SmartBall® Dual Inspection Report

Prepared for
Enbridge

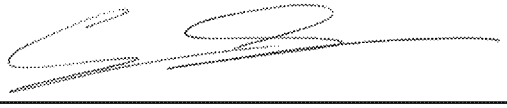
Prepared by
PureHM

Pipeline Number:	Line 5
Pipeline Segment:	Mackinac Straits East Leg
Launch Date:	March 21, 2018
Contact:	Jeremy Ward
Product:	Light Sweet Crude

Line 5 Mackinac 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:



March 29, 2018

Cory Solyom – Business Line Manager - SmartBall — Date

DISCLAIMER

The information provided in this report is not intended to constitute an engineering report and should not be construed as such. The client is advised to retain qualified engineering expertise to interpret the data contained in this report. The information contained in this report is provided 'as is' without warranty of any kind, either express or implied. PureHM is not liable for any lost profits, lost savings or other incidental, special, or consequential damage arising out of the monitoring system or the information contained in this report. Please refer to the terms and conditions attached to the SmartBall® ("the SmartBall") Agreement and PureHM's Technical Support Agreement for further details.

Contains Confidential Information Exempt from Public Disclosure.

	HMUS-PJN000164-001	**Project Name:**	Line 5 Mackinac Straits East Leg
Document Type:	SmartBall Report	Project Manager:	Cory Solyom

Level 1 Reviewer:	Oswaldo Baron	**Amend and Resubmit**	**Amend and Proceed**	**Proceed**
Version Received:	V1.0	☐	☒	☐

Task	Check	Comments
Save a new version with your initials at the end and the date; Track changes	☒	
Document formatting matches the most current internal standard	☒	
Page numbers, table numbers, and figure numbers have been checked	☒	
Word choices and legal names are consistent within the document and agree with the current internal standard (see template folder)	☒	
Grammar, sentence flow, and sentence clarity have been checked	☒	
Signature:	**Date:**	**March 28, 2018**

Level 2 Reviewer:	Robert Lennox	**Amend and Resubmit**	**Amend and Proceed**	**Proceed**
Version Received:	V1.1	☐	☐	☒

Task	Check	Comments
Save a new version with your initials at the end and the date; Track changes	☒	
All document components have been checked for technical correctness	☒	
Supporting information is correct and relevant (e.g., project background, appendices)	☒	
Document fulfills contract requirements	☒	
Signature:	**Date:**	**March 28, 2018**

Level 3 Reviewer:	Cory Solyom	**Amend and Resubmit**	**Amend and Proceed**	**Proceed**
Version Received:	V1.2	☐	☐	☒

Task	Check	Comments
Save a new version with your initials at the end and the date; Track changes	☒	
Review the executive summary for technical quality and contract completeness	☒	
Review recommendations for accuracy and feasibility	☒	
Optional Review the entire document for technical quality and contract completeness	☒	
Signature:	**Date:**	**March 28, 2018**

Contains Confidential Information Exempt from Public Disclosure.

Table of Contents

1. Executive Summary 4
   1.1 Run Success Commentary 4
2. Project Background 5
   2.1 Description of the Subject Pipeline 5
3. SmartBall Inspection Details 6
   3.1 Planning Document 6
   3.2 SmartBall Launch 6
   3.3 SmartBall Tool Retrieval 6
   3.4 AGM Locations and Tracking 6
4. Inspection Results 7
   4.1 Acoustic Anomaly 7
   4.2 SmartBall Inspection Results 9
   4.3 Temperature and Pressure of the SmartBall Inspections 10
5. Conclusions 12

Contains Confidential Information Exempt from Public Disclosure.

