Enbridge Energy Integrity Management Inspection
Inspection Summary Report

Report Issue Date: July 7, 2003

Operator: Enbridge (US) Inc.

Corporate Address: [redacted]

Operator ID Number(s): [redacted] Toledo

Dates of Inspection: May 12 - 16, 2003 (Week 1)
June 2 - 6, 2003 (Week 2)

Location of Inspection: Enbridge's Superior Offices
[redacted]

Primary Contact: Jay Johnson, Compliance Coordinator
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Persons In Attendance:

(Week 1):

Operator Representatives:

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Jay Johnson (Enbridge (US))
Patsy Bolk (Enbridge (US))
Walter Kresic (Enbridge Pipelines, Inc)
Brad Smith (Enbridge Pipelines, Inc)
Garry Sommer (Enbridge Pipelines, Inc)
David Weir (Enbridge Pipelines, Inc)
Gordon Jensen (Enbridge (US))
Gregg Harroom (Enbridge ND)
Brian Johnson (Enbridge ND)
Alina Mustonen (Natural Resources Engineering)
Brad Powers (Natural Resources Engineering)
Arthur Meyer (Enbridge Pipelines, Inc) by Teleconference
Greg Sevick (Enbridge Pipelines, Inc) by Teleconference
John Hayes (Enbridge Pipelines, Inc) by Teleconference

(Week 2):

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Gordon Jensen (Enbridge (US))
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Persons In Attendance:

(Week 1)

OPS Inspection Team:

David Barrett (OPS Midwest Region)
Joshua Johnson (OPS Midwest Region)
Byron Coy (OPS East Region)
Brian Pierzina (Minnesota Dept. of Public Safety)
Boyd Haugrose (Minnesota Dept. Of Public Safety)
Kevin Speicher (New York Dept. Of Public Safety)
David Kuhtenia (Cycla)
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OPS Inspection Team:

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Joshua Johnson (OPS Midwest Region)
Brian Pierzina (Minnesota Dept. of Public Safety)
Boyd Haugrose (Minnesota Dept of Public Safety)
Kevin Speicher (New York Dept. Of Public Safety)
David Kuhtenia (Cycla)
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Inspection Objectives

The purpose of this inspection was to provide assurance that Enbridge (US) (ENB) has developed and implemented an Integrity Management Program as required by 49 CFR 195.452. Specifically, this inspection reviewed the operator's processes for:

- Identifying pipeline segments that could affect High Consequence Areas (HCAs);
- Integrating information from all relevant sources to understand location-specific risks for these segments;
- Developing and implementing a Baseline Assessment Plan;
- Reviewing the results of integrity assessments;
- Identifying and implementing remedial actions for anomalies and defects identified during integrity assessments;
- Identifying and implementing additional preventive and mitigative measures to reduce risk on pipeline segments that can impact HCAs;
- Performing on-going assessments of pipeline integrity; and
- Evaluating Integrity Management Program performance.

This inspection also reviewed the implementation and results of ENB's Integrity Management Program to date including a review of completed integrity assessments, and the repair and mitigation actions taken as a result of these assessments.
This inspection summary report is divided into two major sections. The first section summarizes the key features of the ENB approach for each of the Integrity Management Program Elements in 49 CFR 195.452 (f). The second section summarizes the issues and observations developed by the inspection team during the review of ENB's program and its implementation.

Integrity Management Program Overview

Enbridge Energy, LP, formerly Lakehead Pipeline, spans approximately 3300 miles in the United States from the Canadian border near Neche, North Dakota to the Canadian border near Marysville, Michigan. Multiple lines run between Neche and Superior, Wisconsin. From there Line 5 runs north of Lake Michigan across the Straits of Mackinaw to Sarnia, Ontario. Lines also run south around Lake Michigan to Sarnia, Ontario. An extension also runs across the Niagara River into Buffalo, New York. The 3300 miles of Enbridge Energy pipeline also includes 36 miles of Enbridge Toledo Pipeline. Enbridge Energy reports a total of 700 miles of "could affect" HCA segments.

