PIPELINE WELDING PROCEDURE SPECIFICATION

WPS NUMBER: ENB-MA-WPS-3 REV.0 AUGUST 11, 2014

REVISION LOG
REV. NO. 0:

SCOPE

This welding procedure specification details the procedure to be followed for SMAW / Mechanized FCAW Up, section & tie-in field butt welding of pipe as required by CSA Standard Z662, Oil and Gas Pipeline Systems. This procedure uses CRC Evans Welding Equipment and includes a provision for Mechanized Gas Shielded FCAW Up for fill and cap passes.

Normative References: This welding procedure specification was prepared in accordance to CSA Z662-11 and incorporates by undated references, provisions from other publications. Revision to this specification is not required unless subsequent referenced code and or specification additions include changes to essential welding variables.

Service Restrictions: Sweet
Temperature Restrictions: Notch Toughness Tested to -5°C (23°F)

1. WELDING PROCESS & METHOD

1.1. Shielded Metal Arc Welding (SMAW) - manual method- Root, Hotpass & Lincoln LHD First Fill.
1.2. Flux Core Arc Welding (FCAW) Remaining Fill(s) & Cap- mechanized method.

2. BASE MATERIAL

2.1. Composition: This specification applies to pipe and/or component material manufactured in accordance with, or listed as "Acceptable Alternative Materials" in any of the following standards:

- CSA Z662, Oil and Gas Pipeline Systems
- CAN/CSA-Z245.1, Steel Line Pipe
- CAN/CSA-Z245.11, Steel Fittings
- CAN/CSA-Z245.12, Steel Flanges
- CAN/CSA-Z245.15, Steel Valves

2.2. Pipe Grades: 483 MPa (SMYS) or less
2.3. Wall Thickness Qualified: 4.0 to 14.25 mm (0.157 to 0.561 in.) inclusive.
2.4. Pipe Diameters Qualified: 457 mm (18 in.) O.D. minimum
2.5. Carbon Equivalent: 0.33% maximum

3. FILLER METAL CLASSIFICATION & SIZE

3.1. Root Pass: E6010; 3.2 to 4.8 mm (1/8 to 3/16 in.)
3.2. Hot Pass: E8010-G; 4.0 to 6.4 mm (5/32 to 1/4 in.)
3.3. Fill Pass 1: E8045-P2 H4R (Lincoln LH D80); 3.2 to 4.8mm (1/8 to 3/16 in.)
3.4. Remaining Fill Pass(s): E81T1-GM (Lincoln Pipeliner 81M) 1.2mm (0.047in.)
3.5. Cap pass: E81T1-GM (Lincoln Pipeliner 81M) 1.2mm (0.047in.)
4. JOINT GEOMETRY
   4.1. Joint Type: Groove - Single Vee Butt
   4.2. Bevel Angle: 30°, +6° / -1.5°
   4.3. Root Face: 1.6mm (0.063 in.), +/- 0.8mm (0.031 in.)
   4.4. Root Gap: 3.2mm (0.125 in.), +/- 1.6mm (0.063 in.)
   4.5. The surfaces to be welded shall be smooth, uniform, free of fins, laminations, tears, scale, slag, grease, paint or other foreign matter, which may adversely affect the welding.

5. POSITION & DIRECTION OF WELDING
   5.1. Position: Pipe horizontal, fixed position (5G)
   5.2. Direction of Welding: Root, Hotpass & First Fill Pass: Vertical Down
       Remaining Fill(s) and Cap Passes: Vertical Up

