Enbridge Pipelines Inc.
Pipeline Integrity – U.S. NDE
Scope of Work

This Scope of Work applies to the mainline excavation and inspection of Enbridge Pipelines Inc pipelines. This Scope of Work may be extended to direct or indirect affiliates of Enbridge.

The Vendor shall have the following responsibilities:

Provide necessary personnel, including Technicians and equipment to carry out the Services in relation to an Inspection Project.

Provide necessary personnel and equipment to carry out the lab work.

Provide necessary personnel and equipment to carry out Project Management of each Inspection Project. The Project Manager shall be the prime contact for Enbridge.

Sufficient support personnel shall be maintained to meet the reporting requirements, technical requirements and deadlines.

An internet site with secure log-in for Enbridge to review documents and information placed there by Vendor in relation to the Services.

The Vendor, through its Project Manager or designate, shall complete the following duties:

Ensure Technicians and other personnel have the appropriate and necessary qualifications prior to dispatching the Technicians and other personnel for the Inspection Project.

Maintain the most up to date Technician training records and reports, available for inspection and audit by Enbridge.

Ensure the accuracy of documentation, including the Final Report, provided to Enbridge, including:

- Appropriate measurement units
- Completeness of data entry into report, pictures, and comments within the deadline for reporting.
- Electronic file type and configuration.

Equipment Requirements

Equipment supplied by Vendor to perform Inspection Projects shall be fully operational and in good condition. The Equipment shall be tested and calibrated to provide accurate measurement results using industry best practices and Vendor procedures.

Technician Qualifications and Training Requirements

The on-site Technicians and personnel of the Vendor shall be made up of at least one Lead Technician and if necessary due to the magnitude or scope of the project, one Junior Technician. The training and experience levels shall be documented and stored by Vendor and made available to Enbridge upon request. A summary table of the Technicians' training and certifications shall be posted on the Vendor's website.

The Lead Technician shall have the following qualifications and training requirements as a minimum:

- SNT-TC-1A Level 2 UT and MT certifications
- field experience which demonstrates the capability to perform pipeline inspection services
- shall be ultimately responsible for the assessment(s) being performed, whether performed by himself or by the Junior Technician.

The Junior Technician shall have the following minimum qualifications and training requirements:

- SNT-TC-1A Level 1 MT certification
- No requirement for industry and field experience

The Vendor shall provide a Final Report within 30 days following the completion of each Inspection Project.

External Corrosion Excavation

1. Visually inspect the entire exterior of the pipeline to identify areas for further inspection.

2. Perform Magnetic Particle Testing (MT) of all exposed welds on the Pipeline, including the longseams, girthwelds, and existing fillet welds:

   2.1. Black on white contrast magnetic particle inspection technique
   2.2. Inspect for longitudinal and circumferential linear indications near, adjacent, and in the weld

3. MT all external corrosion areas and areas of coating disbondment for stress corrosion cracking. MT process shall be black on white contrast magnetic particle technique.

4. Assess corrosion features as per Enbridge Operations & Maintenance Procedures (O&MP) Manuals.

5. Assess all other anomalies as per the Enbridge O&MP Manuals, the Enbridge Engineering Standards. Contact Pipeline Integrity if additional assistance is required to evaluate anomalies.

6. Report all corrosion features deeper than 20%.

7. Report, including an RStreng calculation, at least 2 corrosion features (the worst features) on every dig site, even if those features are less than 20% deep.

8. Contact Enbridge Pipeline Integrity, immediately if any of the following occurs:

   8.1. If the field measured maximum depth of a metal loss feature compared with the ILI data provided by the Company is greater than +/- 15%, including unreported ILI defects deeper than 15%.

   8.2. If the field RPR as compared with an ultrasonic in-line inspection tool RPR is greater than +/- 0.10; including unreported ILI defects worse than 1.00.

   8.3. If the field RPR as compared with a magnetic flux leakage (MFL) in-line inspection tool RPR is greater than +/- 0.10, including unreported ILI defects worse than 1.00.

9. Determine soil pH and ORP on site. No soil samples are to be collected and/or analyzed unless instructed otherwise.

10. If the nominal wall thickness indicated on the Dig Package is different than the nominal wall thickness for that joint as found in the ditch, contact Pipeline Integrity to confirm the appropriate nominal thickness to use at that location.

