



**PLAN TO MANAGE CRACKING –  
PIPELINE SECTION BETWEEN NORTH WESTOVER AND WESTOVER**

Submitted to:

NATIONAL ENERGY BOARD

CANADA

Prepared by:

Enbridge Pipelines Inc. Facilities Integrity Department

JUNE 2013

Plan to Manage Cracking -  
Pipeline Section between North Westover (NW) and Westover (WS)

Enbridge Pipeline Inc.

**Table of Contents**

Executive Summary .....3

I. Introduction.....4

II. Plan to Manage Cracking.....4

    A. Crack Susceptibility Assessment .....4

        1. General Susceptibility .....5

        2. Fatigue Susceptibility .....7

        3. SCC Susceptibility .....9

    B. Immediate Actions to Mitigate Threats.....10

    C. Crack Threat Assessment.....10

    D. Re-Assessment Interval .....11

    E. Condition Monitoring .....11

III. Recommendations .....11

Plan to Manage Cracking -  
Pipeline Section between North Westover (NW) and Westover (WS)

Enbridge Pipeline Inc.

## Executive Summary

A plan to manage cracking on the pipeline section between North Westover (“NW”) and Westover Terminal (“WS”) has been developed as a response to NEB Order XO-E101-010-2012 Condition 11.

The assessment is in accordance with the requirements of CSA Z662-11 Section 3.3 – Engineering Assessments and the following Enbridge guidelines and procedures:

- Crack Management Plan
- Crack Susceptibility Guidelines Fatigue and SCC
- Crack Threat Assessment

### Crack Susceptibility Assessment

A crack susceptibility assessment has been completed with the following findings for the pipeline section between NW and WS:

- General susceptibility (a review of the physical pipe properties and historical operations of the pipe segment) is found to be low.
- Fatigue susceptibility is found to be low.
- Stress Corrosion Cracking (“SCC”) susceptibility is found to be low.

### Plan to Manage Cracking

The plan to manage cracking for the pipeline section between NW and WS recommends the following:

- Enbridge to implement company pressure cycle monitoring for the pipeline segment, upon reversal of Line 9 in 2013;
- Enbridge to complete SCC Direct Assessment (“SCCDA”), as per NACE Standard SP0204-2008 Stress Corrosion Cracking (SCC) Direct Assessment Methodology, to quantify possible extents of SCC initiation along the pipeline segment, as well as provide additional pipe examination opportunities to verify concluded low susceptibility to cracking, in 2014; and
- Enbridge to develop an appropriate re-assessment plan/interval following completion of SCCDA in 2014.

Plan to Manage Cracking -  
Pipeline Section between North Westover (NW) and Westover (WS)

Enbridge Pipeline Inc.

## I. Introduction

This plan to manage cracking on the pipeline section between NW and WS (“the pipeline segment”) has been developed as a response to NEB Order XO-E101-010-2012 Condition 11:

Enbridge must submit to the Board, prior to applying for LTO the pipeline in the reversed direction, a plan to manage cracking features in the pipeline section between North Westover Pump Station and Westover Terminal. This plan must include the timeline associated with the assessment methodology, and the rationale for selecting the timeline.

The assessment is in accordance with the requirements of CSA Z662-11 Section 3.3 – Engineering Assessments and the following Enbridge guidelines and procedures:

- Crack Management Plan
- Crack Susceptibility Guidelines Fatigue and SCC
- Crack Threat Assessment

## II. Plan to Manage Cracking

The plan to manage cracking for the pipeline segment consists of the following:

- Completed crack susceptibility assessment to understand the pipe segment’s susceptibility to specific crack threats.
- Selection and planned execution of a crack threat assessment methodology or methodologies to optimally assess identified crack threat(s).
- Determination of a re-assessment interval following the initial crack threat assessment (baseline assessment).
- Implementation of condition monitoring, as required, to confirm current operating conditions and identify changes as they may occur.

A summary of the plan to manage cracking on the pipeline segment is provided in Section III - Recommendations.

### A. Crack Susceptibility Assessment

This section describes the crack susceptibility assessment completed for the pipeline segment.

Plan to Manage Cracking -  
Pipeline Section between North Westover (NW) and Westover (WS)

Enbridge Pipeline Inc.

The crack susceptibility assessment consists of:

- a General Susceptibility assessment (a review of the physical pipe properties and the historical operations of the pipe segment);
- a Fatigue Susceptibility assessment; and
- a SCC Susceptibility assessment.

