.1

$$A_1 = \text{larger of the following} = \underline{1.7195} \text{ in}^2$$

$$\begin{aligned}&= d \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1}) \\&= 8.25 \cdot (1 \cdot 2.375 - 1 \cdot 2.1666) - 2 \cdot 1.75 \cdot (1 \cdot 2.375 - 1 \cdot 2.1666) \cdot (1 - 1) \\&= 1.7195 \text{ in}^2\end{aligned}$$

$$\begin{aligned}&= 2 \cdot (t + t_n) \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1}) \\&= 2 \cdot (2.375 + 1.75) \cdot (1 \cdot 2.375 - 1 \cdot 2.1666) - 2 \cdot 1.75 \cdot (1 \cdot 2.375 - 1 \cdot 2.1666) \cdot (1 - 1) \\&= 1.7195 \text{ in}^2\end{aligned}$$

$$A_2 = \text{smaller of the following} = \underline{12.7164} \text{ in}^2$$

$$\begin{aligned}&= 5 \cdot (t_n - t_m) \cdot f_{r2} \cdot t \\&= 5 \cdot (1.75 - 0.2967) \cdot 1 \cdot 2.375 \\&= 17.2579 \text{ in}^2\end{aligned}$$

$$\begin{aligned}&= 5 \cdot (t_n - t_m) \cdot f_{r2} \cdot t_n \\&= 5 \cdot (1.75 - 0.2967) \cdot 1 \cdot 1.75 \\&= 12.7164 \text{ in}^2\end{aligned}$$

$$A_3 = \text{smaller of the following} = \underline{3.25} \text{ in}^2$$

$$\begin{aligned}&= 5 \cdot t_i \cdot f_{r2} \\&= 5 \cdot 2.375 \cdot 1.625 \cdot 1 \\&= \underline{19.2969} \text{ in}^2\end{aligned}$$

$$\begin{aligned}&= 5 \cdot t_i \cdot t_i \cdot f_{r2} \\&= 5 \cdot 1.625 \cdot 1.625 \cdot 1\end{aligned}$$

$$= \underline{13.2031} \text{ in}^2$$

$$\begin{aligned} &= 2 \cdot h \cdot t_i \cdot f_{r2} \\ &= 2 \cdot 1 \cdot 1.625 \cdot 1 \\ &= \underline{3.25} \text{ in}^2 \end{aligned}$$

$$\begin{aligned} A_{41} &= \text{Leg}^2 \cdot f_{r2} \\ &= 0.375^2 \cdot 1 \\ &= \underline{0.1406} \text{ in}^2 \end{aligned}$$

$$\begin{aligned} A_{43} &= \text{Leg}^2 \cdot f_{r2} \\ &= 0.5714^2 \cdot 1 \\ &= \underline{0.3265} \text{ in}^2 \end{aligned}$$

$$\begin{aligned} \text{Area} &= A_1 + A_2 + A_3 + A_{41} + A_{43} \\ &= 1.7195 + 12.7164 + 3.25 + 0.1406 + 0.3265 \\ &= \underline{18.153} \text{ in}^2 \end{aligned}$$

As Area \geq A the reinforcement is adequate.

UW-16(c) Weld Check

$$\begin{aligned} \text{Fillet weld: } t_{\min} &= \text{lesser of } 0.75 \text{ or } t_n \text{ or } t = 0.75 \text{ in} \\ t_{c(\min)} &= \text{lesser of } 0.25 \text{ or } 0.7 \cdot t_{\min} = \underline{0.25} \text{ in} \\ t_{c(\text{actual})} &= 0.7 \cdot \text{Leg} = 0.7 \cdot 0.375 = 0.2625 \text{ in} \end{aligned}$$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$\begin{aligned} t_{a \text{ UG-27}} &= P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion} \\ &= 1,378.8934 \cdot 4.125 / (20,000 \cdot 1 - 0.6 \cdot 1,378.8934) + 0.125 \\ &= 0.4217 \text{ in} \end{aligned}$$

$$\begin{aligned} t_a &= \max[t_{a \text{ UG-27}}, t_{a \text{ UG-22}}] \\ &= \max[0.4217, 0] \\ &= 0.4217 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{b1} &= P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion} \\ &= 1,378.8934 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 1,378.8934) + 0.125 \\ &= 2.2916 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{b1} &= \max[t_{b1}, t_{b \text{ UG16}}] \\ &= \max[2.2916, 0.1875] \\ &= 2.2916 \text{ in} \end{aligned}$$

$$\begin{aligned}t_b &= \min[t_{b3}, t_{b1}] \\ &= \min[0.4531, 2.2916] \\ &= 0.4531 \text{ in}\end{aligned}$$

$$\begin{aligned}t_{UG-45} &= \max[t_a, t_b] \\ &= \max[0.4217, 0.4531] \\ &= 0.4531 \text{ in}\end{aligned}$$

Available nozzle wall thickness new, $t_n = 1.875$ in

The nozzle neck thickness is adequate.

Reinforcement Calculations for MAEP

UG-37 Area Calculation Summary (in²) For $P_e = 838.94$ psi @ 140 °F The opening is adequately reinforced							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
9.7969	15.3104	--	11.5933	3.25	--	0.4671	0.5501	1.875

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for external pressure 838.94 psi @ 140 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(8.25, 4.125 + (1.875 - 0.125) + (2.5 - 0.125)) \\
 &= 8.25 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.875 - 0.125) + 0) \\
 &= 4.375 \text{ in}
 \end{aligned}$$

Inner Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_I &= \text{MIN}(2.5*(t - C), 2.5*(t_i - C_n - C)) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.875 - 0.125 - 0.125)) \\
 &= 4.0625 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-28 $t_{rn} = 0.4251$ in

From UG-37(d)(1) required thickness $t_r = 2.375$ in

Area required per UG-37(d)(1)

Allowable stresses: $S_n = 20,000$, $S_v = 20,000$ psi

$$f_{r1} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$f_{r2} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$\begin{aligned} A &= 0.5(d_t F + 2t_n t_r F(1 - f_{r1})) \\ &= 0.5(8.25 \cdot 2.375 \cdot 1 + 2 \cdot 1.75 \cdot 2.375 \cdot 1 \cdot (1 - 1)) \\ &= \underline{9.7969} \text{ in}^2 \end{aligned}$$

Area available from FIG. UG-37.1

$$A_1 = \text{larger of the following} = \underline{0} \text{ in}^2$$

$$\begin{aligned} &= d(E_1 t - F t_r) - 2t_n(E_1 t - F t_r)(1 - f_{r1}) \\ &= 8.25(1 \cdot 2.375 - 1 \cdot 2.375) - 2 \cdot 1.75(1 \cdot 2.375 - 1 \cdot 2.375)(1 - 1) \\ &= 0 \text{ in}^2 \\ &= 2(t + t_n)(E_1 t - F t_r) - 2t_n(E_1 t - F t_r)(1 - f_{r1}) \\ &= 2(2.375 + 1.75)(1 \cdot 2.375 - 1 \cdot 2.375) - 2 \cdot 1.75(1 \cdot 2.375 - 1 \cdot 2.375)(1 - 1) \\ &= 0 \text{ in}^2 \end{aligned}$$

$$A_2 = \text{smaller of the following} = \underline{11.5933} \text{ in}^2$$

$$\begin{aligned} &= 5(t_n - t_m) f_{r2} t \\ &= 5(1.75 - 0.4251) \cdot 1 \cdot 2.375 \\ &= 15.7337 \text{ in}^2 \\ &= 5(t_n - t_m) f_{r2} t_n \\ &= 5(1.75 - 0.4251) \cdot 1 \cdot 1.75 \\ &= 11.5933 \text{ in}^2 \end{aligned}$$

$$A_3 = \text{smaller of the following} = \underline{3.25} \text{ in}^2$$

$$\begin{aligned} &= 5t_i f_{r2} \\ &= 5 \cdot 2.375 \cdot 1.625 \cdot 1 \\ &= \underline{19.2969} \text{ in}^2 \\ &= 5t_i t_i f_{r2} \\ &= 5 \cdot 1.625 \cdot 1.625 \cdot 1 \\ &= \underline{13.2031} \text{ in}^2 \\ &= 2h_i f_{r2} \\ &= 2 \cdot 1 \cdot 1.625 \cdot 1 \\ &= \underline{3.25} \text{ in}^2 \end{aligned}$$

$$\begin{aligned} A_{41} &= \text{Leg}^2 f_{r2} \\ &= 0.375^2 \cdot 1 \\ &= \underline{0.1406} \text{ in}^2 \end{aligned}$$

$$A_{43} = \text{Leg}^2 f_{r2}$$

$$= 0.5714^2 * 1$$

$$= \underline{0.3265 \text{ in}^2}$$

$$\text{Area} = A_1 + A_2 + A_3 + A_{41} + A_{43}$$

$$= 0 + 11.5933 + 3.25 + 0.1406 + 0.3265$$

$$= \underline{15.3104 \text{ in}^2}$$

As Area \geq A the reinforcement is adequate.

UW-16(c) Weld Check

Fillet weld: t_{\min} = lesser of 0.75 or t_n or $t = 0.75$ in

$t_{c(\min)}$ = lesser of 0.25 or $0.7 * t_{\min} = \underline{0.25}$ in

$t_{c(\text{actual})} = 0.7 * \text{Leg} = 0.7 * 0.375 = 0.2625$ in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a \text{ UG-28}} = 0.5501 \text{ in}$$

$$t_a = \max[t_{a \text{ UG-28}}, t_{a \text{ UG-22}}]$$

$$= \max[0.5501, 0]$$

$$= 0.5501 \text{ in}$$

$$t_{b2} = P * R / (S * E - 0.6 * P) + \text{Corrosion}$$

$$= 838.9424 * 30.125 / (20,000 * 1 - 0.6 * 838.9424) + 0.125$$

$$= 1.4213 \text{ in}$$

$$t_{b2} = \max[t_{b2}, t_{b \text{ UG16}}]$$

$$= \max[1.4213, 0.1875]$$

$$= 1.4213 \text{ in}$$

$$t_b = \min[t_{b3}, t_{b2}]$$

$$= \min[0.4531, 1.4213]$$

$$= 0.4531 \text{ in}$$

$$t_{\text{UG-45}} = \max[t_a, t_b]$$

$$= \max[0.5501, 0.4531]$$

$$= 0.5501 \text{ in}$$

Available nozzle wall thickness new, $t_n = 1.875$ in

The nozzle neck thickness is adequate.

External Pressure, (Corroded & at 140 °F) UG-28(c)

$$L / D_o = 10.5354 / 11.75 = 0.8966$$

$$D_o / t = 11.75 / 0.4251 = 27.6434$$

From table G: A = 0.010937

From table
CS-2: B = 17,393.3823 psi

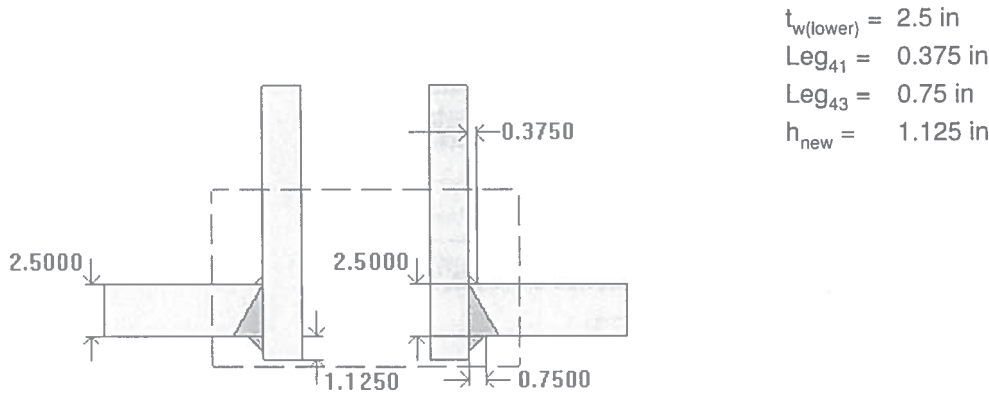
$$\begin{aligned} P_a &= 4 * B / (3 * (D_o / t)) \\ &= 4 * 17,393.38 / (3 * (11.75 / 0.4251)) \\ &= 838.94 \text{ psi} \end{aligned}$$

Design thickness for external pressure $P_a = 838.94$ psi

$$t_a = t + \text{Corrosion} = 0.4251 + 0.125 = 0.5501''$$

Inlet Nozzle (N12)

ASME Section VIII Division 1, 2010 Edition, A11 Addenda



Note: round inside edges per UG-76(c)

Location and Orientation

Located on:	60 ID SHELL
Orientation:	330°
Nozzle center line offset to datum line:	87 in
End of nozzle to shell center:	42.5 in
Passes through a Category A joint:	No

Nozzle

Access opening:	No
Material specification:	SA-350 LF2 Cl 1 (II-D p. 18, In. 10)
Inside diameter, new:	8 in
Nominal wall thickness:	1.875 in
Corrosion allowance:	0.125 in
Projection available outside vessel, L _{pr} :	7.25 in
Internal projection, h _{new} :	1.125 in
Projection available outside vessel to flange face, L _f :	10 in
Local vessel minimum thickness:	2.5 in
Liquid static head included:	3.8714 psi
Longitudinal joint efficiency:	1

ASME B16.5-2009 Flange

Description:	NPS 8 Class 900 LWN A350 LF2 Cl.1
Bolt Material:	SA-193 B7 Bolt <= 2 1/2 (II-D p. 334, In. 32)
Blind included:	No
Rated MDMT:	-55°F per UCS-66(b)(1)(b)
Liquid static head:	3.7126 psi
MAWP rating:	2,146 psi @ 140°F
MAP rating:	2,220 psi @ 50°F
Hydrotest rating:	3,350 psi @ 50°F
PWHT performed:	Yes

Reinforcement Calculations for Chamber MAWP

UG-37 Area Calculation Summary (in²) For P = 1,381.87 psi @ 140 °F The opening is adequately reinforced							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
17.9145	18.1074	1.6792	12.7111	3.25	--	0.4671	0.4531	1.875

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(1)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for internal pressure 1,381.87 psi @ 140 °F

Nozzle is impact test exempt to -155 °F per UCS-66(b)(3) (coincident ratio = 0.1699).

Nozzle UCS-66 governing thk: 1.875 in

Nozzle rated MDMT: -155 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(8.25, 4.125 + (1.875 - 0.125) + (2.5 - 0.125)) \\
 &= 8.25 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.875 - 0.125) + 0) \\
 &= 4.375 \text{ in}
 \end{aligned}$$

Inner Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_I &= \text{MIN}(2.5*(t - C), 2.5*(t_i - C_n - C)) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.875 - 0.125 - 0.125)) \\
 &= 4.0625 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-27(c)(1)

$$\begin{aligned}
 t_m &= P \cdot R_n / (S_n \cdot E - 0.6 \cdot P) \\
 &= 1,381.8714 \cdot 4.125 / (20,000 \cdot 1 - 0.6 \cdot 1,381.8714) \\
 &= 0.2973 \text{ in}
 \end{aligned}$$

Required thickness t_r from UG-37(a)

$$\begin{aligned}t_r &= P \cdot R / (S \cdot E - 0.6 \cdot P) \\&= 1,381.8714 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 1,381.8714) \\&= 2.1715 \text{ in}\end{aligned}$$

Area required per UG-37(c)

Allowable stresses: $S_n = 20,000$, $S_v = 20,000$ psi

$$f_{r1} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$f_{r2} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$\begin{aligned}A &= d \cdot t_r \cdot F + 2 \cdot t_n \cdot t_r \cdot F \cdot (1 - f_{r1}) \\&= 8.25 \cdot 2.1715 \cdot 1 + 2 \cdot 1.75 \cdot 2.1715 \cdot 1 \cdot (1 - 1) \\&= \underline{17.9145 \text{ in}^2}\end{aligned}$$

Area available from FIG. UG-37.1

$$A_1 = \text{larger of the following} = \underline{1.6792 \text{ in}^2}$$

$$\begin{aligned}&= d \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1}) \\&= 8.25 \cdot (1 \cdot 2.375 - 1 \cdot 2.1715) - 2 \cdot 1.75 \cdot (1 \cdot 2.375 - 1 \cdot 2.1715) \cdot (1 - 1) \\&= 1.6792 \text{ in}^2\end{aligned}$$

$$\begin{aligned}&= 2 \cdot (t + t_n) \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1}) \\&= 2 \cdot (2.375 + 1.75) \cdot (1 \cdot 2.375 - 1 \cdot 2.1715) - 2 \cdot 1.75 \cdot (1 \cdot 2.375 - 1 \cdot 2.1715) \cdot (1 - 1) \\&= 1.6792 \text{ in}^2\end{aligned}$$

$$A_2 = \text{smaller of the following} = \underline{12.7111 \text{ in}^2}$$

$$\begin{aligned}&= 5 \cdot (t_n - t_m) \cdot f_{r2} \cdot t \\&= 5 \cdot (1.75 - 0.2973) \cdot 1 \cdot 2.375 \\&= 17.2508 \text{ in}^2\end{aligned}$$

$$\begin{aligned}&= 5 \cdot (t_n - t_m) \cdot f_{r2} \cdot t_n \\&= 5 \cdot (1.75 - 0.2973) \cdot 1 \cdot 1.75 \\&= 12.7111 \text{ in}^2\end{aligned}$$

$$A_3 = \text{smaller of the following} = \underline{3.25 \text{ in}^2}$$

$$\begin{aligned}&= 5 \cdot t_i \cdot f_{r2} \\&= 5 \cdot 2.375 \cdot 1.625 \cdot 1 \\&= \underline{19.2969 \text{ in}^2}\end{aligned}$$

$$\begin{aligned}&= 5 \cdot t_i \cdot f_{r2} \\&= 5 \cdot 1.625 \cdot 1.625 \cdot 1\end{aligned}$$

$$\begin{aligned}
&= \underline{13.2031} \text{ in}^2 \\
&= 2 \cdot h \cdot t_1 \cdot f_{r2} \\
&= 2 \cdot 1 \cdot 1.625 \cdot 1 \\
&= \underline{3.25} \text{ in}^2
\end{aligned}$$

$$\begin{aligned}
A_{41} &= \text{Leg}^2 \cdot f_{r2} \\
&= 0.375^2 \cdot 1 \\
&= \underline{0.1406} \text{ in}^2
\end{aligned}$$

$$\begin{aligned}
A_{43} &= \text{Leg}^2 \cdot f_{r2} \\
&= 0.5714^2 \cdot 1 \\
&= \underline{0.3265} \text{ in}^2
\end{aligned}$$

$$\begin{aligned}
\text{Area} &= A_1 + A_2 + A_3 + A_{41} + A_{43} \\
&= 1.6792 + 12.7111 + 3.25 + 0.1406 + 0.3265 \\
&= \underline{18.1074} \text{ in}^2
\end{aligned}$$

As Area \geq A the reinforcement is adequate.

UW-16(c) Weld Check

Fillet weld: t_{\min} = lesser of 0.75 or t_n or $t = 0.75$ in

$t_{c(\min)}$ = lesser of 0.25 or $0.7 \cdot t_{\min} = \underline{0.25}$ in

$t_{c(\text{actual})} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.375 = 0.2625$ in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$\begin{aligned}
t_{a \text{ UG-27}} &= P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion} \\
&= 1,381.8714 \cdot 4.125 / (20,000 \cdot 1 - 0.6 \cdot 1,381.8714) + 0.125 \\
&= 0.4223 \text{ in}
\end{aligned}$$

$$t_{a \text{ UG-22}} = 0.3798 \text{ in}$$

$$\begin{aligned}
t_a &= \max[t_{a \text{ UG-27}}, t_{a \text{ UG-22}}] \\
&= \max[0.4223, 0.3798] \\
&= 0.4223 \text{ in}
\end{aligned}$$

$$\begin{aligned}
t_{b1} &= P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion} \\
&= 1,381.8714 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 1,381.8714) + 0.125 \\
&= 2.2965 \text{ in}
\end{aligned}$$

$$t_{b1} = \max[t_{b1}, t_{b \text{ UG16}}]$$

$$= \max[2.2965 , 0.1875]$$
$$= 2.2965 \text{ in}$$

$$t_b = \min[t_{b3} , t_{b1}]$$
$$= \min[0.4531 , 2.2965]$$
$$= 0.4531 \text{ in}$$

$$t_{UG-45} = \max[t_a , t_b]$$
$$= \max[0.4223 , 0.4531]$$
$$= 0.4531 \text{ in}$$

Available nozzle wall thickness new, $t_n = 1.875 \text{ in}$

The nozzle neck thickness is adequate.

Applied Loads

Radial load:	$P_r = 2,720$	lb_f
Circumferential moment:	$M_c = 92,535$	$lb_f\text{-in}$
Circumferential shear:	$V_c = 3,332$	lb_f
Longitudinal moment:	$M_L = 92,535$	$lb_f\text{-in}$
Longitudinal shear:	$V_L = 3,332$	lb_f
Torsion moment:	$M_t = 130,858$	$lb_f\text{-in}$
Internal pressure:	$P = 1,381.871$	psi
Mean shell radius:	$R_m = 31.3125$	in
Local shell thickness:	$t = 2.375$	in
Shell yield stress:	$S_y = 36,200$	psi

Maximum stresses due to the applied loads at the nozzle OD (includes pressure)

$$R_m / t = 31.3125 / 2.375 = 13.1842$$

Pressure stress intensity factor, $I = 1.18127$ (derived from PVP-Vol. 399, pages 77-82)

$$\text{Local circumferential pressure stress} = I \cdot P \cdot R_i / t = 20,705 \text{ psi}$$

$$\text{Local longitudinal pressure stress} = I \cdot P \cdot R_i / (2 \cdot t) = 10,353 \text{ psi}$$

$$\text{Maximum combined stress } (P_L + P_b + Q) = 21,608 \text{ psi}$$

$$\text{Allowable combined stress } (P_L + P_b + Q) = +3 \cdot S = +60,000 \text{ psi}$$

The maximum combined stress $(P_L + P_b + Q)$ is within allowable limits.

$$\text{Maximum local primary membrane stress } (P_L) = 20,940 \text{ psi}$$

$$\text{Allowable local primary membrane stress } (P_L) = +1.5 \cdot S = +30,000 \text{ psi}$$

The maximum local primary membrane stress (P_L) is within allowable limits.

Stresses at the nozzle OD per WRC Bulletin 107										
Figure	value	β	A_u	A_l	B_u	B_l	C_u	C_l	D_u	D_l
3C*	2.0727	0.1642	0	0	0	0	-76	-76	-76	-76
4C*	2.341	0.1642	-86	-86	-86	-86	0	0	0	0
1C	0.1247	0.1642	0	0	0	0	-361	361	-361	361
2C-1	0.0907	0.1642	-262	262	-262	262	0	0	0	0
3A*	0.3939	0.1642	0	0	0	0	-95	-95	95	95
1A	0.0981	0.1642	0	0	0	0	-1,878	1,878	1,878	-1,878
3B*	1.3281	0.1642	-321	-321	321	321	0	0	0	0
1B-1	0.0484	0.1642	-927	927	927	-927	0	0	0	0
Pressure stress*			20,705	20,705	20,705	20,705	17,528	17,528	17,528	17,528
Total circumferential stress			19,109	21,487	21,605	20,275	15,118	19,596	19,064	16,030
Primary membrane circumferential stress*			20,298	20,298	20,940	20,940	17,357	17,357	17,547	17,547
3C*	2.0727	0.1642	-76	-76	-76	-76	0	0	0	0
4C*	2.341	0.1642	0	0	0	0	-86	-86	-86	-86
1C-1	0.1264	0.1642	-366	366	-366	366	0	0	0	0
2C	0.0906	0.1642	0	0	0	0	-262	262	-262	262
4A*	0.5797	0.1642	0	0	0	0	-140	-140	140	140
2A	0.0562	0.1642	0	0	0	0	-1,076	1,076	1,076	-1,076
4B*	0.3835	0.1642	-93	-93	93	93	0	0	0	0
2B-1	0.0779	0.1642	-1,492	1,492	1,492	-1,492	0	0	0	0
Pressure stress*			8,764	8,764	8,764	8,764	10,353	10,353	10,353	10,353
Total longitudinal stress			6,737	10,453	9,907	7,655	8,789	11,465	11,221	9,593
Primary membrane longitudinal stress*			8,595	8,595	8,781	8,781	10,127	10,127	10,407	10,407
Shear from M_t			254	254	254	254	254	254	254	254
Circ shear from V_c			76	76	-76	-76	0	0	0	0
Long shear from V_L			0	0	0	0	-76	-76	76	76
Total Shear stress			330	330	178	178	178	178	330	330
Combined stress (P_L+P_b+Q)			19,118	21,497	21,608	20,278	15,123	19,600	19,078	16,047

Note: * denotes primary stress.