    Corrosion Inspection Notes:

    The pass/fail critieria for depth varies between internal corrosion and external corrosion as well as corrosion of welds and heat affected zones.

    When using an automated scanner and data loss occurs during scanning across welds, the thinnest wall thickness in the vicinity shall be used as the remaining wall thickness for those locations as a preliminary fitness for purpose calculation.

Internal Corrosion Excavation

1. Visually inspect the entire exposed pipeline to identify areas for further inspection.

2. Perform MT on all exposed welds, including the long seams, girthwelds, and any fillet welds.

   2.1. Black on white contrast magnetic particle inspection technique

   2.2. Inspect for longitudinal and circumferential linear indications near, adjacent, and in the weld.

3. MT all external corrosion areas and areas of coating disbondment for stress corrosion cracking.

4. Perform UT with an automated ultrasonic scanning apparatus, ensuring adequate area of scanning to inspect the areas identified by in-line inspection.

5. Assess all other anomalies as per the Enbridge O&MP Manuals, the Enbridge Engineering Standards. Contact Enbridge Pipeline Integrity if additional assistance is required to evaluate anomalies.

6. Report all corrosion features deeper than 20%.

7. Report, including an RStreng calculation, at least 2 corrosion features (visually “worst” features) on every dig site, even if those features are less than 20% deep.

8. Determine soil pH and ORP on site. No soil samples are to be collected and/or analyzed unless instructed otherwise.

9. Contact Enbridge Pipeline Integrity, immediately if any of the following occurs:

   9.1. If the field measured maximum depth of a metal loss feature compared with the ILI report is greater than +/- 15%;
   9.2. If the field RPR as compared with an ultrasonic ILI tool RPR is greater than +/- 0.10;
   9.3. If the field RPR as compared with a magnetic flux leakage (MFL) ILI tool RPR is greater than +/- 0.15.

Internal Corrosion Inspection Notes

The pass/fail critieria for depth varies between internal corrosion and external corrosion as well as corrosion of welds and heat affected zones

When corrosion occurs across, near, or in girthwelds, the girthwelds should be inspected for other flaws, including but not limited to lack of fusion and internal or subsurface defects. Buffing of the corrosion area may be required to inspect the girthweld further but to the Vendor shall ensure no flaws are present prior to grinding.

When using an automated scanner and data loss occurs during scanning across welds, the thinnest wall thickness in the vicinity shall be used as the remaining wall thickness for those locations as a preliminary fitness for purpose calculation.

If internal corrosion continues across at girthweld or longseam weld, inspect the weld specifically as preferential corrosion may occur which is more severe than the pipe body corrosion. This may require buffing of the exterior weld profile however this shall only be done if required and after verifying that no significant corrosion has occurred with pen probes or similar.

Dent / Geometric Anomaly Excavation

1. Visually inspect the entire surface of the Pipeline to identify areas for further inspection.

2. Perform MT on all exposed welds, including the long seams, girthwelds, and any fillet welds.

   2.1. Black on white contrast magnetic particle inspection technique

   2.2. Inspect for longitudinal and circumferential linear indications near, adjacent, and in the weld.

3. Assess dents and other geometric anomalies per Enbridge O&MP Manuals.

4. Assess all other anomalies as per Enbridge O&MP Manuals, and Enbridge Engineering Standards. Contact Pipeline Integrity if additional assistance is required to evaluate anomalies.

5. Perform MT of the dent to inspect for external cracking in all areas of the dent (shoulder, center, & perimeter) for cracks with any orientation (axial to circumferential).

6. Perform angle beam UT of the dent to inspect for internal cracking in all areas of the dent (shoulder, center, & perimeter) for cracks with any orientation (axial to circumferential).

7. Contact Enbridge Pipeline Integrity, immediately if any of the following is found:

   7.1. If there is a gouge in or near the dent.

   7.2. If there is cracking in or near the dent.

8. Note the orientation (angle) of the crack with respect to the axial direction of the pipe. Take close up photos of the crack with a line drawn nearby to indicate the axis of the pipe.

