SmartBall® Dual Inspection Report

Prepared for
Enbridge

Prepared by
PureHM

Pipeline Number:	Line 5
Pipeline Segment:	Mackinaw Straits East Leg
Launch Date:	October 5, 2016
Contact:	Sal Paonessa
Product:	Light Crude Oil

Line 5 - Mackinaw Straits East Leg

Quality Assurance and Quality Control Statement

By my signature, I attest that this report has been prepared and reviewed in accordance with PureHM Quality Assurance and Quality Control procedures:

Cory Solyom – Business Line Manager – SmartBall	October 28, 2016 Date

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	HMUS-PJN000052	Project Name:	Line 5 - Mackinaw Straits East Leg
Document Type:	SmartBall Report	Project Manager:	Cory Solyom

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Signature:	Date:	October 28, 2016

Level 3 Reviewer:	Tim Ross	Amend and Resubmit	Amend and Proceed	Proceed
Version Received:	V1.2	☐	☐	☒

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1. Executive Summary

Enbridge retained the services of PureHM Inc. (PureHM) to perform a dual SmartBall® inspection of Line 5 - Mackinaw Straits East Leg from North Straits East (NOE) to Mackinaw East Loop (MAEL) on Wednesday October 5, 2016. The Mackinaw Straits East Leg section is a carbon steel pipeline that transfers Light Crude Oil from the NOE to MAEL. The purpose of the SmartBall inspection was to verify containment along the pipeline section.

Two SmartBall devices were inserted into the pipeline through the launch trap at the NOE. The tools were launched independently of each other. The first tool was launched from NOE and confirmed to have landed at MAEL before launching the second tool. Acoustic and sensor data was collected and recorded as both the SmartBall devices traversed the pipeline. This data was evaluated to identify acoustic anomalies associated with leaks.

PureHM detected zero (0) anomalies characteristic of leaks for both SmartBall inspections. The project details/results of the inspections are summarized in Table 1.1.

Table 1.1: Project Details & Results

Item	Details
Total Length Inspected:	21,777 feet
Pipe Material:	Carbon Steel
Diameter of Pipe:	20 inch
Product:	Light Crude Oil
Acoustic Anomalies Characteristic of Leaks:	0
Duration of the Inspection SmartBall 1 (PT-7274):	45 minutes
Duration of the Inspection SmartBall 1 (PT-7276):	44 minutes
Average SmartBall 1 (PT-7274) Tool Velocity:	8.0 ft/s
Average SmartBall 2 (PT-7276) Tool Velocity:	8.1 ft/s

1.2 Run Success Commentary

The SmartBall tool was successfully launched and received. The tool recorded data throughout the entire length of the inspection. During this time the pressure inside the subject pipeline was recorded to be greater than 100 PSI for the entire span of the inspected sections.

The data quality was not negatively affected by any surrounding noise, environmental factors, tool speed or otherwise. The data collected was of sufficient quality, and the SmartBall's proven minimum leak detection threshold of 0.03 gallons per minute is retained.

2. Project Background

Enbridge retained the services of PureHM to perform a dual SmartBall® inspection of Line 5 - Mackinaw Straits East Leg from NOE to MAEL on Wednesday October 5, 2016.

The pipeline is being inspected to verify containment along the pipeline section.

2.1 Description of the Subject Pipeline

Line 5 - Mackinaw Straits East Leg is a carbon steel pipeline that transfers light crude oil from the North Straits East (NO E) station to the Mackinaw (MA) station. This inspection covers the section of pipe running from the North Straits East (NO E) station to the Mackinaw (MA) station spanning 21,777 feet. During the SmartBall inspections, the pressure in the pipeline was recorded to range from 268 psi to 170 psi for the first SmartBall inspection and from 359 psi to 249 psi for the second SmartBall inspection.

The approximate pipeline location and any anomalies detected by the SmartBall technology are shown in Figure 2.1.



Figure 2.1: General layout of Enbridge Line 5 - Mackinaw Straits East Leg

3. SmartBall Inspection Details

3.1 Planning Document

Prior to the initial inspection of this section of pipeline in October 5, 2016, PureHM reviewed the available pipeline documents provided by Enbridge for suitability. All subsequent inspections have been performed under the same planning document protocol.

