

PIPELINE WELDING PROCEDURE SPECIFICATION

Enbridge Pipelines Inc.
10201 Jasper Avenue
Edmonton, Alberta
T5J 2J9

WPS No: EPI-08-WP9-TW
Rev. No: 1- Change to WPS No.

May 23, 2008

Scope: This welding procedure specification details the procedure to be followed for **thru-wall or partial thru-wall repair welding** of pipe and/or components required by CSA Standard Z662, Oil and Gas Pipeline Systems.

Normative References: This welding procedure specification was prepared in accordance to CSA Z662-07 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

Shielded Metal Arc Welding (SMAW) - manual method.

2. BASE MATERIAL

- a) **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
- b) **Pipe Grades:** 483 MPa (SMYS) or less
- c) **Wall Thickness Qualified:** 4.0 to 19.9 mm (0.157 to 0.783 in.) inclusive
- d) **Pipe Diameters Qualified:** 457 mm (18 in.) O.D. minimum
- e) **Carbon Equivalent:** 0.28% maximum

3. FILLER METAL CLASSIFICATION & SIZE

- a) **Root Pass:** E6010; 3.2 mm (1/8 in.)
- b) **Hot Pass:** E8010-P1; 4.0 mm (5/32 in.)
- c) **First Fill Pass:** E8018-C3; 2.4 mm (3/32 in.)
- d) **Remaining Fill Pass(es):** E8018-C3; 3.2 mm (1/8 in.)
- e) **Cap Pass(es):** E8018-C3; 3.2 mm (1/8 in.)

4. JOINT GEOMETRY

- a) Joint Type: Groove - Single Vee Butt
- b) Bevel Angle: 30°, +6° / -1.5°
- c) Root Face: 1.6 mm (1/16 in.), +/- 1/32 in. (0.8 mm)
- d) Root Gap: 1.6 mm (1/16 in.), +/- 1/32 in. (0.8 mm)

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

- a) Position: All positions
- b) Direction of Welding: Root & Hot Pass - Vertical down
Fill & Cap - Vertical up

6. PREHEATING, INTERPASS TEMPERATURE & CONTROLLED COOLING

- a) Repair Welds: A minimum preheat temperature of 120°(250°F) shall be applied to an area at least 150 mm (6.0 in.) from any point to the area to be repaired.

If the interpass temperature falls below the minimum preheat temperature, the entire weld joint shall be heated to the minimum preheat temperature prior to starting the next weld pass.

The maximum interpass temperature shall not exceed 204°C (400°F). Preheating may be applied by oxy-fuel torch, propane torch, electrical induction coils or any other method approved by the owner. Temperature of the joint shall be verified using temperature indicating crayons, thermocouples, pyrometers or other suitable method.

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. ELECTRICAL CHARACTERISTICS

- a) Current Type: Direct current, reverse polarity
- b) Voltage, amperage & travel speed: See Table #1
- c) Heat Input: See Table #1

9. TECHNIQUE

- a) Minimum number of root & second pass welders: One
- b) String or Weave Bead: Root & Hot: String Fill & Cap: String or Weave
- c) 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.
- d) Filler and Finish Beads and Finish to be achieved: Weld repairs shall be completed in a full operation without stopping. 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. REMOVAL AND REPAIR OF DEFECTS

- a) Repairable defects shall be removed by grinding. The minimum length of any repair shall be 50.8 mm (2.0 in.). Welding shall be performed following the details outlined in this specification.

11. ATTACHMENTS

- a) Procedure Qualification Test Records; EPI-08-WP9-1
- b) Laboratory Test Reports; E08-213.18
- c) Radiographic & MPI Examination Results
- d) Material Test Reports

**TABLE #1
WELDING PARAMETERS**

Pass	ELECTRODE		CURRENT		Volts	Arc Speed mm / min. (i.p.m.)	Heat Input kJ / mm (J / inch)
	Class	Size mm (in.)	Type & Polarity	Amps			
Root	E6010	3.2 (1/8)	DCRP	76 - 120	18.8 - 30.6	162 - 383 (6.4 - 15.1)	0.36 - 0.83 (9,259 - 21,171)
Hot	E8010-P1	4.0 (5/32)	DCRP	128 - 192	22 - 34	219 - 348 (8.6 - 13.7)	0.77 - 1.17 (19,578 - 29,765)
First Fill	E8018-C3	2.4 (3/32)	DCRP	76 - 138	19.2 - 30.6	53 - 108 (2.1 - 4.3)	1.56 - 2.49 (39,726 - 63,177)
Remaining Fill	E8018-C3	3.2 (1/8)	DCRP	100 - 192	20 - 30	31 - 98 (1.2 - 3.9)	2.27 - 4.72 (57,615 - 120,000)
Cap	E8018-C3	3.2 (1/8)	DCRP	96 - 186	18.4 - 28.8	36 - 107 (1.4 - 4.2)	1.92 - 4.61 (48,836 - 117,043)

Note #1 - The use of a stripper pass is optional.

