# PARTY RESPONSE TO LINE 15 PIPELINE EXPLOSION AND FIRE

**ACCIDENT IDENTIFICATION:**

Operator: Enbridge Inc./Texas Eastern Transmission, LP

Location: Danville, KY

Incident Date: August 1, 2019

NTSB No.: PLD19FR002

**PREPARED BY:** NDT GLOBAL LLC

**SUBMITTED TO:** NATIONAL TRANSPORTATION SAFETY BOARD (NTSB)

NDT GLOBAL LLC
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**AUGUST 27, 2021**

# PREFACE:

NDT Global LLC ("NDT Global") thanks the NTSB, the lead investigator in charge, and the other Party members for the opportunity to contribute to the review of the facts, circumstances, and contributing factors leading up to this incident. NDT Global acknowledges and appreciates the cooperative spirit displayed by all in the investigation of this tragic incident. NDT Global's party status, and in turn its participation in this discussion, took place a significant time after the investigation commenced, and this timing limited our contributions to portions of the review. Nevertheless, we hope that our efforts to supplement the initial factual findings provides all involved a further and more complete understanding of the inspection technologies utilized on the pipelines, including the characteristics and limitations of those technologies. In addition, we hope that our involvement demonstrates the way in which operators, regulators, and other industry participants continue to refine, improve, and develop standards and technologies in order to more accurately identify and mitigate threats to prevent future incidents. NDT Global remains committed to being an active industry participant in promoting the ultimate goal of safety.

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# 1 Incident

As stated in the NTSB Factual Reports: "On August 1, 2019, at 1:23 a.m. Eastern Daylight Time, a 30-inch-diameter natural gas transmission pipeline owned and operated by Enbridge Inc. ("Enbridge") ruptured near Danville, Kentucky." In the years preceding the incident, NDT Systems & Services (America) Inc. ("NDT S&S") inspected this segment (and other segments) of Line 15 as directed by the pipeline operator. NDT Global was not involved in any manner with the ownership, operation, or integrity inspections of this pipeline, and was not involved in the post-site incident response. However, as part of an Asset Purchase from NDT S&S in 2012, NDT Global acquired most of the NDT S&S inspection files. The pertinent details around this transaction are set forth in the series of factual reports issued by the NTSB (the “Factual Reports”).

As detailed in the NTSB Factual Reports, the segment of the Line 15 pipeline involved in the incident was inspected by NDT S&S in 2011. NDT S&S performed its inspection of this segment to identify and mitigate several different threats to the integrity of the pipeline, such as corrosion, construction, in-service damages, and manufacturing defects (e.g., hard spots).

While not involved in the inspection, NDT Global was in possession of the data files from the 2011 inspection by NDT S&S. Accordingly, Enbridge contacted NDT Global to determine if the legacy MFL inspection data on the pipeline system was available, and if NDT Global would be willing to re-analyze it. The legacy inspection data from the Line 15 inspections had been archived and was located in the NDT Global file systems, acquired during the asset purchase from NDT S&S. In addition, NDT Global was invited to be a Party to the investigation only on May 11, 2021, after the Factual Reports were issued. Participation in these activities generated the observations and comments included in this submission.

NDT Global collaboratively worked with Enbridge, and later with the NTSB, to collect and review the data in order to support the factual investigation and findings related to the incident. During this initial period, NDT Global was not a formal Party to the investigation. However, as an active industry participant, NDT Global recognized the opportunity to draw upon its vast expertise in data analytics and in-line inspection technology to assist in the investigation. In doing so, NDT Global believes this work will help the NTSB, PHMSA, and the operating industry, including Enbridge, prevent future pipeline incidents and advance the industry’s understanding of the threats involved.

## Origin and Cause

The Factual Reports cover the construction, inspection, and operation of the pipeline, but the origin and root causes of the incident are still pending as of the date of this submission. In general, the scope of most of the Factual Reports is outside of the sphere of concern of in-line inspection companies. However, NDT Global was able to contribute to the technical review of the inspection data, the evaluation of the relevant standards, the processes that controlled the technology selection for the threat identification, and the technical limitations of in-line inspection systems.