Longitudinal stress in the nozzle wall due to internal pressure + external loads

$$\begin{aligned} \sigma_{n(P_m)} &= P \cdot R_i / (2 \cdot t_n) - P_r / (\pi \cdot (R_o^2 - R_i^2)) + M \cdot R_o / I \\ &= 1,381.87 \cdot 4.125 / (2 \cdot 1.75) - 2,720 / (\pi \cdot (5.875^2 - 4.125^2)) + 130,864.3 \cdot 5.875 / 708.2696 \\ &= 2,665 \text{ psi} \end{aligned}$$

The average primary stress P_m (see Division 2 5.6.a.1) across the nozzle wall due to internal pressure + external loads is acceptable ($\leq S = 20,000$ psi)

Shear stress in the nozzle wall due to external loads

$$\begin{aligned} \sigma_{\text{shear}} &= (V_L^2 + V_c^2)^{0.5} / (\pi \cdot R_i \cdot t_n) \\ &= (3,332^2 + 3,332^2)^{0.5} / (\pi \cdot 4.125 \cdot 1.75) \\ &= 208 \text{ psi} \end{aligned}$$

$$\begin{aligned} \sigma_{\text{torsion}} &= M_t / (2 \cdot \pi \cdot R_i^2 \cdot t_n) \\ &= 130,858 / (2 \cdot \pi \cdot 4.125^2 \cdot 1.75) \end{aligned}$$

= 699 psi

$$\begin{aligned}\sigma_{\text{total}} &= \sigma_{\text{shear}} + \sigma_{\text{torsion}} \\ &= 208 + 699 \\ &= 907 \text{ psi}\end{aligned}$$

UG-45: The total combined shear stress (907 psi) is below than the allowable ($0.7 \cdot S_n = 0.7 \cdot 20,000 = 14,000$ psi)

Reinforcement Calculations for MAEP

UG-37 Area Calculation Summary (in ²) For Pe = 838.94 psi @ 140 °F The opening is adequately reinforced							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
9.7969	15.3104	--	11.5933	3.25	--	0.4671	0.5501	1.875

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Calculations for external pressure 838.94 psi @ 140 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(8.25, 4.125 + (1.875 - 0.125) + (2.5 - 0.125)) \\
 &= 8.25 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.875 - 0.125) + 0) \\
 &= 4.375 \text{ in}
 \end{aligned}$$

Inner Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_I &= \text{MIN}(2.5*(t - C), 2.5*(t_i - C_n - C)) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(1.875 - 0.125 - 0.125)) \\
 &= 4.0625 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-28 $t_{rn} = 0.4251 \text{ in}$

From UG-37(d)(1) required thickness $t_r = 2.375 \text{ in}$

Area required per UG-37(d)(1)

Allowable stresses: $S_n = 20,000$, $S_v = 20,000 \text{ psi}$

$$f_{r1} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$f_{r2} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$\begin{aligned} A &= 0.5(d_t F + 2t_n t_r F(1 - f_{r1})) \\ &= 0.5(8.25 \cdot 2.375 \cdot 1 + 2 \cdot 1.75 \cdot 2.375 \cdot 1 \cdot (1 - 1)) \\ &= \underline{9.7969} \text{ in}^2 \end{aligned}$$

Area available from FIG. UG-37.1

$$A_1 = \text{larger of the following} = 0 \text{ in}^2$$

$$\begin{aligned} &= d(E_1 t - F t_r) - 2t_n(E_1 t - F t_r)(1 - f_{r1}) \\ &= 8.25(1 \cdot 2.375 - 1 \cdot 2.375) - 2 \cdot 1.75(1 \cdot 2.375 - 1 \cdot 2.375)(1 - 1) \\ &= 0 \text{ in}^2 \\ &= 2(t + t_n)(E_1 t - F t_r) - 2t_n(E_1 t - F t_r)(1 - f_{r1}) \\ &= 2(2.375 + 1.75)(1 \cdot 2.375 - 1 \cdot 2.375) - 2 \cdot 1.75(1 \cdot 2.375 - 1 \cdot 2.375)(1 - 1) \\ &= 0 \text{ in}^2 \end{aligned}$$

$$A_2 = \text{smaller of the following} = \underline{11.5933} \text{ in}^2$$

$$\begin{aligned} &= 5(t_n - t_m) f_{r2} t \\ &= 5(1.75 - 0.4251) \cdot 1 \cdot 2.375 \\ &= 15.7337 \text{ in}^2 \\ &= 5(t_n - t_m) f_{r2} t_n \\ &= 5(1.75 - 0.4251) \cdot 1 \cdot 1.75 \\ &= 11.5933 \text{ in}^2 \end{aligned}$$

$$A_3 = \text{smaller of the following} = \underline{3.25} \text{ in}^2$$

$$\begin{aligned} &= 5t_i^2 f_{r2} \\ &= 5 \cdot 2.375^2 \cdot 1 \\ &= \underline{19.2969} \text{ in}^2 \\ &= 5t_i^2 f_{r2} \\ &= 5 \cdot 1.625^2 \cdot 1 \\ &= \underline{13.2031} \text{ in}^2 \\ &= 2h t_i f_{r2} \\ &= 2 \cdot 1 \cdot 1.625 \cdot 1 \\ &= \underline{3.25} \text{ in}^2 \end{aligned}$$

$$\begin{aligned} A_{41} &= \text{Leg}^2 f_{r2} \\ &= 0.375^2 \cdot 1 \\ &= \underline{0.1406} \text{ in}^2 \end{aligned}$$

$$A_{43} = \text{Leg}^2 f_{r2}$$

$$= 0.5714^2 * 1$$

$$= \underline{0.3265 \text{ in}^2}$$

$$\text{Area} = A_1 + A_2 + A_3 + A_{41} + A_{43}$$

$$= 0 + 11.5933 + 3.25 + 0.1406 + 0.3265$$

$$= \underline{15.3104 \text{ in}^2}$$

As Area \geq A the reinforcement is adequate.

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \text{lesser of } 0.75 \text{ or } t_n \text{ or } t = 0.75 \text{ in}$
 $t_{c(\min)} = \text{lesser of } 0.25 \text{ or } 0.7 * t_{\min} = \underline{0.25 \text{ in}}$
 $t_{c(\text{actual})} = 0.7 * \text{Leg} = 0.7 * 0.375 = 0.2625 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a \text{ UG-28}} = 0.5501 \text{ in}$$

$$t_{a \text{ UG-22}} = 0.3113 \text{ in}$$

$$t_a = \max[t_{a \text{ UG-28}}, t_{a \text{ UG-22}}]$$

$$= \max[0.5501, 0.3113]$$

$$= 0.5501 \text{ in}$$

$$t_{b2} = P * R / (S * E - 0.6 * P) + \text{Corrosion}$$

$$= 838.9424 * 30.125 / (20,000 * 1 - 0.6 * 838.9424) + 0.125$$

$$= 1.4213 \text{ in}$$

$$t_{b2} = \max[t_{b2}, t_{b \text{ UG16}}]$$

$$= \max[1.4213, 0.1875]$$

$$= 1.4213 \text{ in}$$

$$t_b = \min[t_{b3}, t_{b2}]$$

$$= \min[0.4531, 1.4213]$$

$$= 0.4531 \text{ in}$$

$$t_{\text{UG-45}} = \max[t_a, t_b]$$

$$= \max[0.5501, 0.4531]$$

$$= 0.5501 \text{ in}$$

Available nozzle wall thickness new, $t_n = 1.875 \text{ in}$

The nozzle neck thickness is adequate.

External Pressure, (Corroded & at 140 °F) UG-28(c)

$$L / D_o = 10.5354 / 11.75 = 0.8966$$

$$D_o / t = 11.75 / 0.4251 = 27.6434$$

From table G: A = 0.010937

From table CS-2: B = 17,393.3823 psi

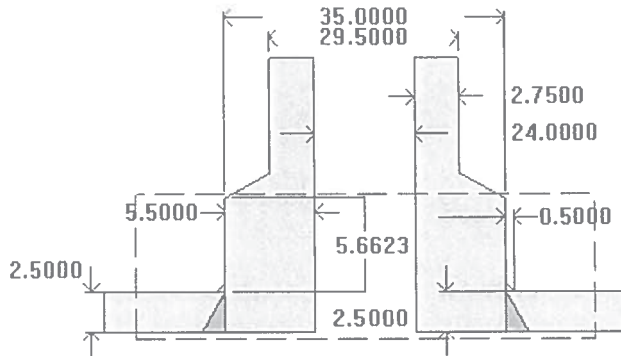
$$\begin{aligned} P_a &= 4*B / (3*(D_o / t)) \\ &= 4*17,393.38 / (3*(11.75 / 0.4251)) \\ &= 838.94 \text{ psi} \end{aligned}$$

Design thickness for external pressure $P_a = 838.94$ psi

$$t_a = t + \text{Corrosion} = 0.4251 + 0.125 = 0.5501''$$

Manway (N13)

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$$t_{w(\text{lower})} = 2.5 \text{ in}$$

$$\text{Leg}_{41} = 0.5 \text{ in}$$

Note: Per UW-16(b), minimum inside corner radius $r_1 = \min [1 \cdot 4", 0.125 \text{ in}] = 0.125 \text{ in}$

Location and Orientation

Located on:	60 ID SHELL
Orientation:	270°
Nozzle center line offset to datum line:	60 in
End of nozzle to shell center:	48.25 in
Passes through a Category A joint:	No

Nozzle

Access opening:	Yes
Material specification:	SA-350 LF2 Cl 1 (II-D p. 18, In. 10)
Inside diameter, new:	24 in
Wall thickness, t_n :	5.5 in
Minimum wall thickness:	2.75 in
Corrosion allowance:	0.125 in
Projection available outside vessel, L_{pr} :	10 in
Heavy barrel length, L_{hb} :	5.6623 in
Projection available outside vessel to flange face, L_f :	15.75 in
Local vessel minimum thickness:	2.5 in
User input radial limit of reinforcement:	23 in
Liquid static head included:	3.117 psi
Longitudinal joint efficiency:	1

ASME B16.5-2009 Flange

Description:	NPS 24 Class 900 V2 A350 LF2 Cl.1 (Nut Relief)
Bolt Material:	SA-193 B7 Bolt $\leq 2 \frac{1}{2}$ (II-D p. 334, In. 32)
Blind included:	Yes
Rated MDMT:	-55°F per UCS-66(b)(1)(b)
Liquid static head:	2.6405 psi
MAWP rating:	2,146 psi @ 140°F
MAP rating:	2,220 psi @ 50°F

Hydrotest rating:
PWHT performed:

3,350 psi @ 50°F
Yes

Reinforcement Calculations for Chamber MAWP

UG-37 Area Calculation Summary (in²) For P = 1,381.12 psi @ 140 °F The opening is adequately reinforced							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
52.6281	58.0278	4.4537	53.3241	--	--	0.25	0.9985	2.75

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(1)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.35	weld size is adequate

Calculations for internal pressure 1,381.12 psi @ 140 °F

Nozzle is impact tested to -50 °F with an additional 5 °F reduction per UCS-66(g).

Nozzle UCS-66 governing thk: 2.5 in
 Nozzle rated MDMT: -55 °F

Parallel Limit of reinforcement per UG-40 and Fig. UG-40 sketch (e-1)

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(24.25, 12.125 + (2.75 - 0.125) + (2.5 - 0.125)) \\
 &= 24.25 \text{ in}
 \end{aligned}$$

$$L_R = 23 \text{ in (User Defined)}$$

Outer Normal Limit of reinforcement per UG-40 and Fig. UG-40 sketch (e-1)

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(2.75 - 0.125) + 4.7631) \\
 &= 5.9375 \text{ in}
 \end{aligned}$$

$$\begin{aligned}
 t_e &= \text{MIN}(5.6623 + 2.75*\tan(30) , 2.75*\tan(60)) \\
 &= 4.7631 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-27(c)(1)

$$\begin{aligned}
 t_{rn} &= P*R_n / (S_n*E - 0.6*P) \\
 &= 1,381.117*12.125 / (20,000*1 - 0.6*1,381.117) \\
 &= 0.8735 \text{ in}
 \end{aligned}$$

Required thickness t_r from UG-37(a)

$$\begin{aligned}
 t_r &= P \cdot R / (S \cdot E - 0.6 \cdot P) \\
 &= 1,381.117 \cdot 30.125 / (20,000 \cdot 1 - 0.6 \cdot 1,381.117) \\
 &= 2.1702 \text{ in}
 \end{aligned}$$

Area required per UG-37(c)

Allowable stresses: $S_n = 20,000$, $S_v = 20,000$ psi

$$f_{r1} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$f_{r2} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$\begin{aligned}
 A &= d \cdot t_r \cdot F + 2 \cdot t_n \cdot t_r \cdot F \cdot (1 - f_{r1}) \\
 &= 24.25 \cdot 2.1702 \cdot 1 + 2 \cdot 5.375 \cdot 2.1702 \cdot 1 \cdot (1 - 1) \\
 &= \underline{52.6281} \text{ in}^2
 \end{aligned}$$

Area available from FIG. UG-37.1

A_1 : (specified limit governs) = 4.4537 in²

$$\begin{aligned}
 &= (2 \cdot \text{limits} - d) \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1}) \\
 &= (2 \cdot 23 - 24.25) \cdot (1 \cdot 2.375 - 1 \cdot 2.1702) - 2 \cdot 5.375 \cdot (1 \cdot 2.375 - 1 \cdot 2.1702) \cdot (1 - 1) \\
 &= \underline{4.4537} \text{ in}^2
 \end{aligned}$$

A_2 = smaller of the following = 53.3241 in²

$$\begin{aligned}
 &= 5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t - (\text{LIMIT} - L_{hb})^2 \cdot f_{r2} / \tan(30) \\
 &= 5 \cdot (5.375 - 0.8735) \cdot 1 \cdot 2.375 - (5.9375 - 5.6623)^2 \cdot 1 / \tan(30) \\
 &= 53.3241 \text{ in}^2 \\
 &= 2 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot L_{pr} - [(t_n - t_p)^2 \cdot \tan(30) + 2 \cdot (\text{LIMIT} - L_{hb} - L_{slope}) \cdot (t_n - t_p)] \cdot f_{r2} \\
 &= 2 \cdot (5.375 - 0.8735) \cdot 1 \cdot 10 - [(5.375 - 2.625)^2 \cdot \tan(30) + 2 \cdot (10 - 5.6623 - 1.5877) \cdot (5.375 - 2.625)] \cdot 1 \\
 &= 70.5388 \text{ in}^2
 \end{aligned}$$

$$\begin{aligned}
 A_{41} &= \text{Leg}^2 \cdot f_{r2} \\
 &= 0.5^2 \cdot 1 \\
 &= \underline{0.25} \text{ in}^2
 \end{aligned}$$

$$\begin{aligned}
 \text{Area} &= A_1 + A_2 + A_{41} \\
 &= 4.4537 + 53.3241 + 0.25 \\
 &= \underline{58.0278} \text{ in}^2
 \end{aligned}$$

As Area \geq A the reinforcement is adequate.

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \text{lesser of } 0.75 \text{ or } t_n \text{ or } t = 0.75 \text{ in}$

$t_{c(\min)} = \text{lesser of } 0.25 \text{ or } 0.7*t_{\min} = 0.25 \text{ in}$

$t_{c(\text{actual})} = 0.7*\text{Leg} = 0.7*0.5 = 0.35 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check (Access Opening)

$$\begin{aligned}t_{a \text{ UG-27}} &= P*R / (S*E - 0.6*P) + \text{Corrosion} \\ &= 1,381.117*12.125 / (20,000*1 - 0.6*1,381.117) + 0.125 \\ &= 0.9985 \text{ in}\end{aligned}$$

$$\begin{aligned}t_a &= \max[t_{a \text{ UG-27}}, t_{a \text{ UG-22}}] \\ &= \max[0.9985, 0] \\ &= 0.9985 \text{ in}\end{aligned}$$

Available nozzle wall thickness new, $t_n = 2.75 \text{ in}$

The nozzle neck thickness is adequate.

Check Large Opening per Appendix 1-7(a)

Area required within 75 percent of the limits of reinforcement
 $= 2 / 3*A = (2 / 3)*52.6281 = 35.0854 \text{ in}^2$

Area that is within 75 percent of the limits of reinforcement is:

$A_1 = \text{larger of } 3.1739 \text{ or}$

$$\begin{aligned}&= (2*\text{limits} - d)*(E_1*t - F*t_r) - 2*t_n*(E_1*t - F*t_r)*(1 - f_{r1}) \\ &= (2*18.1875 - 24.25)*(1*2.375 - 1*2.1702) - 2*5.375*(1*2.375 - 1*2.1702)*(1 - 1) \\ &= 2.4828 \text{ in}^2\end{aligned}$$

$$\begin{aligned}\text{Area} &= A_1 + A_2 + A_3 + A_{41} + A_{42} + A_{43} + A_5 \\ &= 3.1739 + 53.3241 + 0 + 0.25 + 0 + 0 + 0 \\ &= 56.748 \text{ in}^2\end{aligned}$$

The area replacement requirements of Appendix 1-7(a) are satisfied.

Check Large Opening per Appendix 1-7(b)

1-7(b)(1)(a)	$D_1 = 60.25 \text{ in} > 60 \text{ in}$	True
1-7(b)(1)(b)	$d = 24.25 \text{ in} > 40 \text{ in}$	False
1-7(b)(1)(b)	$d = 24.25 \text{ in} > 3.4*(30.125*2.375)^{0.5} = 28.759 \text{ in}$	False

1-7(b)(1)(c) $R_n / R = 12.125 / 30.125 = 0.4025 \leq 0.7$

True

The opening is not within the size range defined by 1-7(b)(1)(a) and (b) so it is exempt from the requirements of 1-7(b)(2),(3) and (4).

$R_n / R = 0.4025$ does not exceed 0.7 so a U-2(g) analysis is not required per 1-7(b)(1)(c).

Reinforcement Calculations for MAEP

UG-37 Area Calculation Summary (in²) For Pe = 838.94 psi @ 140 °F The opening is adequately reinforced							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
28.7969	49.0106	--	48.7606	--	--	0.25	1.3828	2.75

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.35	weld size is adequate

Calculations for external pressure 838.94 psi @ 140 °F

Parallel Limit of reinforcement per UG-40 and Fig. UG-40 sketch (e-1)

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(24.25, 12.125 + (2.75 - 0.125) + (2.5 - 0.125)) \\
 &= 24.25 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40 and Fig. UG-40 sketch (e-1)

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.5 - 0.125), 2.5*(2.75 - 0.125) + 4.7631) \\
 &= 5.9375 \text{ in}
 \end{aligned}$$

$$\begin{aligned}
 t_e &= \text{MIN}(5.6623 + 2.75*\tan(30), 2.75*\tan(60)) \\
 &= 4.7631 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-28 t_{rn} = 1.2578 in

From UG-37(d)(1) required thickness t_r = 2.375 in

Area required per UG-37(d)(1)

Allowable stresses: S_n = 20,000, S_v = 20,000 psi

$$f_{r1} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$f_{r2} = \text{lesser of } 1 \text{ or } S_n / S_v = 1$$

$$\begin{aligned}
A &= 0.5(d \cdot t_r \cdot F + 2 \cdot t_n \cdot t_r \cdot F \cdot (1 - f_{r1})) \\
&= 0.5(24.25 \cdot 2.375 \cdot 1 + 2 \cdot 5.375 \cdot 2.375 \cdot 1 \cdot (1 - 1)) \\
&= \underline{28.7969} \text{ in}^2
\end{aligned}$$

Area available from FIG. UG-37.1

A_1 = larger of the following = 0 in²

$$\begin{aligned}
&= d(E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1}) \\
&= 24.25(1 \cdot 2.375 - 1 \cdot 2.375) - 2 \cdot 5.375(1 \cdot 2.375 - 1 \cdot 2.375)(1 - 1) \\
&= 0 \text{ in}^2 \\
&= 2 \cdot (t + t_n) \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1}) \\
&= 2 \cdot (2.375 + 5.375) \cdot (1 \cdot 2.375 - 1 \cdot 2.375) - 2 \cdot 5.375 \cdot (1 \cdot 2.375 - 1 \cdot 2.375) \cdot (1 - 1) \\
&= 0 \text{ in}^2
\end{aligned}$$

A_2 = smaller of the following = 48.7606 in²

$$\begin{aligned}
&= 5 \cdot (t_n - t_m) \cdot f_{r2} \cdot t - (\text{LIMIT} - L_{hb})^2 \cdot f_{r2} / \tan(30) \\
&= 5 \cdot (5.375 - 1.2578) \cdot 1 \cdot 2.375 - (5.9375 - 5.6623)^2 \cdot 1 / \tan(30) \\
&= 48.7606 \text{ in}^2 \\
&= 2 \cdot (t_n - t_m) \cdot f_{r2} \cdot L_{pr} - [(t_n - t_p)^2 \cdot \tan(30) + 2 \cdot (\text{LIMIT} - L_{hb} - L_{slope}) \cdot (t_n - t_p)] \cdot f_{r2} \\
&= 2 \cdot (5.375 - 1.2578) \cdot 1 \cdot 10 - [(5.375 - 2.625)^2 \cdot \tan(30) + 2 \cdot (10 - 5.6623 - 1.5877) \cdot (5.375 - 2.625)] \cdot 1 \\
&= 62.8529 \text{ in}^2
\end{aligned}$$

$$\begin{aligned}
A_{41} &= \text{Leg}^2 \cdot f_{r2} \\
&= 0.5^2 \cdot 1 \\
&= \underline{0.25} \text{ in}^2
\end{aligned}$$

$$\begin{aligned}
\text{Area} &= A_1 + A_2 + A_{41} \\
&= 0 + 48.7606 + 0.25 \\
&= \underline{49.0106} \text{ in}^2
\end{aligned}$$

As Area \geq A the reinforcement is adequate.

UW-16(c) Weld Check

Fillet weld: t_{\min} = lesser of 0.75 or t_n or $t = 0.75$ in

$t_{c(\min)}$ = lesser of 0.25 or $0.7 \cdot t_{\min} = \underline{0.25}$ in

$t_{c(\text{actual})} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.5 = 0.35$ in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check (Access Opening)

$$t_{a \text{ UG-28}} = 1.3828 \text{ in}$$

$$\begin{aligned} t_a &= \max[t_{a \text{ UG-28}}, t_{a \text{ UG-22}}] \\ &= \max[1.3828, 0] \\ &= 1.3828 \text{ in} \end{aligned}$$

Available nozzle wall thickness new, $t_n = 2.75 \text{ in}$

The nozzle neck thickness is adequate.

Check Large Opening per Appendix 1-7(a)

Area required within 75 percent of the limits of reinforcement
 $= 2 / 3 * A = (2 / 3) * 28.7969 = \underline{19.1979 \text{ in}^2}$

Area that is within 75 percent of the limits of reinforcement is:

$A_1 =$ larger of 0 or

$$\begin{aligned} &= (2 * \text{limits} - d) * (E_1 * t - F * t_r) - 2 * t_n * (E_1 * t - F * t_r) * (1 - f_{r1}) \\ &= (2 * 18.1875 - 24.25) * (1 * 2.375 - 1 * 2.375) - 2 * 5.375 * (1 * 2.375 - 1 * 2.375) * (1 - 1) \\ &= 0 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} \text{Area} &= A_1 + A_2 + A_3 + A_{41} + A_{42} + A_{43} + A_5 \\ &= 0 + 48.7606 + 0 + 0.25 + 0 + 0 + 0 \\ &= \underline{49.0106 \text{ in}^2} \end{aligned}$$

The area replacement requirements of Appendix 1-7(a) are satisfied.

External Pressure, (Corroded & at 140 °F) UG-28(c)

$$\begin{aligned} L / D_o &= 20.8639 / 35 = 0.5961 \\ D_o / t &= 35 / 1.2578 = 27.8265 \\ \text{From table G: } A &= 0.017365 \\ \text{From table CS-2: } B &= 17,508.6251 \text{ psi} \end{aligned}$$

$$\begin{aligned} P_a &= 4 * B / (3 * (D_o / t)) \\ &= 4 * 17,508.63 / (3 * (35 / 1.2578)) \\ &= 838.94 \text{ psi} \end{aligned}$$

Design thickness for external pressure $P_a = 838.94 \text{ psi}$

$$t_a = t + \text{Corrosion} = 1.2578 + 0.125 = 1.3828''$$

$$= 4 * 2,804.88 / (3 * (65.224 / 0.2616))$$

$$= 15 \text{ psi}$$

Design thickness for external pressure $P_a = 15$ psi

$$t_a = t + \text{Corrosion} = 0.2616 + 0.125 = 0.3866''$$

Maximum Allowable External Pressure, (Corroded & at 140 °F) UG-28(c)

$$L / D_o = 110.0833 / 65.224 = 1.6878$$

$$D_o / t = 65.224 / 2.487 = 26.2260$$

From table G: A = 0.005788

From table
CS-2: B = 17,236.009 psi

$$P_a = 4 * B / (3 * (D_o / t))$$

$$= 4 * 17,236.01 / (3 * (65.224 / 2.487))$$

$$= 876.28 \text{ psi}$$

% Extreme fiber elongation - UCS-79(d)

$$\text{EFE} = (50 * t / R_t) * (1 - R_t / R_o)$$

$$= (50 * 2.612 / 31.306) * (1 - 31.306 / \infty)$$

$$= 4.1717\%$$

The extreme fiber elongation does not exceed 5%.

Design thickness = 2.297''

The governing condition is due to internal pressure.

The cylinder thickness of 2.612'' is adequate.