6. PREHEATING, INTERPASS TEMPERATURE & CONTROLLED COOLING
   6.1. Butt Welds: A minimum preheat temperature of 120°C (250°F) shall be applied to an area at least 51 mm (2.0 in.) on each side of the weld joint for its entire circumference prior to welding.
   6.2. During root and second pass welding, under no circumstances shall the minimum temperature fall below the minimum interpass temperature from the start of the root pass until after the completion of the second pass. Reheating is permitted before the start of the fill/cap passes.
   6.3. If the interpass temperature falls below the minimum preheat temperature after completion of the second pass, the entire weld joint shall be heated to the minimum preheat temperature prior to starting the next weld pass.
   6.4. The maximum interpass temperature shall not exceed 204°C (400°F).
   6.5. Preheating may be applied by oxy-fuel torch, propane torch, electrical induction coils or any other method approved by the owner.
   6.6. Temperature of the joint shall be verified using temperature indicating crayons, thermocouples, pyrometers or other suitable method.
   6.7. Where applicable, precautions shall be taken through the use of insulating covers or other means to control the cooling rate of the weld after any pass.

7. POSTWELD HEAT TREATMENT
   Welds prepared in accordance with this specification shall not be subjected to postweld heat treatment.

8. SHIELDING GAS
   8.1. Root, Hotpass & Fill 1: N/A
   8.2. Remaining Fill(s) & Cap Pass(es): 75/25 Argon/CO2 @ 23.6 to 28.3 LPM (50 to 60 CFH)

9. ELECTRICAL CHARACTERISTICS
   9.1. Current Type: Direct current, reverse polarity (DCRP)
   9.2. Voltage, amperage & travel speed: See Table #1
   9.3. Heat Input: See Table #1

10. TECHNIQUE
   10.1. Minimum number of welders: Two for all passes.
   10.2. String or Weave:
       Bead Root, Hotpass & Fill 1-String
       Fill & Cap-Weave
10.3. Number of Weld Layers: Five layers minimum.
10.4. Type of line-up clamp & removal: Internal line-up clamps shall be used wherever practicable and shall not be removed until the root bead is completed.
10.5. Movement shall be minimized until the required hot pass on the bottom has been completed as per table below.

<table>
<thead>
<tr>
<th>Pipe Outside Diameter (OD)</th>
<th>Minimum Length of Second Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>610 mm and Greater</td>
<td>250 mm</td>
</tr>
<tr>
<td>Less than 610 mm to 323.9 mm inclusive</td>
<td>150mm</td>
</tr>
<tr>
<td>Less than 323.9 mm</td>
<td>Not Required</td>
</tr>
</tbody>
</table>

10.6. When external line-up clamps are used, the root bead shall be uniformly spaced around the circumference of the joint and, where practicable, shall have a cumulative length of at least 50% of the circumference prior to removal.
10.7. Cleaning methods: Hand or power tools may be used. Each pass shall be thoroughly cleaned and free of slag and scale prior to depositing the next weld layer. The completed weld shall be brushed and free of spatter.
10.8. Finish Profile: The completed weld shall have a substantially uniform cross-section for its entire circumference. The crown of the weld shall not be below the surface of the adjacent base metal.
10.9. The time and interval requirements for each welding pass is as follows:

<table>
<thead>
<tr>
<th>Interval</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root pass to hot pass</td>
<td>10 minutes maximum</td>
</tr>
<tr>
<td>Hot pass to fill 1</td>
<td>60 minutes maximum</td>
</tr>
<tr>
<td>Fill 1 to completion</td>
<td>24 Hours maximum (Unless otherwise Authorized by Enbridge Assigned Designate)</td>
</tr>
</tbody>
</table>

11. REMOVAL AND REPAIR OF DEFECTS
11.1. Repairable areas are restricted to the weld cap and shall be removed by grinding. Welding of such repairable areas shall be performed following the details outlined in this specification.
11.2. Subsurface weld repairs shall be made in accordance with WPS# EPI-11-WP9 Rev.1.