1. Segment Identification: The ENB segment identification process was documented in their HCA Management Plan (HMP). The process delineated the use of NPMS data for the segment identification process. Enbridge also considered the following features as HCAs:

- The city of Rapid River, Michigan as an OPA using the corporate municipal boundary
- 15 Navigable Water Crossings per 49CFR194
- Municipal drinking water supplies in New York and additional supplies in Michigan

Pipeline locations were identified via a linear stationing system, with reference made in feet to local landmarks such as road and river crossings. As part of the HCA segment identification project, the stationing system was made electronic, tied to the U.S.G.S. coordinate system and imported as an ArcView shape file into ENB's Geographic Information System. The stationing of pipeline segments which may potentially impact an HCA was identified by superimposing the pipeline shape file on top of 7.5 minute U.S.G.S. quadrangle maps and retrieving the relevant start/stop coordinates of the pipeline system.

HCA segments were identified using direct intersect and indirect impact methodologies. Indirect liquid release impact on an HCA was determined using overland, spray, and water transport mechanisms. Air dispersion calculations were used to determine the effect of the release of Natural Gas Liquids. Drinking water HCAs were determined to be impervious to the release of NGLs.

For overland liquid transport the spread distance was calculated based on a spread area determined from spill volume, topographical slope, and spread width. Spill volumes are calculated based on maximum capacity, location of remote controlled valves, elevation profiles, and time to recognize rupture. ENB assumed a maximum rupture isolation time of 8 minutes - 5 minutes for SCADA to recognize a rupture and 3 minutes for isolation. To determine the potential overland flow from a release at a tank, the largest tank at any given terminal was considered. The tanks were assumed to fail at their maximum operating level and the existence of berms or other spill mitigation features were ignored.

The overland spread is not calculated automatically; instead an analyst must determine the slope at each release location and calculate the spread using algorithms specifically developed for the shallow, moderate, and steep topography. The analyst then determines if any HCAs have been impacted by the release.

The water transport model described in the HMP used either hydraulic gradients or stream velocities to determine the transport distance given a 3 hour response time. However, on further discussion with the analyst, “control points” were also used to determine maximum water transport. Control points are locations along a waterway where interdiction can occur to stop the transport of crude oil. Based on accessibility, these points may be further downstream than the distance that would be calculated from hydraulic gradients. Again, the analyst did much of the calculation of water transport distances manually.

The NGL transport model used by ENB was RMP*COMP. This model was selected based on its ability to predict measured LEL levels during an NGL release in 1975. To simplify the analysis and provide a common basis for comparisons throughout the pipeline system, ENB determined the worst case scenario as the location specific release that resulted in the greatest travel distance to an endpoint i.e., the maximum distance between the release point and an endpoint. The endpoint is where the concentration of the vapor cloud is calculated to be less than 10% LEL.

With respect to performing segment identification prior to placing new lines into service, the inspection team noted that ENB was installing new pipeline from Gretna, ND to Clearbrook, MN as part of their "Terrace Phase III" project. Portions of the new "Terrace III" pipeline had been placed into service ahead of the originally anticipated in-service date without having completed segment identification as required by 195.452(b)(2). ENB provided the in-service dates of these Terrace lines and noted that segment identification was anticipated as being completed by the end of June, 2003.

2. Baseline Assessment Plan: ENB identified approximately 1500 HCA segments through their segment identification process. These 1500 HCA segments are rolled into 30 trap to trap testable pipeline segments. The Baseline Assessment Plan for these thirty segments was presented in the HMP. Based on the assessment schedule at the time of inspection, approximately 64% of the could affect HCA segment mileage will be assessed by September 30, 2004.

ENB determined the schedule for performing Baseline Assessments using Enbridge's "Fitness For Purpose" (FFP) approach to pipeline management. ENB's Fitness For Purpose approach was stated as being based on applying a series of programs and risk control measures over the lifecycle of the pipeline to manage defect growth.