Thickness Required Due to Pressure + External Loads

Condition	Pressure P (psi)	Allowable Stress Before UG-23 Stress Increase (psi)		Temperature (°F)	Corrosion C (in)	Load	Req'd Thk Due to Tension (in)	Req'd Thk Due to Compression (in)
		S _t	S _c					
Operating, Hot & Corroded	1,378	20,000	17,359	140	0.125	Wind	0.8543	0.8459
						Seismic	0.8726	0.8227
Operating, Hot & New	1,378	20,000	17,371	140	0	Wind	0.8506	0.8421
						Seismic	0.8694	0.8182
Hot Shut Down, Corroded	0	20,000	17,359	140	0.125	Wind	0.0008	0.0105
						Seismic	0.0176	0.0372
Hot Shut Down, New	0	20,000	17,371	140	0	Wind	0.001	0.0108
						Seismic	0.018	0.0383
Empty, Corroded	0	20,000	17,359	70	0.125	Wind	0.0008	0.0105
						Seismic	0.0118	0.0306
Empty, New	0	20,000	17,371	70	0	Wind	0.001	0.0108
						Seismic	0.0122	0.0317
Vacuum	-15	20,000	17,359	140	0.125	Wind	0.0116	0.0214
						Seismic	0.0082	0.048
Hot Shut Down, Corroded, Weight & Eccentric Moments Only	0	20,000	17,359	140	0.125	Weight	0.0016	0.0119

Allowable Compressive Stress, Hot and Corroded- S_{CHC} (table CS-2)

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (32.612 / 2.487) \\
 &= 0.009533 \\
 B &= 17,359 \text{ psi} \\
 S &= 20,000 / 1.00 = 20,000 \text{ psi} \\
 S_{CHC} &= \min(B, S) = 17,359 \text{ psi}
 \end{aligned}$$

Allowable Compressive Stress, Hot and New- S_{CHN} (table CS-2)

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (32.612 / 2.612) \\
 &= 0.010012 \\
 B &= 17,371 \text{ psi} \\
 S &= 20,000 / 1.00 = 20,000 \text{ psi} \\
 S_{CHN} &= \min(B, S) = 17,371 \text{ psi}
 \end{aligned}$$

Allowable Compressive Stress, Cold and New- S_{CCN} (table CS-2)

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (32.612 / 2.612) \\
 &= 0.010012 \\
 B &= 17,371 \text{ psi} \\
 S &= 20,000 / 1.00 = 20,000 \text{ psi} \\
 S_{CCN} &= \min(B, S) = 17,371 \text{ psi}
 \end{aligned}$$

Allowable Compressive Stress, Cold and Corroded- S_{cCC} , (table CS-2)

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (32.612 / 2.487) \\
 &= 0.009533 \\
 B &= 17,359 \text{ psi} \\
 S &= 20,000 / 1.00 = 20,000 \text{ psi} \\
 S_{cCC} &= \min(B, S) = \underline{17.359 \text{ psi}}
 \end{aligned}$$

Allowable Compressive Stress, Vacuum and Corroded- S_{cVC} , (table CS-2)

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (32.612 / 2.487) \\
 &= 0.009533 \\
 B &= 17,359 \text{ psi} \\
 S &= 20,000 / 1.00 = 20,000 \text{ psi} \\
 S_{cVC} &= \min(B, S) = \underline{17.359 \text{ psi}}
 \end{aligned}$$

Operating, Hot & Corroded, Wind, Bottom Seam

$$\begin{aligned}
 t_p &= P \cdot R / (2 \cdot S_t \cdot K_s \cdot E_c + 0.40 \cdot |P|) && \text{(Pressure)} \\
 &= 1,378 \cdot 30.125 / (2 \cdot 20,000 \cdot 1.20 \cdot 1.00 + 0.40 \cdot |1,378|) \\
 &= 0.855" \\
 t_m &= M / (\pi \cdot R_m^2 \cdot S_t \cdot K_s \cdot E_c) && \text{(bending)} \\
 &= 312,960 / (\pi \cdot 31.3685^2 \cdot 20,000 \cdot 1.20 \cdot 1.00) \\
 &= 0.0042" \\
 t_w &= W / (2 \cdot \pi \cdot R_m \cdot S_t \cdot K_s \cdot E_c) && \text{(Weight)} \\
 &= 23,199.5 / (2 \cdot \pi \cdot 31.3685 \cdot 20,000 \cdot 1.20 \cdot 1.00) \\
 &= 0.0049" \\
 t_t &= t_p + t_m - t_w && \text{(total required, tensile)} \\
 &= 0.855 + 0.0042 - (0.0049) \\
 &= \underline{0.8543"} \\
 t_c &= |t_{mc} + t_{wc} - t_{pc}| && \text{(total, net tensile)} \\
 &= |0.0042 + (0.0049) - (0.855)| \\
 &= \underline{0.8459"}
 \end{aligned}$$

Maximum allowable working pressure, Longitudinal Stress

$$\begin{aligned}
 P &= 2 \cdot S_t \cdot K_s \cdot E_c \cdot (t - t_m + t_w) / (R - 0.40 \cdot (t - t_m + t_w)) \\
 &= 2 \cdot 20,000 \cdot 1.20 \cdot 1.00 \cdot (2.487 - 0.0042 + (0.0049)) / (30.125 - 0.40 \cdot (2.487 - 0.0042 + (0.0049))) \\
 &= 4,099.18 \text{ psi}
 \end{aligned}$$

Operating, Hot & New, Wind, Bottom Seam

$$\begin{aligned}
 t_p &= P \cdot R / (2 \cdot S_t \cdot K_s \cdot E_c + 0.40 \cdot |P|) && \text{(Pressure)} \\
 &= 1,378 \cdot 30 / (2 \cdot 20,000 \cdot 1.20 \cdot 1.00 + 0.40 \cdot |1,378|) \\
 &= 0.8515"
 \end{aligned}$$

$$t_m = M / (\pi R_m^2 S_t K_s E_c) \quad (\text{bending})$$

$$= 315,781 / (\pi 31.306^2 20,000 1.20 1.00)$$

$$= 0.0043"$$

$$t_w = W / (2 \pi R_m S_t K_s E_c) \quad (\text{Weight})$$

$$= 24,089.2 / (2 \pi 31.306 20,000 1.20 1.00)$$

$$= 0.0051"$$

$$t_t = t_p + t_m - t_w \quad (\text{total required, tensile})$$

$$= 0.8515 + 0.0043 - (0.0051)$$

$$= \underline{0.8506}"$$

$$t_c = |t_{mc} + t_{wc} - t_{pc}| \quad (\text{total, net tensile})$$

$$= |0.0043 + (0.0051) - (0.8515)|$$

$$= \underline{0.8421}"$$

Maximum allowable working pressure, Longitudinal Stress

$$P = 2 S_t K_s E_c (t - t_m + t_w) / (R - 0.40 (t - t_m + t_w))$$

$$= 2 20,000 1.20 1.00 (2.612 - 0.0043 + (0.0051)) / (30 - 0.40 (2.612 - 0.0043 + (0.0051)))$$

$$= 4,331.42 \text{ psi}$$

Hot Shut Down, Corroded, Wind, Bottom Seam

$$t_p = 0" \quad (\text{Pressure})$$

$$t_m = M / (\pi R_m^2 S_c K_s) \quad (\text{bending})$$

$$= 312,960 / (\pi 31.3685^2 17,359.27 1.20)$$

$$= 0.0049"$$

$$t_w = W / (2 \pi R_m S_c K_s) \quad (\text{Weight})$$

$$= 23,199.5 / (2 \pi 31.3685 17,359.27 1.20)$$

$$= 0.0057"$$

$$t_t = |t_p + t_m - t_w| \quad (\text{total, net compressive})$$

$$= |0 + 0.0049 - (0.0057)|$$

$$= \underline{0.0008}"$$

$$t_c = t_{mc} + t_{wc} - t_{pc} \quad (\text{total required, compressive})$$

$$= 0.0049 + (0.0057) - (0)$$

$$= \underline{0.0105}"$$

Hot Shut Down, New, Wind, Bottom Seam

$$t_p = 0" \quad (\text{Pressure})$$

$$t_m = M / (\pi R_m^2 S_c K_s) \quad (\text{bending})$$

$$= 315,781 / (\pi 31.306^2 17,371.43 1.20)$$

$$= 0.0049"$$

$$t_w = W / (2 \pi R_m S_c K_s) \quad (\text{Weight})$$

$$= 24,089.2 / (2 \pi 31.306 17,371.43 1.20)$$

$$= 0.0059"$$

$$t_t = |t_p + t_m - t_w| \quad (\text{total, net compressive})$$

$$= |0 + 0.0049 - (0.0059)|$$

$$= \underline{0.001}"$$

$$\begin{aligned}
 t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\
 &= 0.0049 + (0.0059) - (0) \\
 &= \underline{0.0108"}
 \end{aligned}$$

Empty, Corroded, Wind, Bottom Seam

$$\begin{aligned}
 t_p &= 0" && \text{(Pressure)} \\
 t_m &= M / (\pi * R_m^2 * S_c * K_s) && \text{(bending)} \\
 &= 312,960 / (\pi * 31.3685^2 * 17,359.27 * 1.20) \\
 &= 0.0049" \\
 t_w &= W / (2 * \pi * R_m * S_c * K_s) && \text{(Weight)} \\
 &= 23,199.5 / (2 * \pi * 31.3685 * 17,359.27 * 1.20) \\
 &= 0.0057" \\
 t_t &= |t_p + t_m - t_w| && \text{(total, net compressive)} \\
 &= |0 + 0.0049 - (0.0057)| \\
 &= \underline{0.0008"} \\
 t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\
 &= 0.0049 + (0.0057) - (0) \\
 &= \underline{0.0105"}
 \end{aligned}$$

Empty, New, Wind, Bottom Seam

$$\begin{aligned}
 t_p &= 0" && \text{(Pressure)} \\
 t_m &= M / (\pi * R_m^2 * S_c * K_s) && \text{(bending)} \\
 &= 315,781 / (\pi * 31.306^2 * 17,371.43 * 1.20) \\
 &= 0.0049" \\
 t_w &= W / (2 * \pi * R_m * S_c * K_s) && \text{(Weight)} \\
 &= 24,089.2 / (2 * \pi * 31.306 * 17,371.43 * 1.20) \\
 &= 0.0059" \\
 t_t &= |t_p + t_m - t_w| && \text{(total, net compressive)} \\
 &= |0 + 0.0049 - (0.0059)| \\
 &= \underline{0.001"} \\
 t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\
 &= 0.0049 + (0.0059) - (0) \\
 &= \underline{0.0108"}
 \end{aligned}$$

Vacuum, Wind, Bottom Seam

$$\begin{aligned}
 t_p &= P * R / (2 * S_c * K_s + 0.40 * |P|) && \text{(Pressure)} \\
 &= -15 * 30.125 / (2 * 17,359.27 * 1.20 + 0.40 * |15|) \\
 &= -0.0108" \\
 t_m &= M / (\pi * R_m^2 * S_c * K_s) && \text{(bending)} \\
 &= 312,960 / (\pi * 31.3685^2 * 17,359.27 * 1.20) \\
 &= 0.0049" \\
 t_w &= W / (2 * \pi * R_m * S_c * K_s) && \text{(Weight)} \\
 &= 23,199.5 / (2 * \pi * 31.3685 * 17,359.27 * 1.20) \\
 &= 0.0057"
 \end{aligned}$$

$$t_t = |t_p + t_m - t_w| \quad \text{(total, net compressive)}$$

$$= |-0.0108 + 0.0049 - (0.0057)|$$

$$= \underline{0.0116''}$$

$$t_c = t_{mc} + t_{wc} - t_{pc} \quad \text{(total required, compressive)}$$

$$= 0.0049 + (0.0057) - (-0.0108)$$

$$= \underline{0.0214''}$$

Maximum Allowable External Pressure, Longitudinal Stress

$$P = 2 * S_c * K_s * (t - t_{mc} - t_{wc}) / (R - 0.40 * (t - t_{mc} - t_{wc}))$$

$$= 2 * 17,359.27 * 1.20 * (2.487 - 0.0049 - 0.0057) / (30.125 - 0.40 * (2.487 - 0.0049 - 0.0057))$$

$$= 3,541.38 \text{ psi}$$

Hot Shut Down, Corroded, Weight & Eccentric Moments Only, Bottom Seam

$$t_p = 0'' \quad \text{(Pressure)}$$

$$t_m = M / (\pi * R_m^2 * S_c * K_s) \quad \text{(bending)}$$

$$= 276,644 / (\pi * 31.3685^2 * 17,359.27 * 1.00)$$

$$= 0.0052''$$

$$t_w = W / (2 * \pi * R_m * S_c * K_s) \quad \text{(Weight)}$$

$$= 23,199.5 / (2 * \pi * 31.3685 * 17,359.27 * 1.00)$$

$$= 0.0068''$$

$$t_t = |t_p + t_m - t_w| \quad \text{(total, net compressive)}$$

$$= |0 + 0.0052 - (0.0068)|$$

$$= \underline{0.0016''}$$

$$t_c = t_{mc} + t_{wc} - t_{pc} \quad \text{(total required, compressive)}$$

$$= 0.0052 + (0.0068) - (0)$$

$$= \underline{0.0119''}$$

Operating, Hot & Corroded, Seismic, Bottom Seam

$$t_p = P * R / (2 * S_t * K_s * E_c + 0.40 * |P|) \quad \text{(Pressure)}$$

$$= 1,378 * 30.125 / (2 * 20,000 * 1.20 * 1.00 + 0.40 * |1,378|)$$

$$= 0.855''$$

$$t_m = M / (\pi * R_m^2 * S_t * K_s * E_c) \quad \text{(bending)}$$

$$= 1,667,950 / (\pi * 31.3685^2 * 20,000 * 1.20 * 1.00)$$

$$= 0.0225''$$

$$t_w = W / (2 * \pi * R_m * S_t * K_s * E_c) \quad \text{(Weight)}$$

$$= 23,199.5 / (2 * \pi * 31.3685 * 20,000 * 1.20 * 1.00)$$

$$= 0.0049''$$

$$t_t = t_p + t_m - t_w \quad \text{(total required, tensile)}$$

$$= 0.855 + 0.0225 - (0.0049)$$

$$= \underline{0.8726''}$$

$$t_{wc} = (1 + V_{\text{Accel}}) * W / (2 * \pi * R_m * S_t * K_s * E_c) \quad \text{(Weight)}$$

$$= 2.00 * 23,199.5 / (2 * \pi * 31.3685 * 20,000 * 1.20 * 1.00)$$

$$= 0.0098''$$

$$t_c = |t_{mc} + t_{wc} - t_{pc}| \quad \text{(total, net tensile)}$$

$$= |0.0225 + (0.0098) - (0.855)|$$

$$= \underline{0.8227''}$$

Maximum allowable working pressure, Longitudinal Stress

$$P = 2*S_t*K_s*E_c*(t - t_m + t_w) / (R - 0.40*(t - t_m + t_w))$$

$$= 2*20,000*1.20*1.00*(2.487 - 0.0225 + (0.0049)) / (30.125 - 0.40*(2.487 - 0.0225 + (0.0049)))$$

$$= 4,068.07 \text{ psi}$$

Operating, Hot & New, Seismic, Bottom Seam

$$t_p = P*R / (2*S_t*K_s*E_c + 0.40*|P|) \quad (\text{Pressure})$$

$$= 1,378*30 / (2*20,000*1.20*1.00 + 0.40*|1,378|)$$

$$= 0.8515''$$

$$t_m = M / (\pi*R_m^2*S_t*K_s*E_c) \quad (\text{bending})$$

$$= 1,705,206 / (\pi*31.306^2*20,000*1.20*1.00)$$

$$= 0.0231''$$

$$t_w = W / (2*\pi*R_m*S_t*K_s*E_c) \quad (\text{Weight})$$

$$= 24,089.2 / (2*\pi*31.306*20,000*1.20*1.00)$$

$$= 0.0051''$$

$$t_t = t_p + t_m - t_w \quad (\text{total required, tensile})$$

$$= 0.8515 + 0.0231 - (0.0051)$$

$$= \underline{0.8694''}$$

$$t_{wc} = (1 + V\text{Accel})*W / (2*\pi*R_m*S_t*K_s*E_c) \quad (\text{Weight})$$

$$= 2.00*24,089.2 / (2*\pi*31.306*20,000*1.20*1.00)$$

$$= 0.0102''$$

$$t_c = |t_{mc} + t_{wc} - t_{pc}| \quad (\text{total, net tensile})$$

$$= |0.0231 + (0.0102) - (0.8515)|$$

$$= \underline{0.8182''}$$

Maximum allowable working pressure, Longitudinal Stress

$$P = 2*S_t*K_s*E_c*(t - t_m + t_w) / (R - 0.40*(t - t_m + t_w))$$

$$= 2*20,000*1.20*1.00*(2.612 - 0.0231 + (0.0051)) / (30 - 0.40*(2.612 - 0.0231 + (0.0051)))$$

$$= 4,299.14 \text{ psi}$$

Hot Shut Down, Corroded, Seismic, Bottom Seam

$$t_p = 0'' \quad (\text{Pressure})$$

$$t_m = M / (\pi*R_m^2*S_t*K_s*E_c) \quad (\text{bending})$$

$$= 1,667,950 / (\pi*31.3685^2*20,000*1.20*1.00)$$

$$= 0.0225''$$

$$t_w = W / (2*\pi*R_m*S_t*K_s*E_c) \quad (\text{Weight})$$

$$= 23,199.5 / (2*\pi*31.3685*20,000*1.20*1.00)$$

$$= 0.0049''$$

$$t_t = t_p + t_m - t_w \quad (\text{total required, tensile})$$

$$= 0 + 0.0225 - (0.0049)$$

$$= \underline{0.0176''}$$

$$\begin{aligned}
 t_{mc} &= M / (\pi R_m^2 S_c K_s) && \text{(bending)} \\
 &= 1,667,950 / (\pi 31.3685^2 17,359.27 1.20) \\
 &= 0.0259" \\
 t_{wc} &= (1 + V_{\text{Accel}}) W / (2 \pi R_m S_c K_s) && \text{(Weight)} \\
 &= 2.00 * 23,199.5 / (2 \pi 31.3685 17,359.27 1.20) \\
 &= 0.0113" \\
 t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\
 &= 0.0259 + (0.0113) - (0) \\
 &= \underline{0.0372"}
 \end{aligned}$$

Hot Shut Down, New, Seismic, Bottom Seam

$$\begin{aligned}
 t_p &= 0" && \text{(Pressure)} \\
 t_m &= M / (\pi R_m^2 S_t K_s E_c) && \text{(bending)} \\
 &= 1,705,206 / (\pi 31.306^2 20,000 1.20 1.00) \\
 &= 0.0231" \\
 t_w &= W / (2 \pi R_m S_t K_s E_c) && \text{(Weight)} \\
 &= 24,089.2 / (2 \pi 31.306 20,000 1.20 1.00) \\
 &= 0.0051" \\
 t_t &= t_p + t_m - t_w && \text{(total required, tensile)} \\
 &= 0 + 0.0231 - (0.0051) \\
 &= \underline{0.018"} \\
 t_{mc} &= M / (\pi R_m^2 S_c K_s) && \text{(bending)} \\
 &= 1,705,206 / (\pi 31.306^2 17,371.43 1.20) \\
 &= 0.0266" \\
 t_{wc} &= (1 + V_{\text{Accel}}) W / (2 \pi R_m S_c K_s) && \text{(Weight)} \\
 &= 2.00 * 24,089.2 / (2 \pi 31.306 17,371.43 1.20) \\
 &= 0.0117" \\
 t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\
 &= 0.0266 + (0.0117) - (0) \\
 &= \underline{0.0383"}
 \end{aligned}$$

Empty, Corroded, Seismic, Bottom Seam

$$\begin{aligned}
 t_p &= 0" && \text{(Pressure)} \\
 t_m &= M / (\pi R_m^2 S_t K_s E_c) && \text{(bending)} \\
 &= 1,240,219 / (\pi 31.3685^2 20,000 1.20 1.00) \\
 &= 0.0167" \\
 t_w &= W / (2 \pi R_m S_t K_s E_c) && \text{(Weight)} \\
 &= 23,199.5 / (2 \pi 31.3685 20,000 1.20 1.00) \\
 &= 0.0049" \\
 t_t &= t_p + t_m - t_w && \text{(total required, tensile)} \\
 &= 0 + 0.0167 - (0.0049) \\
 &= \underline{0.0118"} \\
 t_{mc} &= M / (\pi R_m^2 S_c K_s) && \text{(bending)} \\
 &= 1,240,219 / (\pi 31.3685^2 17,359.27 1.20)
 \end{aligned}$$

$$= 0.0193''$$

$$\begin{aligned} t_{wc} &= (1 + V_{Accel}) * W / (2 * \pi * R_m * S_c * K_s) && \text{(Weight)} \\ &= 2.00 * 23,199.5 / (2 * \pi * 31.3685 * 17,359.27 * 1.20) \\ &= 0.0113'' \end{aligned}$$

$$\begin{aligned} t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\ &= 0.0193 + (0.0113) - (0) \\ &= \underline{0.0306''} \end{aligned}$$

Empty, New, Seismic, Bottom Seam

$$\begin{aligned} t_p &= 0'' && \text{(Pressure)} \\ t_m &= M / (\pi * R_m^2 * S_t * K_s * E_c) && \text{(bending)} \\ &= 1,281,341 / (\pi * 31.306^2 * 20,000 * 1.20 * 1.00) \\ &= 0.0173'' \end{aligned}$$

$$\begin{aligned} t_w &= W / (2 * \pi * R_m * S_t * K_s * E_c) && \text{(Weight)} \\ &= 24,089.2 / (2 * \pi * 31.306 * 20,000 * 1.20 * 1.00) \\ &= 0.0051'' \end{aligned}$$

$$\begin{aligned} t_t &= t_p + t_m - t_w && \text{(total required, tensile)} \\ &= 0 + 0.0173 - (0.0051) \\ &= \underline{0.0122''} \end{aligned}$$

$$\begin{aligned} t_{mc} &= M / (\pi * R_m^2 * S_c * K_s) && \text{(bending)} \\ &= 1,281,341 / (\pi * 31.306^2 * 17,371.43 * 1.20) \\ &= 0.02'' \end{aligned}$$

$$\begin{aligned} t_{wc} &= (1 + V_{Accel}) * W / (2 * \pi * R_m * S_c * K_s) && \text{(Weight)} \\ &= 2.00 * 24,089.2 / (2 * \pi * 31.306 * 17,371.43 * 1.20) \\ &= 0.0117'' \end{aligned}$$

$$\begin{aligned} t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\ &= 0.02 + (0.0117) - (0) \\ &= \underline{0.0317''} \end{aligned}$$

Vacuum, Seismic, Bottom Seam

$$\begin{aligned} t_p &= P * R / (2 * S_t * K_s * E_c + 0.40 * |P|) && \text{(Pressure)} \\ &= -15 * 30.125 / (2 * 20,000 * 1.20 * 1.00 + 0.40 * |15|) \\ &= -0.0094'' \end{aligned}$$

$$\begin{aligned} t_m &= M / (\pi * R_m^2 * S_t * K_s * E_c) && \text{(bending)} \\ &= 1,667,950 / (\pi * 31.3685^2 * 20,000 * 1.20 * 1.00) \\ &= 0.0225'' \end{aligned}$$

$$\begin{aligned} t_w &= W / (2 * \pi * R_m * S_t * K_s * E_c) && \text{(Weight)} \\ &= 23,199.5 / (2 * \pi * 31.3685 * 20,000 * 1.20 * 1.00) \\ &= 0.0049'' \end{aligned}$$

$$\begin{aligned} t_t &= t_p + t_m - t_w && \text{(total required, tensile)} \\ &= -0.0094 + 0.0225 - (0.0049) \\ &= \underline{0.0082''} \end{aligned}$$

$$\begin{aligned} t_{pc} &= P * R / (2 * S_c * K_s + 0.40 * |P|) && \text{(Pressure)} \\ &= -15 * 30.125 / (2 * 17,359.27 * 1.20 + 0.40 * |15|) \end{aligned}$$

$$= -0.0108''$$

$$\begin{aligned}t_{mc} &= M / (\pi R_m^2 S_c K_s) && \text{(bending)} \\ &= 1,667,950 / (\pi 31.3685^2 17,359.27 1.20) \\ &= 0.0259''\end{aligned}$$

$$\begin{aligned}t_{wc} &= (1 + V_{\text{Accel}}) W / (2 \pi R_m S_c K_s) && \text{(Weight)} \\ &= 2.00 23,199.5 / (2 \pi 31.3685 17,359.27 1.20) \\ &= 0.0113''\end{aligned}$$

$$\begin{aligned}t_c &= t_{mc} + t_{wc} - t_{pc} && \text{(total required, compressive)} \\ &= 0.0259 + (0.0113) - (-0.0108) \\ &= \underline{0.048''}\end{aligned}$$

Maximum Allowable External Pressure, Longitudinal Stress

$$\begin{aligned}P &= 2 S_c K_s (t - t_{mc} - t_{wc}) / (R - 0.40 (t - t_{mc} - t_{wc})) \\ &= 2 17,359.27 1.20 (2.487 - 0.0259 - 0.0113) / (30.125 - 0.40 (2.487 - 0.0259 - 0.0113)) \\ &= 3,501.93 \text{ psi}\end{aligned}$$

60 ID BOTTOM SE HEAD

ASME Section VIII, Division 1, 2010 Edition, A11 Addenda

Component: Ellipsoidal Head
Material Specification: SA-516 70 (II-D p.18, In. 19)
Straight Flange governs MDMT

Internal design pressure: $P = 1,378$ psi @ 140 °F
External design pressure: $P_e = 15$ psi @ 140 °F

Static liquid head:

$P_s = 4.75$ psi (SG=1.1, $H_s = 119.625$ " Operating head)
 $P_{th} = 2.54$ psi (SG=1, $H_s = 70.5$ " Horizontal test head)

Corrosion allowance: Inner C = 0.125" Outer C = 0"

Design MDMT = -20 °F Impact test performed
Rated MDMT = -32.7 °F Material is normalized
Material is not produced to fine grain practice
PWHT is performed
Do not Optimize MDMT / Find MAWP

Radiography: Category A joints - Seamless No RT
Head to shell seam - Full UW-11(a) Type 1

Estimated weight*: new = 3,524.5 lb corr = 3,363.9 lb
Capacity*: new = 146.9 US gal corr = 149.1 US gal
* includes straight flange

Inner diameter = 60"
Minimum head thickness = 2.491"
Head ratio D/2h = 2 (new)
Head ratio D/2h = 1.9917 (corroded)
Straight flange length L_{sf} = 2"
Nominal straight flange thickness t_{sf} = 2.612"

Results Summary

The governing condition is internal pressure.
Minimum thickness per UG-16 = $0.0625" + 0.125" = 0.1875"$
Design thickness due to internal pressure (t) = 2.2108"
Design thickness due to external pressure (t_e) = 0.2819"
Maximum allowable working pressure (MAWP) = 1,562.35 psi
Maximum allowable external pressure (MAEP) = 750.1 psi

K (Corroded)

$$K = (1/6) * [2 + (D / (2*h))^2] = (1/6) * [2 + (60.25 / (2*15.125))^2] = 0.994502$$

K (New)

$$K = (1/6) * [2 + (D / (2*h))^2] = (1/6) * [2 + (60 / (2*15))^2] = 1$$

Design thickness for internal pressure, (Corroded at 140 °F) Appendix 1-4(c)

$$\begin{aligned}t &= P \cdot D \cdot K / (2 \cdot S \cdot E - 0.2 \cdot P) + \text{Corrosion} \\&= 1,382.75 \cdot 60.25 \cdot 0.994502 / (2 \cdot 20,000 \cdot 1 - 0.2 \cdot 1,382.75) + 0.125 \\&= 2.2107''\end{aligned}$$

The head internal pressure design thickness is 2.2108".