12. ATTACHMENTS
12.1. Procedure Qualification Test Records: E2H-MA-11.4-1
12.2. Laboratory Test Reports: E14-413.1
12.3. Radiographic, Automated Ultrasonic & MPI Examination Results:
    CRC Evans RT Report: 1071U (E2H-MA-11.4-1)
    Applus RTD AUT Report: E2H-MA-11.4/15.9-WPQ
12.4. Material Test Reports: Evraz Heat No.514112
### TABLE #1

**WELDING PARAMETERS**

<table>
<thead>
<tr>
<th>Pass</th>
<th>Process</th>
<th>Size mm (in.)</th>
<th>AWS Class</th>
<th>Wire Speed mm/min (in./min)</th>
<th>Amperage Range Amperes</th>
<th>Voltage Range volts</th>
<th>Travel Speed mm/min (in./min)</th>
<th>OSC/BPM</th>
<th>Heat Input kJ/mm (J/in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root</td>
<td>SMAW</td>
<td>4.0mm (5/32)</td>
<td>E6010</td>
<td>NA</td>
<td>104-191</td>
<td>17.9-32.5</td>
<td>215-349 (8.5 – 13.7)</td>
<td>NA</td>
<td>0.50-1.14 (12700-28956)</td>
</tr>
<tr>
<td>Hot Pass</td>
<td>SMAW</td>
<td>4.8mm (3/16)</td>
<td>E8010-G</td>
<td>NA</td>
<td>151-245</td>
<td>19.6-40</td>
<td>320-508 (12.6-20)</td>
<td>NA</td>
<td>0.55 – 1.15 (13970-29210)</td>
</tr>
<tr>
<td>Fill-1</td>
<td>SMAW</td>
<td>4.0mm (5/32)</td>
<td>*E8045-P2 H4R</td>
<td>NA</td>
<td>166-275</td>
<td>14.9-28.6</td>
<td>197-300 (7.7-11.8)</td>
<td>NA</td>
<td>0.76 – 1.57 (19304-39878)</td>
</tr>
<tr>
<td>Fill(s) Mech.</td>
<td>FCAW</td>
<td>1.2mm (0.047)</td>
<td>**E81T1-GM</td>
<td>5029-7645 (198-301)</td>
<td>142-264</td>
<td>18.1-28.5</td>
<td>120-280 (4.7-11.0)</td>
<td>As Req.</td>
<td>0.96 – 2.13 (24384-54102)</td>
</tr>
<tr>
<td>Cap(s) Mech.</td>
<td>FCAW</td>
<td>1.2mm (0.047)</td>
<td>**E81T1-GM</td>
<td>4623-7010 (182-276)</td>
<td>129-240</td>
<td>18.2-28.6</td>
<td>102-210 (4.0-8.3)</td>
<td>As Req.</td>
<td>1.11-2.56 (28194-65024)</td>
</tr>
</tbody>
</table>

* - Lincoln LH-D80  
** - Lincoln Pipeliner 81M

Note #1 - The use of stripper passes is optional, however welding parameters must remain within the parameters of the above table.

Note #2 - Maximum cap height above adjacent parent material: 2.5mm for W.T.≤ 10.0mm. 3.5mm for W.T. >10.0 mm. (+1mm permitted in localized areas).

### 13. JOINT GEOMETRY

**Schematic of Joint Design**

![Schematic of Joint Design](image)