1. **General Susceptibility**

a) *Physical Properties of the Line Segment*

The pipeline segment is a 508 mm (20 inch) diameter liquids pipeline, approximately 917 m (0.57 miles) in length (see Figure 1). This pipeline section was originally constructed in 1971 using API 5LX-X52 grade pipe (IPSCO – Regina) with 7.14 mm (0.281 inch) nominal wall thickness (“WT”). The external coating for both pipe body and girth welds is Polyethylene (“PE”) tape.



Figure 1: The Pipeline Segment – Approximate Centre line (pink)

Plan to Manage Cracking -  
Pipeline Section between North Westover (NW) and Westover (WS)

Enbridge Pipeline Inc.

The original design and construction parameters are outlined in Table 1, below.

**Table 1: Selected Properties of the Pipe Section between NW and WS**

<b>Pipe Properties</b>	<b>Pipe Section between NW and WS</b>
<b>Diameter</b>	508 mm (20 inch)
<b>Wall Thickness</b>	7.14 mm (0.281 inch)
<b>Grade</b>	359 MPa (X52)
<b>Construction Date</b>	1971
<b>Long Seam Weld Type</b>	Submerged Arc Weld ("SAW") – Spiral
<b>Manufacturer</b>	IPSCO – Regina
<b>Maximum MOP (kPa/psi)</b>	8011/1162
<b>Maximum MOP (% SMYS)</b>	80
<b>Commissioning Hydrotest (% SMYS)</b>	100
<b>External Coating – pipe body and girth welds</b>	PE Tape
<b>Girth Welds</b>	Manual Shielded Metal Arc Weld
<b>Cathodic Protection</b>	Protected from time of construction

### ***b) Historical Operations***

#### Hydrotest Failures

There were no leaks or ruptures on the pipeline segment during its original hydrostatic test conducted in 1971.

#### In-Service Leaks and Ruptures

The pipeline segment has not experienced any historic leaks or ruptures.

#### In-Line Inspection History

The pipeline segment was inspected between November 2 and 7, 2008 by AGR Pipetech using a tethered 128 channel PipeScan ultrasonic inspection tool (to inspect for corrosion). A total of 894.5 m (2934.7 feet) of the pipeline segment starting at a flange upstream of valve 9-DELV-2 and continuing towards Westover Terminal was successfully inspected.

No in-line crack inspections have been completed.

#### Excavations and Repairs

Two excavations, resulting from the 2008 in-line inspection, were completed in May - June 2009 on identified girth welds 270 and 380, respectively. Girth weld 270 was reported to contain an 'axial grooving' feature (maximum depth = 31% wall loss) associated with a dent (depth < 2%). Girth Weld

Plan to Manage Cracking -  
Pipeline Section between North Westover (NW) and Westover (WS)

Enbridge Pipeline Inc.

380 was reported to contain a 'general corrosion' feature (maximum depth = 31% wall loss) associated with a dent (depth < 2%). Non-Destructive Examination ("NDE") at the locations indicated bottom-side dents without observable metal loss defects. Both dents were repaired in accordance with Enbridge repair criteria.

NDE of exposed pipe, SAW spiral welds, and circumferential girth welds identified no linear indications, no SCC, no external corrosion greater than 10% wall thickness, and one arc burn associated with girth weld 270.