While the NTSB has not formally stated the contributing factors to the incident or established a root cause of the incident, the NTSB Pipeline Operations and Integrity Management and Metallurgical Factual Reports discuss in detail the identification of a hard spot proximate to the origin of the pipe rupture. A "hard spot," according to API 1163, is an area in the pipe with a localized increase in hardness throughout the thickness of a pipe, produced during the hot rolling of a steel plate due to localized quenching. The presence of a hard spot proximate to the pipeline failure origin is a material piece of information. Similar hard spots have been determined to be contributing factors in other non-related prior incidents. While the presence of a hard spot itself is not detrimental to the pipeline, it allows for the potential of other typical operating conditions, e.g., environmental stress and physical damage to the protective coating, to have a larger impact on the integrity of the pipeline by interaction with an otherwise benign hard spot.

To mitigate potential risk factors, including hard spots, the operators, regulators, standards associations, engineering firms, and inspection companies work to reduce the probability that any one of these items will lead to a failure.

## 2 Standards

The Factual Reports cover the standards and processes used at the time to identify, validate, and eliminate pipeline integrity risks using in-line inspection techniques. The Metallurgical Factual Report goes into detail on the Industry standards that address "hard spots" in pipelines:

> *The 6th edition of API Standard 5LX did not address or define a "hard spot" and did not provide a reject criterion for a hard spot. The reject criterion for a hard spot is specified in API Specification 5L, "Specification for Line Pipe." The 42nd edition of API Specification 5L, dated January 2000, states that any hard spot having a minimum dimension greater than 2 inches in any direction and a hardness <u>greater than or equal to 35 HRC</u> (327 HB) shall be rejected. The section of pipe containing the hard spot shall be removed as a cylinder.*

API Standard 5L is the most relevant Industry standard addressing the hard spot threat. The scope of API Specification 5L is strictly limited to the requirements for manufacturing seamless and welded steel pipes for use in pipeline transportation systems in the petroleum and natural gas industries. Since hard spots are created during the manufacturing process, standard scopes that include inspections during manufacturing are the appropriate place for identifying and managing hard spots. As it pertains to the post-failure metallurgical review of the fractured Line 15 pipe condition, API Standard 5L is also appropriate in the assessment of the material and its susceptibility to environmental conditions. The NTSB investigators point out in the Factual Reports that API Standard 5LX, available at the time of manufacturing, did not address hard spots. The Factual Reports do not differentiate applying the API 5L Standard to the inspecting/remediating pipe at the time of manufacture from applying the same Standard to in-line inspections. The extension of the API 5L standard into the in-line inspection requirements is not appropriate but the application occurs because the Industry lacks definitive requirements or recommended practices on the threat of hard spots. More than seventy years ago, when the Line 15 pipe was manufactured, the Industry was largely unaware of the potential injurious nature of these hard spot features. The Industry also lacked the technology to identify them, either during manufacturing or post-installation. As stated in the Factual Reports, the Industry continued to tighten the controls on these features, as the injurious nature of hard spots became apparent when coupled with other specific operating conditions.

In tightening these controls, and in an effort to provide resources and guidance for operators, NDT Global and other Industry organizations collaborated with regulators to create a new document addressing the assessment of cracks in pipelines. The first edition of API Recommended Practice (RP) 1176 (2016), "Recommended Practice for Assessment and Managing Cracking in Pipelines" provides, among other guidance, the assessment and repair methods for hard spots. API RP 1176 states "High hardness materials can be susceptible to hydrogen assisted cracking, where hardness exceeds about Rockwell C 22 (236 BHN), either in the weld or at a hard spot." It further continues that, "This is most often a factor for pipelines operated with very high CP potentials, wet soil conditions, and where the coating integrity is suspect." According to API RP 1176, the acceptable repair methods for in-service pipelines that contain "cracks in hard spots" are: replacement as a Cylinder; pressure containing sleeve (Type B); and a mechanical Bolt-on Clamp. This Standard was not available in 2011 at the time the operator was conducting Line 15 inspections for hard spots, but demonstrates how the Industry continues to evolve its practices around these types of threats. Unlike the API Standard 5L, API RP 1176's scope specifically addresses and provides guidance to the pipeline Industry:

> *. . . for assessment and management of defects in the form of cracking, with particular emphasis on contributing threats and the applicable assessments."*
> *. . . and . . .*
> *"Although the genesis and structure of this RP is the API 1160 RP for liquid hazardous pipeline managed under U.S. Department of Transportation (DOT) 49 Code of Federal Regulations (CFR) 195.452 of the U.S. federal pipeline safety regulations, this RP is written as a broadly applicable framework for both hazardous liquid and gas pipelines located in any location or under any jurisdiction. This RP augments API 1160 in aiding the development of integrity management programs which are required under U.S. federal pipeline safety regulations.*