**Pass Sequence**

![Pass Sequence](image)
**Procedure Qualification Record**

**E2H-MA-11.4-1 (1071-U)**

**Semi-Mechanized Tie-In Weld - F1 SMAW Low Hydrogen Downhill**

**Material Specification**
- CSA Z245.1-07
- Client: Enbridge

**Type or Grade**
- Gr. 483 CAT I M5C
- Project: E2H Project

**Nominal Thickness**
- 11.4mm to 11.4mm
- % C: Not Applicable

**Nominal Diameter**
- 914.4mm to 914.4mm
- CE: 0.280

**Manufacturer(s)**
- Evraz to Evraz
- Pcm: Not Applicable

**Heat Number(s)**
- 514112 to 514112

### Welding Parameters

<table>
<thead>
<tr>
<th>Pass No.</th>
<th>Units</th>
<th>Root</th>
<th>Hot Pass</th>
<th>Fill 1</th>
<th>Remaining Fills</th>
<th>Caps</th>
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<tbody>
<tr>
<td>Travel Direction</td>
<td>Vertical Down</td>
<td>Vertical Down</td>
<td>Vertical Down</td>
<td>Vertical Up</td>
<td>Vertical Up</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Pass No.</th>
<th>Max Amps (A)</th>
<th>Min Amps (A)</th>
<th>Max Volts (V)</th>
<th>Min Volts (V)</th>
<th>Max WFS (mm/min)</th>
<th>Min WFS (mm/min)</th>
<th>Max Travel Speed (mm/min)</th>
<th>Min Travel Speed (mm/min)</th>
<th>Max Heat Input (kJ/mm)</th>
<th>Min Heat Input (kJ/mm)</th>
<th>Max Interpass (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max Amps</td>
<td>178</td>
<td>125</td>
<td>28.0</td>
<td>21.0</td>
<td>N/A</td>
<td>N/A</td>
<td>393</td>
<td>182</td>
<td>1.64</td>
<td>0.40</td>
<td>N/A</td>
</tr>
<tr>
<td>Min Amps</td>
<td>211</td>
<td>175</td>
<td>35.0</td>
<td>24.0</td>
<td>N/A</td>
<td>N/A</td>
<td>497</td>
<td>345</td>
<td>1.28</td>
<td>0.51</td>
<td>133</td>
</tr>
<tr>
<td>Fill 1</td>
<td>237</td>
<td>189</td>
<td>24.5</td>
<td>18.0</td>
<td>N/A</td>
<td>N/A</td>
<td>288</td>
<td>187</td>
<td>1.86</td>
<td>0.71</td>
<td>184</td>
</tr>
<tr>
<td>Fill 2</td>
<td>220</td>
<td>176</td>
<td>23.7</td>
<td>22.6</td>
<td>N/A</td>
<td>N/A</td>
<td>234</td>
<td>150</td>
<td>1.78</td>
<td>1.20</td>
<td>131</td>
</tr>
<tr>
<td>Cap</td>
<td>200</td>
<td>161</td>
<td>23.8</td>
<td>22.8</td>
<td>N/A</td>
<td>N/A</td>
<td>175</td>
<td>127</td>
<td>2.13</td>
<td>1.39</td>
<td>130</td>
</tr>
</tbody>
</table>

### Notes
- CW Side Welded By: Trevor Wilson
- CCW Side Welded By: Chris Schubert
- Welding Power Supplies: Miller XMT 350 - Root, Hot, Fills, and Cap
- Method of Heating: Propane
- Location of Seams: N/A
- Power Grinder as needed
- Cleaning: Power Brush as needed
- After 50% Completion of the Root Pass: Minimum Preheat 121°C
- Fronius Program: Not Applicable

This information is the proprietary property of CRC-Evans Automatic Welding, which contains trade secrets and/or know how and may only be used in conjunction with equipment rented from CRC-Evans Automatic Welding.
# Tensile / Bend / Nick Break

**Customer:** Enbridge Pipelines Inc.  
PO Box 398, 10201 Jasper Avenue  
Edmonton, Alberta  
T5J 2J9

**Laboratory Test No.:** E14-413.1  
**Date:** July 16, 2014  
**P.O. No.:** WP-41001-10135

**Attention:** Luke Ludwig

**Weld I.D.:** E2H-MA-11.4-1 (NI)  
**Project:** Edmonton to Hardisty  
**Material:** CSA Z245.1 Gr. 483  
**Size:** 914.4 mm (36.0 in.) O.D. x 11.4 mm (0.449 in.) w.t.  
**Thermal Condition:** As Welded