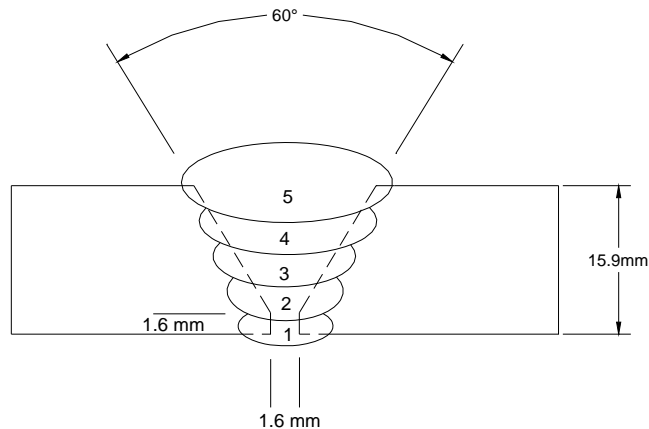
PROCEDURE QUALIFICATION TEST REPORT

PQR No. <u>EPI-08-WP9-1</u>	Date <u>March 19, 2008</u>
Welder (a) <u>Brad Whitworth</u>	Welder (b) <u>Shannon Whitworth</u>
Base Material <u>CSA Z245.1</u>	Grade <u>483</u>
Heat Number <u>591747</u>	Carbon Equivalent <u>0.23</u>
Size <u>914 mm (36.0 in.) O.D.</u>	Wall Thickness <u>15.9 mm (0.625 in.)</u>
Preheat & Min. Interpass <u>120°C (250°F)</u>	Max. Interpass <u>160°C (320°F)</u>
Technique <u>Root & hot pass - string, Fill & Cap - weave</u>	Thermal Condition <u>As welded</u>
Welding Progression <u>Root & Hot: Down Remaining: Up</u>	Welding Position <u>Horizontal - fixed (5G)</u>
Time Delay: <u>N/A</u>	Test No.: <u>25RD</u>
Electrode Trade Name: <u>E6010 (Lincoln Fleetweld 5P+), E8010-P1 (Lincoln Pipeliner 8P+)</u>	
<u>E8018-C3 (Air Liquide LA 8018-C3)</u>	

WELDING PARAMETERS

Pass	ELECTRODE		CURRENT		Voltage	Arc Speed mm / min. (i.p.m.)	Heat Input kJ / mm (J / inch)
	Class	Size	Type & Polarity	Amperage			
1a	E6010	1/8	DCRP	100	23.5	203 (8.0)	0.69 (17,625)
1b	E6010	1/8	DCRP	95	25.5	319 (12.5)	0.46 (11,628)
2a	E8010-P1	5/32	DCRP	160	27.5	274 (10.8)	0.96 (24,444)
2b	E8010-P1	5/32	DCRP	160	29.5	290 (11.4)	0.98 (24,842)
3a	E8018-C3	3/32	DCRP	115	25.5	90 (3.5)	1.96 (50,271)
3b	E8018-C3	3/32	DCRP	95	24	66 (2.6)	2.07 (52,615)
4a	E8018-C3	1/8	DCRP	155	25	82 (3.2)	2.84 (72,656)
4b	E8018-C3	1/8	DCRP	125	25	39 (1.5)	4.81 (125,000)
5a	E8018-C3	1/8	DCRP	160	25	80 (3.2)	3.00 (75,000)
5b	E8018-C3	1/8	DCRP	120	24	45 (1.8)	3.84 (96,000)
*6a	E8018-C3	1/8	DCRP	155	23	89 (3.5)	2.40 (61,114)

* Brad Completed the weld using six passes, Shannon used five.





LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Enbridge Pipelines Inc.
10201 Jasper Avenue
Edmonton, AB
T5J 2J9

Laboratory Test No.: E08-213.18
Date: April 11, 2008

Attention: Bob Hogg

PQR No.:	EPI-08-WP9-1	Heat No.:	591747
Material:	CSA Z245.1 Gr. 483	Weld Test No.:	25rd
Size:	914 mm (36.0 in.) O.D. x 15.9 mm (0.626 in.) w.t.		
Thermal Condition:	As Welded		

TENSILE TEST

SAMPLE NUMBER	T1	T2
WIDTH mm (in.)	25.5 (1.00)	25.3 (0.996)
THICKNESS mm (in.)	15.8 (0.624)	15.7 (0.618)
AREA sq. mm (sq. in.)	404 (0.626)	397 (0.616)
ULTIMATE LOAD N (lbs)	249 819 (56,200)	251 183 (56,500)
UTS MPa (psi)	618 (89,600)	632 (91,700)
FRACTURE TYPE	Partial Cup & Cone	Partial Cup & Cone
FRACTURE LOCATION	Parent Metal	Parent Metal

GUIDED-BEND TEST

SAMPLE WIDTH:	12.7 mm (0.500 in.)	SAMPLE THICKNESS:	15.9 mm (0.626 in.)
PLUNGER SIZE:	88.9 mm (3.50 in.)	YOKE SIZE:	120 mm (4.72 in.)
SAMPLE TYPE	Side Bend	Side Bend	Side Bend
SAMPLE NUMBER(S)	S1	S2	S3
RESULTS	Pass	Pass	Pass

NICK BREAK TEST

SAMPLE NUMBER(S)	N1	N2
REMARKS	Pass	Pass

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of CSA Z662 - 07. Material information has been provided by the Customer whose name appears on this report.

Samples associated with this report will be discarded in 30 days.

Laboratory Test Conducted By: _____

Natashua Collier, C.E.T.



LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Enbridge Pipelines Inc.
10201 Jasper Avenue
Edmonton, AB
T5J 2J9

Laboratory Test No.: E08-213.18
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PQR No.:	EPI-08-WP9-1	Heat No.:	591747
Material:	CSA Z245.1 Gr. 483	Weld Test No.:	25rd
Size:	914 mm (36.0 in.) O.D. x 15.9 mm (0.626 in.) w.t.		
Thermal Condition:	As Welded		

NOTCH-TOUGHNESS TEST

TYPE OF TEST: Charpy V-Notch
TEST TEMPERATURE: -5°C (23°F)

ORIENTATION: Transverse
SPECIMEN SIZE: 10 x 10 mm

Specimen Number	Notch Location	Impact Values	
		Joules	(ft.lbs)
J2.1	Weld Metal within 1/16" of root	152	(112)
J2.2	Weld Metal within 1/16" of root	130	(96.2)
J2.3	Weld Metal within 1/16" of root	>163	(>120)
J3.1	HAZ	>163	(>120)
J3.2	HAZ	>163	(>120)
J3.3	HAZ	>163	(>120)

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section VIII, Div. I, UG-84 - 2007 edition and latest addenda. Material information has been provided by the Customer whose name appears on this report.

Samples associated with this report will be discarded in 30 days.

Laboratory Test Conducted By: _____

Natashua Collier, C.E.T.



LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Enbridge Pipelines Inc.
10201 Jasper Avenue
Edmonton, AB
T5J 2J9

Laboratory Test No.: E08-213.18
Date: April 11, 2008

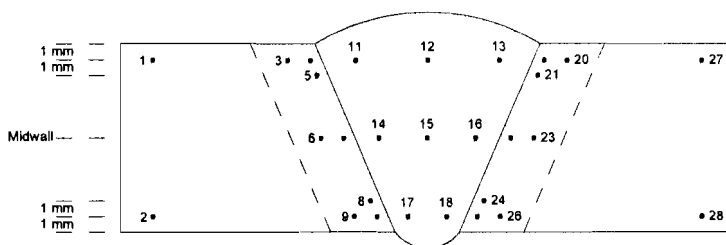
Attention: Bob Hogg

PQR No.:	EPI-08-WP9-1	Heat No.:	591747
Material:	CSA Z245.1 Gr. 483	Weld Test No.:	25rd
Size:	914 mm (36.0 in.) O.D. x 15.9 mm (0.626 in.) w.t.		
Thermal Condition:	As Welded		

HARDNESS TEST

Type of Test: Vickers 10kg (HV10)

Instrument: Leco V-100-C1



Parent Metal		HAZ		Weld Metal		HAZ		Parent Metal	
1	230	3	203	11	200	19	208	27	230
2	227	4	210	12	202	20	202	28	231
		5	208	13	203	21	209		
		6	208	14	203	22	214		
		7	224	15	202	23	201		
		8	186	16	197	24	187		
		9	175	17	166	25	184		
		10	182	18	166	26	174		

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E92-82 (Reapproved 2003). Material information has been provided by the Customer whose name appears on this report.