The ENB Integrity Management Program employs a "defect management" approach that is largely built around information and knowledge collected from past ILI data. A defect tolerance level has been established based on restoring line pipe to its original pressure capacity, and defects that exceed ENB's tolerance level are excavated and remediated. Defects not exceeding ENB's tolerance levels are tracked and, where applicable, programs are set in place to monitor the defects. Assessment intervals are also calculated as part of the defect management approach, based on the non-remediated anomalies not growing past the ENB tolerance level prior to the next assessment.

As part of determining the schedule for performing baseline assessments on all 30 testable pipeline segments, ENB prepared a Line Description Document (LDD) for each segment. The LDD discussed corrosion growth rates, susceptibility to cracking, dents, and other information that could provide insight into the type of assessment that should be performed and the frequency with which it should be performed. For each of the 30 testable segments, ILI (geometry tool with metal loss tool) was the recommended method of assessment.

Enbridge explained the overall methodology for developing the BAP as a non-quantitative likelihood times consequence analysis. "Likelihood" is not based on output of a risk model, but is taken as the assessment interval defined by the defect management approach. Consequence is considered based on the Consequence of Failure (COF) score for each of the 30 testable segments as calculated by a risk model.

ENB has developed a Risk Model using the Bass-Trigon Integrity Assessment Program (IAP). The risk model will be discussed in more detail in Section 5.0. The output of the risk model is used in two ways. First, the risk model calculates a risk for each of the 1500 plus could affect line segments. This is used by ENB to verify that high risk could affect HCA segments are assessed prior to September 30, 2004. Second, the risk model is used to calculate a COF for each of the 30 testable segments included in the BAP. If a testable segment is ranked within the top two thirds based on COF, its assessment frequency, as initially determined from the FFP analysis, is reduced by one year. As such, actual use of risk analysis values in determining the BAP schedule was limited to applying a one year reduction in the nominal FFP-calculated assessment interval in certain cases.

All 30 BAP testable segments were scheduled to be assessed by March 31, 2008.

The inspection team noted that the FFP approach to BAP development did not appear to directly include consideration of data that was not directly related to a defect. This included the 195.452(e)(1)-required "Existing or projected activities in the area" factor (3rd party damage), use of Cathodic Protection data, and "non-pipe' issues such as flange and fitting leaks.

3. Integrity Assessment Results Review: Training requirements for integrity assessment results personnel were delineated in a Training and Qualification manual. Training is provided through activities such as formal training courses, participation in conferences and workshops, presentation of papers at conferences, participation on standards committees, and participation in industry associations.

ENB relies upon ILI vendors to interpret assessment data. ENB then takes the data, reviews it for accuracy, determines if any anomalies meet the repair criteria, and forwards excavation (dig) sheets to field personnel. Standard in the vendor's contract was the requirement to receive a preliminary data report within 30 days and a final report within 60 days.

Several recent assessments were reviewed by the inspection team and it appeared that the vendor's final report was often not being received within 180 days of completion of the ILI run as required by the IMP rule. In addition, the date of discovery for repair conditions was when the final report for the MFL tool was accepted by ENB. Any anomalies identified by the geometry tool were not investigated until the final report for the MFL tool was received.

ENB provided unity plots of "as reported" versus "as found" conditions for anomalies. This information was used as part of their Fitness For Purpose process.

4. Remedial Action: The major requirements for remedial action pressure reductions, OPS notifications, etc., were covered by the HMP. One exception was that the HMP referenced use of RSTRENG to determine the amount of pressure reduction to be taken for addressing immediate repair conditions. This is contrary to the requirements of 195.452(h)(4)(i), which requires the use of Section 451.7 of ASME/ANSI B31.4. Also, the timeliness of engineering evaluations to determine the pressure reduction for immediate repair anomalies that can not be addressed by the ASME/ANSI B31.4 formula was not specified in HMP.