**Governing Spec.:** CSA Z662-2011

<table>
<thead>
<tr>
<th>SAMPLE NO.</th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>WIDTH mm (in.)</td>
<td>25.3 (0.996)</td>
<td>25.4 (1.00)</td>
</tr>
<tr>
<td>THICKNESS mm (in.)</td>
<td>11.5 (0.453)</td>
<td>11.5 (0.453)</td>
</tr>
<tr>
<td>AREA sq. mm (sq. in.)</td>
<td>291 (0.451)</td>
<td>292 (0.453)</td>
</tr>
<tr>
<td>ULTIMATE LOAD N (lbf)</td>
<td>183,504 (41,300)</td>
<td>185,260 (41,600)</td>
</tr>
<tr>
<td>ULTIMATE STRESS MPa (psi)</td>
<td>631 (91,500)</td>
<td>634 (92,000)</td>
</tr>
<tr>
<td>FRACTURE TYPE</td>
<td>Partial Cup &amp; Cone</td>
<td>Partial Cup &amp; Cone</td>
</tr>
<tr>
<td>FRACTURE LOCATION</td>
<td>Parent Metal</td>
<td>Parent Metal</td>
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</table>

*Note: Imperial values calculated by direct conversion.*

**SAMPLE TYPE**  
**SAMPLE NO.**  
**RESULTS**

<table>
<thead>
<tr>
<th></th>
<th>Face Bend</th>
<th>Face Bend</th>
<th>Root Bend</th>
<th>Root Bend</th>
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</thead>
<tbody>
<tr>
<td>SAMPLE NO.</td>
<td>F1</td>
<td>F2</td>
<td>R1</td>
<td>R2</td>
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<tr>
<td>RESULTS</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
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</table>

**NICK BREAK NO.**  
**REMARKS**

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<tr>
<th></th>
<th>N1</th>
<th>N2</th>
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</thead>
<tbody>
<tr>
<td>REMARKS</td>
<td>Pass</td>
<td>Pass</td>
</tr>
</tbody>
</table>

**Test Conducted By:** Tong Zhao, T.T.  
**Certified By:** [Signature]  
Karen Koons, R.E.T.

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**CHARPY V-NOTCH IMPACT TEST**

**Customer:** Enbridge Pipelines Inc.  
PO Box 398, 10201 Jasper Avenue  
Edmonton, Alberta  
T5J 2J9

**Laboratory Test No.:** E14-413.1  
**Date:** July 21, 2014  
**P.O. No.:** WP-41001-10135

**Attention:** Luke Ludwig

<table>
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<tr>
<th>Weld I.D.:</th>
<th>E2H-MA-11.4-1 (NI)</th>
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<tbody>
<tr>
<td>Project:</td>
<td>Edmonton to Hardisty</td>
</tr>
<tr>
<td>Material:</td>
<td>CSA Z245.1 Gr. 483</td>
</tr>
<tr>
<td>Size:</td>
<td>914.4 mm (36.0 in.) O.D. x 11.4 mm (0.449 in.) w.t.</td>
</tr>
<tr>
<td>Thermal Condition:</td>
<td>As Welded</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specimen Size:</th>
<th>10 x 10 mm (0.394 x 0.394 in.)</th>
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</thead>
<tbody>
<tr>
<td>Orientation:</td>
<td>Transverse</td>
</tr>
<tr>
<td>Test Temperature:</td>
<td>-5°C (23°F)</td>
</tr>
<tr>
<td>Governing Spec.:</td>
<td>ASME Section VIII, Div. I, UG-84 – 2013</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specimen Number</th>
<th>Notch Location</th>
<th>Impact Values</th>
<th>Shear %</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2.1</td>
<td>Weld Metal within 1/16&quot; of root</td>
<td>87.6 (54.6)</td>
<td>70</td>
</tr>
<tr>
<td>D2.2</td>
<td>Weld Metal within 1/16&quot; of root</td>
<td>77.8 (57.4)</td>
<td>56</td>
</tr>
<tr>
<td>D2.3</td>
<td>Weld Metal within 1/16&quot; of root</td>
<td>62.6 (46.2)</td>
<td>59</td>
</tr>
<tr>
<td>D3.1</td>
<td>HAZ (fusionline @ midwall)</td>
<td>149 (110)</td>
<td>75</td>
</tr>
<tr>
<td>D3.2</td>
<td>HAZ (fusionline @ midwall)</td>
<td>&gt;149 (&gt;110)</td>
<td>85</td>
</tr>
<tr>
<td>D3.3</td>
<td>HAZ (fusionline @ midwall)</td>
<td>97.1 (71.6)</td>
<td>66</td>
</tr>
</tbody>
</table>