Maximum allowable working pressure, (Corroded at 140 °F) Appendix 1-4(c)

$$\begin{aligned}P &= 2 \cdot S \cdot E \cdot t / (K \cdot D + 0.2 \cdot t) - P_s \\&= 2 \cdot 20,000 \cdot 1 \cdot 2.366 / (0.994502 \cdot 60.25 + 0.2 \cdot 2.366) - 4.75 \\&= 1,562.35 \text{ psi}\end{aligned}$$

The maximum allowable working pressure (MAWP) is 1,562.35 psi.

Design thickness for external pressure, (Corroded at 140 °F) UG-33(d)

Equivalent outside spherical radius (R_o)

$$\begin{aligned}R_o &= K_o \cdot D_o \\&= 0.8359 \cdot 64.982 \\&= 54.3193 \text{ in}\end{aligned}$$

$$\begin{aligned}A &= 0.125 / (R_o / t) \\&= 0.125 / (54.3193 / 0.156888) \\&= 0.000361\end{aligned}$$

From Table CS-2: $B = 5,193.454$ psi

$$\begin{aligned}P_a &= B / (R_o / t) \\&= 5,193.454 / (54.3193 / 0.1569) \\&= 15 \text{ psi}\end{aligned}$$

$$t = 0.1569'' + \text{Corrosion} = 0.1569'' + 0.125'' = 0.2819''$$

Check the external pressure per UG-33(a)(1) Appendix 1-4(c)

$$\begin{aligned}t &= 1.67 \cdot P_e \cdot D \cdot K / (2 \cdot S \cdot E - 0.2 \cdot 1.67 \cdot P_e) + \text{Corrosion} \\&= 1.67 \cdot 15 \cdot 60.25 \cdot 0.994502 / (2 \cdot 20,000 \cdot 1 - 0.2 \cdot 1.67 \cdot 15) + 0.125 \\&= 0.1625''\end{aligned}$$

The head external pressure design thickness (t_e) is 0.2819".

Maximum Allowable External Pressure, (Corroded at 140 °F) UG-33(d)

Equivalent outside spherical radius (R_o)

$$\begin{aligned}R_o &= K_o \cdot D_o \\&= 0.8359 \cdot 64.982 \\&= 54.3193 \text{ in}\end{aligned}$$

$$\begin{aligned}A &= 0.125 / (R_o / t) \\&= 0.125 / (54.3193 / 2.366) \\&= 0.005445\end{aligned}$$

From Table CS-2: $B = 17,220.94$ psi

$$\begin{aligned}
 P_a &= B / (R_o / t) \\
 &= 17,220.94 / (54.3193 / 2.366) \\
 &= 750.0974 \text{ psi}
 \end{aligned}$$

Check the Maximum External Pressure, UG-33(a)(1) Appendix 1-4(c)

$$\begin{aligned}
 P &= 2 * S * E * t / ((K * D + 0.2 * t) * 1.67) - P_{s2} \\
 &= 2 * 20,000 * 1 * 2.366 / ((0.994502 * 60.25 + 0.2 * 2.366) * 1.67) - 0 \\
 &= 938.38 \text{ psi}
 \end{aligned}$$

The maximum allowable external pressure (MAEP) is 750.1 psi.

% Extreme fiber elongation - UCS-79(d)

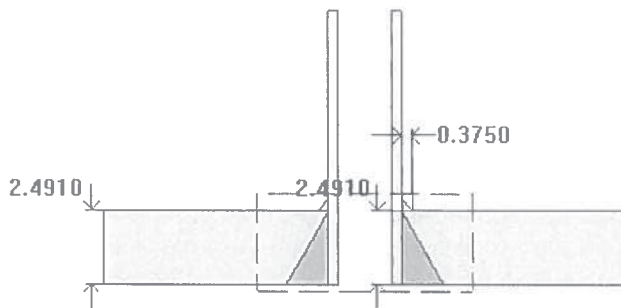
$$\begin{aligned}
 EFE &= (75 * t / R_f) * (1 - R_f / R_o) \\
 &= (75 * 2.612 / 11.506) * (1 - 11.506 / \infty) \\
 &= 17.0259\%
 \end{aligned}$$

Bottom Drain (N1)

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$$t_{w(\text{lower})} = 2.491 \text{ in}$$

$$Leg_{41} = 0.375 \text{ in}$$



Note: round inside edges per UG-76(c)

Location and Orientation

Located on:	60 ID BOTTOM SE HEAD
Orientation:	0°
End of nozzle to datum line:	123.7383 in
Calculated as hillside:	No
Distance to head center, R:	0 in
Passes through a Category A joint:	No

Nozzle

Access opening:	No
Material specification:	SA-333 1 Wld & smls pipe (II-D p. 10, In. 1)
Description:	NPS 2 Sch 160
Inside diameter, new:	1.687 in
Nominal wall thickness:	0.344 in
Corrosion allowance:	0.125 in
Projection available outside vessel, Lpr:	4.009 in
Projection available outside vessel to flange face, Lf:	8.259 in
Local vessel minimum thickness:	2.491 in
Liquid static head included:	5.0724 psi
Longitudinal joint efficiency:	1

ASME B16.5-2009 Flange

Description:	NPS 2 Class 900 WN A350 LF2
Bolt Material:	SA-193 B7 Bolt <= 2 1/2 (II-D p. 334, In. 32)
Blind included:	No
Rated MDMT:	-55°F per UCS-66(b)(1)(b)
Liquid static head:	5.1713 psi
MAWP rating:	2,146 psi @ 140°F
MAP rating:	2,220 psi @ 50°F
Hydrotest rating:	3,350 psi @ 50°F

PWHT performed:

Yes

Circumferential joint radiography:

Full UW-11(a) Type 1

Reinforcement Calculations for Chamber MAWP

UG-37 Area Calculation Summary (in ²) For P = 1,383.07 psi @ 140 °F							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.2598	0.301

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (In)	Actual weld throat size (In)	Status
Nozzle to shell fillet (Leg ₄₁)	0.1533	0.2625	weld size is adequate

Calculations for internal pressure 1,383.07 psi @ 140 °F

Fig UCS-66.2 general note (1) applies.

Nozzle is impact tested to -50 °F with an additional 5 °F reduction per UCS-66(g).

Nozzle UCS-66 governing thk: 0.301 in

Nozzle rated MDMT: -55 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(1.937, 0.9685 + (0.344 - 0.125) + (2.491 - 0.125)) \\
 &= 3.5535 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.491 - 0.125), 2.5*(0.344 - 0.125) + 0) \\
 &= 0.5475 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-27(c)(1)

$$\begin{aligned}
 t_m &= P \cdot R_n / (S_n \cdot E - 0.6 \cdot P) \\
 &= 1,383.0724 \cdot 0.9685 / (15,700 \cdot 1 - 0.6 \cdot 1,383.0724) \\
 &= 0.0901 \text{ in}
 \end{aligned}$$

Required thickness t_r from UG-37(a)(c)

$$\begin{aligned}t_r &= P \cdot K_1 \cdot D / (2 \cdot S \cdot E - 0.2 \cdot P) \\&= 1,383.0724 \cdot 0.8963 \cdot 60.25 / (2 \cdot 20,000 \cdot 1 - 0.2 \cdot 1,383.0724) \\&= 1.8802 \text{ in}\end{aligned}$$

This opening does not require reinforcement per UG-36(c)(3)(a)

UW-16(c) Weld Check

Fillet weld: t_{\min} = lesser of 0.75 or t_n or $t = 0.219$ in

$t_{c(\min)}$ = lesser of 0.25 or $0.7 \cdot t_{\min} = 0.1533$ in

$t_{c(\text{actual})} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.375 = 0.2625$ in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$\begin{aligned}t_{a \text{ UG-27}} &= P \cdot R / (S \cdot E - 0.6 \cdot P) + \text{Corrosion} \\&= 1,383.1713 \cdot 0.9685 / (15,700 \cdot 1 - 0.6 \cdot 1,383.1713) + 0.125 \\&= 0.2151 \text{ in}\end{aligned}$$

$$\begin{aligned}t_a &= \max[t_{a \text{ UG-27}}, t_{a \text{ UG-22}}] \\&= \max[0.2151, 0] \\&= 0.2151 \text{ in}\end{aligned}$$

$$t_{b1} = 2.2112 \text{ in}$$

$$\begin{aligned}t_{b1} &= \max[t_{b1}, t_{b \text{ UG16}}] \\&= \max[2.2112, 0.1875] \\&= 2.2112 \text{ in}\end{aligned}$$

$$\begin{aligned}t_b &= \min[t_{b3}, t_{b1}] \\&= \min[0.2598, 2.2112] \\&= 0.2598 \text{ in}\end{aligned}$$

$$\begin{aligned}t_{\text{UG-45}} &= \max[t_a, t_b] \\&= \max[0.2151, 0.2598] \\&= 0.2598 \text{ in}\end{aligned}$$

Available nozzle wall thickness new, $t_n = 0.875 \cdot 0.344 = 0.301$ in

The nozzle neck thickness is adequate.

Reinforcement Calculations for MAEP

UG-37 Area Calculation Summary (in ²) For Pe = 750.1 psi @ 140 °F							UG-45 Nozzle Wall Thickness Summary (in) The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.2598	0.301

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.1533	0.2625	weld size is adequate

Calculations for external pressure 750.1 psi @ 140 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned}
 L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\
 &= \text{MAX}(1.937, 0.9685 + (0.344 - 0.125) + (2.491 - 0.125)) \\
 &= 3.5535 \text{ in}
 \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned}
 L_H &= \text{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\
 &= \text{MIN}(2.5*(2.491 - 0.125), 2.5*(0.344 - 0.125) + 0) \\
 &= 0.5475 \text{ in}
 \end{aligned}$$

Nozzle required thickness per UG-28 t_{rn} = 0.0861 in

From UG-37(d)(1) required thickness t_r = 2.366 in

This opening does not require reinforcement per UG-36(c)(3)(a)

UW-16(c) Weld Check

Fillet weld: t_{min} = lesser of 0.75 or t_n or t = 0.219 in
t_{c(min)} = lesser of 0.25 or 0.7*t_{min} = 0.1533 in
t_{c(actual)} = 0.7*Leg = 0.7*0.375 = 0.2625 in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$t_{a \text{ UG-28}} = 0.2111 \text{ in}$$

$$\begin{aligned} t_a &= \max[t_{a \text{ UG-28}}, t_{a \text{ UG-22}}] \\ &= \max[0.2111, 0] \\ &= 0.2111 \text{ in} \end{aligned}$$

$$t_{b2} = 1.2529 \text{ in}$$

$$\begin{aligned} t_{b2} &= \max[t_{b2}, t_{b \text{ UG16}}] \\ &= \max[1.2529, 0.1875] \\ &= 1.2529 \text{ in} \end{aligned}$$

$$\begin{aligned} t_b &= \min[t_{b3}, t_{b2}] \\ &= \min[0.2598, 1.2529] \\ &= 0.2598 \text{ in} \end{aligned}$$

$$\begin{aligned} t_{\text{UG-45}} &= \max[t_a, t_b] \\ &= \max[0.2111, 0.2598] \\ &= 0.2598 \text{ in} \end{aligned}$$

Available nozzle wall thickness new, $t_n = 0.875 \cdot 0.344 = 0.301 \text{ in}$

The nozzle neck thickness is adequate.

External Pressure, (Corroded & at 140 °F) UG-28(c)

$$\begin{aligned} L / D_o &= 8.259 / 2.375 = 3.4775 \\ D_o / t &= 2.375 / 0.0861 = 27.5742 \\ \text{From table G: A} &= 0.002387 \\ \text{From table CS-2: B} &= 15,512.509 \text{ psi} \end{aligned}$$

$$\begin{aligned} P_a &= 4 \cdot B / (3 \cdot (D_o / t)) \\ &= 4 \cdot 15,512.51 / (3 \cdot (2.375 / 0.0861)) \\ &= 750.1 \text{ psi} \end{aligned}$$

Design thickness for external pressure $P_a = 750.1 \text{ psi}$

$$t_a = t + \text{Corrosion} = 0.0861 + 0.125 = 0.2111''$$

63-1/4" OD Skirt

Material:	SA-516 70 (II-D p. 18, In. 19)
Design temperature, operating:	140 °F
Design temperature, vacuum:	0 °F
Inner diameter at top, new:	61.75 in
Inner diameter at bottom, new:	61.75 in
Overall length (includes base ring thickness):	23.25 in
Corrosion allowance inside:	0 in
Corrosion allowance outside:	0 in
Weld joint efficiency top:	0.55
Weld joint efficiency bottom:	0.8
Nominal thickness, new:	0.75 in
Skirt is attached to:	60 ID BOTTOM SE HEAD
Skirt attachment offset:	7.4575in down from the top seam

Skirt design thickness, largest of the following + corrosion = 0.0557 in

The governing condition is due to earthquake, compressive stress at the base, operating & new.

The skirt thickness of 0.75 in is adequate.

Loading	Vessel Condition (Stress)	Governing Skirt Location	Temperature (°F)	Allowable Stress (psi)	Calculated Stress/E (psi)	Required thickness (In)
Wind	operating, corroded (+)	top	140	21,012.37	-130.1	<u>0.0046</u>
Wind	operating, corroded (-)	bottom	140	21,012.37	419.41	<u>0.015</u>
Wind	operating, new (+)	top	140	21,012.37	-135.09	<u>0.0048</u>
Wind	operating, new (-)	bottom	140	21,012.37	426.85	<u>0.0152</u>
Wind	empty, corroded (+)	top	50	21,012.37	-41.16	<u>0.0015</u>
Wind	empty, corroded (-)	bottom	50	21,012.37	330.47	<u>0.0118</u>
Wind	empty, new (+)	top	50	21,012.37	-46.98	<u>0.0017</u>
Wind	empty, new (-)	bottom	50	21,012.37	338.74	<u>0.0121</u>
Wind	vacuum, corroded (+)	top	0	21,012.37	-130.1	<u>0.0046</u>
Wind	vacuum, corroded (-)	bottom	0	21,012.37	419.41	<u>0.015</u>
Seismic	operating, corroded (+)	top	140	26,000	912.72	<u>0.0263</u>
Seismic	operating, corroded (-)	bottom	140	21,012.37	1,525.18	<u>0.0544</u>
Seismic	operating, new (+)	top	140	26,000	932.63	<u>0.0269</u>
Seismic	operating, new (-)	bottom	140	21,012.37	1,559.42	<u>0.0557</u>
Seismic	empty, corroded (+)	top	50	26,000	709.59	<u>0.0205</u>
Seismic	empty, corroded (-)	bottom	50	21,012.37	1,080.46	<u>0.0386</u>
Seismic	empty, new (+)	top	50	26,000	731.28	<u>0.0211</u>
Seismic	empty, new (-)	bottom	50	21,012.37	1,118.79	<u>0.0399</u>
Seismic	vacuum, corroded (+)	top	0	26,000	912.72	<u>0.0263</u>
Seismic	vacuum, corroded (-)	bottom	0	21,012.37	1,525.18	<u>0.0544</u>

Loading due to wind, operating & corroded

Windward side (tensile)

Required thickness, tensile stress at base:

$$\begin{aligned}
 t &= -W / (\pi \cdot D \cdot S_t \cdot E) + 48 \cdot M / (\pi \cdot D^2 \cdot S_t \cdot E) \\
 &= -40,423.69 / (\pi \cdot 62.5 \cdot 21,012 \cdot 1) + 48 \cdot 27,784.9 / (\pi \cdot 62.5^2 \cdot 21,012 \cdot 1) \\
 &= \underline{0.0046} \text{ in}
 \end{aligned}$$

Required thickness, tensile stress at the top:

$$\begin{aligned}
 t &= -W_t / (\pi \cdot D_t \cdot S_t \cdot E) + 48 \cdot M_t / (\pi \cdot D_t^2 \cdot S_t \cdot E) \\
 &= -39,411.11 / (\pi \cdot 62.5 \cdot 21,012 \cdot 1) + 48 \cdot 26,370.5 / (\pi \cdot 62.5^2 \cdot 21,012 \cdot 1) \\
 &= \underline{0.0046} \text{ in}
 \end{aligned}$$

Leeward side (compressive)

Required thickness, compressive stress at base:

$$\begin{aligned}
 t &= W / (\pi \cdot D \cdot S_c \cdot E_c) + 48 \cdot M / (\pi \cdot D^2 \cdot S_c \cdot E_c) \\
 &= 40,423.69 / (\pi \cdot 62.5 \cdot 21,012 \cdot 1) + 48 \cdot 27,784.9 / (\pi \cdot 62.5^2 \cdot 21,012 \cdot 1) \\
 &= \underline{0.015} \text{ in}
 \end{aligned}$$

Required thickness, compressive stress at the top:

$$\begin{aligned}t &= W_t / (\pi \cdot D_t \cdot S_c \cdot E_c) + 48 \cdot M_t / (\pi \cdot D_t^2 \cdot S_c \cdot E_c) \\&= 39,411.11 / (\pi \cdot 62.5 \cdot 21,012 \cdot 1) + 48 \cdot 26,370.5 / (\pi \cdot 62.5^2 \cdot 21,012 \cdot 1) \\&= \underline{0.0145} \text{ in}\end{aligned}$$

Loading due to wind, operating & new

Windward side (tensile)

Required thickness, tensile stress at base:

$$\begin{aligned}t &= -W / (\pi \cdot D \cdot S_t \cdot E) + 48 \cdot M / (\pi \cdot D^2 \cdot S_t \cdot E) \\&= -41,339.78 / (\pi \cdot 62.5 \cdot 21,012 \cdot 1) + 48 \cdot 28,020 / (\pi \cdot 62.5^2 \cdot 21,012 \cdot 1) \\&= \underline{0.0048} \text{ in}\end{aligned}$$

Required thickness, tensile stress at the top:

$$\begin{aligned}t &= -W_t / (\pi \cdot D_t \cdot S_t \cdot E) + 48 \cdot M_t / (\pi \cdot D_t^2 \cdot S_t \cdot E) \\&= -40,327.2 / (\pi \cdot 62.5 \cdot 21,012 \cdot 1) + 48 \cdot 26,605.6 / (\pi \cdot 62.5^2 \cdot 21,012 \cdot 1) \\&= \underline{0.0048} \text{ in}\end{aligned}$$

Leeward side (compressive)

Required thickness, compressive stress at base:

$$\begin{aligned}t &= W / (\pi \cdot D \cdot S_c \cdot E_c) + 48 \cdot M / (\pi \cdot D^2 \cdot S_c \cdot E_c) \\&= 41,339.78 / (\pi \cdot 62.5 \cdot 21,012 \cdot 1) + 48 \cdot 28,020 / (\pi \cdot 62.5^2 \cdot 21,012 \cdot 1) \\&= \underline{0.0152} \text{ in}\end{aligned}$$

Required thickness, compressive stress at the top:

$$\begin{aligned}t &= W_t / (\pi \cdot D_t \cdot S_c \cdot E_c) + 48 \cdot M_t / (\pi \cdot D_t^2 \cdot S_c \cdot E_c) \\&= 40,327.2 / (\pi \cdot 62.5 \cdot 21,012 \cdot 1) + 48 \cdot 26,605.6 / (\pi \cdot 62.5^2 \cdot 21,012 \cdot 1) \\&= \underline{0.0147} \text{ in}\end{aligned}$$

Loading due to wind, empty & corroded

Windward side (tensile)

Required thickness, tensile stress at base:

$$\begin{aligned}t &= -W / (\pi \cdot D \cdot S_t \cdot E) + 48 \cdot M / (\pi \cdot D^2 \cdot S_t \cdot E) \\&= -27,326.21 / (\pi \cdot 62.5 \cdot 21,012 \cdot 1) + 48 \cdot 27,784.9 / (\pi \cdot 62.5^2 \cdot 21,012 \cdot 1) \\&= \underline{0.0015} \text{ in}\end{aligned}$$

Required thickness, tensile stress at the top:

$$\begin{aligned}t &= -W_t / (\pi \cdot D_t \cdot S_t \cdot E) + 48 \cdot M_t / (\pi \cdot D_t^2 \cdot S_t \cdot E) \\&= -26,313.63 / (\pi \cdot 62.5 \cdot 21,012 \cdot 1) + 48 \cdot 26,370.5 / (\pi \cdot 62.5^2 \cdot 21,012 \cdot 1) \\&= \underline{0.0015} \text{ in}\end{aligned}$$

Leeward side (compressive)

Required thickness, compressive stress at base:

$$\begin{aligned}t &= W / (\pi \cdot D \cdot S_c \cdot E_c) + 48 \cdot M / (\pi \cdot D^2 \cdot S_c \cdot E_c) \\&= 27,326.21 / (\pi \cdot 62.5 \cdot 21,012 \cdot 1) + 48 \cdot 27,784.9 / (\pi \cdot 62.5^2 \cdot 21,012 \cdot 1) \\&= \underline{0.0118} \text{ in}\end{aligned}$$

Required thickness, compressive stress at the top:

$$\begin{aligned}t &= W_t / (\pi \cdot D_t \cdot S_c \cdot E_c) + 48 \cdot M_t / (\pi \cdot D_t^2 \cdot S_c \cdot E_c) \\&= 26,313.63 / (\pi \cdot 62.5 \cdot 21,012 \cdot 1) + 48 \cdot 26,370.5 / (\pi \cdot 62.5^2 \cdot 21,012 \cdot 1) \\&= \underline{0.0113} \text{ in}\end{aligned}$$

Loading due to wind, empty & new

Windward side (tensile)

Required thickness, tensile stress at base:

$$\begin{aligned}t &= -W / (\pi \cdot D \cdot S_t \cdot E) + 48 \cdot M / (\pi \cdot D^2 \cdot S_t \cdot E) \\&= -28,364.53 / (\pi \cdot 62.5 \cdot 21,012 \cdot 1) + 48 \cdot 28,020 / (\pi \cdot 62.5^2 \cdot 21,012 \cdot 1) \\&= \underline{0.0017} \text{ in}\end{aligned}$$

Required thickness, tensile stress at the top:

$$\begin{aligned}t &= -W_t / (\pi \cdot D_t \cdot S_t \cdot E) + 48 \cdot M_t / (\pi \cdot D_t^2 \cdot S_t \cdot E) \\&= -27,351.94 / (\pi \cdot 62.5 \cdot 21,012 \cdot 1) + 48 \cdot 26,605.6 / (\pi \cdot 62.5^2 \cdot 21,012 \cdot 1) \\&= \underline{0.0017} \text{ in}\end{aligned}$$

Leeward side (compressive)

Required thickness, compressive stress at base:

$$\begin{aligned}t &= W / (\pi \cdot D \cdot S_c \cdot E_c) + 48 \cdot M / (\pi \cdot D^2 \cdot S_c \cdot E_c) \\&= 28,364.53 / (\pi \cdot 62.5 \cdot 21,012 \cdot 1) + 48 \cdot 28,020 / (\pi \cdot 62.5^2 \cdot 21,012 \cdot 1) \\&= \underline{0.0121} \text{ in}\end{aligned}$$

Required thickness, compressive stress at the top:

$$\begin{aligned}t &= W_t / (\pi \cdot D_t \cdot S_c \cdot E_c) + 48 \cdot M_t / (\pi \cdot D_t^2 \cdot S_c \cdot E_c) \\&= 27,351.94 / (\pi \cdot 62.5 \cdot 21,012 \cdot 1) + 48 \cdot 26,605.6 / (\pi \cdot 62.5^2 \cdot 21,012 \cdot 1) \\&= \underline{0.0116} \text{ in}\end{aligned}$$

Loading due to wind, vacuum & corroded

Windward side (tensile)

Required thickness, tensile stress at base:

$$\begin{aligned}t &= -W / (\pi * D_t * S_t * E) + 48 * M / (\pi * D_t^2 * S_t * E) \\&= -40,423.69 / (\pi * 62.5^2 * 21,012 * 1) + 48 * 27,784.9 / (\pi * 62.5^2 * 21,012 * 1) \\&= \underline{0.0046} \text{ in}\end{aligned}$$

Required thickness, tensile stress at the top:

$$\begin{aligned}t &= -W_t / (\pi * D_t * S_t * E) + 48 * M_t / (\pi * D_t^2 * S_t * E) \\&= -39,411.11 / (\pi * 62.5^2 * 21,012 * 1) + 48 * 26,370.5 / (\pi * 62.5^2 * 21,012 * 1) \\&= \underline{0.0046} \text{ in}\end{aligned}$$