## 2. Fatigue Susceptibility

### Pipe Manufacturer and Long Seam Type

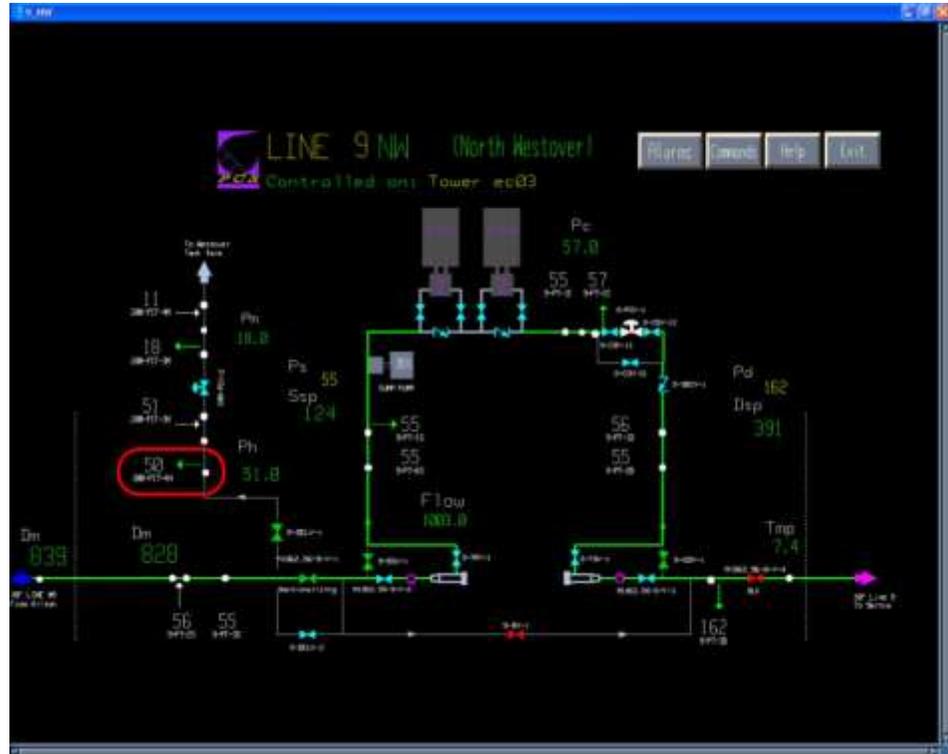
Fatigue susceptibility of potential long seam flaws associated with the pipe segment's identified long seam type (spiral SAW) and manufacturer (IPSCO – Regina) is considered low (or unlikely) based upon the 2009 NDE inspection of girth welds 270 and 380 (visual and NDE of spiral long seam and pipe body) and no identification of potential fatigue susceptible flaws associated with the spiral long seam and pipe body.

### Historic and Proposed Operating Pressures

Historic operating pressures for the pipe segment between 2008 and present were collected and reviewed as part of the fatigue susceptibility analysis. Line pressures from the pipe segment were collected from the pressure transmitter location 200-PIT-4H (circled in red in Figure 2) located at the inlet of the pipeline segment.

Plan to Manage Cracking -  
Pipeline Section between North Westover (NW) and Westover (WS)

Enbridge Pipeline Inc.



**Figure 2: Pressure Transmitter Location 200-PIT-4H**

From the collected data, it was confirmed that the inlet operating pressures for the pipeline segment were predominantly less than 20% SMYS (2013 kPa (292 psi)) for the pipe segment (Figure 3). Operating pressures at this low level are not typically associated with fatigue susceptibility on liquids pipelines. Following the Line 9A reversal, the pipeline segment is expected to continue to see operating pressures in the 690 – 1380 kPa (100 – 200 psi) range (less than 20% SMYS for the pipe segment).

Plan to Manage Cracking -  
Pipeline Section between North Westover (NW) and Westover (WS)

Enbridge Pipeline Inc.

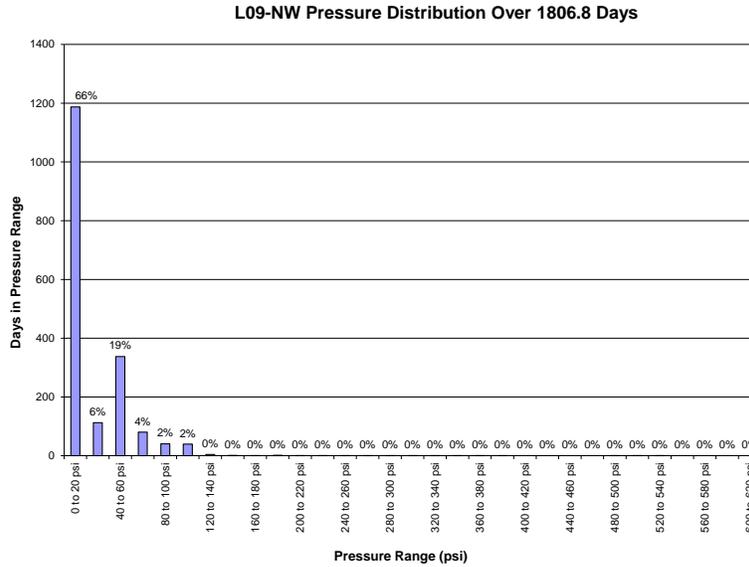


Figure 3: Pressure Distribution 2008 - Present

### 3. SCC Susceptibility

#### Coating Type and Corrosion Condition

The pipeline segment is externally coated with PE tape. Enbridge considers PE tape coatings as susceptible to SCC. This susceptibility is due to the potential for PE tape coatings to disbond from the pipe surface, typically on large diameter (greater than 305 mm (12 inch)) pipe segments buried in wet-dry areas with noted soil movement (soil stress). Once disbonded, PE tape coatings will shield the pipe from applied cathodic protection, increasing the potential of corrosion or SCC.