The documents received and reviewed by PureHM included:

- 03_L0005_WNO-WMA_BPB.xls – Geopig Data
- 04_L0005_ENO-EMA_BPB.xls – Geopig Data
- L5 NOEW-MA New Traps-2016-07-22.pdf - Trap dimensions
- T2015-032V.pdf - Trap dimensions
- Appendix 3. Internal Diameter Restriction Listing.pdf
- Appendix 5. Bend Listing.pdf

3.2 SmartBall Launch

For the deployment of the two SmartBall tools, no lead and trailing pig was sent down the line. The first SmartBall (PT-7274) was launched on October 5, 2016 at 9:06:25 AM; the second SmartBall (PT-7276) was launched on October 5, 2016 at 10:03:54 AM.

The SmartBall tools were tracked using individual AGM's at each launch and receive sites. See Table 3.1 for launch details.

Table 3.1: Launch Schedule

Item	Comments
Location:	North Straits East (NOE)
Date:	October 5, 2016
Time Zone:	Eastern Standard Time (EST)
SmartBall 1 (PT-7274):	9:06:25 AM
SmartBall 2 (PT-7276):	10:03:54 AM

3.3 SmartBall Tool Retrieval

Both inspections were concluded when the second SmartBall had arrived in the extraction trap at the Mackinaw (MAEL) station on October 5, 2016 at 10:48:34 AM. The pig trap was not drained and opened until it was confirmed from the operators that the SmartBall tools were in the trap.

Table 3.2: Receive Schedule	
Item	**Comments**
Location:	Mackinaw East Loop
Date:	October 3, 2016
Time Zone:	Eastern Standard Time (EST)
SmartBall 1 (PT-7274):	9:51:38 AM
SmartBall 2 (PT-7276):	10:48:34 AM

3.4 AGM Locations and Tracking

The SmartBall tools were tracked using an individual AGM at each launch and receive sites.

4. Inspection Results

The data collected by both SmartBall tools was internally peer reviewed to verify that all acoustic anomalies were detected and accurately classified. There were no acoustic anomalies resembling leaks. This indicated that there were no leaks within the detection limits of the SmartBall technology present in the pipeline under the operating conditions at the time of the inspections.

4.1 Acoustic Anomaly

One of the first steps in the Integrity Management Process is to identify potential pipeline threats. Once a risk assessment identifies the pipeline locations with increased threat levels, an appropriate integrity assessment for the type of threat is conducted. The integrity assessment methods that can be used include inline inspections, pressure testing, direct assessments, or other methodologies. ASME B31.8G under Section 6.1, Integrity Assessment, states the following in regards to classification of anomalies;

> *It is important to note that some of the integrity assessment methods (inline inspection, pressure testing, direct assessment) only provide indications of defects. Examination using visual inspection and a variety of nondestructive examination (NDE) techniques are required, followed by evaluation of these inspection results in order to characterize the defect.*

Furthermore, in ASME B31.8G under section 13, Terms, Definitions, and Acronyms, the hierarchy of terminology for integrity assessment is outlined (see Figure 5 Below).

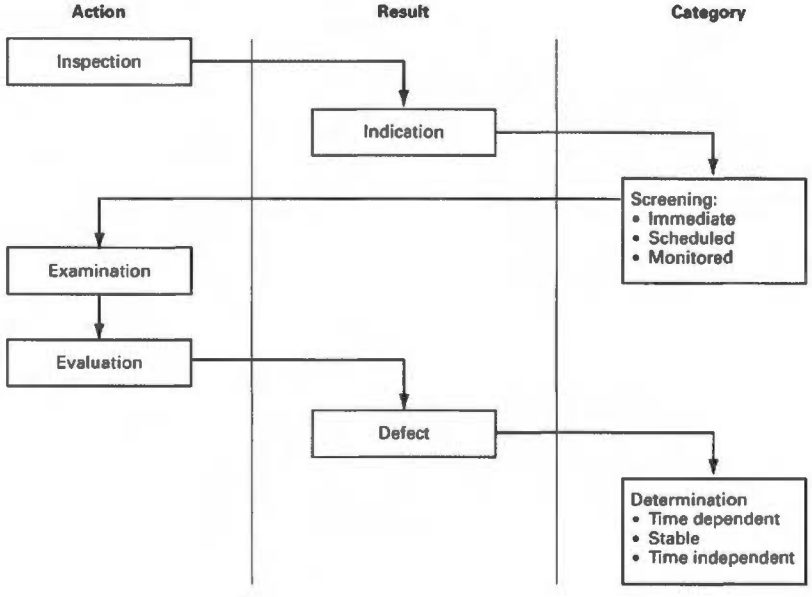


Figure 4.1: Hierarchy of Terminology for Integrity Assessment

It is important to note that once an inspection has presented a change in data from baseline response, the data at that particular location is defined as an "Anomaly". If the change in data response has aspects which increase the confidence that it is an integrity concern, it is classified as an "indication". ASME B31.8s defines an "Anomaly" and "Indication" as;