During the review of assessment results, a pressure reduction on the 30 inch Bay City to Sarnia pipeline was not taken for approximately 30 days after discovery of an immediate repair condition. In another instance, a Line 4 Plummer to Clearbrook assessment was completed on May 30, 2002 and the final ILI report received on 11/1/02. Several anomalies were excluded on the basis that they had previously been remediated. In May, 2003, it was determined that these anomalies had not been previously remediated and needed to be repaired. The date of discovery for these anomalies was then set as May, 2003. The anomalies were 180 day repairs and were scheduled to be remediated by November, 2003. The inspection team noted that under the circumstances the anomalies should have been addressed promptly

5. Risk Analysis Process: ENB uses IAP to perform the risk assessment of line piping. The risk model calculates the Likelihood of Failure (LOF), the Consequence of Failure (COF), and the combined Failure Risk (LOF*COF). As noted previously, for the purpose of scheduling Baseline Assessments, only the COF was considered. For the purpose of identifying Preventive and Mitigative measures, and quantifying their impacts, both the LOF and COF were intended to be used.

Risk factor categories considered in LOF, and their respective weighting factors, were:

1) Corrosion (Internal and External) (31%)
2) Design/Material (33%)
3) System Operations (5%)
4) Ground Movement (3%)
5) Third Party Damage (28%)

Risk factor categories considered in COF, and their respective weighting factors, were:

1) Impact on Environment (30%)
2) Impact on Population (50%)
3) Impact on Business (20%)

Each of these risk factors had an extensive list of sub factors populated in the model, with a weighting score assigned to each sub factor.

The risk assessment model was also used to:

1) Identify the placement of EFRDs for minimization of spill volumes
2) Help prioritize digs
3) Prioritize projects

6. Preventive & Mitigative Measures: The IAP risk assessment model is also intended to be used to help identify and evaluate potential Preventive and Mitigative projects. The before and after results of the model can be used to evaluate the overall cost effectiveness of risk reduction projects. ENB anticipated that the risk assessment model will be fully utilized in the evaluation of P&M projects by 2004.

With respect to leak detection, ENB described the capabilities of existing and planned SCADA and CPM systems. At the time of inspection, CPM was installed on all of their US pipelines with the exception of Lines 6A and 6B. Line 6A was anticipated as having CPM operational in 2003 and Line 6B by 2004.

Regarding the evaluation of the need for additional EFRDs, the HMP contained a variety of technical detail regarding the criteria for placement of additional EFRDs, but the process for determining if/where additional EFRDs are necessary had not yet been well defined and implemented.

7. Continual Process of Evaluation and Assessment: As part of their Fitness For Purpose program, ENB had scheduled each of their 30 testable segments for a Baseline Assessment. In many cases the interval for reassessing each segment after the baseline was greater than 5 years. ENB anticipated that they will request a variance to the 5 year re-assessment interval for specific pipelines based on corrosion growth rate analysis, susceptibility to cracking, previous ILI testing history, age of pipe, etc. The inspection team noted the need for a thorough engineering analysis to be provided as part of any request for reassessment intervals beyond five years.

8. IM Program Performance Monitoring and Evaluation: Enbridge has adopted ten performance measures from API-1160, and stated that they will examine the need for implementation of future metrics as part of the continual improvement process. Current and past performance will be evaluated, trending analyses will be conducted, and the basic goals that performance metrics support will be subsequently analyzed to determine the need for modifications.

ENB had several other existing programs in place to measure its performance against industry standards, including:

Release database - By utilizing the release database ENB is able to determine the number of releases for each year by size and other variables.

API Pipeline Performance Tracking System (PPTS) - ENB has been a voluntary participant in the API PPTS since its inception. Use of this information was stated as enabling ENB personnel to assess the implications for operations and the impact of incidents as well as to prioritize risk mitigation strategies.