The overall corrosion condition of the pipeline segment can be viewed as good, based upon the 2008 in-line inspection results and the corresponding excavations/NDE results. The in-line inspection identified very few potential corrosion defects and these findings were verified after completing NDE. No observation of SCC was noted on pipe exposed during completed excavations.

#### Operational Considerations Specific to SCC

As noted previously, the historic and proposed operating pressures (following the Line 9A reversal), are at levels less than 20% SMYS for the pipeline segment. Operating pressures at these low levels typically do not promote the continued growth of SCC, though SCC initiation may still be

Plan to Manage Cracking -  
Pipeline Section between North Westover (NW) and Westover (WS)

Enbridge Pipeline Inc.

possible due to potential combination of PE tape coating disbondment, cathodic protection shielding, and wet-dry soil conditions.

### Soil and Drainage Conditions

Enbridge has completed soils sampling and record keeping as part of its mainline integrity excavation program. Company and industry experience has shown that areas that have poor drainage and fluctuate between wet and dry often are the most susceptible to a corrosive environment. Examples include the edges of lake/wetlands and low areas that sometimes fill with water, like ditches or low spots in a field.

The pipeline segment traverses two roadside ditches, and one potentially intermittent wet area north of Concession Road. Enbridge typically assumes that an environment conducive to SCC initiation and potential SCC growth is present. Enbridge has quantified the overall corrosion condition of the pipeline segment as low, based upon previous in-line inspection and field excavations. Assessment of the specific threat of SCC (if any) on the pipeline segment will be completed using NACE Standard SP0204-2008 Stress Corrosion Cracking (SCC) Direct Assessment Methodology.

## **B. Immediate Actions to Mitigate Threats**

The Crack Susceptibility Assessment completed in Part A of this report concludes that general crack susceptibility, fatigue susceptibility, and SCC susceptibility for the pipeline segment are all low and do not present active crack-related threats which require immediate mitigative actions.

## **C. Crack Threat Assessment**

Following the completion of this report, it can be concluded that the general and fatigue-related crack susceptibilities for the pipeline segment are low and do not warrant the completion of additional crack threat assessment activities (e.g. crack in-line inspection and/or pressure testing).

SCC susceptibility for the pipeline segment is viewed as low (potentially prone to SCC initiation due to PE tape coating, but low susceptibility to SCC growth due to low pressure cycling). Given the potential environmental impacts associated with the pipeline segment's location (associated flood plain areas), an SCC Direct

Plan to Manage Cracking -  
Pipeline Section between North Westover (NW) and Westover (WS)

Enbridge Pipeline Inc.

Assessment (“SCCDA”) methodology is proposed to be initiated in Q3 2013 and completed in 2014 (timing of completion dependent on selection of aboveground survey techniques, and timing to complete above ground surveys prior to ground freeze) to quantify the possible extents of SCC initiation and growth on the pipeline segment, and also to provide additional excavation data to further confirm the low general and fatigue cracking susceptibilities of the segment.

#### **D. Re-Assessment Interval**

An appropriate crack re-assessment interval will be determined following initial crack threat assessment (baseline assessment) activities and analysis.

#### **E. Condition Monitoring**

Upon reversal of Line 9, pressure cycling severity of the pipeline segment will be monitored (using established company pressure cycle monitoring procedures) to confirm on-going operating pressures and pressure cycling conditions result in a low susceptibility to fatigue crack growth and SCC propagation.

### **III. Recommendations**

The plan to manage cracking for the pipeline section between NW and WS is the following:

- Enbridge to implement pressure cycle monitoring for the pipeline segment, upon reversal of Line 9 in 2013;
- Enbridge to complete SCCDA, as per NACE Standard SP0204-2008 Stress Corrosion Cracking (SCC) Direct Assessment Methodology, to quantify possible extents of SCC initiation along the pipeline segment, as well as provide additional pipe examination opportunities to verify concluded low susceptibility to cracking, in 2014, and
- Enbridge to develop an appropriate re-assessment plan/interval following completion of SCCDA in 2014.