Leeward side (compressive)

Required thickness, compressive stress at base:

$$\begin{aligned}t &= W / (\pi * D_c * S_c * E_c) + 48 * M / (\pi * D_c^2 * S_c * E_c) \\&= 40,423.69 / (\pi * 62.5^2 * 21,012 * 1) + 48 * 27,784.9 / (\pi * 62.5^2 * 21,012 * 1) \\&= \underline{0.015} \text{ in}\end{aligned}$$

Required thickness, compressive stress at the top:

$$\begin{aligned}t &= W_t / (\pi * D_t * S_c * E_c) + 48 * M_t / (\pi * D_t^2 * S_c * E_c) \\&= 39,411.11 / (\pi * 62.5^2 * 21,012 * 1) + 48 * 26,370.5 / (\pi * 62.5^2 * 21,012 * 1) \\&= \underline{0.0145} \text{ in}\end{aligned}$$

Loading due to earthquake, operating & corroded

Tensile side

Required thickness, tensile stress at base:

$$\begin{aligned}t &= -W / (\pi * D_t * S_t * E) + 48 * M / (\pi * D_t^2 * S_t * E) \\&= -40,423.69 / (\pi * 62.5^2 * 26,000 * 0.8) + 48 * 187,179.7 / (\pi * 62.5^2 * 26,000 * 0.8) \\&= \underline{0.0253} \text{ in}\end{aligned}$$

Required thickness, tensile stress at the top:

$$\begin{aligned}t &= -W_t / (\pi * D_t * S_t * E) + 48 * M_t / (\pi * D_t^2 * S_t * E) \\&= -39,411.11 / (\pi * 62.5^2 * 26,000 * 0.55) + 48 * 147,573.4 / (\pi * 62.5^2 * 26,000 * 0.55) \\&= \underline{0.0263} \text{ in}\end{aligned}$$

Compressive side

Required thickness, compressive stress at base:

$$\begin{aligned}t &= (1 + V_{\text{Accel}}) * W / (\pi * D * S_c * E_c) + 48 * M / (\pi * D^2 * S_c * E_c) \\&= (1 + 1) * 40,423.69 / (\pi * 62.5 * 21,012 * 1) + 48 * 187,179.7 / (\pi * 62.5^2 * 21,012 * 1) \\&= \underline{0.0544} \text{ in}\end{aligned}$$

Required thickness, compressive stress at the top:

$$\begin{aligned}t &= (1 + V_{\text{Accel}}) * W_t / (\pi * D_t * S_c * E_c) + 48 * M_t / (\pi * D_t^2 * S_c * E_c) \\&= (1 + 1) * 39,411.11 / (\pi * 62.5 * 21,012 * 1) + 48 * 147,573.4 / (\pi * 62.5^2 * 21,012 * 1) \\&= \underline{0.0466} \text{ in}\end{aligned}$$

Loading due to earthquake, operating & new

Tensile side

Required thickness, tensile stress at base:

$$\begin{aligned}t &= -W / (\pi * D * S_t * E) + 48 * M / (\pi * D^2 * S_t * E) \\&= -41,339.78 / (\pi * 62.5 * 26,000 * 0.8) + 48 * 191,359.8 / (\pi * 62.5^2 * 26,000 * 0.8) \\&= \underline{0.0259} \text{ in}\end{aligned}$$

Required thickness, tensile stress at the top:

$$\begin{aligned}t &= -W_t / (\pi * D_t * S_t * E) + 48 * M_t / (\pi * D_t^2 * S_t * E) \\&= -40,327.2 / (\pi * 62.5 * 26,000 * 0.55) + 48 * 150,865.9 / (\pi * 62.5^2 * 26,000 * 0.55) \\&= \underline{0.0269} \text{ in}\end{aligned}$$

Compressive side

Required thickness, compressive stress at base:

$$\begin{aligned}t &= (1 + V_{\text{Accel}}) * W / (\pi * D * S_c * E_c) + 48 * M / (\pi * D^2 * S_c * E_c) \\&= (1 + 1) * 41,339.78 / (\pi * 62.5 * 21,012 * 1) + 48 * 191,359.8 / (\pi * 62.5^2 * 21,012 * 1) \\&= \underline{0.0557} \text{ in}\end{aligned}$$

Required thickness, compressive stress at the top:

$$\begin{aligned}t &= (1 + V_{\text{Accel}}) * W_t / (\pi * D_t * S_c * E_c) + 48 * M_t / (\pi * D_t^2 * S_c * E_c) \\&= (1 + 1) * 40,327.2 / (\pi * 62.5 * 21,012 * 1) + 48 * 150,865.9 / (\pi * 62.5^2 * 21,012 * 1) \\&= \underline{0.0476} \text{ in}\end{aligned}$$

Loading due to earthquake, empty & corroded

Tensile side

Required thickness, tensile stress at base:

$$\begin{aligned}t &= -W / (\pi * D * S_t * E) + 48 * M / (\pi * D^2 * S_t * E) \\&= -27,326.21 / (\pi * 62.5 * 26,000 * 0.8) + 48 * 136,014.5 / (\pi * 62.5^2 * 26,000 * 0.8) \\&= \underline{0.0189} \text{ in}\end{aligned}$$

Required thickness, tensile stress at the top:

$$\begin{aligned}t &= -W_t / (\pi * D_t * S_t * E) + 48 * M_t / (\pi * D_t^2 * S_t * E) \\&= -26,313.63 / (\pi * 62.5 * 26,000 * 0.55) + 48 * 109,096.9 / (\pi * 62.5^2 * 26,000 * 0.55) \\&= \underline{0.0205} \text{ in}\end{aligned}$$

Compressive side

Required thickness, compressive stress at base:

$$\begin{aligned}t &= (1 + V_{\text{Accel}}) * W / (\pi * D * S_c * E_c) + 48 * M / (\pi * D^2 * S_c * E_c) \\&= (1 + 1) * 27,326.21 / (\pi * 62.5 * 21,012 * 1) + 48 * 136,014.5 / (\pi * 62.5^2 * 21,012 * 1) \\&= \underline{0.0386} \text{ in}\end{aligned}$$

Required thickness, compressive stress at the top:

$$\begin{aligned}t &= (1 + V_{\text{Accel}}) * W_t / (\pi * D_t * S_c * E_c) + 48 * M_t / (\pi * D_t^2 * S_c * E_c) \\&= (1 + 1) * 26,313.63 / (\pi * 62.5 * 21,012 * 1) + 48 * 109,096.9 / (\pi * 62.5^2 * 21,012 * 1) \\&= \underline{0.0331} \text{ in}\end{aligned}$$

Loading due to earthquake, empty & new

Tensile side

Required thickness, tensile stress at base:

$$\begin{aligned}t &= -W / (\pi * D * S_t * E) + 48 * M / (\pi * D^2 * S_t * E) \\&= -28,364.53 / (\pi * 62.5 * 26,000 * 0.8) + 48 * 140,660.2 / (\pi * 62.5^2 * 26,000 * 0.8) \\&= \underline{0.0195} \text{ in}\end{aligned}$$

Required thickness, tensile stress at the top:

$$\begin{aligned}t &= -W_t / (\pi * D_t * S_t * E) + 48 * M_t / (\pi * D_t^2 * S_t * E) \\&= -27,351.94 / (\pi * 62.5 * 26,000 * 0.55) + 48 * 112,736.4 / (\pi * 62.5^2 * 26,000 * 0.55) \\&= \underline{0.0211} \text{ in}\end{aligned}$$

Compressive side

Required thickness, compressive stress at base:

$$\begin{aligned}t &= (1 + V_{\text{Accel}}) * W / (\pi * D * S_c * E_c) + 48 * M / (\pi * D^2 * S_c * E_c) \\&= (1 + 1) * 28,364.53 / (\pi * 62.5 * 21,012 * 1) + 48 * 140,660.2 / (\pi * 62.5^2 * 21,012 * 1) \\&= \underline{0.0399} \text{ in}\end{aligned}$$

Required thickness, compressive stress at the top:

$$\begin{aligned}t &= (1 + V_{\text{Accel}}) * W_t / (\pi * D_t * S_c * E_c) + 48 * M_t / (\pi * D_t^2 * S_c * E_c) \\&= (1 + 1) * 27,351.94 / (\pi * 62.5 * 21,012 * 1) + 48 * 112,736.4 / (\pi * 62.5^2 * 21,012 * 1) \\&= \underline{0.0342} \text{ in}\end{aligned}$$

Loading due to earthquake, vacuum & corroded

Tensile side

Required thickness, tensile stress at base:

$$\begin{aligned}t &= -W / (\pi * D * S_t * E) + 48 * M / (\pi * D^2 * S_t * E) \\&= -40,423.69 / (\pi * 62.5 * 26,000 * 0.8) + 48 * 187,179.7 / (\pi * 62.5^2 * 26,000 * 0.8) \\&= \underline{0.0253} \text{ in}\end{aligned}$$

Required thickness, tensile stress at the top:

$$\begin{aligned}t &= -W_t / (\pi * D_t * S_t * E) + 48 * M_t / (\pi * D_t^2 * S_t * E) \\&= -39,411.11 / (\pi * 62.5 * 26,000 * 0.55) + 48 * 147,573.4 / (\pi * 62.5^2 * 26,000 * 0.55) \\&= \underline{0.0263} \text{ in}\end{aligned}$$

Compressive side

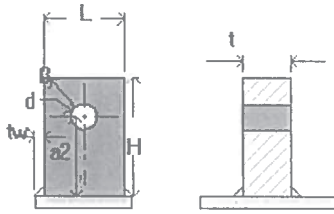
Required thickness, compressive stress at base:

$$\begin{aligned}t &= (1 + V_{\text{Accel}}) * W / (\pi * D * S_c * E_c) + 48 * M / (\pi * D^2 * S_c * E_c) \\&= (1 + 1) * 40,423.69 / (\pi * 62.5 * 21,012 * 1) + 48 * 187,179.7 / (\pi * 62.5^2 * 21,012 * 1) \\&= \underline{0.0544} \text{ in}\end{aligned}$$

Required thickness, compressive stress at the top:

$$\begin{aligned}t &= (1 + V_{\text{Accel}}) * W_t / (\pi * D_t * S_c * E_c) + 48 * M_t / (\pi * D_t^2 * S_c * E_c) \\&= (1 + 1) * 39,411.11 / (\pi * 62.5 * 21,012 * 1) + 48 * 147,573.4 / (\pi * 62.5^2 * 21,012 * 1) \\&= \underline{0.0466} \text{ in}\end{aligned}$$

Tail lug



Geometry Inputs

Attached To	63-1/4" OD Skirt
Material	SA-516 70N
Orientation	Longitudinal
Distance of Lift Point From Datum	123.2075"
Angular Position	225.00°
Length of Lug, L	5"
Height of Lug, H	7.5"
Thickness of Lug, t	1.5"
Hole Diameter, d	1.5625"
Pin Diameter, D _p	1.5"
Load Eccentricity, a ₁	0"
Distance from Load to Shell or Pad, a ₂	5"
Weld Size, t _w	0.625"
Load Angle Normal to Vessel, β	42.0000 °
Load Angle from Vertical, φ	-48.0000 °

Intermediate Values

Load Factor	1.5000
Vessel Weight (new, incl. Load Factor), W	43247 lb
Lug Weight (new), W_{lug}	16 lb
Distance from Center of Gravity to Top Lug, l_1	67.5931"
Distance from Center of Gravity to Tail Lug, l_2	70.6144"
Distance from Vessel Center Line to Tail Lug, l_3	36.625"
Allowable Stress, Tensile, σ_t	19980 psi
Allowable Stress, Shear, σ_s	13320 psi
Allowable Stress, Bearing, σ_p	29970 psi
Allowable Stress, Bending, σ_b	22201 psi
Allowable Stress, Weld Shear, $\tau_{allowable}$	13320 psi
Allowable Stress set to 1/3 Sy per ASME B30.20	No

Summary Values

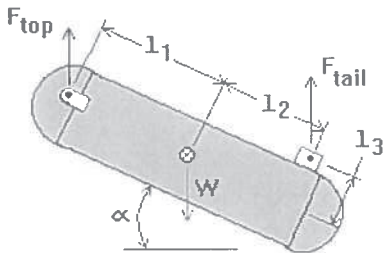
Required Lift Pin Diameter, d_{reqd}	1.0054"
Required Lug Thickness, t_{reqd}	0.4705"
Lug Stress Ratio, σ_{ratio}	0.51
Weld Shear Stress Ratio, τ_{ratio}	0.33
Lug Design	Acceptable
Local Stresses	Unacceptable
Base ring loading	Acceptable

Lift Forces

Lift force on lugs during rotational lift ($0^\circ \leq \alpha \leq 90^\circ$):

$$2 * F_{top} = W * (l_2 * \cos(\alpha) + l_3 * \sin(\alpha)) / (l_1 * \cos(\alpha) + l_2 * \cos(\alpha) + l_3 * \sin(\alpha))$$

$$F_{tail} = W - (2 * F)$$



α [°]	F_{top} [lbf]	F_{tail} [lbf]
0	11,048	21,151
15	11,749	19,749
30	12,451	18,344
45	13,264	16,720
60	14,375	14,497
75	16,307	10,634
90	21,624	0
52 ¹	13,726	15,794
0 ²	11,048	21,151
¹ Lift angle at maximum lug stress.		
² Lift angle at maximum weld stress.		

Lug Pin Diameter - Shear stress

$$d_{reqd} = (2 \cdot F_r / (\pi \cdot \sigma_s))^{0.5}$$

$$= (2 \cdot 21,151 / (\pi \cdot 13,320))^{0.5} = \underline{1.0054"}$$

$$d_{reqd} / D_p = 1.0054 / 1.5 = 0.67 \quad \text{Acceptable}$$

$$\sigma = F_r / A$$

$$= F_r / (2 \cdot (0.25 \cdot \pi \cdot D_p^2))$$

$$= 21,151 / (2 \cdot (0.25 \cdot \pi \cdot 1.5^2)) = 5,984 \text{ psi}$$

$$\sigma / \sigma_s = 5,984 / 13,320 = 0.45 \quad \text{Acceptable}$$

Lug Thickness - Tensile stress

$$t_{reqd} = F_r / ((L - d) \cdot \sigma_t)$$

$$= 21,151 / ((5 - 1.5625) \cdot 19,980) = 0.308"$$

$$t_{reqd} / t = 0.308 / 1.5 = 0.21 \quad \text{Acceptable}$$

$$\sigma = F_r / A$$

$$= F_r / ((L - d) \cdot t)$$

$$= 21,151 / ((5 - 1.5625) \cdot 1.5) = 4,102 \text{ psi}$$

$$\sigma / \sigma_t = 4,102 / 19,980 = 0.21 \quad \text{Acceptable}$$

Lug Thickness - Bearing stress

$$t_{reqd} = F_v / (D_p \cdot \sigma_p)$$

$$= 21,151 / (1.5 \cdot 29,970) = \underline{0.4705"}$$

$$t_{\text{reqd}} / t = 0.4705 / 1.5 = 0.31 \quad \text{Acceptable}$$

$$\begin{aligned} \sigma &= F_v / A_{\text{bearing}} \\ &= F_v / (D_p * t) \\ &= 21,151 / (1.5 * 1.5) = 9,400 \text{ psi} \end{aligned}$$

$$\sigma / \sigma_p = 9,400 / 29,970 = 0.31 \quad \text{Acceptable}$$

Lug Thickness - Shear stress

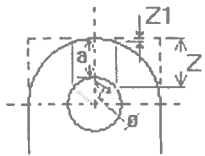
$$\begin{aligned} t_{\text{reqd}} &= [F_v / \sigma_s] / (2 * L_{\text{shear}}) \\ &= (21,151 / 13,320) / (2 * 2.0153) = \underline{0.394"} \end{aligned}$$

$$t_{\text{reqd}} / t = 0.394 / 1.5 = 0.26 \quad \text{Acceptable}$$

$$\begin{aligned} \tau &= F_v / A_{\text{shear}} \\ &= F_v / (2 * t * L_{\text{shear}}) \\ &= 21,151 / (2 * 1.5 * 2.0153) = 3,498 \text{ psi} \end{aligned}$$

$$\tau / \sigma_s = 3,498 / 13,320 = 0.26 \quad \text{Acceptable}$$

Shear stress length (per Pressure Vessel and Stacks, A. Keith Escoe)



$$\begin{aligned} \phi &= 55 * D_p / d \\ &= 55 * 1.5 / 1.5625 \\ &= 52.8^\circ \end{aligned}$$

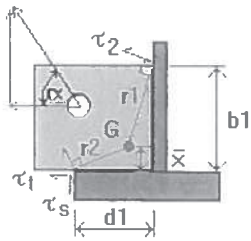
$$\begin{aligned} L_{\text{shear}} &= (H - a - 0.5 * d) + 0.5 * D_p * (1 - \cos(\phi)) \\ &= (7.5 - 5 - 0.5 * 1.5625) + 0.5 * 1.5 * (1 - \cos(52.8)) \\ &= 2.0153" \end{aligned}$$

Lug Plate Stress

Lug stress tensile + bending during lift:

$$\begin{aligned} \sigma_{\text{ratio}} &= [F_{\text{ten}} / (A_{\text{ten}} * \sigma_t)] + [M_{\text{bend}} / (Z_{\text{bend}} * \sigma_b)] \leq 1 \\ &= [(F_{\text{tail}}(\alpha) * \cos(\alpha)) / (t * L * \sigma_t)] + [(6 * \text{abs}(F_{\text{tail}}(\alpha) * \sin(\alpha) * \text{Hght} - F_{\text{tail}}(\alpha) * \cos(\alpha) * a_1)) / (t * L^2 * \sigma_b)] \leq 1 \\ &= 15,794 * \cos(52.0) / (1.5 * 5 * 19,980) + 6 * \text{abs}(15,794 * \sin(52.0) * 5 - 15,794 * \cos(52.0) * 0) / (1.5 * 5^2 * 22,201) \\ &= \underline{0.51} \quad \text{Acceptable} \end{aligned}$$

Weld Stress



Weld stress, tensile, bending and shear during lift:

Direct shear:

Maximum shear stress occurs at lift angle 0.00°; lift force = 21,151 lbf

$$A_{\text{weld}} = 2 * (0.707) * t_w * (b_1 + d_1 + t)$$

$$= 2 * (0.707) * 0.625 * (5 + 4.875 + 1.5) = 10.0527 \text{ in}^2$$

$$\tau_t = F_{\text{tail}} * \cos(\alpha) / A_{\text{weld}}$$

$$= 21,151 * \cos(0.0) / 10.0527 = 2,104 \text{ psi}$$

$$\tau_s = F_{\text{tail}} * \sin(\alpha) / A_{\text{weld}}$$

$$= 21,151 * \sin(0.0) / 10.0527 = 0 \text{ psi}$$

Torsional shear:

Weld areas

$$A_1 = 0.707 * t_w * L_1$$

$$A_1 = 0.707 * 0.625 * 4.875 = 2.1541 \text{ in}^2$$

$$A_2 = 0.707 * 0.625 * 5 = 2.2094 \text{ in}^2$$

$$A_{\text{weld torsion}} = \sum A_i = 4.3635 \text{ in}^2$$

Weld centroid locations

$$x_1 = 0"$$

$$y_1 = 2.4375"$$

$$x_2 = 2.5"$$

$$y_2 = 0"$$

$$X_{\text{bar}} = \sum (A_i * x_i) / \sum A_i$$

$$Y_{\text{bar}} = \sum (A_i * y_i) / \sum A_i$$

$$X_{\text{bar}} = (2.1541 * 0 + 2.2094 * 2.5) / 4.3635 = 1.2658"$$

$$Y_{\text{bar}} = (2.1541 * 2.4375 + 2.2094 * 0) / 4.3635 = 1.2033"$$

Radius to centroid locations

$$r_i = \text{sqr}((X_{\text{bar}} - x_i)^2 + (Y_{\text{bar}} - y_i)^2)$$

$$r_1 = \text{sqr}((1.2658 - 0)^2 + (1.2033 - 2.4375)^2) = 1.7679"$$

$$r_2 = \text{sqr}((1.2658 - 2.5)^2 + (1.2033 - 0)^2) = 1.7237"$$

Radial distance from centroid to weld:

$$r = \text{sqr}(\Delta X^2 + \Delta Y^2)$$

$$= \text{sqr}(3.7342^2 + 1.2033^2) = 3.9233''$$

$$\theta_r = \text{arctan}(\Delta Y / \Delta X)$$

$$= \text{arctan}(1.2033 / 3.7342) = 17.86^\circ$$

Polar Moment of Area

$$J_i = 0.707 \cdot t_w \cdot (L_i^3) / 12$$

$$J_1 = 0.707 \cdot 0.625 \cdot (4.875^3) / 12 = 4.2662 \text{ in}^4$$

$$J_2 = 0.707 \cdot 0.625 \cdot (5^3) / 12 = 4.6029 \text{ in}^4$$

Parallel axis theorem (weld on both sides of lug)

$$J = 2 \cdot \Sigma (J_i + A_i \cdot r_i^2)$$

$$J = 2 \cdot [4.2662 + 2.1541 \cdot (1.7679)^2 + 4.6029 + 2.2094 \cdot (1.7237)^2] = 44.33 \text{ in}^4$$

Secondary shear

$$\tau_2 = M \cdot r / J$$

$$= [F(\alpha) \cdot \cos(\alpha) \cdot (X - X_{\text{bar}}) - F(\alpha) \cdot \sin(\alpha) \cdot (Y - Y_{\text{bar}})] \cdot r / J$$

$$= (21,151 \cdot \cos(0.0) \cdot (2.5 - 1.2658) - 21,151 \cdot \sin(0.0) \cdot (5 - 1.2033)) \cdot 3.9233 / 44.3326$$

$$= 2,310 \text{ psi}$$

$$\tau_{\text{ratio}} = \text{sqr}((\tau_1 + \tau_2 \cdot \cos(\theta_r))^2 + (\tau_s + \tau_2 \cdot \sin(\theta_r))^2) / \tau_{\text{allowable}} \leq 1$$

$$= \text{sqr}((2,104 + 2,310 \cdot \cos(17.86))^2 + (0 + 2,310 \cdot \sin(17.86))^2) / 13,320$$

$$= 0.33 \quad \text{Acceptable}$$

EN 13445 Lift Lug Procedure

Geometry Inputs - EN13445

Nominal Vessel Thickness, e_n	0.75"
Pad Thickness, e_2	0"
Length of Lug, b_1	5"
Width of Pad, b_2	0"
Length of Pad, b_3	0"

Intermediate Values - EN13445

Equivalent Diameter of Vessel at Lug, ID_{eq}	61.75"
Shell Allowable Stress, f	20000 psi
Pad Allowable Stress, f_2	N/A
Design Factor, K_2	1.2500

Summary Values - EN13445

Force on Vessel, F_r	17.076 lbf
Maximum Allowable Load, F_{Rmax}	12.200 lbf
Load Acceptance Ratio, F_R / F_{Rmax}	1.3997
Lug Design	Unacceptable

Equivalent Inner Diameter

$$ID_{eq} = \text{cone inner diameter at center of lug}$$

$$ID_{eq} = D_{cone} / \cos(\alpha)$$

$$ID_{eq} = 61.75 / \cos(0)$$

$$ID_{eq} = 61.75''$$

Applied Force

$$F_r = \text{force on vessel at lug}$$

$$F_{tail} = W[1 - (l_2 \cos(\alpha) + l_3 \sin(\alpha)) / (l_1 \cos(\alpha) + l_2 \cos(\alpha) + l_3 \sin(\alpha))] = 43,247 * (1 - (70.6144 * \cos(42.0000) + 36.625 * \sin(42.0000)) / (67.5931 * \cos(42.0000) + 70.6144 * \cos(42.0000) + 36.625 * \sin(42.0000))) = 17.076 \text{ lbf}$$

where 'l₁' is the distance between the center of gravity and the top lug
'l₂' is the distance between this tailing lug and the center of gravity
'l₃' is the distance between the vessel centerline and this tailing lug

Lug factors

$$\lambda = \text{line load factor}$$

$$\lambda = b / \sqrt{ID_{eq} * e_n} = 5 / \sqrt{61.75 * 0.75} = 0.735$$

$$v_1 = \text{ratio between local membrane stress and local bending stress}$$

$$v_1 = \min(0.08 * \lambda, 0.2) = 0.059$$

$$\sigma_m = \text{global membrane stress}$$

$$\sigma_m = P * ID_{eq} / (2 * e_n) = 0 * 61.75 / (2 * 0.75) = 0.0000 \text{ psi}$$

$$v_2 = \text{ratio between global membrane stress and allowable stress}$$

$$v_2 = \sigma_m / (K_2 * f) = 0 / (1.25 * 20,000) = 0$$

$$\begin{aligned}
 K_{13} &= 1 / (1.2 * \text{sqr}(1 + 0.06 * \lambda^2)) \\
 &= 1 / (1.2 * \text{sqr}(1 + 0.06 * 0.7347^2)) \\
 &= 0.8202
 \end{aligned}$$

$$\begin{aligned}
 K_{14} &= 1 / (0.6 * \text{sqr}(1 + 0.03 * \lambda^2)) \\
 &= 1 / (0.6 * \text{sqr}(1 + 0.03 * 0.7347^2)) \\
 &= 1.6533
 \end{aligned}$$