Dent/Gouge Inspection Notes

If a dent is relatively sharp or is in combination with any other feature, contact Enbridge Pipeline Integrity immediately for further guidance on assessing and repairing the defect.

Crack Anomaly Excavation

1. Visually inspect the entire surface of the Pipeline to identify areas for further inspection.

2. Perform MT on all exposed welds, including the long seams, girthwelds, and any fillet welds.

   1.1. Black on white contrast magnetic particle inspection technique

2. Inspect for longitudinal and circumferential linear indications near, adjacent, and in the weld.

3. MT all external corrosion areas and areas of coating disbondment for stress corrosion cracking.

4. Locate in-line inspection reported feature area, perform UT and MT to assess features.

5. Assess and repair as per the Enbridge O&MP Manuals, the Enbridge Standards.

6. Assess all other anomalies as per the Enbridge O&MP Manuals and Enbridge Engineering Standards.

7. All linear indications must be removed by grinding OR enclosed by a pressure containing sleeve unless indicated otherwise by Enbridge.

8. Contact Enbridge Pipeline Integrity, immediately if any of the following occurs:

   8.1. If the field measured maximum depth of a crack feature compared with the ILI report is greater than +/- 15%

   8.2. If the field measured crack size is deeper than 0.040” and longer than 2” and not reported by the crack detection ILI run.

9. The term linear indication is a generic reference to planar defects in the pipe. This would include SCC, long seam toe cracks, lack of fusion and hook cracks in ERW – electric resistance weld – and flash weld pipe.

10. Single Features or Small SCC Features (Length<12”)

    10.1. If the maximum depth is less than 0.040” deep, only the peak depth and length need to be recorded.

    10.2. If the recorded depth is greater or equal to 0.040” deep, record the depth readings at 1” increments, similar to an RStreng (KAPA) assessment. In addition, record the length of the indication that was 0.040” or deeper separately as well as the total defect length.

11. Large SCC Colonies (>12” long)

    11.1. If the maximum depth is less than 0.040” deep, only the peak depth and length need to be recorded.
    11.2. Identify areas within the colony that appear deeper than the typical appearance of the colony and identify subcolonies which visually appear more severe than the overall colony.

11.3. Spot grind to determine the depth of these areas and confirm depth is greater than the typical depth. If deeper than 0.040", treat these areas as a sub colony of the larger colony.

11.4. Report length of the subcolony, which is deeper than 0.040" to assist with comparing to ILI data and the profile of the colony, similar to a single linear indication.

11.5. Report the large colony with dimensions excluding the sub colonies which should be reported separately (ie. peak depth should be less than 0.040" for the large colony).

Repair Sleeve Inspection

1.1. Visual inspection of long seam and fillet welds to ensure welds meet dimensional requirements of procedure (pass sequence, leg length, fill volume)

1.2. MT of fillet welds and long seam welds, as per the Enbridge O&MP Book 3

1.3. Ultrasonic Testing (UT) of fillet welds if MT or visual indications are found and/or at the request of the Technician, the Enbridge employee or designate.

1.4. Complete as-built forms indicating inspection time and location of sleeve referencing upstream and/or downstream girthwelds.

Field NDE feature definitions to used in reporting.