*Note: Metric values calculated by direct conversion.*

**Test Conducted By:** Eric Dacyk, C.E.T.  
**Certified By:** Eric Dacyk, C.E.T.

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HARDNESS TEST

Customer: Enbridge Pipelines Inc.
PO Box 398, 12201 Jasper Avenue
Edmonton, Alberta
T5J 2J9

Laboratory Test No.: E14-413.1
Date: July 18, 2014
P.O. No.: WP-41001-10135

Attention: Luke Ludwig

Weld I.D.: E2H-MA-11.4-1 (NI)
Project: Edmonton to Hardisty
Material: CSA Z245.1 Gr. 483
Size: 914.4 mm (36.0 in.) O.D. x 11.4 mm (0.449 in.) w.t.
Thermal Condition: As Welded

Type of Test: Vickers 10kg (HV10)
Instrument: DuraScan 70
 Governing Spec.: ASTM E384-11\textsuperscript{c1}

Test Conducted By: Tong Zhao, T.T.

Certified By: Karen Koen, R.E.T.

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<table>
<thead>
<tr>
<th>No.</th>
<th>Weld No.</th>
<th>Insp. Time (mm)</th>
<th>W.T. (mm)</th>
<th>Distance (mm)</th>
<th>Length (mm)</th>
<th>Depth (mm)</th>
<th>Height (mm)</th>
<th>Location</th>
<th>+Thr</th>
<th>Evaluati on</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>E2H-M-11.4-01-U-Inf</td>
<td>16:12:1:9</td>
<td>11.4</td>
<td>0-0</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
<td>Acc.</td>
<td></td>
<td>Bohler on CW and CCW</td>
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**Applus RTD Operator**

Name: Gerard Vollert  CGSB UT2  
Signature: [Signature Image]

**Report checked by Enbridge Pipelines Inc**

Name: Luke Ludwig  
Signature: [Signature Image]

**Contractor Midwest Pipelines**

Name:  
Signature:  

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Page 1 of 1
# Radiography Report

**Customer:** ENBRIDGE  
**Inspection Std:** CSA-Z662-11  
**Base Metal:** CSA 483 X-70  
**Dia/Wt:** 36" x 11.4mm  
**Weld No:** 1071-U (E2H-MA-11.4-1)  
**Project:** E2H  
**Date:** 05/24/2014  
**Film Type:** FUJI 50  
**No Films:** 1  
**Sensitivity:** 2.0%  
**100% X-Ray**  
RT Procedure #: 1071-1

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<th>Porosity</th>
<th>Slag Inclusions</th>
<th>LSF</th>
<th>LCP</th>
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<th>Incomplete Penetration</th>
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Radiographer/Interpreted By: Robert Collier  
Level: II  
Accepted By:

---

This information is the proprietary property of CRC-Evans Automatic Welding which contains trade secrets and/or know how and may only be used in conjunction with equipment rented from CRC-Evans Automatic Welding.
Reporting and Mill Certificates

Date: April 24, 2014
Customer: ENBRIDGE PIPELINES INC.
Product: 914.4 mm OD x 11.4 mm WT, Grade 483 CAT I EVRAZ Changeover L-314E
Mill Order: TU-001156
Customer P.O.: P4000-12652-2W
Mill Certificate: EVRAZ Certification Package ID 5686

All supplied pipe have been manufactured, sampled, tested, and inspected in accordance with the requirements of the Enbridge Submerged-Arc-Welded Pipe Specification Supplementary to CSA Z245.1-07 EES102-2010 Rev.1 and CSA Z245.1-07 and was found to have met such requirements.