Bending Limit Stress

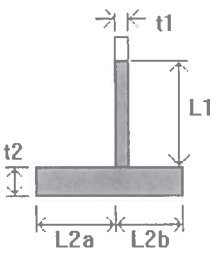
$$\begin{aligned}
 K_1 &= (1 - v_2^2) / ((1/3 + v_1 * v_2) + \text{sqr}((1/3 + v_1 * v_2)^2 + (1 - v_2^2) * v_1^2)) \\
 &= (1 - 0^2) / ((1/3 + 0.0588 * 0) + \text{sqr}((1/3 + 0.0588 * 0)^2 + (1 - 0^2) * 0.0588^2)) \\
 &= 1.4885
 \end{aligned}$$

$$\begin{aligned}
 \sigma_b &= K_1 * K_2 * f \\
 &= 1.4885 * 1.25 * 20,000 \\
 &= 37,213 \text{ psi}
 \end{aligned}$$

Maximum Allowable Load

$$\begin{aligned}
 F_{Rmax} &= \sigma_b * e_n^2 / (K_{13} * |\cos(\beta)| + K_{14} * |a_2 * \sin(\beta) - a_1 * \cos(\beta)| / b_1) \\
 &= 37,213 * (0.75)^2 / (0.8202 * |\cos(42.0000)| + 1.6533 * |5 * \sin(42.0000) - 0 * \cos(42.0000)| / 5) \\
 &= \underline{12,200 \text{ lbf}}
 \end{aligned}$$

Base Ring Sectional Properties

t_1	0.75"	L_1	3.7762"	
t_2	1"	L_{2a}	4.875"	
		L_{2b}	2.625"	
Base Ring Geometry				

Effective skirt length:

$$\begin{aligned}
 R_m &= (D_i + t_1) * 0.5 \\
 &= (61.75 + 0.75) * 0.5 = 31.25" \\
 L_1 &= \text{Min}(0.78 * \text{sqr}(R_m * t_1), 16 * t_1) \\
 &= 0.78 * \text{sqr}(31.25 * 0.75) = 3.7762"
 \end{aligned}$$

Section Area:

$$\begin{aligned}
 A_1 &= t_1 * L_1 = 0.75 * 3.7762 = 2.8321 \text{ in}^2 \\
 A_2 &= t_2 * L_2 = 1 * (4.875 + 2.625) = 7.5 \text{ in}^2 \\
 A_{total} &= A_1 + A_2 = 2.8321 + 7.5 = 10.3321 \text{ in}^2
 \end{aligned}$$

Centroid, C:

$$\begin{aligned}
 h_1 &= L_{2a} + 0.5 * t_1 = 4.875 + 0.5 * 0.75 = 5.25" \\
 h_2 &= 0.5 * (L_{2a} + L_{2b}) = 0.5 * (4.875 + 2.625) = 3.75" \\
 C &= ((A_1 * h_1) + (A_2 * h_2)) / A_{total}
 \end{aligned}$$

$$= ((2.8321*5.25) + (7.5*3.75)) / 10.3321 = 4.1612''$$

Moment of Inertia, I:

$$I_1 = (L_1 * t_1^3) / 12 + A_1 * (h_1 - C)^2$$

$$= (3.7762 * 0.75^3) / 12 + 2.8321 * (5.25 - 4.1612)^2 = 3.5 \text{ in}^4$$

$$I_2 = t_2 * (L_{2a} + L_{2b})^3 / 12 + A_2 * (h_2 - C)^2$$

$$= 1 * (4.875 + 2.625)^3 / 12 + 7.5 * (3.75 - 4.1612)^2 = 36.4 \text{ in}^4$$

$$I_{ring} = I_1 + I_2$$

$$= 3.4904 + 36.4242 = 39.9146 \text{ in}^4$$

Section Modulus, Z:

$$Z = I_{ring} / C_{max} = 39.9146 / 4.1612 = 9.592 \text{ in}^3$$

Base Ring Loads without stiffener beam

Base Ring Load

$$W_r = W = F_{tail} = 21,151 \text{ lbf}$$

Base Ring Loading

Reference: Roark's Formulas for Stress & Strain - 6th Edition. Table 17, Case 20

For thin ring sections $k_1 = k_2 = 1$

$$\text{Change in vertical diameter, } D_v = (-W) * R^3 * (\pi * k_1 / 8 - k_2^2 / \pi) / (E * I)$$

$$\text{Internal Moment, } M_A = W * R * (k_2 - 0.5) / (2 * \pi)$$

$$\text{Internal Force, } N_A = 0.75 * W / \pi$$

$$\text{Internal Shear Force, } V_A = 0$$

$$\text{Ring loading, } W_r = 21,151 \text{ lbf}$$

$$D_{vr} = -21,151 * 32.3388^3 * (\pi * 1 / 8 - 1^2 / \pi) / (29,000,000 * 39.9146) = -0.046''$$

$$M_{Ar} = 21,151 * 32.3388 * (1 - 0.5) / (2 * \pi) = 54430.4090 \text{ lbf-in}$$

$$N_{Ar} = 0.75 * 21,151 / \pi = 5,049 \text{ lbf}$$

Load Equations

$$LT_M = W * R * (1 - \cos(x) - 0.5 * x * \sin(x)) / \pi$$

$$LT_N = -W * (x * \sin(x)) / (2 * \pi)$$

$$LT_V = W * (\sin(x) - x * \cos(x)) / (2 * \pi)$$

$$M = M_A - N_A * R * (1 - \cos(x)) + V_A * R * \sin(x) + LT_M$$

$$N = N_A * \cos(x) + V_A * \sin(x) + LT_N$$

$$V = -N_A * \sin(x) + V_A * \cos(x) + LT_V$$

Load Table for Load W_r

x [°]	LT _M [in-lbf]	LT _N [lbf]	LT _V [lbf]	M [in-lbf]	N [lbf]	V [lbf]
180	0.00	-0.00	0.00	54430.41	5049.38	0.00
150	669.47	-881.28	156.70	33223.01	3491.61	-2367.99
120	10134.98	-3052.86	1152.70	-17080.23	-528.16	-3220.20
90	46723.46	-5287.70	3366.26	-62137.36	-5287.70	-1683.13
60	129130.77	-6105.71	6440.40	-61375.66	-8630.41	2067.50
30	263775.63	-4406.42	9315.27	13500.46	-8779.31	6790.58
0	435443.27	-0.00	10575.41	163291.23	-5049.38	10575.41

(0 ° at lug)

Maximum Stress in Base Ring Section

Allowable Base Ring Stresses

$$F_a = 0.6 \cdot F_y = 21,600 \text{ psi}$$

$$F_b = 0.66 \cdot F_y = 23,760 \text{ psi}$$

$$F_s = 0.4 \cdot F_y = 14,400 \text{ psi}$$

Base Ring Stresses

Maximum combined stress occurs at 0.00 degrees

$$f_a = N / A = -5,049 / 10.3321 = -489 \text{ psi}$$

$$f_b = M / Z = 163,291 / 9.5922 = 17,023 \text{ psi}$$

$$f_a / F_a + f_b / F_b = 0.74 \quad \text{Acceptable}$$

Maximum shear stress occurs at 0.00 degrees

$$f_s = V / A = 10,575 / 10.3321 = 1,024 \text{ psi}$$

$$f_s / F_s = 0.07 \quad \text{Acceptable}$$

Skirt Base Ring

Base configuration:	single base plate
Foundation compressive strength:	1,658 psi
Concrete ultimate 28-day strength:	3,000 psi
Anchor bolt material:	A-325
Anchor bolt allowable stress, S_b :	20,000 psi
Bolt circle, BC:	68.5 in
Anchor bolt corrosion allowance (applied to root radius):	0 in
Anchor bolt clearance:	0.375 in
Base plate material:	SA-516 70
Base plate allowable stress, S_p :	20,000 psi
Base plate inner diameter, D_i :	58 in
Base plate outer diameter, D_o :	73 in
Base plate thickness, t_b :	1 in
Gusset separation, w :	4 in
Gusset height, h :	4.625 in
Gusset thickness, t_g :	0.375 in
Initial bolt preload:	0 % (0 psi)
Number of bolts, N :	8
Bolt size and type:	1.25 inch series 8 threaded
Bolt root area (corroded), A_b :	0.929 in ²
Diameter of anchor bolt holes, d_b :	1.625 in

Load	Vessel condition	Base M (lb-ft)	W (lb)	Required bolt area (in ²)	t_r Base (in)	Foundation bearing stress (psi)
Wind	operating, corroded	27,784.9	40,890.5	0	0.365	41.3
Wind	operating, new	28,020	41,806.6	0	0.3682	42.02
Wind	empty, corroded	27,784.9	27,793	0	0.3249	32.72
Wind	empty, new	28,020	28,831.4	0	0.3288	33.52
Wind	vacuum, corroded	27,784.9	40,890.5	0	0.365	41.3
Seismic	operating, corroded	187,179.7	40,890.5	0.5642	0.9511	280.41
Seismic	operating, new	191,359.8	41,806.6	0.5768	0.9617	286.68
Seismic	empty, corroded	136,014.5	27,793	0.422	0.8056	201.17
Seismic	empty, new	140,660.2	28,831.4	0.4358	0.8195	208.17
Seismic	vacuum, corroded	187,179.7	40,890.5	0.5642	0.9511	280.41

Anchor bolt load (operating, corroded + Wind)

$$\begin{aligned}
 P &= -W / N + 48 * M / (N * BC) \\
 &= -40,890.52 / 8 + 48 * 27,784.9 / (8 * 68.5) \\
 &= -2,677.6 \text{ lb}_f
 \end{aligned}$$

The anchor bolts are satisfactory (no net uplift on anchor bolt)

Foundation bearing stress (operating, corroded + Wind)

$$\begin{aligned}
 A_c &= \pi * (D_o^2 - D_i^2) / 4 - N * \pi * d_b^2 / 4 \\
 &= \pi * (73^2 - 58^2) / 4 - 8 * \pi * 1.625^2 / 4
 \end{aligned}$$

$$= 1,526.7159 \text{ in}^2$$

$$\begin{aligned} I_c &= \pi(D_o^4 - D_i^4) / 64 \\ &= \pi(73^4 - 58^4) / 64 \\ &= 838,498.2 \text{ in}^4 \end{aligned}$$

$$\begin{aligned} f_c &= N \cdot A_b \cdot \text{Preload} / A_c + W / A_c + 6 \cdot M \cdot D_o / I_c \\ &= 8 \cdot 0.929 \cdot 0 / 1,526.7159 + 40,890.52 / 1,526.7159 + 6 \cdot 27,784.9 \cdot 73 / 838,498.2 \\ &= \underline{41} \text{ psi} \end{aligned}$$

As $f_c \leq 1,658$ psi the base plate width is satisfactory.

Base plate required thickness (operating, corroded + Wind)

From Brownell & Young, Table 10.3: $l / b = 0.2201$

$$M_x = 0.0052 \cdot 41 \cdot 22.1499^2 = 104.3 \text{ lb}_f$$

$$M_y = -0.4525 \cdot 41 \cdot 4.875^2 = -444.1 \text{ lb}_f$$

$$\begin{aligned} t_r &= (6 \cdot M_{\max} / S_p)^{0.5} \\ &= (6 \cdot 444.07 / 20,000)^{0.5} \\ &= \underline{0.365} \text{ in} \end{aligned}$$

The base plate thickness is satisfactory.

Base plate bolt load (Jawad & Farr eq. 12.13, operating, corroded + Wind)

$$\text{Bolt load} = A_b \cdot f_s = 0.929 \cdot 0 = 0 \text{ lb}_f$$

$$\begin{aligned} t_r &= (3.91 \cdot F / (S_y \cdot (2 \cdot b / w + w / (2 \cdot l) - d_b \cdot (2 / w + 1 / (2 \cdot l))))))^{0.5} \\ &= (3.91 \cdot 0 / (36,000 \cdot (2 \cdot 4.875 / 4 + 4 / (2 \cdot 2.625) - 1.625 \cdot (2 / 4 + 1 / (2 \cdot 2.625))))))^{0.5} \\ &= 0 \text{ in} \end{aligned}$$

The base plate thickness is satisfactory.

Check skirt for gusset reaction (Jawad & Farr eq. 12.14)

$$\begin{aligned} S_r &= 1.5 \cdot F \cdot b / (\text{gussets} \cdot \pi \cdot t_{sk}^2 \cdot h) \\ &= 1.5 \cdot 0 \cdot 4.875 / (2 \cdot \pi \cdot 0.75^2 \cdot 4.625) \\ &= 0 \text{ psi} \end{aligned}$$

As $S_r \leq 30,000$ psi the skirt thickness is adequate to resist the gusset reaction.

Anchor bolt load (operating, new + Wind)

$$\begin{aligned} P &= -W / N + 48 \cdot M / (N \cdot BC) \\ &= -41,806.61 / 8 + 48 \cdot 28,020 / (8 \cdot 68.5) \\ &= -2,771.52 \text{ lb}_f \end{aligned}$$

The anchor bolts are satisfactory (no net uplift on anchor bolt)

Foundation bearing stress (operating, new + Wind)

$$\begin{aligned} A_c &= \pi(D_o^2 - D_i^2) / 4 - N \cdot \pi \cdot d_b^2 / 4 \\ &= \pi(73^2 - 58^2) / 4 - 8 \cdot \pi \cdot 1.625^2 / 4 \\ &= 1,526.7159 \text{ in}^2 \end{aligned}$$

$$I_c = \pi(D_o^4 - D_i^4) / 64$$

$$= \pi(73^4 - 58^4) / 64$$

$$= 838,498.2 \text{ in}^4$$

$$f_c = N \cdot A_b \cdot \text{Preload} / A_c + W / A_c + 6 \cdot M \cdot D_o / I_c$$

$$= 8 \cdot 0.929 \cdot 0 / 1,526.7159 + 41,806.61 / 1,526.7159 + 6 \cdot 28,020 \cdot 73 / 838,498.2$$

$$= 42 \text{ psi}$$

As $f_c \leq 1,658$ psi the base plate width is satisfactory.

Base plate required thickness (operating, new + Wind)

From Brownell & Young, Table 10.3.; $l / b = 0.2201$

$$M_x = 0.0052 \cdot 42 \cdot 22.1499^2 = 106.2 \text{ lb}_f$$

$$M_y = -0.4525 \cdot 42 \cdot 4.875^2 = -451.8 \text{ lb}_f$$

$$t_r = (6 \cdot M_{\max} / S_p)^{0.5}$$

$$= (6 \cdot 451.84 / 20,000)^{0.5}$$

$$= 0.3682 \text{ in}$$

The base plate thickness is satisfactory.

Base plate bolt load (Jawad & Farr eq. 12.13, operating, new + Wind)

$$\text{Bolt load} = A_b \cdot f_s = 0.929 \cdot 0 = 0 \text{ lb}_f$$

$$t_r = (3.91 \cdot F / (S_y \cdot (2 \cdot b / w + w / (2 \cdot l) - d_b \cdot (2 / w + 1 / (2 \cdot l))))))^{0.5}$$

$$= (3.91 \cdot 0 / (36,000 \cdot (2 \cdot 4.875 / 4 + 4 / (2 \cdot 2.625) - 1.625 \cdot (2 / 4 + 1 / (2 \cdot 2.625))))))^{0.5}$$

$$= 0 \text{ in}$$

The base plate thickness is satisfactory.

Check skirt for gusset reaction (Jawad & Farr eq. 12.14)

$$S_r = 1.5 \cdot F \cdot b / (\text{gussets} \cdot \pi \cdot t_{sk}^2 \cdot h)$$

$$= 1.5 \cdot 0 \cdot 4.875 / (2 \cdot \pi \cdot 0.75^2 \cdot 4.625)$$

$$= 0 \text{ psi}$$

As $S_r \leq 30,000$ psi the skirt thickness is adequate to resist the gusset reaction.

Anchor bolt load (empty, corroded + Wind)

$$P = -W / N + 48 \cdot M / (N \cdot BC)$$

$$= -27,793.03 / 8 + 48 \cdot 27,784.9 / (8 \cdot 68.5)$$

$$= -1,040.42 \text{ lb}_f$$

The anchor bolts are satisfactory (no net uplift on anchor bolt)

Foundation bearing stress (empty, corroded + Wind)

$$A_c = \pi(D_o^2 - D_i^2) / 4 - N \cdot \pi \cdot d_b^2 / 4$$

$$= \pi(73^2 - 58^2) / 4 - 8 \cdot \pi \cdot 1.625^2 / 4$$

$$= 1,526.7159 \text{ in}^2$$

$$\begin{aligned}
 I_c &= \pi(D_o^4 - D_i^4) / 64 \\
 &= \pi(73^4 - 58^4) / 64 \\
 &= 838,498.2 \text{ in}^4
 \end{aligned}$$

$$\begin{aligned}
 f_c &= N \cdot A_b \cdot \text{Preload} / A_c + W / A_c + 6 \cdot M \cdot D_o / I_c \\
 &= 8 \cdot 0.929 \cdot 0 / 1,526.7159 + 27,793.03 / 1,526.7159 + 6 \cdot 27,784.9 \cdot 73 / 838,498.2 \\
 &= \underline{33} \text{ psi}
 \end{aligned}$$

As $f_c \leq 1,658$ psi the base plate width is satisfactory.

Base plate required thickness (empty, corroded + Wind)

From Brownell & Young, Table 10.3: $l / b = 0.2201$

$$M_x = 0.0052 \cdot 33 \cdot 22.1499^2 = 82.7 \text{ lb}_f$$

$$M_y = -0.4525 \cdot 33 \cdot 4.875^2 = -351.8 \text{ lb}_f$$

$$\begin{aligned}
 t_r &= (6 \cdot M_{\max} / S_p)^{0.5} \\
 &= (6 \cdot 351.82 / 20,000)^{0.5} \\
 &= \underline{0.3249} \text{ in}
 \end{aligned}$$

The base plate thickness is satisfactory.

Base plate bolt load (Jawad & Farr eq. 12.13, empty, corroded + Wind)

$$\text{Bolt load} = A_b \cdot f_s = 0.929 \cdot 0 = 0 \text{ lb}_f$$

$$\begin{aligned}
 t_r &= (3.91 \cdot F / (S_v \cdot (2 \cdot b / w + w / (2 \cdot l) - d_b \cdot (2 / w + 1 / (2 \cdot l))))))^{0.5} \\
 &= (3.91 \cdot 0 / (36,000 \cdot (2 \cdot 4.875 / 4 + 4 / (2 \cdot 2.625) - 1.625 \cdot (2 / 4 + 1 / (2 \cdot 2.625))))))^{0.5} \\
 &= 0 \text{ in}
 \end{aligned}$$

The base plate thickness is satisfactory.

Check skirt for gusset reaction (Jawad & Farr eq. 12.14)

$$\begin{aligned}
 S_r &= 1.5 \cdot F \cdot b / (\text{gussets} \cdot \pi \cdot t_{sk}^2 \cdot h) \\
 &= 1.5 \cdot 0 \cdot 4.875 / (2 \cdot \pi \cdot 0.75^2 \cdot 4.625) \\
 &= 0 \text{ psi}
 \end{aligned}$$

As $S_r \leq 30,000$ psi the skirt thickness is adequate to resist the gusset reaction.

Anchor bolt load (empty, new + Wind)

$$\begin{aligned}
 P &= -W / N + 48 \cdot M / (N \cdot BC) \\
 &= -28,831.35 / 8 + 48 \cdot 28,020 / (8 \cdot 68.5) \\
 &= -1,149.61 \text{ lb}_f
 \end{aligned}$$

The anchor bolts are satisfactory (no net uplift on anchor bolt)

Foundation bearing stress (empty, new + Wind)

$$\begin{aligned}
 A_c &= \pi(D_o^2 - D_i^2) / 4 - N \cdot \pi \cdot d_b^2 / 4 \\
 &= \pi(73^2 - 58^2) / 4 - 8 \cdot \pi \cdot 1.625^2 / 4 \\
 &= 1,526.7159 \text{ in}^2
 \end{aligned}$$

$$I_c = \pi(D_o^4 - D_i^4) / 64$$

$$= \pi(73^4 - 58^4) / 64$$

$$= 838,498.2 \text{ in}^4$$

$$f_c = N \cdot A_b \cdot \text{Preload} / A_c + W / A_c + 6 \cdot M \cdot D_o / I_c$$

$$= 8 \cdot 0.929 \cdot 0 / 1,526.7159 + 28,831.35 / 1,526.7159 + 6 \cdot 28,020 \cdot 73 / 838,498.2$$

$$= \underline{34} \text{ psi}$$

As $f_c \leq 1,658$ psi the base plate width is satisfactory.

Base plate required thickness (empty, new + Wind)

From Brownell & Young, Table 10.3., $l / b = 0.2201$

$$M_x = 0.0052 \cdot 34 \cdot 22.1499^2 = 84.7 \text{ lb}_f$$

$$M_y = -0.4525 \cdot 34 \cdot 4.875^2 = -360.5 \text{ lb}_f$$

$$t_r = (6 \cdot M_{\max} / S_p)^{0.5}$$

$$= (6 \cdot 360.45 / 20,000)^{0.5}$$

$$= \underline{0.3288} \text{ in}$$

The base plate thickness is satisfactory.

Base plate bolt load (Jawad & Farr eq. 12.13, empty, new + Wind)

$$\text{Bolt load} = A_b \cdot f_s = 0.929 \cdot 0 = 0 \text{ lb}_f$$

$$t_r = (3.91 \cdot F / (S_y \cdot (2 \cdot b / w + w / (2 \cdot l) - d_b \cdot (2 / w + 1 / (2 \cdot l))))))^{0.5}$$

$$= (3.91 \cdot 0 / (36,000 \cdot (2 \cdot 4.875 / 4 + 4 / (2 \cdot 2.625) - 1.625 \cdot (2 / 4 + 1 / (2 \cdot 2.625))))))^{0.5}$$

$$= 0 \text{ in}$$

The base plate thickness is satisfactory.

Check skirt for gusset reaction (Jawad & Farr eq. 12.14)

$$S_r = 1.5 \cdot F \cdot b / (\text{gussets} \cdot \pi \cdot t_{sk}^2 \cdot h)$$

$$= 1.5 \cdot 0 \cdot 4.875 / (2 \cdot \pi \cdot 0.75^2 \cdot 4.625)$$

$$= 0 \text{ psi}$$

As $S_r \leq 30,000$ psi the skirt thickness is adequate to resist the gusset reaction.

Anchor bolt load (vacuum, corroded + Wind)

$$P = -W / N + 48 \cdot M / (N \cdot BC)$$

$$= -40,890.52 / 8 + 48 \cdot 27,784.9 / (8 \cdot 68.5)$$

$$= -2,677.6 \text{ lb}_f$$

The anchor bolts are satisfactory (no net uplift on anchor bolt)

Foundation bearing stress (vacuum, corroded + Wind)

$$A_c = \pi \cdot (D_o^2 - D_i^2) / 4 - N \cdot \pi \cdot d_b^2 / 4$$

$$= \pi \cdot (73^2 - 58^2) / 4 - 8 \cdot \pi \cdot 1.625^2 / 4$$

$$= 1,526.7159 \text{ in}^2$$

$$I_c = \pi \cdot (D_o^4 - D_i^4) / 64$$

$$= \pi \cdot (73^4 - 58^4) / 64$$

$$= 838,498.2 \text{ in}^4$$

$$f_c = N \cdot A_b \cdot \text{Preload} / A_c + W / A_c + 6 \cdot M \cdot D_o / I_c$$

$$= 8 \cdot 0.929 \cdot 0 / 1,526.7159 + 40,890.52 / 1,526.7159 + 6 \cdot 27,784.9 \cdot 73 / 838,498.2$$

$$= \underline{41} \text{ psi}$$

As $f_c \leq 1,658$ psi the base plate width is satisfactory.

Base plate required thickness (vacuum, corroded + Wind)

From Brownell & Young, Table 10.3: $l / b = 0.2201$

$$M_x = 0.0052 \cdot 41 \cdot 22.1499^2 = 104.3 \text{ lb}_f$$

$$M_y = -0.4525 \cdot 41 \cdot 4.875^2 = -444.1 \text{ lb}_f$$

$$t_r = (6 \cdot M_{\max} / S_p)^{0.5}$$

$$= (6 \cdot 444.07 / 20,000)^{0.5}$$

$$= \underline{0.365} \text{ in}$$

The base plate thickness is satisfactory.

Base plate bolt load (Jawad & Farr eq. 12.13, vacuum, corroded + Wind)

$$\text{Bolt load} = A_b \cdot f_s = 0.929 \cdot 0 = 0 \text{ lb}_f$$

$$t_r = (3.91 \cdot F / (S_y \cdot (2 \cdot b / w + w / (2 \cdot l) - d_b \cdot (2 / w + 1 / (2 \cdot l))))))^{0.5}$$

$$= (3.91 \cdot 0 / (36,000 \cdot (2 \cdot 4.875 / 4 + 4 / (2 \cdot 2.625) - 1.625 \cdot (2 / 4 + 1 / (2 \cdot 2.625))))))^{0.5}$$

$$= 0 \text{ in}$$

The base plate thickness is satisfactory.

Check skirt for gusset reaction (Jawad & Farr eq. 12.14)

$$S_r = 1.5 \cdot F \cdot b / (\text{gussets} \cdot \pi \cdot t_{sk}^2 \cdot h)$$

$$= 1.5 \cdot 0 \cdot 4.875 / (2 \cdot \pi \cdot 0.75^2 \cdot 4.625)$$

$$= 0 \text{ psi}$$

As $S_r \leq 30,000$ psi the skirt thickness is adequate to resist the gusset reaction.