While the guidance in the API RP 1176 does attempt to close the gaps between the API 5L manufacturing standard and the needed regulatory practices, the Industry has a varied approach to the implementation of this Standard. Additionally, the technologies to inspect for hard spot threats are still evolving within the Industry and continue to face several technical limitations. API RP 1176 only includes repair guidance for hard spots that contain cracks, and is silent to repairs of hard spots in general. The guidance from the Industry, including the *U.S. Department of Transportation (DOT) 49 Code of Federal Regulations (CFR) 192 of the U.S. federal pipeline* *safety regulations*, is still unclear on the required frequency of inspections for hard spots and the interpretation of stable manufacturing defects, especially with regard to the probability of detection.

The Code of Federal Regulations (CFR) §192.917 clarifies the treatment of threats resulting from manufacturing defects. Since they are created during the manufacturing process, hard spots are considered covered by this portion of the Standard. The 49 CFR 192 leaves the identification and assessments of the threats within the operator integrity management plans.

> CFR §192.917: *(3) Manufacturing and construction defects. If an operator identifies the threat of manufacturing and construction defects (including seam defects) in the covered segment, an operator must analyze the covered segment to determine the risk of failure from these defects. The analysis must consider the results of prior assessments on the covered segment. An operator may consider manufacturing and construction-related defects to be stable defects if the operating pressure on the covered segment has not increased over the maximum operating pressure experienced during the five years preceding identification of the high consequence area. If any of the following changes occur in the covered segment, an operator must prioritize the covered segment as a high risk segment for the baseline assessment or a subsequent reassessment.*
>
> > *(i) Operating pressure increases above the maximum operating pressure experienced during the preceding five years;*
> > *(ii) MAOP increases; or*
> > *(iii) The stresses leading to cyclic fatigue increase*

Pipeline operators, combined with governmental oversight, regularly review applicable threats and develop integrity management programs with the goal of ensuring safe operating conditions. On many occasions NDT Global has worked with the Industry to revise the standards and develop technology to adequately monitor and reduce these threats.

# 3 In-Line Inspection Technology

To support this investigation, NDT Global conducted a review of the technology used by NDT S&S to perform the hard spot inspections on Line 15 noted in the Factual Reports. The NDT S&S hard spot inspection equipment used in 2011 included a ring of "reduced field" sensors at the rear of an MFL tool behind the singular magnetization unit utilized to detect hard spots, Figure 1. These "reduced field" sensors measure the remaining magnetization of the pipe steel after the magnetizer unit has passed the "considered area." Unlike the newer HSMFL tool run post-incident (described and depicted in the Pipeline Operations and Integrity Management Factual Report: Figure 29), the NDT S&S 2011 system did not have a second magnetization unit. The detection of hard spots was dependent on the behavior of residual magnetism of the different microstructures of the base material (X-52) and the quenched (martensitic) microstructure of the hard spot.

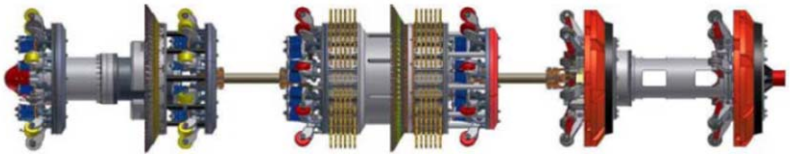


*Figure 1 Depiction of the 2011 NDT S&S HSMFL tool.*

*Diagram by NDT Systems & Services (America) Inc.*

In comparison, the 2020 HSMFL inspection tool had three sections: the first section contains sensors within a high magnetic field unit, followed by a second section with low magnetic field unit with additional sensors. The third section includes the technology to provide the Caliper ILI service described in the Factual Reports, and is not connected with identifying hard spots. The 2020 HSMFL tool contained 912 MFL channel sensors for use in hard spot and material analysis and 576 Electronic Feeler channels for internal metal loss detection and sizing. In comparison, the 2011 HSMFL tool contained merely 186 hard spot/ "reduced field" sensors and 186 corrosion sensors, considerably fewer than the number of sensors reported in the specification sheets for the 2020 HSMFL tool. While NDT Global was not involved in the qualification of the technology used post-incident, the additional sensors, and the newer tool configuration likely provide enhanced detection capabilities over the 2011 MFL tool.