Pipeline Integrity Tracking System (PITS) - The ENB Pipeline Integrity Department has an existing database (PITS) that is being expanded to facilitate tracking of all investigative excavations and mitigation activities in the United States. This database can be queried to illustrate the number of excavations in a given year and their location. This output, when overlaid with the HCA data, allows ENB to determine the number of digs completed on a segment that could affect an HCA.

MAXIMO - ENB has a maintenance tracking database, MAXIMO, which can be used to track events that can affect the integrity of the pipeline.

An ENB steering committee is responsible for the continual monitoring of the HMP. The chairman of the steering committee is the Manager, U.S. Compliance and Risk Management. The steering committee is comprised of individuals from Pipeline Integrity, Safety & Environment, Operations Services, SCADA, Control Center Operations, Engineering, Operations and Compliance and Risk Management. The steering committee meets via teleconference whenever issues arise that warrant the attention and discussion of the committee.

OPS Feedback

<u>Enbridge Inspection Feedback</u>

Segment Identification

1. Given that segment identification is performed manually using 7.5 minute U.S.G.S. maps it is difficult to validate the methodology. Some issues are:

- Overland buffer zones were not presented graphically as the composite final buffer zones.
- Water transport was dependent on stream velocities, which was dependent on hydraulic gradients. It was not clear where water transport was terminated.
- For some waterways control points were used to determine the extent of transport. The actual locations of these control points, however, was not documented and apparently only known to the analyst performing the could affect analysis.

2. HMP does not provide the basis for the adequacy of the assumed five minute operator response time for lines that do not have CPM (i.e., five minute backs-up CPM indication, so application of the “ten minute rule” for lines that do not have CPM may be appropriate).

3. ENB used regression analysis to predict overland spread versus release volume for the three topographical slopes. Not all release data was used to perform the curve fits. For example, the release data for the Cohasset, MN leak was not used.

4. Discrepancies were noted between the could affect segments identified on the HCA maps and those listed in HMP Table 2. The tables are used to determine if an anomaly is within an HCA segment. If the tables are not current, a n anomaly could be treated outside of the IMP rule repair criteria.

5. Enbridge needs to substantiate the assumptions used in the water transport model. These include:

- Validating the three hour response time for stream flow transport termination (e.g., comparison with the 7/4/02 Cohasset response time).
- Validating that the 2x mean stream flow velocity is appropriate.

6. Lack of accounting for multiple instances (overlap) of common types of HCAs when segment identification results are input into the consequence analysis. For example, if several drinking water supplies are potentially affected by a particular testable section of line, the occasion of multiple drinking water supplies being affected is important in addition to the fact that drinking water needs to be included in the types of HCAs affected by that section.

7. Since the segment identification process is visually/manually performed by an analyst, detailed process documentation should be developed. Examples include:

- Description of the process of connecting tangential buffer zones into a composite buffer zone not included in HMP.

- Description of use of control points for the termination of water transport not included in the HMP.

8. Requirements for record retention times, locations, and responsibility not clearly specified in the HMP.

9. HCA segment identification was not performed prior to putting the new 36" Category 3 lines into service. [Enbridge stated the input data for IAP volume release calculations would be completed by the end of June, 2003, and that segment ID completed thereafter. Inspection team noted OPS requirement to have segment ID completed prior to placing new lines into service - 195.452(b)(2).]

Risk Analysis

1. Historical operating data is not being used in the Risk Assessment Model to the fullest extent. E.g., near misses and unscheduled shutdowns.

2. Decisions regarding preventive and mitigative actions for external and internal corrosion are being made outside of the risk model.

3. A quality check of the data in the risk model should be performed. For example, the variable score for the pipeline segment at the Mississippi River crossing in the Cass Lake to Deer River pipeline was not populated and the ICF variable had not been changed for pipelines where an ILI ran had been completed.

4. Impact on Business (Customer Service Disruption) was a major contributor to Consequence of Failure in both of the mainline sections reviewed. Given the weighting of this risk factor, it appears this may be true for all mainline testable sections.