Anomaly: Any deviation from nominal conditions in the external wall of a pipe, its coating, or the electromagnetic conditions around the pipe. In a SmartBall inspection, any acoustic anomaly with characteristics of a leak, encompassing all confidence intervals, will be reported to the client.

Indication: Finding of a nondestructive testing technique. It may or may not be a defect.

As can be seen in Figure 5 above, an "indication" is not identified as a "defect" until the pipeline undergoes "examination" and "evaluation". These terms are defined in order of hierarchy;

Examination: Direct physical inspection of the pipelines by a person and may also include the use of nondestructive examination techniques (NDE).

Evaluation: Analysis and determination of the facility's fitness for service under the current operating conditions.

Defect: An imperfection of a type and magnitude exceeding acceptable criteria. In a SmartBall inspection, a defect that has been confirmed through examination and evaluation will be referred to as a leak.

Therefore, no indication or anomaly from an NDE inspection can be called a defect or specific type of integrity threat until direct physical inspection by a person has been conducted. A defect can represent any number of pipeline integrity threats such as; corrosion pit, surface corrosion, crack, lamination, buckle, leak, wall loss, dent, etc.

4.2 SmartBall Inspection Results

Figures 4.2A and 4.2B show the acoustic profile of each inspection with respect to the position of each tool within the pipeline, as detected by the SmartBall technology.

Table 4.2A and table 4.2B show the acoustic profile of SmartBall 1 and SmartBall 2.

For the first SmartBall, starting at approximately 5,813.1 feet and ending at approximately 9,664.39 feet, an acoustic event has been identified which is not leak related. This event is external to the pipeline and is most likely to be an underwater current making contact with the pipeline. The second SmartBall did not detect the same event which leads to think it is a transitory event.

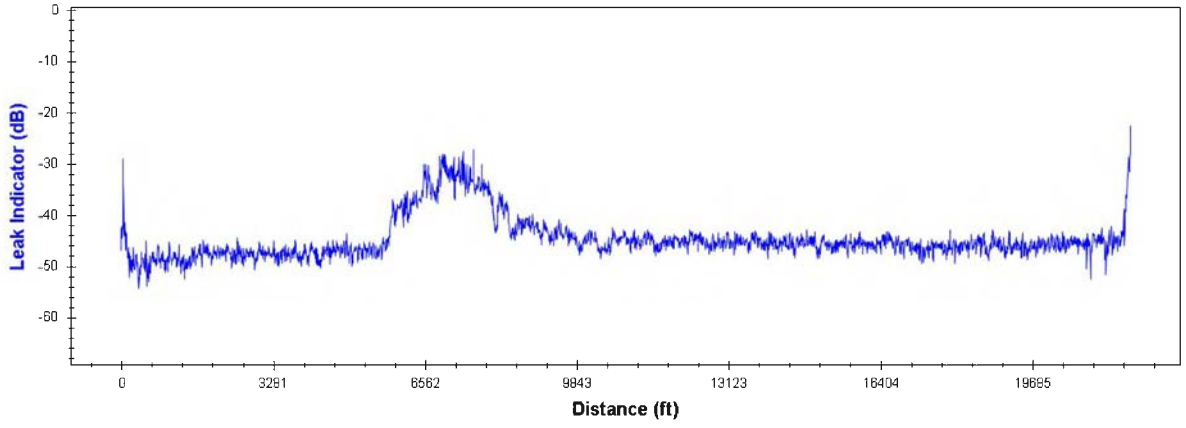


Figure 4.2A: Acoustic summary of the first SmartBall inspection versus Distance Traveled