While the 2011 NDT S&S MFL tool was configured to detect hard spots in the Line 15 pipeline, the Brinell hardness of a specific hard spot could not be directly measured in the recorded ILI data such as would be possible through a direct assessment. Instead, and like many other MFL inspection and reporting methods, algorithms in the NDT S&S software were used to calculate the most probable Brinell hardness based on the measured magnetic data. NDT S&S created an algorithm within the software to compare the magnetic signature of a detected hard spot in the data to historical data of field-verified hard spots. Conclusions on the hardness of the considered hard spot were correlated to the field data. In the legacy NDT S&S ILI software, the comparison is done using a "calibration curve," which was configured using the historical data, test spool qualifications, and regression techniques.

The Brinell hardness of a hard spot is determined by comparing the measured peak-to-baseline amplitude in the axial field and the background magnetization (i.e., the measured magnetic field in the surrounding area). The measurement is unable to account for the thickness of the hard spot, which is a principal variable of the residual magnetism. The thickness of the hard spot has a strong effect on the MFL signals, but the NDT S&S MFL software was unable to separate the impact of the thickness of the feature from the relative hardness of the hard spot.

The basic shape of the NDT S&S calibration curve was fixed and comprised 180 values ranging from a Brinell hardness of 235.5 to a Brinell hardness of 434.5. The system could not report values lower than 235.5 Brinell and could not report values higher than 434.5 Brinell.

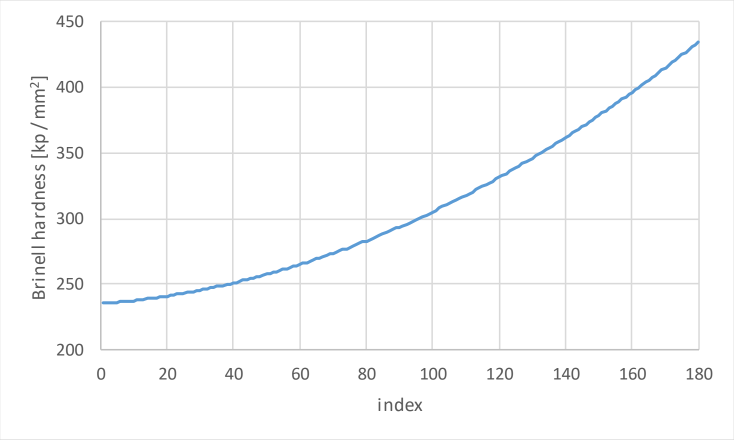


*Figure 2 Calibration curve used for calculating the Brinell hardness of a hard spot.*

Data analysts, such as those who reviewed the Line 15 data, would visually identify indications in the MFL data but did not have the ability to control the software's assessment of the hardness value. The hardness value was provided by the system’s algorithm and recorded by the analyst in the report provided to the client. The NDT S&S specification sheet and marketing documentation stated the reported hardness value had a +/- 50 BHN tolerance. The tolerance was based on the historical performance of the curve when compared to field and initial testing results completed by NDT S&S. Unlike the NDT S&S MFL data algorithm used to identify metal loss, the hard spot algorithm did not have a software check that reviewed the data identified or selected by the analyst. Any data identified or selected by the analyst, even an area with no apparent hard spot, would be given a Brinell Hardness value between 235.5 and 434.5.

Today's in-line inspection data analytic techniques have progressed with layers of controls, including artificial intelligence (AI) and machine learning (ML) techniques that augment rule-based coding and quality control oversight techniques. These controls improve the quality of the information provided to operators and help ensure the technology and data review have generated, within the limits of the technology, an accurate characterization of the pipeline condition. These tools were not available for application to the data during either the initial inspection or the re-analysis of the data in 2019.

The NTSB Factual Reports covered the history of in-line inspections performed on Line 15 since its installation. The Factual Report also describes NDT Global's departure from the use of MFL technology and the version of this technology adapted to inspect for variations in material hardness. NDT Global has, since 2012, focused technology on ultrasonic technologies used to detect pipeline threats and is recognized as the Industry leader in this space. As a result of the focus on ultrasonic technology developments, the MFL inspections and the continuing evolution of the technology were left to others in the Industry.

With the implementation of ultrasonic technology for in-line inspections, NDT Global has delivered significant improvements in the ability to recognize and characterize defects. NDT Global has led the Industry in ultrasonic crack detection and metal loss. The evolution of this technology has increased the probability of detection, provided enhanced clarity around features detected with the complex inspection systems, and leveraged AI/ML to supplement the human analyst’s work. Many of these technological advancements have been supported by Industry operators, like Enbridge, that provide both technical and financial support for industry research and development. NDT Global's advancements were also followed with improvements in the MFL technology by others in the Industry that perform MFL In-line inspection services.