1. Executive Summary

Enbridge retained the services of PureHM Inc. (PureHM) to perform a dual SmartBall® inspection of Line 5 Mackinac Straits East Leg from the North Straits East (NOE) station to Mackinac East Loop (MAEL) station on March 21, 2018. Line 5 Mackinac Straits East Leg is a carbon steel pipeline that transfers light sweet crude from the NOE station to the MAEL station. 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 station with a 1 hour separation from each other. 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 (4.12 Miles)
Pipe Material:	Carbon Steel
Diameter of Pipe:	20 inch
Product:	Light Sweet Crude
Acoustic Anomalies Characteristic of Leaks:	0
Duration of the Inspection for SmartBall 1 (PT-7276):	47 minutes
Average SmartBall 1 (PT-7276) Tool Velocity:	7.6 ft/s
Duration of the Inspection for SmartBall 2 (PT-8741):	48 minutes
Average SmartBall 2 (PT-8741) Tool Velocity:	7.5 ft/s

1.1 Run Success Commentary

The SmartBall tools were successfully launched and received. The tools recorded data throughout the entire length of the inspection. During this time the pressure inside the subject pipeline was recorded to be greater than 135 psi for the entire span of the inspected section.

The SmartBall did not roll along the entire length of the inspection but this did not affect the leak detection capabilities of the SmartBall.

The data quality was not negatively affected by any surrounding noise, environmental factors, and 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.

Contains Confidential Information Exempt from Public Disclosure.

2. Project Background

Enbridge retained the services of PureHM to perform a dual SmartBall inspection of Line 5 Mackinac Straits East Leg from the NOE station to MAEL station on March 21, 2018.

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

2.1 Description of the Subject Pipeline

Line 5 Mackinac Straits East Leg is a carbon steel pipeline that transfers light sweet crude from the **North Straits East (NOE) station** to the Mackinac East Loop (MAEL) station. This inspection covers the section of pipe running from the **North Straits East (NOE) station** to the **Mackinac East Loop (MAEL) station** spanning 21,777 feet (4.12 Miles). During the SmartBall inspections, the pressure in the pipeline was recorded to be above 135 psi.

The approximate pipeline location is shown in Figure 2.1.