5. Risk assessments of facilities do not include operator error.

6. Flange and fitting leaks is the number one problem at facilities, Enbridge is trending flange and fitting leaks using MAXIMO but does not appear to be including this information in the current evaluation of risks.

7. The qualification requirements for risk analysis personnel are not well documented in the HMP.

8. The Risk Assessment team must solicit input regarding updated system configurations and operating practices from field organizations rather than having the field input information based on trigger points that are defined by the HMP.

Baseline Assessment Plan

1. A crack susceptibility study is ongoing; however, it should have been completed and the conclusions factored into the development of the BAP.

2. Lack of consideration of 195.452(e)(1) required factor (vi) "Existing or projected activities in the area" (third party damage) in the process for establishing the baseline assessment schedule. It appears that third party damage is not taken into consideration when prioritizing the Baseline Assessment schedule.

3. The HMP does not include the requirements for incorporating new HCA could affect segments into the BAP within 1 year and performing a Baseline Assessment within 5 years (§195.452(d)(3)(ii)).

Integrity Assessment Results Review

1. In general, the IM plan is the place to bring all elements of the ENB integrity management program together. Areas of possible improvement include the following:

- As the primary IM document, the HMP does not incorporate by reference all associated IM documents. For example, the Qualifications & Training Guideline Document was described as part of the ENB integrity management processes, but was not referenced in the HMP.

- Integration of information/risk analysis (195.452(g)) results does not appear to have a central role in the overall evaluation of integrity challenges. For example, 3rd party damage potential is left to the discretion of regional operations to determine if additional geometry assessments need to be conducted, CP data is not well integrated with ILI results, and "non-pipe" issues such as flange leakage events are treated outside of the risk analysis process.

2. The ENB approach to assessment tool tolerances (e.g., use of unity plots, etc.) could be clarified in the HMP.

Remedial Action

1. HMP references use of RSTRENG to determine the amount of pressure reduction to be taken for addressing immediate repair conditions. This is contrary to the requirements of 195.452(h)(4)(I), which requires the use of Section 451.7 of ASME/ANSI B31.4.

2. Timeliness of engineering evaluations to determine the pressure reduction for immediate repair anomalies that can not be addressed by the ASME/ANSI B31.4 formula is not specified in HMP.

3. Line 4 Plummer to Clearbrook assessment was completed on May 30, 2002; the final ILI report was received on 11/1/02. Several anomalies that were identified were excluded on the basis that they had previously been remediated. In May, 2003, it was determined that this was not the case and the date of discovery for those anomalies was revised to be May, 2003. The anomalies were categorized as 180 day repairs and are scheduled to be remediated by November, 2003. This highlights the following issues:

- There may be a weakness that needs to be corrected in ENB's process to identify previously remediated locations.
- The rule requires that discovery be within 180 days of completion of a tool run. The proper response to the error may be to schedule the anomalies for immediate remediation.

4. Discovery was greater than 180 days in several cases due to delayed ILI vendor reporting. Examples included Line 5 Bay City to Sarnia, Line 3 Gretna to Clearbrook, Line 2 Gretna to Clearbrook.

5. Review of assessment results indicated that anomaly results spreadsheets did not identify geometry tool results.

6. For the baseline assessment of Line 10 (Grand Island-E. Niagara, E. Niagara-Kiantone), ENB appears to have missed identification of one HPA HCA (~ 80,000 ft. in Buffalo) when evaluating assessment anomalies. Pressure reduction taken upstream, but no evaluation if pressure reduction was sufficient for the Buffalo section. [Note: Posting of "could affect" data to ENB intranet may facilitate improved accuracy of locating anomalies within HCAs.]

Continual Process of Evaluation and Assessment

1. HMP does not explicitly address the "unavailable technology" 180 day notification. Inclusion of this aspect may be an enhancement to the HMP, given that this is also applicable to instances of tool unavailability as well as basic technology being unavailable.