Figure 3 NDT Global Ultrasonic Technology Evolution

## 4 NDT Global's Post-Incident Data Analysis and Results

Shortly after the failure and during the on-scene NTSB investigation, NDT Global was contacted to locate and "re-analyze" the data from the 2011 MFL hard spot Line 15 inspection. While MFL inspections and MFL hard spot analysis were not within its current service offerings, NDT Global agreed to review the data in support of the investigation. The request for NDT Global to review the data was made by Enbridge and occurred prior to NDT Global’s addition as a Party to the investigation.

NDT Global's initial review of the data highlighted a significant number of hard spot indications that were not reported in 2011 by NDT S&S. Indications as defined by API Standard 1163 are: "A signal from an in-line inspection system. An indication may further be classified or characterized as an anomaly, imperfection, or component." The indications were "further classified" as Non-Corrosion Anomalies (NCA) by the NDT Global data analysts. Anomalies are: "unexamined deviations from the norm in the pipe material, coatings, or welds" according to the API STD 1163. The Factual Reports highlight the difference between the original 14 reported anomalies (NDT S&S) and the 438 hard spot anomalies reported in 2019 by NDT Global. NDT Global provided an initial explanation for the difference in results as part of the re-analysis, which is covered in the Factual Reports. The results were influenced by the conservative approach NDT Global took to the data review following the pipeline failure; in order to ensure the investigation team was provided with the information needed to ensure the pipeline integrity, NDT Global reported every hard spot indication "(however minor)." This approach would not have been typical during normal pipeline inspections and likely would not have been the approach undertaken by NDT S&S. The information available from the time of the inspection showed NDT S&S typically reported features above 250 BHN. This is consistent with the technical review of the calibration curve data. In a full review of the historical data, NDT Global did find other occasions where hard spot indications below 250 BHN were reported by the NDT S&S analysts. However, most of these reported indications were within the same joint as other hard spot features that were over the 250 Brinell value.

As part of the re-analysis, NDT Global provided an expedited initial review of the 2011 inspection data for the failed joint to the on-site investigation team. The data analyst highlighted nine hard spot indications within the failed joint. A similar set of information using the high contrast view is included in the Factual Reports as provided by NDT Global. The view below in Figure 4, however, is the typical view used by data analysts for the inspection review.

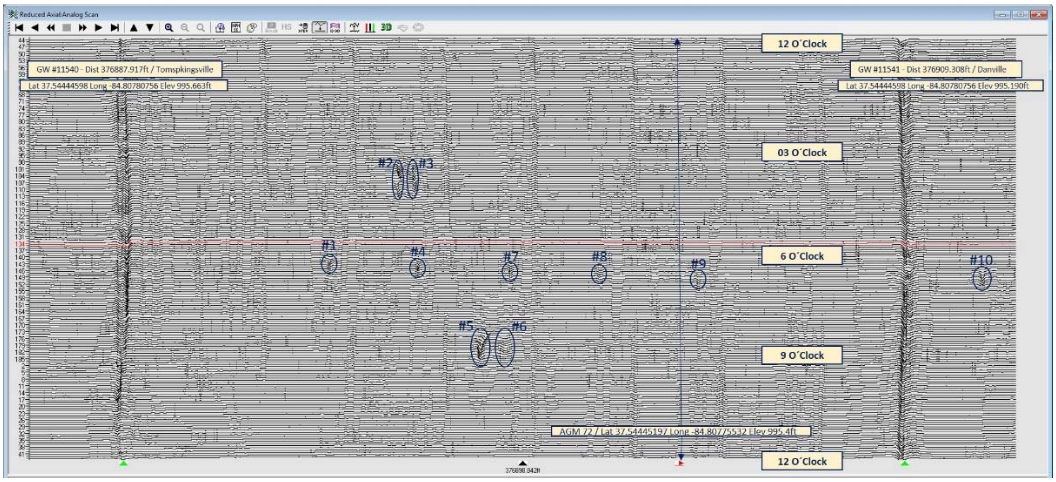
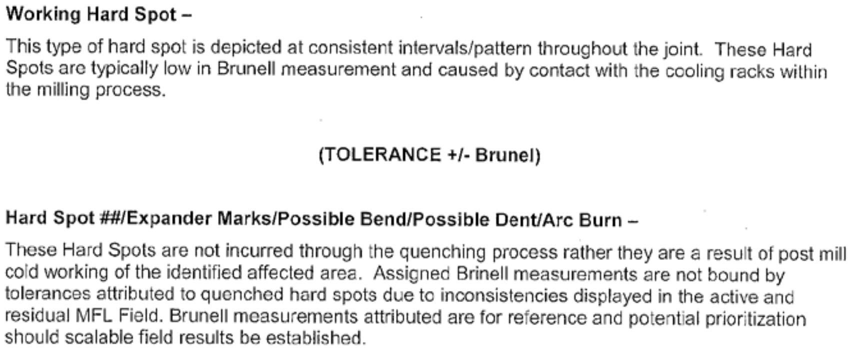