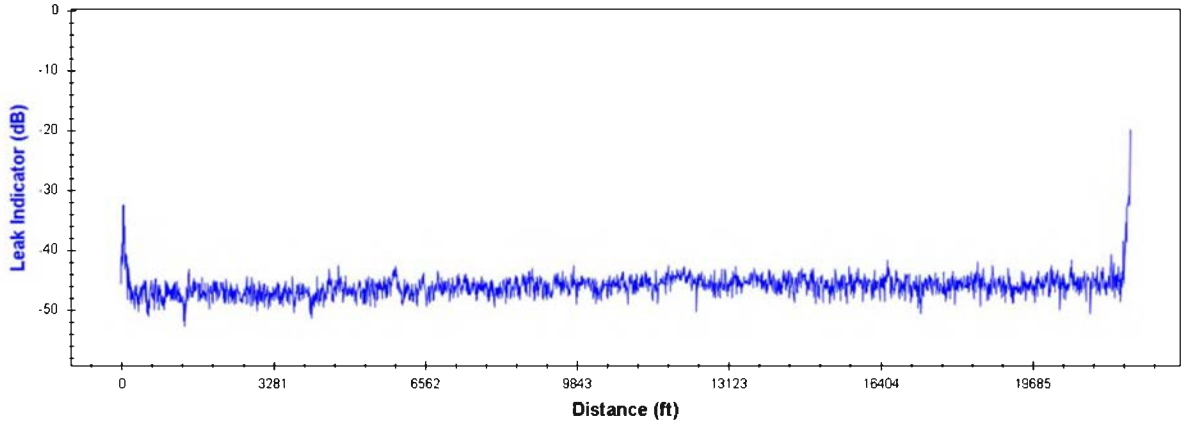


Figure 4.2B: Acoustic summary of the second SmartBall inspection versus Distance Traveled

It is important to note that this overview may contain anomalous spikes in the data. These spikes may have been caused by ambient noise around the pipeline from external sources such as

pumps or nearby traffic. These sources of ambient noise are easily distinguishable from leaks or other points of interest upon further analysis by trained personnel.

Ambient noise generally occurs at a much lower frequency than the frequencies generated by a leak or pockets of trapped gas.

4.3 Temperature and Pressure of the SmartBall Inspections

Figures 4.3A and 4.3B show the corresponding plots of the temperature the first and second SmartBall tools experienced vs time of day.

Figure 4.4A and 4.4B show the corresponding plots of the pressure the first and second SmartBall tools experienced vs time of day.