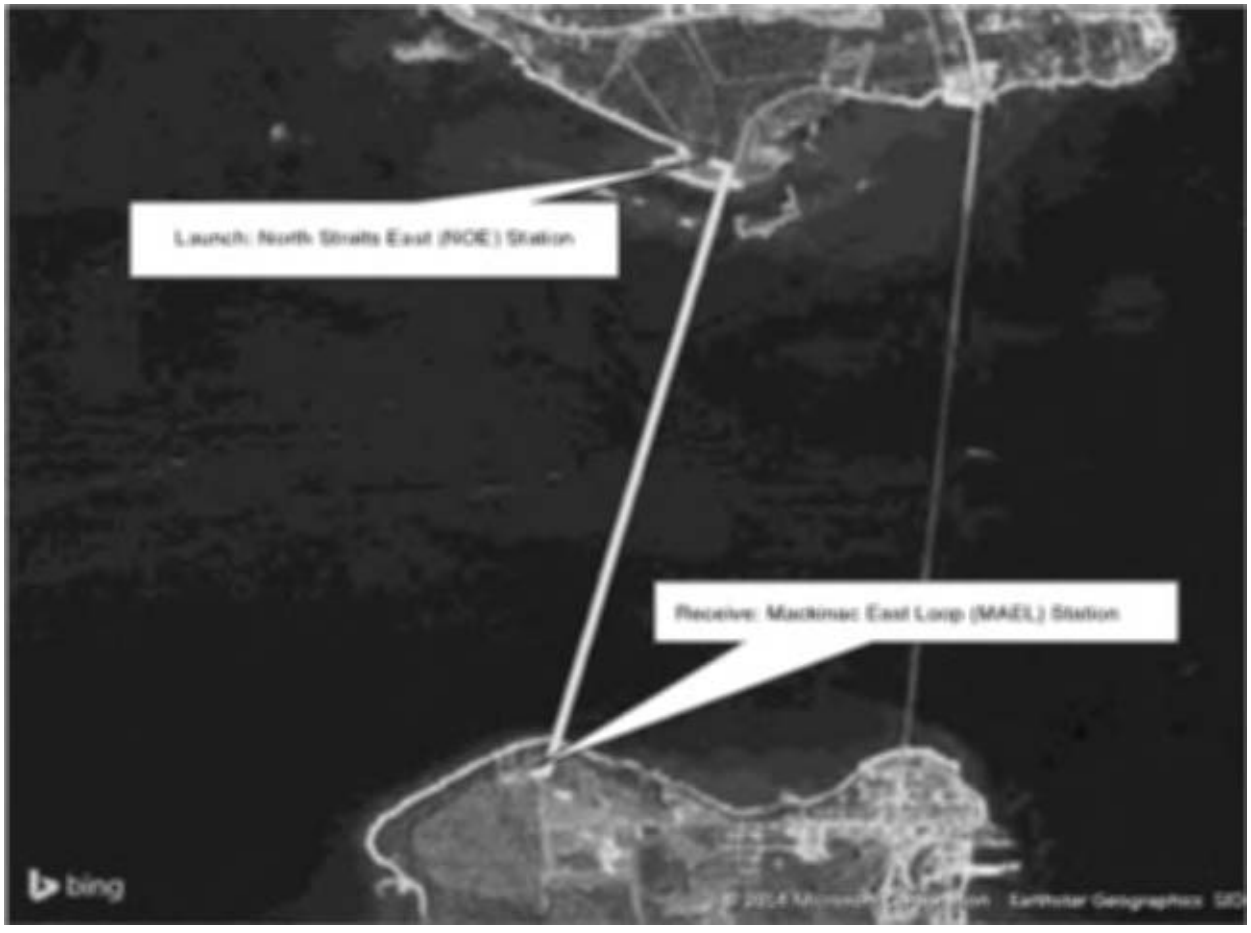


Figure 2.1: General layout of Line 5 Mackinac Straits East Leg

3. SmartBall Inspection Details

3.1 Planning Document

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

The first SmartBall (PT-7276) was launched on March 21, 2018 at 3:38 PM, the second SmartBall (PT-8741) was launched at 4:43 PM.

The SmartBall tools were tracked as they were launched into the main line using a SmartBall Receiver, see Table 3.1 for launch details.

Table 3.1: Launch Schedule

Item	Comments
Location:	North Straits East (NOE) station
Date:	March 21, 2018
SmartBall 1 (PT-7276):	3:38 PM
SmartBall 2 (PT-8741):	4:43 PM

3.3 SmartBall Tool Retrieval

Both inspections were concluded when the second SmartBall had arrived in the extraction trap at the MAEL station on March 21, 2018 at 5:31 PM. The pig trap was not drained and opened until it was confirmed from the operators that the SmartBall tools and the lead pig were in the trap.

3.4 AGM Locations and Tracking

No tracking was performed for this inspection.

Contains Confidential Information Exempt from Public Disclosure.

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).

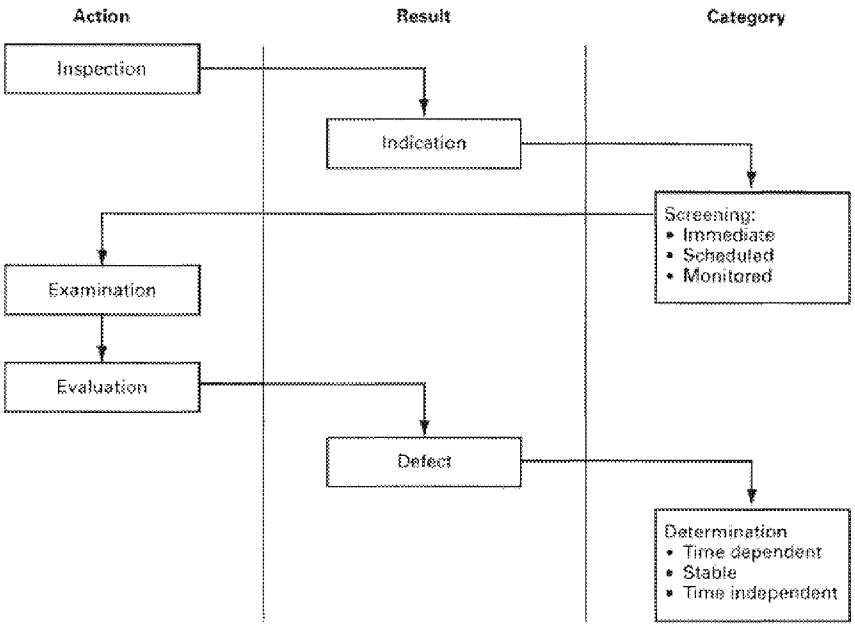


Figure 4.1: Hierarchy of Terminology for Integrity Assessment

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.