Figure 1 Analog Reduced axial scan of the failed joint on Line 15.

Indication "4," reviewed in detail within the Mears report in Appendix 5, was indicated by NDT Global at a hardness value of 236 BHN. The NTSB Metallurgical Factual Report showed no evidence of an elevated hardness reading in this area. The indication "4" was reported at regular spacing, and within the same general "clock" orientation, as four other hard spots in the failed joint (#1, #7, #8, #9). An additional indication (#10) is at the same apparent "clock" position and has a similar reported hardness value, 238 BHN.

NDT Global found that 235.5 BHN is the lowest evaluation value the NDT S&S ILI software system could report within the embedded calibration algorithm. Six of the 10 indications identified in the 2019 NDT Global review were reported at 236 BHN, or the lowest value allowed by the software.

The NDT S&S Hard Spot specification sheet reviews working hard spots and expander marks. The specification sheet indicates the software "Assigned Brinell measurements are not bound by the tolerances attributed to quenched hard spots…."



**Working Hard Spot –**

This type of hard spot is depicted at consistent intervals/pattern throughout the joint. These Hard Spots are typically low in Brunell measurement and caused by contact with the cooling racks within the milling process.

**(TOLERANCE +/- Brunel)**

**Hard Spot ##/Expander Marks/Possible Bend/Possible Dent/Arc Burn –**

These Hard Spots are not incurred through the quenching process rather they are a result of post mill cold working of the identified affected area. Assigned Brinell measurements are not bound by tolerances attributed to quenched hard spots due to inconsistencies displayed in the active and residual MFL Field. Brunell measurements attributed are for reference and potential prioritization should scalable field results be established.

*Figure 2 Screen Capture from the NDT S&S Hard Spot Specification Sheet*

While NDT Global was not able to directly examine the six features, the data are consistent with expander marks found in vintage hot-rolled steel created during the rounding process by pressure from the expanding machine mandrel.

During the NTSB examination of the ejected pipe segment, the general area of the fracture origin was hardness tested using a portable hardness tester. NDT Global was not consulted or involved in the metallurgical review of the failed joint or in subsequent field reviews conducted by the operator. These examinations were post-explosion and after the segment was subjected to an undetermined amount of heat. It is unclear in the NTSB Factual Reports how, and if, the pipeline explosion itself impacted the fracture and surrounding areas. According to the Factual Reports, the portable hardness testing indicated "an elevated hardness level relative to the surrounding areas." The highest level of measured hardness was 336 Brinell (BHN). This area of elevated hardness was proximate to the hard spot indication #2 and #3 reported by NDT Global in the expedited report and later in the re-analysis report. The indications #2 and #3 were reported to have an elevated hardness of 245 and 241 BHN respectively. Neither indications from the inspection in 2011 matched the reported hardness in the NTSB metallurgical review. It is unclear from the NDT Global review of the technology, the inspection data, and the information in the Metallurgical report why the hardness values collected by the NDT S&S MFL inspection system did not match the post-incident results. The NDT S&S technology was Industry leading at the time of the inspection in 2011. Enbridge was ahead of the industry in evaluating pipeline systems for hard spot threats through the application of this technology. As with all inspection technology, the NDT S&S MFL inspection tool had limitations related to the several metallurgical factors and the system's Probability of Detection.

The next step in the inspection process would have been a direct physical inspection of the anomalies that met the operator's required assessment thresholds. These are typically used to provide feedback on the technology and allow for further calibration of the assessment techniques. Some of the assessment surveys are detailed in the Factual Reports. NDT Global does not have independent records, either in the legacy NDT S&S files or in the recent NDT Global records, of these assessments.