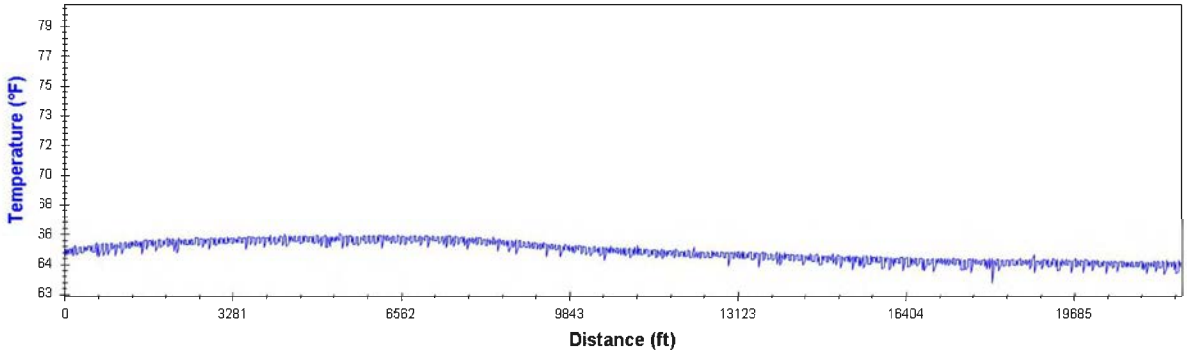


Figure 4.3A: Temperature Profile of the first SmartBall vs. Time of Day

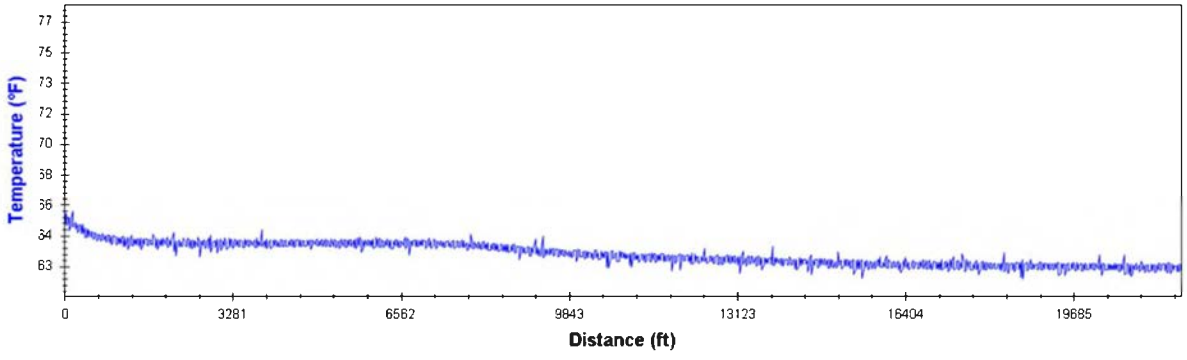


Figure 4.3B: Temperature Profile of the second SmartBall vs. Time of Day

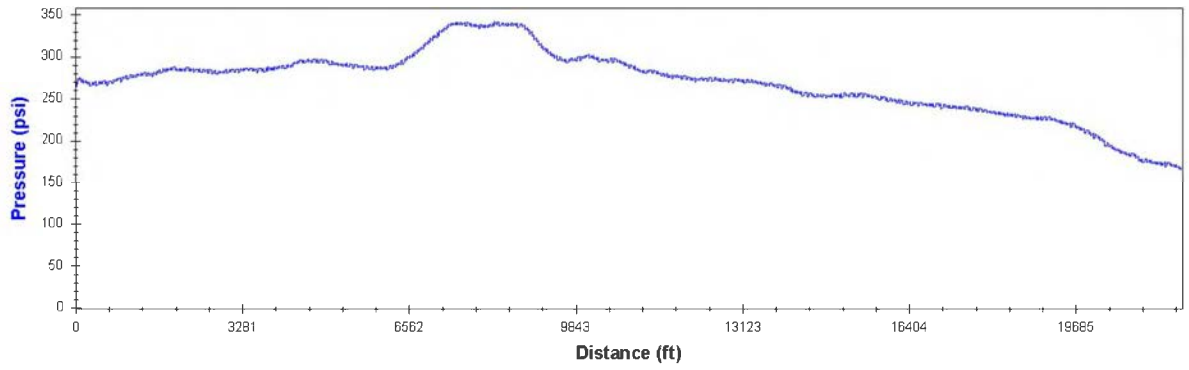


Figure 4.4A Pressure Profile of the first SmartBall vs. Time of Day

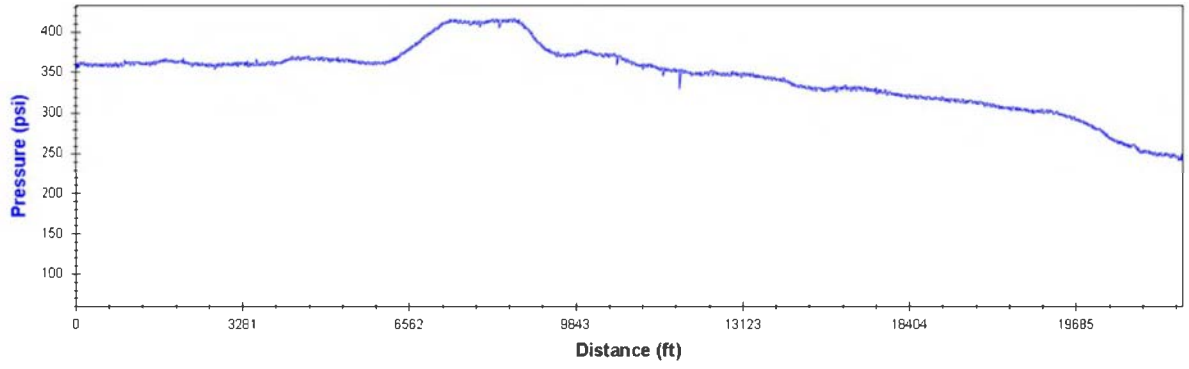


Figure 4.4B Pressure Profile of the second SmartBall vs. Time of Day

5 Conclusions

From the results of the data analysis, it can be concluded that no acoustic anomalies were present within the detection limit of both SmartBall tools for this line, under the operating conditions at the time of inspection.

Table 5.1: Project Details	
Item	**Details**
Total Length Inspected:	21,777 ft feet
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Average SmartBall 2 (PT-7276) Tool Velocity:	8.1 ft/s