Samples associated with this report will be discarded in 30 days

Laboratory Test Conducted By: _____

Natashua Collier, C.E.T.



MILL CERTIFICATE

Chemistry

Certificate Package ID:	4454
Certificate Form Number:	L 2422

Customer: ENBRIDGE PIPELINES INC.	Customer Order No: P4000-4722	Date: 03/04/2008	Size: 36.000 in
Specification: API 5L 43RD ED / ENBRIDGE EES103-2006 REV 0 8/4/06	Mill Order No: 70008861	Time: 13:05:41	Wall: 0.625 in
			Grade: X70 PSL 2

Coil	Pipe	Type	C	Mn	S	P	Si	Cu	Ni	Cr	V	Cb	Sn	Mo	Al	Ca	B	Ti	N	Ce	CE _{pcm}	SoAl
Heat 591747																						
		HEAT	0.03	1.54	0.001	0.007	0.25	0.21	0.38	0.06	0.001	0.070	0.047	0.190	0.038	0.0028	0.0001	0.016	0.008	0.000	0.15	0.030
C52	3170	PRODUCT	0.03	1.57	0.002	0.008	0.25	0.22	0.39	0.07	0.002	0.070	0.038	0.191	0.037	0.0032	0.0002	0.015	0.008	0.000	0.16	0.031
C53	3173	PRODUCT	0.03	1.54	0.002	0.008	0.25	0.21	0.38	0.07	0.003	0.072	0.043	0.195	0.039	0.0030	0.0002	0.015	0.008	0.000	0.16	0.033

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

WE HEREBY CERTIFY THAT THE PRODUCT DESCRIBED ABOVE HAS PASSED ALL THE TESTS REQUIRED BY THE SPECIFICATIONS.

Ernest Baluyut

Quality Assurance



RTD Quality Services Inc.
1431 - 70 Avenue
Edmonton, Alberta T6P 1N5
Tel: (780) 440-8600
Fax: (780) 440-2538

Date m/d/y: Mar-24-08
Time: _____
Page: 1 of 1
Report #: 12522

RADIOGRAPHIC TESTING REPORT

Client/Contractor: <u>Exbridge</u>	RTD Job #: <u>00941</u>
Project: <u>Alberta Clipper Procedures</u>	RTD Procedure: <u>RT-001</u> Rev. #: _____
Location: <u>Nisku AB (Rms)</u>	Code/Specification: <u>CSA-Z662.07</u>
Client Job #/P.O.#: _____	Item(s) Inspected: <u>36" Pipe Weld</u>

Material: Type: <u>Carbon Steel</u>	Thickness: _____	Weld Reinforcement: <u>3.5mm</u>
Exposure: <input checked="" type="checkbox"/> Single Wall <input type="checkbox"/> Double Wall	Viewing: <input checked="" type="checkbox"/> Single Wall <input type="checkbox"/> Double Wall	RTD Technique: <u>A</u>

Manufacturer	Type	Size	Qty/Cassette	Total # of Film
<u>AGFA</u>	<u>D-5</u>	<u>70mm X 300mm</u>	<u>1</u>	<u>1 - Roll Pac</u>

Source: <input checked="" type="checkbox"/> X-Ray <input type="checkbox"/> Gamma	Type: <input type="checkbox"/> Iridium 192 <input checked="" type="checkbox"/> Tube <input type="checkbox"/> Cobalt 60 <input type="checkbox"/> Other	Source Size: _____	Screens: 0.005" <input type="checkbox"/> Front <input type="checkbox"/> Back 0.010" <input type="checkbox"/> Front <input type="checkbox"/> Back
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SOD: _____	Processing: <input checked="" type="checkbox"/> Manual <input type="checkbox"/> Automatic	Screen Type: <u>Pb. 0.27mm</u>
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OFD: _____ Note: The OFD (Object to Film Distance) shall be measured from the maximum distance from the source side of the object to the film.