# 5 Technical Advancements with In-line Inspection Techniques

The NTSB Factual Reports and API 1160 review the potential interactions between hard spots of susceptible microstructure that have a higher potential for hydrogen cracking and other pipeline operating conditions. Conditions specifically called out in the report are operating stress, cathodic protections levels, presence of sour gas, high soil acidity, and pipeline coating integrity. Most of these interacting threats fall outside of the in-line inspection companies' scope of work.

Currently the Industry is using direct assessment and close interval surveys (CIS) to potentially find and address coating defects. However, these methods were not specifically engineered to address coating integrity, and are an inefficient approach to identifying coating integrity concerns over a pipeline system.

## In-line Inspection Technology Use for Coating Assessment

NDT Global developed an ILI technique, Acoustic Resonance Technique (ART), for use in gas and liquid lines. ART technology is an acoustic technique in which wideband acoustic pulses are transmitted towards the pipe wall. The signals that are reflected from the target contain a signature which is characteristic of the wall thickness and coating condition. Analysis of the reflected signal yields an accurate, direct measurement of the wall thickness, pipeline geometry, and coating condition. ART is a direct measurement method and requires knowledge of the speed of sound in the pipe wall material.

The ART tools were originally developed for the gas networks that can have multiple diameters in the same section, high wall thicknesses up to 75mm and high gas pressure and flow. ART has been rigorously tested and qualified to successfully run in the most challenging conditions with excellent results, including safely traversing all pipelines inspected and providing value-added data that shows a significant improvement to identification and sizing of features compared to alternative techniques. The returned sound energy from the pipe, tail energy, can be evaluated to assess the level of signal attenuation (or dampening) of the signal. If there is an area of disbondment, a significant increase in tail energy will occur. This technique provides an indication of the condition of the coating.

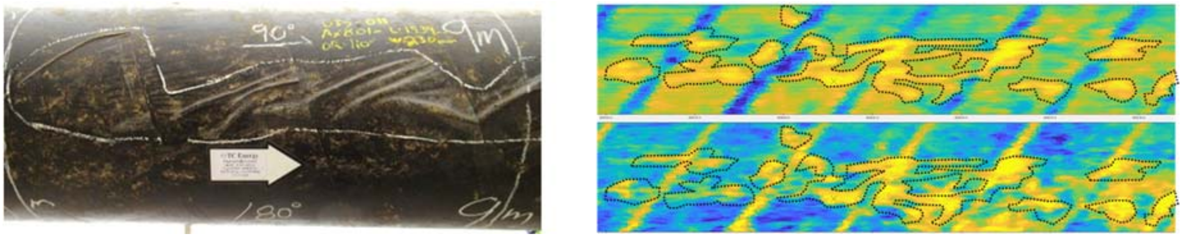
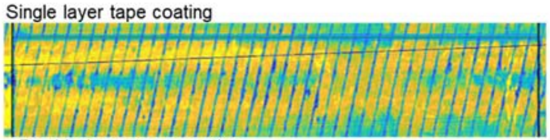


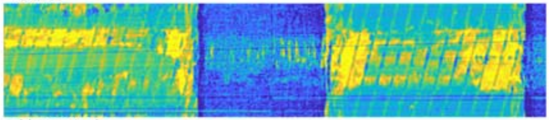
Figure 3 Identification of coating features

Detection of indications of coating disbondment relies on identifying change in the signal attenuation compared to the adjacent area. The relative difference in the tail energy values will depend largely on the external interface, which in turn is affected by the acoustic impedance of the two materials.  Whenever there is an energy difference exclusively in the tail energy plot, it is due to coating disbondment or a change in the coating, e.g., a double coating layer.

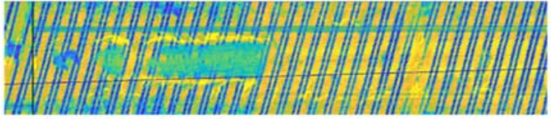
Single layer tape coating



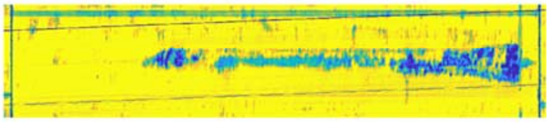
Other



Double layer tape coating



Uncoated



FBE (in-site application)

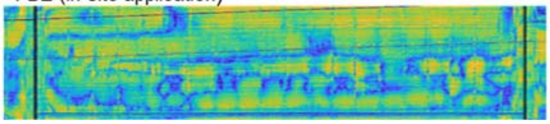


Figure 4 Coating Disbondment

To illustrate the effectiveness of this technique, NDT Global conducted performance testing on a 24" pipe (WT 11.9 mm) with cracked and disbonded coal tar coating. This coating is similar to the coating found on Line 15. The test yields wall thickness measurements and highlights areas without coating or with disbonded coating. For areas with interacting threats susceptible to coating conditions, the technology provides an alternative or supplementation to the CIS and current direct assessment methods.