EES102-2010 Clause 17 Certification

17.2 Reported on Mill Certificate (Chemistry).
17.3 Reported on Mill Certificate (Chemistry).
17.4 Reported on Mill Certificate (Chemistry).
17.8 a) Reported on Mill Certificates (All).
17.8 b) Reported on Mill Certificates (Microhardness Test & Tensile).
17.8 c) Reported on Mill Certificate (Tensile).
17.8 d) Reported on Mill Certificate (Tensile).
17.8 e) Non-destructive inspection was performed in accordance with, and met the requirements of Enbridge Submerged-Arc-Welded Pipe Specification Supplementary to CSA Z245.1-07 EES102-2010 Rev. 1 and CSA Z245.1-07.
17.8 f) Reported on Heat to Pipe Correlation.
17.8 g) Pipe have been manufactured in accordance with the approved EVRAZ Manufacturing Procedure Specification Enbridge E2H Project Revision 2 January 20, 2014, CSA Z245.1-07, and Enbridge Submerged-Arc-Welded Pipe Specification Supplementary to CSA Z245.1-07 EES102-2010 Rev. 1.
17.8 h) Not applicable.

David Crone
Quality Assurance Manager – Regina Tubular
CC: File
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<th>Changeover</th>
<th>Heat</th>
<th>Coil</th>
<th>Pipe</th>
<th>Test Type</th>
<th>Scale</th>
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MS = Micro Structure

Measurement Taken In HV500

We certify that the product described above has been manufactured, sampled, inspected, and tested in accordance to the referenced specification. The product has been found to be in compliance with all requirements.

Quality Assurance
### CERTIFICATE OF TESTING

**Tensile**

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<th>Test Type</th>
<th>Orientation</th>
<th>Test Type</th>
<th>Orientation</th>
<th>Test Width (mm)</th>
<th>Yield Strength (MPa)</th>
<th>Tensile Strength (MPa)</th>
<th>% Elongation</th>
<th>Y/T</th>
<th>Weld Break (mm)</th>
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**Hydrostatic Parameters:**
- Pressure: 11400 KPA
- Hydro(%): 95.0
- Hold Time: 10 sec.

Guided Bend Tests Were Performed In Accordance With
And Meet The Requirements Of The Above Specification.

We certify that the product described above has been manufactured, sampled, inspected, and tested in accordance to the referenced specification. The product has been found to be in compliance with all requirements.
| Heat   | Changeover | Coil | Type  | C   | Mn   | S    | P    | Si   | Cu   | Ni   | Cr   | V    | Cb   | Mo   | Al   | Ca   | B    | Ti   | N    | Ce   | Ceq | SoAl |
|--------|------------|------|-------|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 495826 |            |      | HEAT  | 0.05| 1.72 | 0.002| 0.009| 0.27 | 0.21 | 0.07 | 0.22 | 0.001| 0.079| 0.008| 0.116| 0.041| 0.0025| 0.0001| 0.17 | 0.007| 0.000| 0.26 | 0.035|
|        |            |      | PRODUCT | 0.05| 1.72 | 0.001| 0.009| 0.28 | 0.20 | 0.06 | 0.23 | 0.001| 0.078| 0.008| 0.118| 0.040| 0.0022| 0.0001| 0.17 | 0.007| 0.000| 0.26 | 0.035|
| 514112 |            |      | HEAT  | 0.06| 1.74 | 0.002| 0.009| 0.24 | 0.26 | 0.09 | 0.22 | 0.001| 0.079| 0.009| 0.116| 0.040| 0.0031| 0.0002| 0.15 | 0.008| 0.000| 0.28 | 0.034|
|        |            |      | PRODUCT | 0.06| 1.78 | 0.002| 0.009| 0.24 | 0.26 | 0.09 | 0.23 | 0.001| 0.077| 0.009| 0.117| 0.040| 0.0026| 0.0001| 0.15 | 0.009| 0.000| 0.28 | 0.034|

Deoxidization Practice: Aluminum Fully Killed
Furnace: ELECTRIC ARC  Casting: CONTINUOUS SLAB  Rolling Mill: STECKEL

We certify that the product described above has been manufactured, sampled, inspected, and tested in accordance to the referenced specification. The product has been found to be in compliance with all requirements.

[Signature]
Quality Assurance