Anchor bolt load (operating, corroded + Seismic)

$$P = -W / N + 48 \cdot M / (N \cdot BC)$$

$$= -40,890.52 / 8 + 48 \cdot 187,179.7 / (8 \cdot 68.5)$$

$$= 11,283.99 \text{ lb}_f$$

$$\text{Required area per bolt} = P / S_b = \underline{0.5642} \text{ in}^2$$

The area provided (0.929 in²) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, operating, corroded + Seismic)

Base plate width, t_c :	7.5	in
Average base plate diameter, d :	65.5	in
Base plate elastic modulus, E_s :	29.0E+06	psi
Base plate yield stress, S_y :	36,000	psi

$$E_c = 57,000 * \text{Sqr}(3,000) = 3,122,019 \text{ psi}$$

$$n = E_s / E_c = 29.0E+06 / 3,122,019 = 9.2889$$

$$\begin{aligned} t_s &= (N * A_b) / (\pi * d) \\ &= (8 * 0.929) / (\pi * 65.5) \\ &= 0.0361 \text{ in} \end{aligned}$$

From table 12.4 for k = 0.271492:

$$\begin{aligned} K_1 &= 2.5042, \quad K_2 = 1.4308 \\ L_1 &= 14.9706, \quad L_2 = 36.9789, \quad L_3 = 14.0992 \end{aligned}$$

Total tensile force on bolting

$$\begin{aligned} T &= (12 * M - W * (L_1 + L_3)) / (L_2 + L_3) \\ &= (12 * 187,179.7 - 40,890.52 * (14.9706 + 14.0992)) / (36.9789 + 14.0992) \\ &= 20,703.19 \text{ lb}_f \end{aligned}$$

Tensile stress in bolts use the larger of f_s or bolt preload = 0 psi

$$\begin{aligned} f_s &= T / (t_s * (d / 2) * K_1) \\ &= 20,703.19 / (0.0361 * (65.5 / 2) * 2.5042) \\ &= 6,989 \text{ psi} \end{aligned}$$

Total compressive load on foundation

$$\begin{aligned} C_c &= T + (1 + V_{\text{Accel}}) * W + \text{Bolt Preload} \\ &= 20,703.19 + (1 + 1) * 40,890.52 + 0 \\ &= 102,484.22 \text{ lb}_f \end{aligned}$$

Foundation bearing stress

$$\begin{aligned} f_c &= C_c / (((t_c - t_s) + n * t_s) * (d / 2) * K_2) \\ &= 102,484.22 / (((7.5 - 0.0361) + 9.2889 * 0.0361) * (65.5 / 2) * 1.4308) \\ &= \underline{280} \text{ psi} \end{aligned}$$

As $f_c \leq 1,658$ psi the base plate width is satisfactory.

$$\begin{aligned} k &= 1 / (1 + f_s / (n * f_c)) \\ &= 1 / (1 + 6,989 / (9.2889 * 280)) \\ &= 0.271492 \end{aligned}$$

Base plate required thickness (operating, corroded + Seismic)

From Brownell & Young, Table 10.3:, $l / b = 0.2201$

$$M_x = 0.0052 * 280 * 22.1499^2 = 708.5 \text{ lb}_f$$

$$M_y = -0.4525 * 280 * 4.875^2 = -3,015.3 \text{ lb}_f$$

$$\begin{aligned} t_r &= (6 * M_{\text{max}} / S_p)^{0.5} \\ &= (6 * 3,015.29 / 20,000)^{0.5} \\ &= \underline{0.9511} \text{ in} \end{aligned}$$

The base plate thickness is satisfactory.

Base plate bolt load (Jawad & Farr eq. 12.13, operating, corroded + Seismic)

$$\text{Bolt load} = A_b \cdot f_s = 0.929 \cdot 6,989 = 6,493.17 \text{ lb}_f$$

$$t_r = (3.91 \cdot F / (S_y \cdot (2 \cdot b / w + w / (2 \cdot l) - d_b \cdot (2 / w + 1 / (2 \cdot l))))))^{0.5}$$
$$= (3.91 \cdot 6,493.17 / (36,000 \cdot (2 \cdot 4.875 / 4 + 4 / (2 \cdot 2.625)) - 1.625 \cdot (2 / 4 + 1 / (2 \cdot 2.625))))^{0.5}$$
$$= 0.5827 \text{ in}$$

The base plate thickness is satisfactory.

Check skirt for gusset reaction (Jawad & Farr eq. 12.14)

$$S_r = 1.5 \cdot F \cdot b / (\text{gussets} \cdot \pi \cdot t_{sk}^2 \cdot h)$$
$$= 1.5 \cdot 6,493.17 \cdot 4.875 / (2 \cdot \pi \cdot 0.75^2 \cdot 4.625)$$
$$= 2,904.75 \text{ psi}$$

As $S_r \leq 30,000$ psi the skirt thickness is adequate to resist the gusset reaction.

Anchor bolt load (operating, new + Seismic)

$$P = -W / N + 48 \cdot M / (N \cdot BC)$$
$$= -41,806.61 / 8 + 48 \cdot 191,359.8 / (8 \cdot 68.5)$$
$$= 11,535.62 \text{ lb}_f$$

$$\text{Required area per bolt} = P / S_b = 0.5768 \text{ in}^2$$

The area provided (0.929 in²) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, operating, new + Seismic)

Base plate width, t_c : 7.5 in
Average base plate diameter, d : 65.5 in
Base plate elastic modulus, E_s : 29.0E+06 psi
Base plate yield stress, S_y : 36,000 psi

$$E_c = 57,000 \cdot \text{Sqr}(3,000) = 3,122,019 \text{ psi}$$

$$n = E_s / E_c = 29.0E+06 / 3,122,019 = 9.2889$$

$$t_s = (N \cdot A_b) / (\pi \cdot d)$$
$$= (8 \cdot 0.929) / (\pi \cdot 65.5)$$
$$= 0.0361 \text{ in}$$

From table 12.4 for $k = 0.271506$:

$$K_1 = 2.5042, \quad K_2 = 1.4309$$
$$L_1 = 14.9697, \quad L_2 = 36.9782, \quad L_3 = 14.0999$$

Total tensile force on bolting

$$T = (12 \cdot M - W \cdot (L_1 + L_3)) / (L_2 + L_3)$$
$$= (12 \cdot 191,359.8 - 41,806.61 \cdot (14.9697 + 14.0999)) / (36.9782 + 14.0999)$$
$$= 21,164.02 \text{ lb}_f$$

Tensile stress in bolts use the larger of f_s or bolt preload = 0 psi

$$f_s = T / (t_s \cdot (d / 2) \cdot K_1)$$

$$= 21,164.02 / (0.0361 * (65.5 / 2) * 2.5042)$$

$$= 7,145 \text{ psi}$$

Total compressive load on foundation

$$C_c = T + (1 + V_{\text{Accel}}) * W + \text{Bolt Preload}$$

$$= 21,164.02 + (1 + 1) * 41,806.61 + 0$$

$$= 104,777.23 \text{ lb}_f$$

Foundation bearing stress

$$f_c = C_c / (((t_c - t_s) + n * t_s) * (d / 2) * K_2)$$

$$= 104,777.23 / (((7.5 - 0.0361) + 9.2889 * 0.0361) * (65.5 / 2) * 1.4309)$$

$$= \underline{287} \text{ psi}$$

As $f_c \leq 1,658$ psi the base plate width is satisfactory.

$$k = 1 / (1 + f_s / (n * f_c))$$

$$= 1 / (1 + 7,145 / (9.2889 * 287))$$

$$= 0.271506$$

Base plate required thickness (operating, new + Seismic)

From Brownell & Young, Table 10.3:, $l / b = 0.2201$

$$M_x = 0.0052 * 287 * 22.1499^2 = 724.3 \text{ lb}_f$$

$$M_y = -0.4525 * 287 * 4.875^2 = -3,082.7 \text{ lb}_f$$

$$t_r = (6 * M_{\text{max}} / S_p)^{0.5}$$

$$= (6 * 3,082.67 / 20,000)^{0.5}$$

$$= \underline{0.9617} \text{ in}$$

The base plate thickness is satisfactory.

Base plate bolt load (Jawad & Farr eq. 12.13, operating, new + Seismic)

$$\text{Bolt load} = A_b * f_s = 0.929 * 7,145 = 6,637.79 \text{ lb}_f$$

$$t_r = (3.91 * F / (S_y * (2 * b / w + w / (2 * l) - d_b * (2 / w + 1 / (2 * l))))))^{0.5}$$

$$= (3.91 * 6,637.79 / (36,000 * (2 * 4.875 / 4 + 4 / (2 * 2.625) - 1.625 * (2 / 4 + 1 / (2 * 2.625))))))^{0.5}$$

$$= 0.5891 \text{ in}$$

The base plate thickness is satisfactory.

Check skirt for gusset reaction (Jawad & Farr eq. 12.14)

$$S_r = 1.5 * F * b / (\text{gussets} * \pi * t_{\text{sk}}^2 * h)$$

$$= 1.5 * 6,637.79 * 4.875 / (2 * \pi * 0.75^2 * 4.625)$$

$$= 2,969.44 \text{ psi}$$

As $S_r \leq 30,000$ psi the skirt thickness is adequate to resist the gusset reaction.

Anchor bolt load (empty, corroded + Seismic)

$$P = -W / N + 48 * M / (N * BC)$$

$$= -27,793.03 / 8 + 48 * 136,014.5 / (8 * 68.5)$$

$$= 8,439.55 \text{ lb}_f$$

$$\text{Required area per bolt} = P / S_b = \underline{0.422} \text{ in}^2$$

The area provided (0.929 in²) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, empty, corroded + Seismic)

$$\begin{aligned} \text{Base plate width, } t_c &: 7.5 && \text{in} \\ \text{Average base plate diameter, } d &: 65.5 && \text{in} \\ \text{Base plate elastic modulus, } E_s &: 29.0\text{E}+06 && \text{psi} \\ \text{Base plate yield stress, } S_y &: 36,000 && \text{psi} \end{aligned}$$

$$E_c = 57,000 * \text{Sqr}(3,000) = 3,122,019 \text{ psi}$$

$$n = E_s / E_c = 29.0\text{E}+06 / 3,122,019 = 9.2889$$

$$\begin{aligned} t_s &= (N * A_b) / (\pi * d) \\ &= (8 * 0.929) / (\pi * 65.5) \\ &= 0.0361 \text{ in} \end{aligned}$$

From table 12.4 for $k = 0.258551$:

$$\begin{aligned} K_1 &= 2.5324, \quad K_2 = 1.3942 \\ L_1 &= 15.8189, \quad L_2 = 37.6005, \quad L_3 = 13.4328 \end{aligned}$$

Total tensile force on bolting

$$\begin{aligned} T &= (12 * M - W * (L_1 + L_3)) / (L_2 + L_3) \\ &= (12 * 136,014.5 - 27,793.03 * (15.8189 + 13.4328)) / (37.6005 + 13.4328) \\ &= 16,051.88 \text{ lb}_f \end{aligned}$$

Tensile stress in bolts use the larger of f_s or bolt preload = 0 psi

$$\begin{aligned} f_s &= T / (t_s * (d / 2) * K_1) \\ &= 16,051.88 / (0.0361 * (65.5 / 2) * 2.5324) \\ &= 5,359 \text{ psi} \end{aligned}$$

Total compressive load on foundation

$$\begin{aligned} C_c &= T + (1 + V\text{Accel}) * W + \text{Bolt Preload} \\ &= 16,051.88 + (1 + 1) * 27,793.03 + 0 \\ &= 71,637.95 \text{ lb}_f \end{aligned}$$

Foundation bearing stress

$$\begin{aligned} f_c &= C_c / (((t_c - t_s) + n * t_s) * (d / 2) * K_2) \\ &= 71,637.95 / (((7.5 - 0.0361) + 9.2889 * 0.0361) * (65.5 / 2) * 1.3941) \\ &= \underline{201} \text{ psi} \end{aligned}$$

As $f_c \leq 1,658$ psi the base plate width is satisfactory.

$$\begin{aligned} k &= 1 / (1 + f_s / (n * f_c)) \\ &= 1 / (1 + 5,359 / (9.2889 * 201)) \\ &= 0.258551 \end{aligned}$$

Base plate required thickness (empty, corroded + Seismic)

From Brownell & Young, Table 10.3:, $l / b = 0.2201$

$$M_x = 0.0052 * 201 * 22.1499^2 = 508.3 \text{ lb}_f$$

$$M_y = -0.4525 * 201 * 4.875^2 = -2,163.2 \text{ lb}_f$$

$$\begin{aligned} t_r &= (6 * M_{\max} / S_p)^{0.5} \\ &= (6 * 2,163.18 / 20,000)^{0.5} \\ &= \underline{0.8056} \text{ in} \end{aligned}$$

The base plate thickness is satisfactory.

Base plate bolt load (Jawad & Farr eq. 12.13, empty, corroded + Seismic)

$$\text{Bolt load} = A_b * f_s = 0.929 * 5,359 = 4,978.26 \text{ lb}_f$$

$$\begin{aligned} t_r &= (3.91 * F / (S_y * (2 * b / w + w / (2 * l) - d_b * (2 / w + 1 / (2 * l))))))^{0.5} \\ &= (3.91 * 4,978.26 / (36,000 * (2 * 4.875 / 4 + 4 / (2 * 2.625) - 1.625 * (2 / 4 + 1 / (2 * 2.625))))))^{0.5} \\ &= 0.5102 \text{ in} \end{aligned}$$

The base plate thickness is satisfactory.

Check skirt for gusset reaction (Jawad & Farr eq. 12.14)

$$\begin{aligned} S_r &= 1.5 * F * b / (\text{gussets} * \pi * t_{sk}^2 * h) \\ &= 1.5 * 4,978.26 * 4.875 / (2 * \pi * 0.75^2 * 4.625) \\ &= 2,227.05 \text{ psi} \end{aligned}$$

As $S_r \leq 30,000$ psi the skirt thickness is adequate to resist the gusset reaction.

Anchor bolt load (empty, new + Seismic)

$$\begin{aligned} P &= -W / N + 48 * M / (N * BC) \\ &= -28,831.35 / 8 + 48 * 140,660.2 / (8 * 68.5) \\ &= 8,716.68 \text{ lb}_f \end{aligned}$$

$$\text{Required area per bolt} = P / S_b = \underline{0.4358} \text{ in}^2$$

The area provided (0.929 in²) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, empty, new + Seismic)

Base plate width, t_c :	7.5	in
Average base plate diameter, d :	65.5	in
Base plate elastic modulus, E_s :	29.0E+06	psi
Base plate yield stress, S_y :	36,000	psi

$$E_c = 57,000 * \text{Sqr}(3,000) = 3,122,019 \text{ psi}$$

$$n = E_s / E_c = 29.0E+06 / 3,122,019 = 9.2889$$

$$\begin{aligned} t_s &= (N * A_b) / (\pi * d) \\ &= (8 * 0.929) / (\pi * 65.5) \\ &= 0.0361 \text{ in} \end{aligned}$$

From table 12.4 for $k = 0.259119$:

$$K_1 = 2.5312, \quad K_2 = 1.3958$$

$$L_1 = 15.7817, \quad L_2 = 37.5733, \quad L_3 = 13.462$$

Total tensile force on bolting

$$T = (12 \cdot M - W \cdot (L_1 + L_3)) / (L_2 + L_3)$$

$$= (12 \cdot 140,660.2 - 28,831.35 \cdot (15.7817 + 13.462)) / (37.5733 + 13.462)$$

$$= 16,552.95 \text{ lb}_f$$

Tensile stress in bolts use the larger of f_s or bolt preload = 0 psi

$$f_s = T / (t_s \cdot (d / 2) \cdot K_1)$$

$$= 16,552.95 / (0.0361 \cdot (65.5 / 2) \cdot 2.5312)$$

$$= 5,529 \text{ psi}$$

Total compressive load on foundation

$$C_c = T + (1 + V_{\text{Accel}}) \cdot W + \text{Bolt Preload}$$

$$= 16,552.95 + (1 + 1) \cdot 28,831.35 + 0$$

$$= 74,215.65 \text{ lb}_f$$

Foundation bearing stress

$$f_c = C_c / (((t_c - t_s) + n \cdot t_s) \cdot (d / 2) \cdot K_2)$$

$$= 74,215.65 / (((7.5 - 0.0361) + 9.2889 \cdot 0.0361) \cdot (65.5 / 2) \cdot 1.3958)$$

$$= \underline{208} \text{ psi}$$

As $f_c \leq 1,658$ psi the base plate width is satisfactory.

$$k = 1 / (1 + f_s / (n \cdot f_c))$$

$$= 1 / (1 + 5,529 / (9.2889 \cdot 208))$$

$$= 0.259119$$

Base plate required thickness (empty, new + Seismic)

From Brownell & Young, Table 10.3.; $l / b = 0.2201$

$$M_x = 0.0052 \cdot 208 \cdot 22.1499^2 = 526 \text{ lb}_f$$

$$M_y = -0.4525 \cdot 208 \cdot 4.875^2 = -2,238.4 \text{ lb}_f$$

$$t_r = (6 \cdot M_{\text{max}} / S_p)^{0.5}$$

$$= (6 \cdot 2,238.41 / 20,000)^{0.5}$$

$$= \underline{0.8195} \text{ in}$$

The base plate thickness is satisfactory.

Base plate bolt load (Jawad & Farr eq. 12.13, empty, new + Seismic)

$$\text{Bolt load} = A_b \cdot f_s = 0.929 \cdot 5,529 = 5,136.17 \text{ lb}_f$$

$$t_r = (3.91 \cdot F / (S_y \cdot (2 \cdot b / w + w / (2 \cdot l) - d_b \cdot (2 / w + 1 / (2 \cdot l))))))^{0.5}$$

$$= (3.91 \cdot 5,136.17 / (36,000 \cdot (2 \cdot 4.875 / 4 + 4 / (2 \cdot 2.625)) - 1.625 \cdot (2 / 4 + 1 / (2 \cdot 2.625))))^{0.5}$$

$$= 0.5182 \text{ in}$$

The base plate thickness is satisfactory.

Check skirt for gusset reaction (Jawad & Farr eq. 12.14)

$$\begin{aligned} S_r &= 1.5 \cdot F \cdot b / (\text{gussets} \cdot \pi \cdot t_{sk}^2 \cdot h) \\ &= 1.5 \cdot 5,136.17 \cdot 4.875 / (2 \cdot \pi \cdot 0.75^2 \cdot 4.625) \\ &= 2,297.69 \text{ psi} \end{aligned}$$

As $S_r \leq 30,000$ psi the skirt thickness is adequate to resist the gusset reaction.

Anchor bolt load (vacuum, corroded + Seismic)

$$\begin{aligned} P &= -W / N + 48 \cdot M / (N \cdot BC) \\ &= -40,890.52 / 8 + 48 \cdot 187,179.7 / (8 \cdot 68.5) \\ &= 11,283.99 \text{ lb}_f \end{aligned}$$

$$\text{Required area per bolt} = P / S_b = \underline{0.5642} \text{ in}^2$$

The area provided (0.929 in²) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, vacuum, corroded + Seismic)

Base plate width, t_c : 7.5 in
Average base plate diameter, d : 65.5 in
Base plate elastic modulus, E_s : 29.0E+06 psi
Base plate yield stress, S_y : 36,000 psi

$$E_c = 57,000 \cdot \text{Sqr}(3,000) = 3,122,019 \text{ psi}$$

$$n = E_s / E_c = 29.0E+06 / 3,122,019 = 9.2889$$

$$\begin{aligned} t_s &= (N \cdot A_b) / (\pi \cdot d) \\ &= (8 \cdot 0.929) / (\pi \cdot 65.5) \\ &= 0.0361 \text{ in} \end{aligned}$$

From table 12.4 for $k = 0.271492$:

$$\begin{aligned} K_1 &= 2.5042, \quad K_2 = 1.4308 \\ L_1 &= 14.9706, \quad L_2 = 36.9789, \quad L_3 = 14.0992 \end{aligned}$$

Total tensile force on bolting

$$\begin{aligned} T &= (12 \cdot M - W \cdot (L_1 + L_3)) / (L_2 + L_3) \\ &= (12 \cdot 187,179.7 - 40,890.52 \cdot (14.9706 + 14.0992)) / (36.9789 + 14.0992) \\ &= 20,703.19 \text{ lb}_f \end{aligned}$$

Tensile stress in bolts use the larger of f_s or bolt preload = 0 psi

$$\begin{aligned} f_s &= T / (t_s \cdot (d / 2) \cdot K_1) \\ &= 20,703.19 / (0.0361 \cdot (65.5 / 2) \cdot 2.5042) \\ &= 6,989 \text{ psi} \end{aligned}$$

Total compressive load on foundation

$$\begin{aligned} C_c &= T + (1 + V_{\text{Accel}}) \cdot W + \text{Bolt Preload} \\ &= 20,703.19 + (1 + 1) \cdot 40,890.52 + 0 \\ &= 102,484.22 \text{ lb}_f \end{aligned}$$

Foundation bearing stress

$$f_c = C_c / (((t_c - t_s) + n \cdot t_s) \cdot (d / 2) \cdot K_2)$$
$$= 102,484.22 / (((7.5 - 0.0361) + 9.2889 \cdot 0.0361) \cdot (65.5 / 2) \cdot 1.4308)$$
$$= \underline{280 \text{ psi}}$$

As $f_c \leq 1,658$ psi the base plate width is satisfactory.

$$k = 1 / (1 + f_s / (n \cdot f_c))$$
$$= 1 / (1 + 6,989 / (9.2889 \cdot 280))$$
$$= 0.271492$$

Base plate required thickness (vacuum, corroded + Seismic)

From Brownell & Young, Table 10.3:, $l / b = 0.2201$

$$M_x = 0.0052 \cdot 280 \cdot 22.1499^2 = 708.5 \text{ lb}_f$$

$$M_y = -0.4525 \cdot 280 \cdot 4.875^2 = -3,015.3 \text{ lb}_f$$

$$t_r = (6 \cdot M_{\max} / S_p)^{0.5}$$
$$= (6 \cdot 3,015.29 / 20,000)^{0.5}$$
$$= \underline{0.9511 \text{ in}}$$

The base plate thickness is satisfactory.

Base plate bolt load (Jawad & Farr eq. 12.13, vacuum, corroded + Seismic)

$$\text{Bolt load} = A_b \cdot f_s = 0.929 \cdot 6,989 = 6,493.17 \text{ lb}_f$$

$$t_r = (3.91 \cdot F / (S_y \cdot (2 \cdot b / w + w / (2 \cdot l) - d_b \cdot (2 / w + 1 / (2 \cdot l))))))^{0.5}$$
$$= (3.91 \cdot 6,493.17 / (36,000 \cdot (2 \cdot 4.875 / 4 + 4 / (2 \cdot 2.625) - 1.625 \cdot (2 / 4 + 1 / (2 \cdot 2.625))))))^{0.5}$$
$$= 0.5827 \text{ in}$$

The base plate thickness is satisfactory.

Check skirt for gusset reaction (Jawad & Farr eq. 12.14)

$$S_r = 1.5 \cdot F \cdot b / (\text{gussets} \cdot \pi \cdot t_{sk}^2 \cdot h)$$
$$= 1.5 \cdot 6,493.17 \cdot 4.875 / (2 \cdot \pi \cdot 0.75^2 \cdot 4.625)$$
$$= 2,904.75 \text{ psi}$$

As $S_r \leq 30,000$ psi the skirt thickness is adequate to resist the gusset reaction.