Contains Confidential Information Exempt from Public Disclosure.

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.

For both inspections, external transitory acoustic events were identified which are not leak related. These acoustic events may be present in SmartBall inspections although with a different signal intensity in each case, as depicted below in Figures 4.2A and 4.2B.

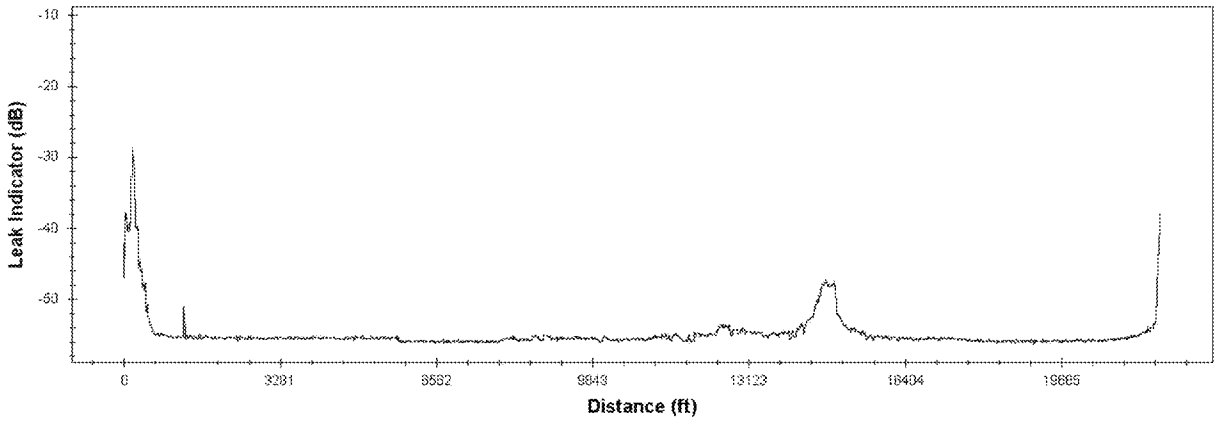


Figure 4.2A: Acoustic summary of the first SmartBall inspection versus Distance Traveled

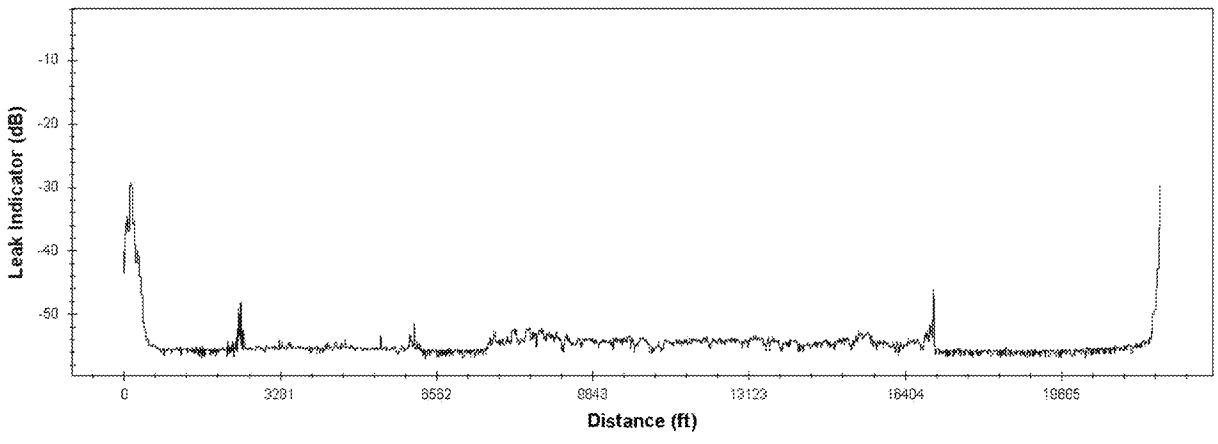


Figure 4.2B: Acoustic summary of the second SmartBall inspection versus Distance Traveled

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.