IP Incomplete Penetration	CK Crack	EP Excess Penetration	LC Low Cover	WS Welder Symbol	A Acceptable
LF Lack of Fusion	S Slag	IC Internal Concavity	HB Hollow Bead	T Technique	R Rejectable
BT Burn Through	P Porosity	IU Internal Undercut	EU External Undercut		

	SIZE/SCH	WS	IP	LF	CK	P	S	BT	EP	IC	LC	HB	IU	EU	T	COMMENTS	A	R	
1	Test 25RD 36" X 15.9mm																		
3	48hr @ 0-50cm (upper Quadrant) Thru Wall																		
5	Test 25RD 36" X 15.9mm																		
7	48hr @ 175-210cm (lower Quadrant Thru Wall)																		
9	Test 26RD 36" X 15.9mm																		
11	48hr @ 125-140 (lower Quadrant Back Weld)																		
13	Test 26RD 36" X 15.9mm																		
15	48hr @ 270-290cm (upper Quadrant Back Weld)																		
17	Notes: ① the above weld test appears on 1 piece of film																		
19	② above welds were performed on Test Weld 22D																		

<u>Rick OSTRON</u> Client Name <u>[Signature]</u> Client Signature	Start Time: <u>0700</u> End Time: <u>1700</u> Total Hours: <u>10hr</u> Kilometres: _____	Tech. Name: <u>GARY HELLEWANG</u> Cert #: <u>2309</u> Tech. Signature: <u>[Signature]</u> <input checked="" type="checkbox"/> CGSB <input type="checkbox"/> ASNT <input type="checkbox"/> SNT Level: <u>II</u> Disc.: <u>RT</u> Assistant Name: <u>Don GRIMARD</u> Cert #: _____ <input type="checkbox"/> CGSB <input type="checkbox"/> ASNT <input type="checkbox"/> SNT <input type="checkbox"/> Level I <input type="checkbox"/> QO <input type="checkbox"/> CEDO <input checked="" type="checkbox"/> Trainee
Date: _____	Consumables: <input type="checkbox"/> Yes <input type="checkbox"/> No	



RTD QUALITY SERVICES INC.
1431 - 70 AVENUE, EDMONTON,
ALBERTA, CANADA T6P 1N5
TEL: (780) 440-6600 FAX: (780) 440-2538

NDE REPORT # 2585

Date m/d/y: Mar-24-08 Page 1 of 1

RTD Job #: 00941

RTD Dep. #: PS

Client: Enbridge
Address: _____

PO/WO: _____

Job location: Nisku AB

Procedure(s): MT-005

Code(s): CSA-2662.07

Client Rep.: _____

Part (s) Examined: 36" Pipe Weld internal side, root only

Calibration Standard: _____

Surface Condition: ☒ Weldment ☐ Ground ☐ Machined ☐ Sandblasted ☐ Painted ☐ Other

Method: ☒ MT ☐ PT ☐ VT ☐ Other

Surface Temp (C°): ☐ < 5 ☐ > 5 ☒ < 60 ☐ > 60

Equipment

Type: RTD Asset # Calibration Date
☒ Yoke 10722 Mar-01-08
☐ Perm. Magnet
☐ Coil
☐ Blacklight
☐ Alloy Analyzer
☐ Hardness Tester
☐ Other

Test Medium

☐ Wet Fluorescent
☐ Dry Powder
☒ Black and White
☐ Fluorescent
☐ Visible Dye
☐ Other

Technique

MPI LPI
☒ AC ☐ Water Washable
☐ DC ☐ Post Emulsified
☐ Continuous ☐ Solvent Removable
☐ Residual
☐ Other

Dwell Time: _____
Developer Time: _____

Scope: No Black on white color contrast MPI inspection on internal side of pipe on root only

INSPECTION DETAILS

WELD #	WALL THICKNESS & SIZE	Comments	Results
Test 21 D	36" x 15.9 mm	No relevant indications found at time of inspection.	Accept
Test 23 D	36" x 15.9 mm		Accept
Test 24 C	36" x 10.3 mm		Accept
Test 25 RD-Upper	36" x 15.9 mm		Accept
Test 25 RD-Lwr	36" x 15.9 mm		Accept
Test 26 RD-Upper	36" x 15.9 mm		Accept
Test 26 RD-Lwr	36" x 15.9 mm		Accept

Assistant: DON GRIMARD
☐ CGSB ☐ ASNT ☐ SNT Level: ☐ I ☐ II
Discipline: ☐ UT ☐ MT ☐ PT ☐ ET ☐ RT ☐ VT

Technician: GARY HELLEVANG
7309 ☐ CGSB ☐ ASNT ☐ SNT Level: ☐ I ☒ II
Discipline: ☐ UT ☒ MT ☐ PT ☐ ET ☒ RT ☐ VT

Unit: _____ Km: _____ Travel Time: _____
Start Time: _____ Stop Time: _____ Work hrs: _____
☐ OT Meal ☐ Subsistence required Total hrs: _____
Consumables: _____

Signature: Gary Hellevang

Client Name: RICK OSTRUM

Client Signature: Rick Ostrum