Features:

1. Represents nominal wall thickness with no coating (residual coating on steel).
2. Metal loss with no coating
3. Natural cracked coating
4. Internal metal loss feature
5. Hidden feature. No visual on anomaly.

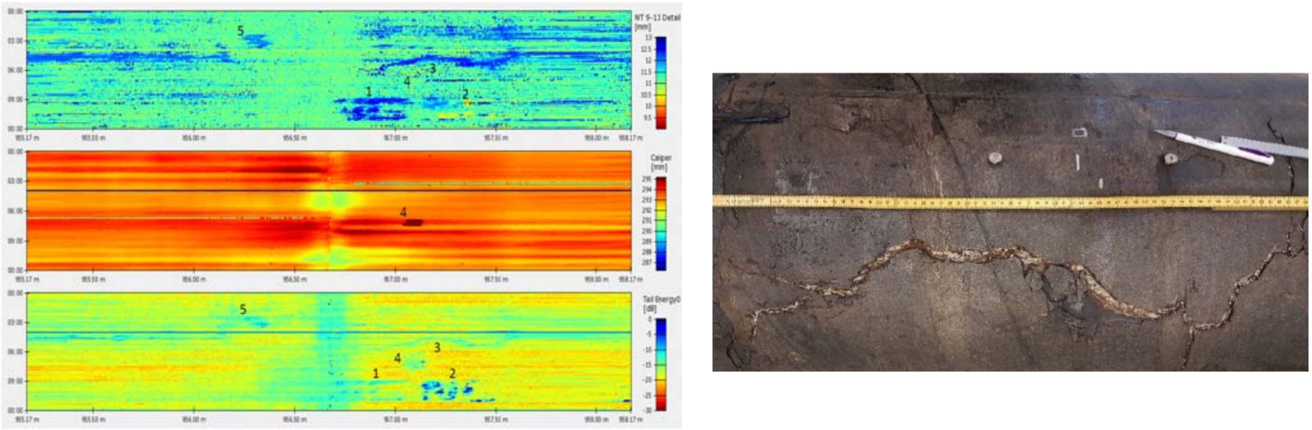


*Figure 5 Results from Coating Disbondment Testing*

To fully deploy these new technologies, NDT Global depends on the support from the operating and regulatory communities. Many of the advancements in threat detection and assessment systems have been supported by various operators, including technical and financial support from Enbridge. Without access to these key resources, the new technology needed to strengthen pipeline integrity would not be possible.

## 6 Conclusion

The NTSB initiated its investigation shortly after the pipeline incident. NDT Global supported these efforts in the early portion of the investigation but was not invited by the NTSB to become a formal part of the investigation until May 2021. Since accepting the NTSB's invitation to formally participate in the investigation as of May 11, 2021, NDT Global has leveraged its resources to conduct a considered and substantive review of the incident, technology, and causal factors. NDT Global hopes its effort to contribute to this investigation assist the Industry and regulators to understand the contributing factors and ensure pipeline integrity across the infrastructure network.

NDT Global strategically applies in-line inspection technologies to detect, diagnose, and model pipeline integrity threats like circumferential or axial cracks, metal loss, geometry, mapping, and coating condition so asset owners can be confident they are taking the right actions to maintain the integrity of their pipelines. Predictive, decision-ready insights, driven by the world's most accurate data, all serve to enable optimal asset health and operational efficiency.

NDT Global will continue its research and development to further evolve detection and assessment technologies. This includes the development and introduction of new tools, improved hardware, integration of artificial intelligence/ machine learning, and the adoption of Industry leading practices. NDT Global’s ongoing work with Industry bodies and operators to evaluate the effectiveness of standards and inspection frequencies is a core part of the value NDT Global brings to pipeline safety and further reflects its ongoing investment in its human capital; the technical personnel who facilitate and promote this important collaboration.

NDT Global remains fully committed to the safety of the systems it inspects and the communities that live near and depend on the resources they deliver. To that end, NDT Global, and its team of capable engineers, analysts, and executives, stands ready to assist operators, regulators, and other Industry participants in the development and implementation of effective technologies to identify and mitigate risks.