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 distance.

Figure 4.3C and 4.3D show the corresponding plots of the pressure the first and second SmartBall tools experienced vs distance.

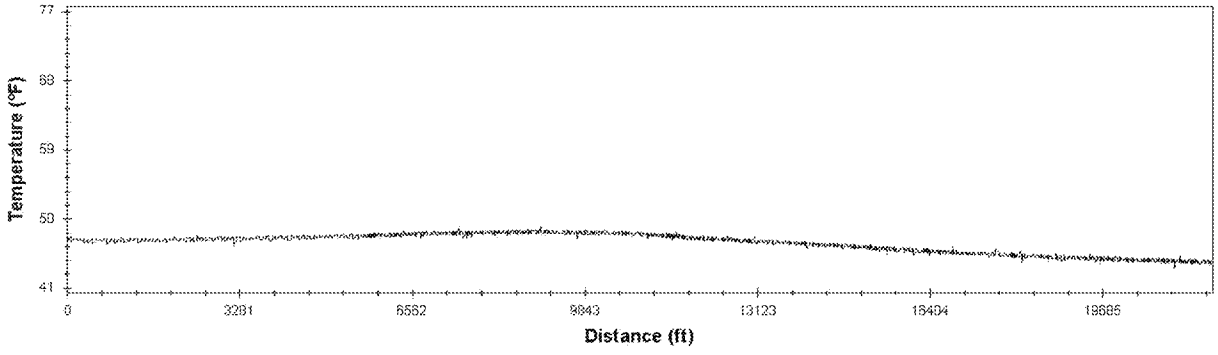


Figure 4.3A: Temperature Profile of the first SmartBall vs. Distance

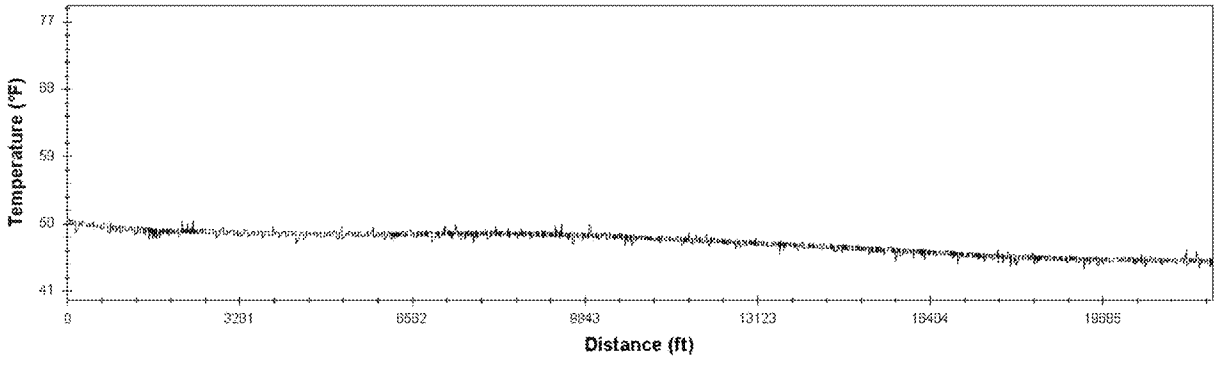


Figure 4.3B: Temperature Profile of the second SmartBall vs. Distance

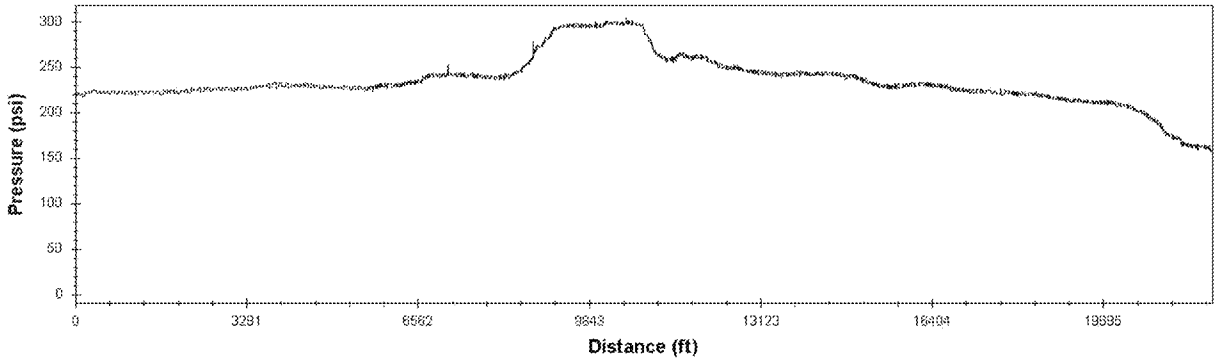


Figure 4.3C Pressure Profile of the first SmartBall vs. Distance

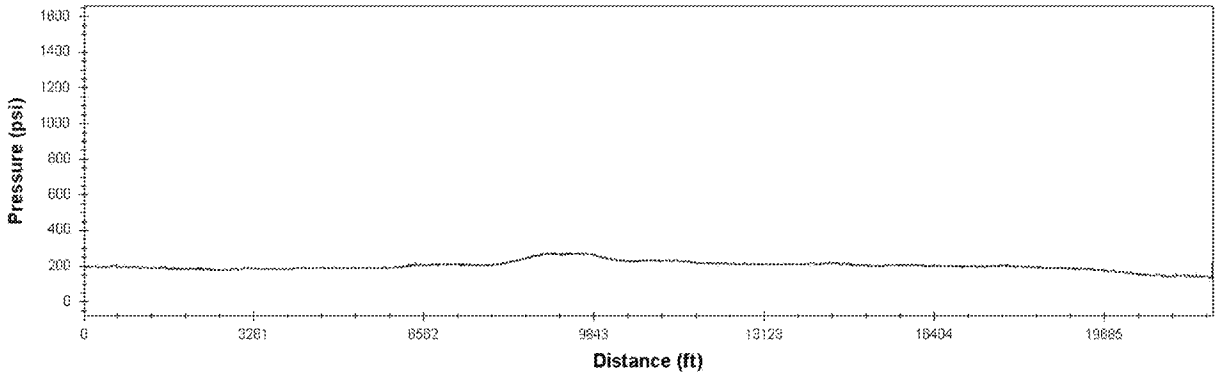


Figure 4.3D Pressure Profile of the second SmartBall vs. Distance

Contains Confidential Information Exempt from Public Disclosure.

5. Conclusions

The SmartBall tools were successfully launched and received. The tools recorded data throughout the entire length of the inspection. During this time the pressure inside the subject pipeline was recorded to be above 135 psi for the entire span of the inspected section. Acoustic anomalies resembling leaks were not found on the Enbridge Line 5 Mackinac Straits East Leg section, within the detection limits of the SmartBalls under the operating conditions at the time of the inspection. The SmartBall did not roll along the entire length of the inspection but this did not affect the leak detection capabilities of the SmartBall.

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.

Table 5.1: Project Details

Item	Details
Total Length Inspected:	21,777 feet (4.12 Miles)
Pipe Material:	Carbon Steel
Diameter of Pipe:	20 inch
Product:	Light Sweet Crude
Acoustic Anomalies Characteristic of Leaks:	0
Duration of the Inspection for SmartBall 1 (PT-7276):	47 minutes
Average SmartBall 1 (PT-7276) Tool Velocity:	7.6 ft/s
Duration of the Inspection for SmartBall 2 (PT-8741):	48 minutes
Average SmartBall 2 (PT-8741) Tool Velocity:	7.5 ft/s

Contains Confidential Information Exempt from Public Disclosure.