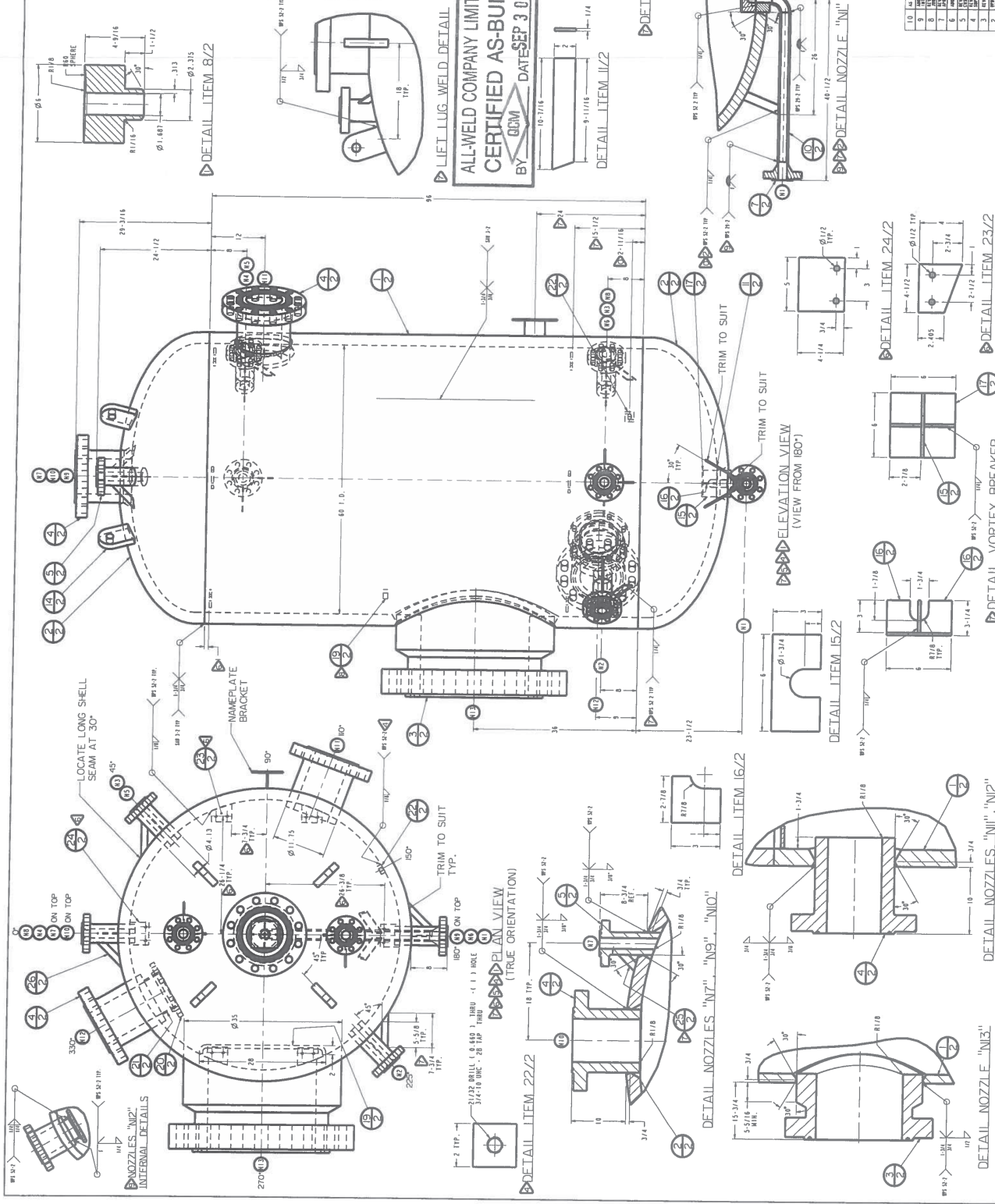
Liquid Level bounded by Ellipsoidal Head #2

Location from datum -6.5"

Operating Liquid Specific Gravity 1.1

BILL OF MATERIAL

ITEM QTY	DESCRIPTION	SPEC.
2	1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
10	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
1	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
3	4" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
4	4" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
6	5/8" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
8	5/8" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
13	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
14	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
17	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
18	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
19	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
20	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
21	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
22	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
23	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
24	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
25	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
26	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
27	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
28	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
29	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
30	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
31	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
32	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
33	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
34	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
35	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
36	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
37	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
38	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
39	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
40	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
41	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
42	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
43	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
44	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
45	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
46	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
47	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
48	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
49	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
50	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
51	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
52	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
53	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
54	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
55	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
56	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
57	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
58	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
59	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100
60	1" X 1/2" PLATE 4' X 8' (SEE DRAWING FOR DIMS)	SA-516 100



ALL-WELD COMPANY LIMITED
CERTIFIED AS-BUILT
 BY GCM DATE SEP 3 0 2018

ALL-WELD COMPANY LIMITED
 Equipment Division
 601 I.D. VERTICAL RES CONDUCTOR
 SHELL ASS'Y FOR 120" DIA. VERTICAL RES CONDUCTOR
 SHELL ASS'Y FOR 120" DIA. VERTICAL RES CONDUCTOR
 SHELL ASS'Y FOR 120" DIA. VERTICAL RES CONDUCTOR

ITEM QTY	DESCRIPTION	SPEC.
1	NAMEPLATE	SA-516 100
2	NAMEPLATE BRACKET	SA-516 100
3	NAMEPLATE BRACKET	SA-516 100
4	NAMEPLATE BRACKET	SA-516 100
5	NAMEPLATE BRACKET	SA-516 100
6	NAMEPLATE BRACKET	SA-516 100
7	NAMEPLATE BRACKET	SA-516 100
8	NAMEPLATE BRACKET	SA-516 100
9	NAMEPLATE BRACKET	SA-516 100
10	NAMEPLATE BRACKET	SA-516 100
11	NAMEPLATE BRACKET	SA-516 100
12	NAMEPLATE BRACKET	SA-516 100
13	NAMEPLATE BRACKET	SA-516 100
14	NAMEPLATE BRACKET	SA-516 100
15	NAMEPLATE BRACKET	SA-516 100
16	NAMEPLATE BRACKET	SA-516 100
17	NAMEPLATE BRACKET	SA-516 100
18	NAMEPLATE BRACKET	SA-516 100
19	NAMEPLATE BRACKET	SA-516 100
20	NAMEPLATE BRACKET	SA-516 100
21	NAMEPLATE BRACKET	SA-516 100
22	NAMEPLATE BRACKET	SA-516 100
23	NAMEPLATE BRACKET	SA-516 100
24	NAMEPLATE BRACKET	SA-516 100
25	NAMEPLATE BRACKET	SA-516 100
26	NAMEPLATE BRACKET	SA-516 100
27	NAMEPLATE BRACKET	SA-516 100
28	NAMEPLATE BRACKET	SA-516 100
29	NAMEPLATE BRACKET	SA-516 100
30	NAMEPLATE BRACKET	SA-516 100

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PLOTTED:

PURCHASE ORDER NUMBER: III/2

DETAIL NOZZLES "N1", "N2", "N3", "N4", "N5", "N6", "N8"

DETAIL NOZZLE "N1"

DETAIL NOZZLES "N7", "N9", "N10"

DETAIL NOZZLES "N11", "N12"

DETAIL NOZZLE "N13"

DETAIL ITEM 14/2

DETAIL ITEM 15/2

DETAIL ITEM 16/2

DETAIL ITEM 22/2

DETAIL ITEM 23/2

DETAIL ITEM 24/2

DETAIL VORTEX BREAKER

DETAIL LUG WELD DETAIL

DETAIL ITEM 11/2

DETAIL ITEM 12/2

DETAIL ITEM 13/2

DETAIL ITEM 17/2

DETAIL ITEM 18/2

DETAIL ITEM 19/2

DETAIL ITEM 20/2

DETAIL ITEM 21/2

DETAIL ITEM 25/2

DETAIL ITEM 26/2

DETAIL ITEM 27/2

DETAIL ITEM 28/2

DETAIL ITEM 29/2

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DETAIL ITEM 41/2

DETAIL ITEM 42/2

DETAIL ITEM 43/2

DETAIL ITEM 44/2

DETAIL ITEM 45/2

DETAIL ITEM 46/2

DETAIL ITEM 47/2

DETAIL ITEM 48/2

DETAIL ITEM 49/2

DETAIL ITEM 50/2

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DETAIL ITEM 53/2

DETAIL ITEM 54/2

DETAIL ITEM 55/2

DETAIL ITEM 56/2

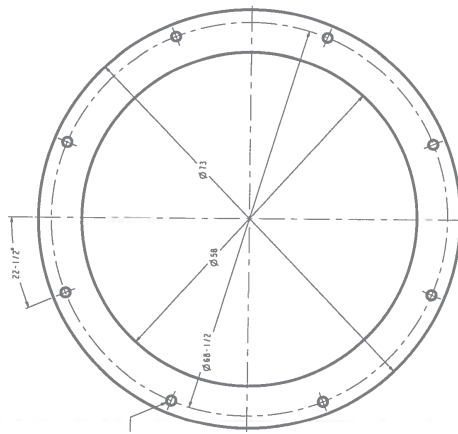
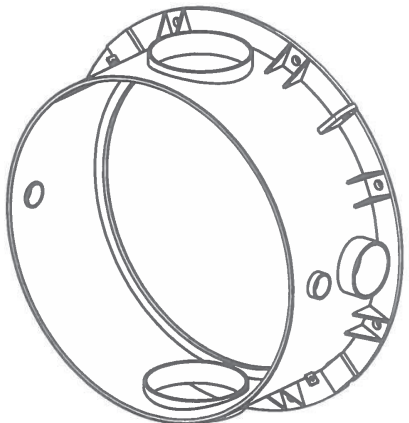
DETAIL ITEM 57/2

DETAIL ITEM 58/2

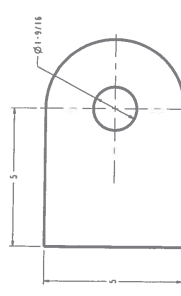
DETAIL ITEM 59/2

DETAIL ITEM 60/2

BILL OF MATERIAL		
ITEM QTY.	DESCRIPTION	SPEC.
19	18 HOLES Ø1-5/8	AS-SH1 10K
20	18 HOLES Ø1-5/8	AS-SH1 10K
21	18 HOLES Ø1-5/8	AS-SH1 10K
22	18 HOLES Ø1-5/8	AS-SH1 10K
23	18 HOLES Ø1-5/8	AS-SH1 10K
24	18 HOLES Ø1-5/8	AS-SH1 10K
25	18 HOLES Ø1-5/8	AS-SH1 10K
26	18 HOLES Ø1-5/8	AS-SH1 10K
27	18 HOLES Ø1-5/8	AS-SH1 10K
28	18 HOLES Ø1-5/8	AS-SH1 10K
29	18 HOLES Ø1-5/8	AS-SH1 10K
30	18 HOLES Ø1-5/8	AS-SH1 10K
31	18 HOLES Ø1-5/8	AS-SH1 10K
32	18 HOLES Ø1-5/8	AS-SH1 10K
33	18 HOLES Ø1-5/8	AS-SH1 10K
34	18 HOLES Ø1-5/8	AS-SH1 10K
35	18 HOLES Ø1-5/8	AS-SH1 10K
36	18 HOLES Ø1-5/8	AS-SH1 10K
37	18 HOLES Ø1-5/8	AS-SH1 10K
38	18 HOLES Ø1-5/8	AS-SH1 10K
39	18 HOLES Ø1-5/8	AS-SH1 10K
40	18 HOLES Ø1-5/8	AS-SH1 10K
41	18 HOLES Ø1-5/8	AS-SH1 10K
42	18 HOLES Ø1-5/8	AS-SH1 10K
43	18 HOLES Ø1-5/8	AS-SH1 10K
44	18 HOLES Ø1-5/8	AS-SH1 10K
45	18 HOLES Ø1-5/8	AS-SH1 10K
46	18 HOLES Ø1-5/8	AS-SH1 10K
47	18 HOLES Ø1-5/8	AS-SH1 10K
48	18 HOLES Ø1-5/8	AS-SH1 10K
49	18 HOLES Ø1-5/8	AS-SH1 10K
50	18 HOLES Ø1-5/8	AS-SH1 10K
51	18 HOLES Ø1-5/8	AS-SH1 10K
52	18 HOLES Ø1-5/8	AS-SH1 10K
53	18 HOLES Ø1-5/8	AS-SH1 10K
54	18 HOLES Ø1-5/8	AS-SH1 10K
55	18 HOLES Ø1-5/8	AS-SH1 10K
56	18 HOLES Ø1-5/8	AS-SH1 10K
57	18 HOLES Ø1-5/8	AS-SH1 10K
58	18 HOLES Ø1-5/8	AS-SH1 10K
59	18 HOLES Ø1-5/8	AS-SH1 10K
60	18 HOLES Ø1-5/8	AS-SH1 10K
61	18 HOLES Ø1-5/8	AS-SH1 10K
62	18 HOLES Ø1-5/8	AS-SH1 10K
63	18 HOLES Ø1-5/8	AS-SH1 10K
64	18 HOLES Ø1-5/8	AS-SH1 10K
65	18 HOLES Ø1-5/8	AS-SH1 10K
66	18 HOLES Ø1-5/8	AS-SH1 10K
67	18 HOLES Ø1-5/8	AS-SH1 10K
68	18 HOLES Ø1-5/8	AS-SH1 10K
69	18 HOLES Ø1-5/8	AS-SH1 10K
70	18 HOLES Ø1-5/8	AS-SH1 10K
71	18 HOLES Ø1-5/8	AS-SH1 10K
72	18 HOLES Ø1-5/8	AS-SH1 10K
73	18 HOLES Ø1-5/8	AS-SH1 10K
74	18 HOLES Ø1-5/8	AS-SH1 10K
75	18 HOLES Ø1-5/8	AS-SH1 10K
76	18 HOLES Ø1-5/8	AS-SH1 10K
77	18 HOLES Ø1-5/8	AS-SH1 10K
78	18 HOLES Ø1-5/8	AS-SH1 10K
79	18 HOLES Ø1-5/8	AS-SH1 10K
80	18 HOLES Ø1-5/8	AS-SH1 10K
81	18 HOLES Ø1-5/8	AS-SH1 10K
82	18 HOLES Ø1-5/8	AS-SH1 10K
83	18 HOLES Ø1-5/8	AS-SH1 10K
84	18 HOLES Ø1-5/8	AS-SH1 10K
85	18 HOLES Ø1-5/8	AS-SH1 10K
86	18 HOLES Ø1-5/8	AS-SH1 10K
87	18 HOLES Ø1-5/8	AS-SH1 10K
88	18 HOLES Ø1-5/8	AS-SH1 10K
89	18 HOLES Ø1-5/8	AS-SH1 10K
90	18 HOLES Ø1-5/8	AS-SH1 10K
91	18 HOLES Ø1-5/8	AS-SH1 10K
92	18 HOLES Ø1-5/8	AS-SH1 10K
93	18 HOLES Ø1-5/8	AS-SH1 10K
94	18 HOLES Ø1-5/8	AS-SH1 10K
95	18 HOLES Ø1-5/8	AS-SH1 10K
96	18 HOLES Ø1-5/8	AS-SH1 10K
97	18 HOLES Ø1-5/8	AS-SH1 10K
98	18 HOLES Ø1-5/8	AS-SH1 10K
99	18 HOLES Ø1-5/8	AS-SH1 10K
100	18 HOLES Ø1-5/8	AS-SH1 10K



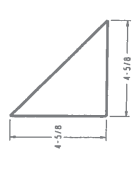
18 HOLES Ø1-5/8
ON A Ø4-1/2 P.C.D.
ON A Ø13 HUB



DETAIL ITEM 9/3



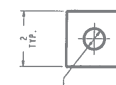
DRAIN CUT OUT DETAIL



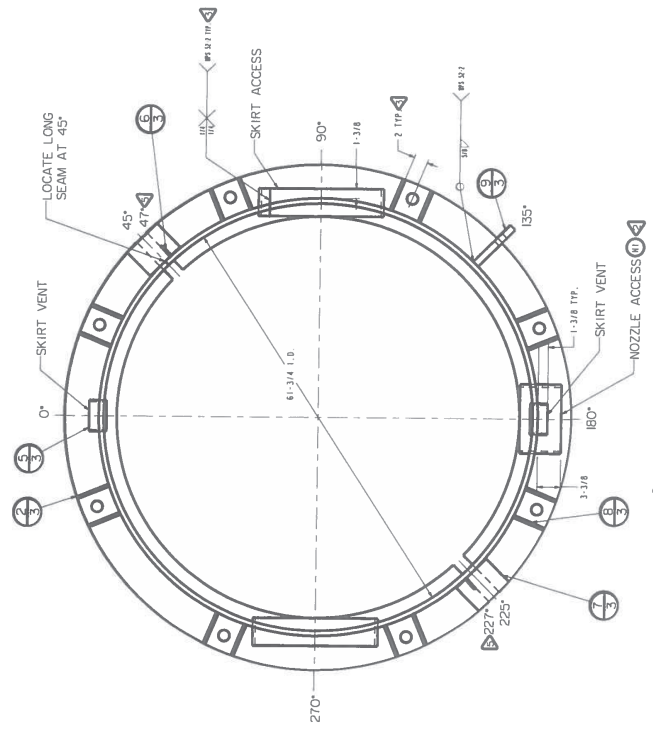
DETAIL ITEM 8/3



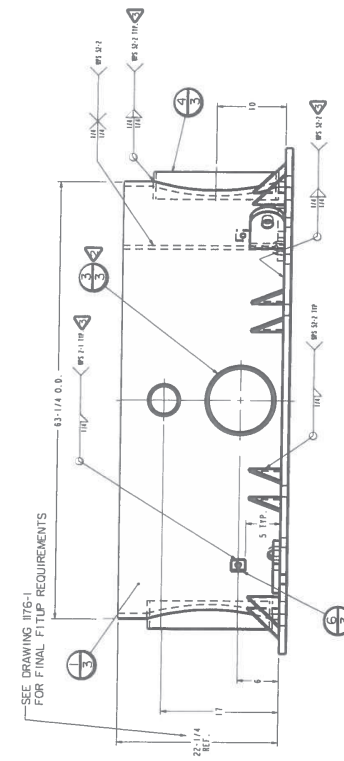
DETAIL ITEM 7/3



DETAIL ITEM 6/3



PLAN VIEW
(TRUE ORIENTATION)



ELEVATION VIEW
(VIEW FROM 180°)

SEE DRAWING 1176-1
FOR FINAL FITUP REQUIREMENTS

DETAIL ITEM 2/3

PURCHASE ORDER NUMBER: 1112.

(2) REQUIRED

PLOTTED:

ALL-WELD COMPANY LIMITED
CERTIFIED AS-BUILT
BY: BOM DATE SEP 3 2013

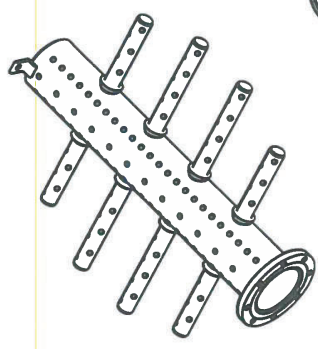
ALL-WELD COMPANY LIMITED
48 FERRIS AVE., WILLOWDALE, ONT. M2H 4B7
Canada
ULTRAFAB INDUSTRIES LIMITED
48 FERRIS AVE., WILLOWDALE, ONT. M2H 4B7
Canada
WELD SHOP DRIVING
CARBON STEEL, SA 240, 250, 260, 270, 280, 290, 300, 310, 315, 320, 330, 340, 350, 360, 370, 380, 390, 400, 410, 420, 430, 440, 450, 460, 470, 480, 490, 500, 510, 520, 530, 540, 550, 560, 570, 580, 590, 600, 610, 620, 630, 640, 650, 660, 670, 680, 690, 700, 710, 720, 730, 740, 750, 760, 770, 780, 790, 800, 810, 820, 830, 840, 850, 860, 870, 880, 890, 900, 910, 920, 930, 940, 950, 960, 970, 980, 990, 1000

ITEM QTY.	DESCRIPTION	SPEC.
19	18 HOLES Ø1-5/8	AS-SH1 10K
20	18 HOLES Ø1-5/8	AS-SH1 10K
21	18 HOLES Ø1-5/8	AS-SH1 10K
22	18 HOLES Ø1-5/8	AS-SH1 10K
23	18 HOLES Ø1-5/8	AS-SH1 10K
24	18 HOLES Ø1-5/8	AS-SH1 10K
25	18 HOLES Ø1-5/8	AS-SH1 10K
26	18 HOLES Ø1-5/8	AS-SH1 10K
27	18 HOLES Ø1-5/8	AS-SH1 10K
28	18 HOLES Ø1-5/8	AS-SH1 10K
29	18 HOLES Ø1-5/8	AS-SH1 10K
30	18 HOLES Ø1-5/8	AS-SH1 10K
31	18 HOLES Ø1-5/8	AS-SH1 10K
32	18 HOLES Ø1-5/8	AS-SH1 10K
33	18 HOLES Ø1-5/8	AS-SH1 10K
34	18 HOLES Ø1-5/8	AS-SH1 10K
35	18 HOLES Ø1-5/8	AS-SH1 10K
36	18 HOLES Ø1-5/8	AS-SH1 10K
37	18 HOLES Ø1-5/8	AS-SH1 10K
38	18 HOLES Ø1-5/8	AS-SH1 10K
39	18 HOLES Ø1-5/8	AS-SH1 10K
40	18 HOLES Ø1-5/8	AS-SH1 10K
41	18 HOLES Ø1-5/8	AS-SH1 10K
42	18 HOLES Ø1-5/8	AS-SH1 10K
43	18 HOLES Ø1-5/8	AS-SH1 10K
44	18 HOLES Ø1-5/8	AS-SH1 10K
45	18 HOLES Ø1-5/8	AS-SH1 10K
46	18 HOLES Ø1-5/8	AS-SH1 10K
47	18 HOLES Ø1-5/8	AS-SH1 10K
48	18 HOLES Ø1-5/8	AS-SH1 10K
49	18 HOLES Ø1-5/8	AS-SH1 10K
50	18 HOLES Ø1-5/8	AS-SH1 10K
51	18 HOLES Ø1-5/8	AS-SH1 10K
52	18 HOLES Ø1-5/8	AS-SH1 10K
53	18 HOLES Ø1-5/8	AS-SH1 10K
54	18 HOLES Ø1-5/8	AS-SH1 10K
55	18 HOLES Ø1-5/8	AS-SH1 10K
56	18 HOLES Ø1-5/8	AS-SH1 10K
57	18 HOLES Ø1-5/8	AS-SH1 10K
58	18 HOLES Ø1-5/8	AS-SH1 10K
59	18 HOLES Ø1-5/8	AS-SH1 10K
60	18 HOLES Ø1-5/8	AS-SH1 10K
61	18 HOLES Ø1-5/8	AS-SH1 10K
62	18 HOLES Ø1-5/8	AS-SH1 10K
63	18 HOLES Ø1-5/8	AS-SH1 10K
64	18 HOLES Ø1-5/8	AS-SH1 10K
65	18 HOLES Ø1-5/8	AS-SH1 10K
66	18 HOLES Ø1-5/8	AS-SH1 10K
67	18 HOLES Ø1-5/8	AS-SH1 10K
68	18 HOLES Ø1-5/8	AS-SH1 10K
69	18 HOLES Ø1-5/8	AS-SH1 10K
70	18 HOLES Ø1-5/8	AS-SH1 10K
71	18 HOLES Ø1-5/8	AS-SH1 10K
72	18 HOLES Ø1-5/8	AS-SH1 10K
73	18 HOLES Ø1-5/8	AS-SH1 10K
74	18 HOLES Ø1-5/8	AS-SH1 10K
75	18 HOLES Ø1-5/8	AS-SH1 10K
76	18 HOLES Ø1-5/8	AS-SH1 10K
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96	18 HOLES Ø1-5/8	AS-SH1 10K
97	18 HOLES Ø1-5/8	AS-SH1 10K
98	18 HOLES Ø1-5/8	AS-SH1 10K
99	18 HOLES Ø1-5/8	AS-SH1 10K
100	18 HOLES Ø1-5/8	AS-SH1 10K

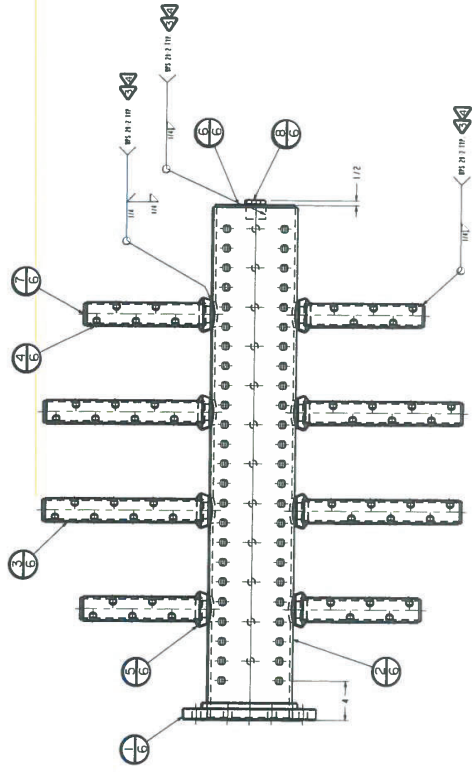
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BILL OF MATERIAL

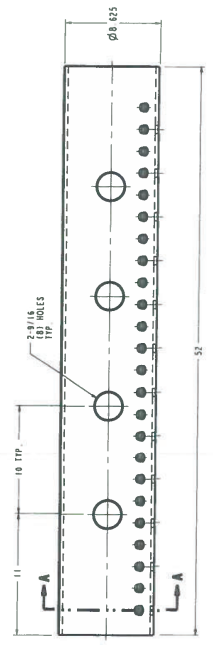
ITEM	QTY.	DESCRIPTION	SPEC.
33	1	2" DIA. END BRACKET	SA-304 L/2
40	2/6	1/2" DIA. END BRACKET	SA-304 L
41	3/6	1/2" DIA. END BRACKET	SA-304 L
42	5/6	1/2" DIA. END BRACKET	SA-304 L/2
43	7/6	1/2" DIA. END BRACKET	SA-304 L/2
44	8/6	1/2" DIA. END BRACKET	SA-304 L/2



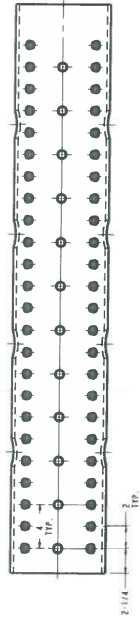
ISO VIEW



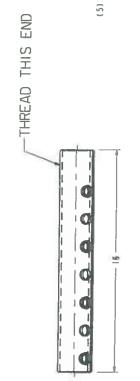
PLAN VIEW
(TRUE ORIENTATION)



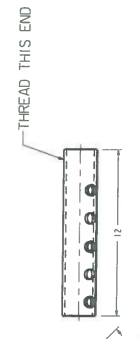
DETAIL ITEM 2/6



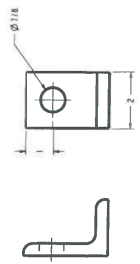
DETAIL ITEM 3/6



DETAIL ITEM 4/6



DETAIL ITEM 5/6



DETAIL ITEM 6/6

(2) REQUIRED
NO. PWHT REQUIRED
PURCHASE ORDER NUMBER:
11112



ALL-WELD COMPANY LIMITED
8" SPARGER BAR ASSEMBLY
ATTACHED TO NOZZLE #12

REV.	DATE	BY	CHKD.	DESCRIPTION
4	09/30/13	UWM	UWM	AS-BUILT
3	09/30/13	UWM	UWM	AS-BUILT
2	09/30/13	UWM	UWM	AS-BUILT
1	09/30/13	UWM	UWM	AS-BUILT

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