Anomaly Type		Definition	In-Field NDE Techniques
ERW Weld Defects	**Lack of Fusion**	Is a separation created within the volume of any weld due to incomplete melting or fusion of the weld material to either the parent material, or a previous weld pass. The location of this anomaly within the weld volume is determined by the welding process itself (i.e. ERW is located at various depths through the center fusion area, and DSAW is generally a sidewall flaw, but can be located at mid wall along the center where the two passes meet).	Shear Wave UT WCAMT Inspection H.A.L.T. Inspection
	Hook Defect	Is a separation created within the volume of any weld due to incomplete melting or fusion of the weld material to either the parent material. Created during the ERW seam welding process when the parent material is pushed together causing any voids existing in the axial direction to be partially shifted into a circumferential direction as well. Is distinguished from Lack of Fusion by a "J" cross sectional shape.	Zero Degree UT scan Shear Wave UT WCAMT Inspection
Crack		A linear crack with multi-faceted edges existing within a single plane created by the material tearing as the crack propagates through the weld volume, or parent material.	WCAMT Inspection Shear Wave UT H.A.L.T. Inspection Specialized UT
Stress Corrosion Cracking		Interlinking crack clusters that result from the combined influence of pipeline stress and a corrosive external environment.	WCAMT Inspection Specialized UT Shear Wave UT
Miss-Alignment		Is caused when the parent material on either side of the weld volume exist at different depths creating an uneven surface (either OD or ID).	Zero Degree UT Shear Wave UT
Internal Undercut		An irregular groove at the toe of a run in the parent plate, or in a previously deposited weld pass.	Zero Degree UT Shear Wave UT
Incomplete Penetration		A continuous or intermittent (along the center or along one or both sides of the weld) in the surface of a weld running along its length, due to insufficient weld metal.	Zero Degree UT Shear Wave UT
Excess Penetration		A welding flaw created by the welding material to be fused beyond the depth of the parent material on the opposite surface of the weld deposit.	Zero Degree UT Shear Wave UT
Slag Inclusion		A manufacturing or welding flaw created by embedding foreign material, or particles within the parent material or weld volume. These materials / particles can be either soluble or insoluble in nature.	Zero Degree UT Shear Wave UT H.A.L.T. Inspection

Anomaly Type	Definition	In-Field NDE Techniques
Porosity	A welding flaw creating small voids, or gas pockets within the volume of the weld. These usually exist within clusters of several gas pockets together at a certain depth in the material.	Zero Degree UT Shear Wave UT
Lamination	is a void or discontinuity elongated during the manufacturing process embedded within the pipe wall generally existing in a plane parallel to the pipe surface.	Zero Degree UT Shear Wave UT
Mill Scab (external / internal)	is a piece of incompletely bonded parent material, or foreign material that has been embedded and partially or fully removed from either surface of the pipe due to the manufacturing process.	Zero Degree UT Shear Wave UT WCAMT Inspection Pit Gauge Inspection
Manufacturing Defects "Trim Tool Notches"	is a flaw created during the trimming process to remove the internal cap of a long seam when the trim tool creates uniform mechanical gouges along the internal long seam root surface.	Zero Degree UT Shear Wave UT
Dent	A local depression or radial deflection in the pipe surface caused be an external mechanical force without reducing the material wall thickness of the pipe segment.	Zero Degree UT WCAMT Inspection Profile Inspection
External Corrosion	Metal loss due to electrochemical, galvanic, microbiological, or other attack on the pipe due to the external pipe surface being exposed to a corrosive environment surrounding the pipe.	Zero Degree UT WCAMT Inspection Pit Gauge Inspection
Internal Corrosion	Metal loss due to a corrosive / erosive type environment created by the product being transported within the pipe diameter.	Zero Degree UT Shear Wave UT WCAMT Inspection Pit Gauge Inspection
Gouge	A localized flaw created by direct mechanical damage to the pipe surface removing material, possibly creating sharp stress concentrators and work hardening the pipe surface making it more susceptible to cracking.	Zero Degree UT WCAMT Inspection Pit Gauge Inspection
Pipe Slug	Is a imperfection or discontinuity from the manufacturing process that has been embedded within the material on angle possibly connected to either surface of the pipe.	Zero Degree UT Shear Wave UT WCAMT Inspection Pit Gauge Inspection
CAD Welds	Are the welds used to attach test leads to the surface of the pipe at all the testing stations along the length of the pipeline, generally found at the 12:00 position on the pipe.	Zero Degree UT WCAMT Inspection
Welded Attachments	Are the attachments welded to the surface of the pipeline for various reasons (I.e. flanges, valves, hot taps, stopple tees, etc…)	N/A

Anomaly Type	Definition	In-Field NDE Techniques
Welded Sleeves	Any steel sleeve welded to the surface of the pipe to repair known anomalies at various locations along the pipeline.	N/A
Fiberglass Sleeve with Marking Band	Fiberglass sleeves used to repair known anomalies at various locations along the pipeline marked with steel bands to identify its location for future ILI tool runs.	N/A

H.A.L.T.	High Angle Longitudinal Transducer (70L-wave, ID Creep wave)	**WCAMT**	Wet Color Assisted Magnetic Particle Testing
TOFD	Time Of Flight Diffraction		