

Corrosion ILI Program Summary Document

Line 5 ENO-EMA GE MFL 2018

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1.0 Purpose

This document will provide a summary of all aspects associated with the corrosion management program. Contents of this summary may include but it is not limited to:

- Summary of priority notification features
- Summary of the results of Lakehead system integrity remediation process

It is important to consider that this document is a working file that tracks learnings and/or status of the corrosion program. Therefore, all changes to the selection process should be included in the corresponding sections and a clear summary of the learnings and resultant actions should be documented within this document.

All sections that are not applicable to the ILI program should be deleted.

2.0 Scope

This record applies to the ILI reports indicated on the front page of this document. This document will reference Pipeline Integrity (PI) procedures and work instructions as part of the Fitness for Service (FfS) process defined further in Integrated Management System IMS-09.

3.0 Basic Inspection Remarks

Table 1 Previous Inspections

Year Month	ILI Corrosion Tool	ILI Vendor
2017 April	GEMINIMFL	BH
2013 August	MFL	GE
2008 May	MFL	GE
2003 March	MFL	PII
1998 September	Metal Loss	PII

Hazard specific susceptibility ranking for the line is:

External corrosion	Low
Internal Corrosion	Low
Axial slotting corrosion	Low

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4.0 Priority Notification for Imperative Condition

Were there any features reported meeting imperative condition?

☐ Yes
☒ No

If Yes, summarize actions taken for the priority notification(s).

Were there any features not reported as imperative condition that meet the imperative condition criteria?

☐ Yes
☒ No

If Yes, summarize additional actions taken to ensure a successful program.

Were the imperative condition confirmed by NDE?

☐ Yes
☐ No

Summarizes the ILI and field findings

5.0 Inspection Report Review (PI-36) and Remarks

Prepared by: Mengshan Yu Date: 6/22/2018

Approved by: Sameul Cheng Date: 7/10/2018

Complete review based on PI-36 Data Quality Review In-Line Inspection.

Step 1.0 Was the data degraded?

☐ Yes
☒ No

If Yes, explain the cause and affected region of the data degradation. And follow PI-36 to document additional actions taken to ensure a successful program.

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1.3. Inspection Quality

Inspection data was obtained for the full length (4.1 miles) of the pipeline.

The quality of the inspection data is satisfactory and this has enabled a comprehensive assessment of the pipeline to be carried out.

Step 2.0 Do features align with expectations?

☒ Yes

☐ No

The following table summarises the differences in the numbers of reported features between the current inspection and the previous 2013 MFL inspection.

Feature Type	436881_20A - 28 August 2013	450634_20A - 20 March 2018	Comment
External metal loss	0	0	No changes between inspections.
Internal metal loss	9	12	No significant changes between inspections.
External mill/manufacturing faults	71	75	No significant changes between inspections.
Internal mill/manufacturing faults	61	74	No significant changes between inspections.
Dents	0	0	No changes between inspections.
Girth weld anomalies	0	0	No changes between inspections.
Metal objects	0	0	No changes between inspections.
Eccentric casings	0	0	No changes between inspections.
Shell repairs	0	0	No changes between inspections.
Patch repaired spools	0	0	No changes between inspections.

Use Appendix A of PI-36 as guidance.

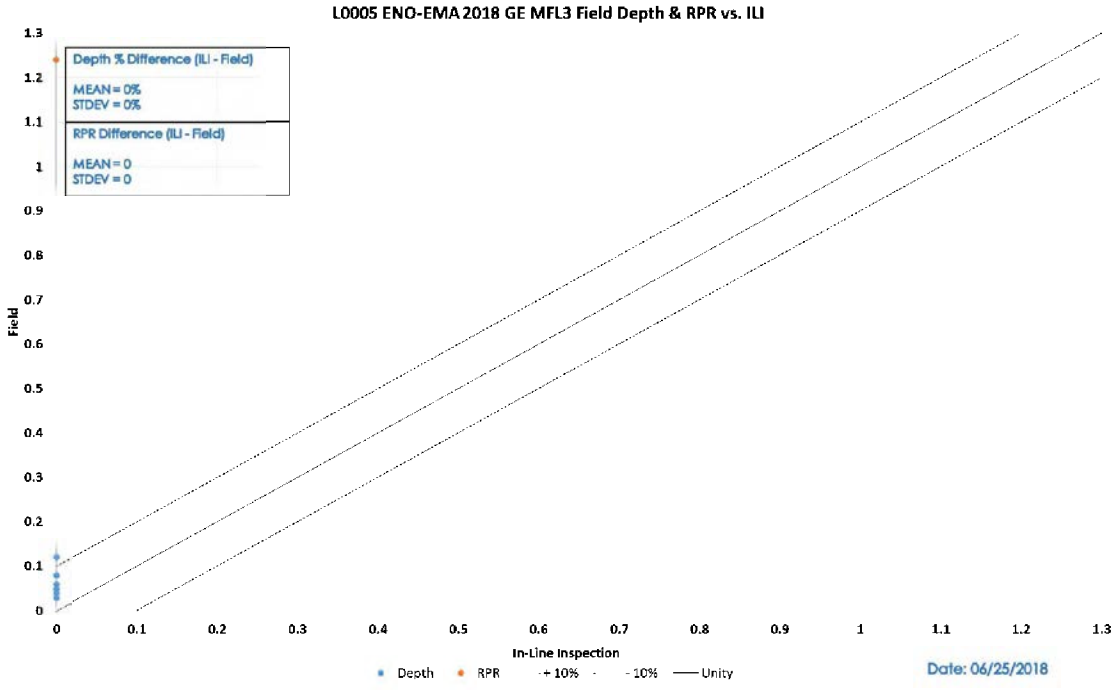
1) No Matched features

2017 BH GEMINIMFL did not report any corrosion features.

Table 2 No matched features cases in PI-36

Current ILI	Previous ILI(2017, GEMINIMFL)	Description	# of features	Comments
2018 GE MFL	>=40%	No Match	**0**	**N/A**
2018 GE MFL	1.0<RPR <1.05	No Match	**0**	**N/A**

2) Preliminary Unity Plot



Probability of Sizing Analysis								
	Pitting	Extended Corrosion	Axial Slotting	Circumferential Slotting	Pinhole	Circumferential Grooving	Axial Grooving	Overall POS
Number of True Positive Features Above Threshold	-	-	-	-	-	-	-	-
POS (%)	-	-	-	-	-	-	-	-

Probability of Detection Analysis								
	Pitting	Extended Corrosion	Axial Slotting	Circumferential Slotting	Pinhole	Circumferential Grooving	Axial Grooving	Overall POD
Number of Features Above Threshold	-	-	-	-	-	-	-	-
POD (%)	-	-	-	-	-	-	-	-

Overall Validation										CEPA Check				
ILI Certainty	Confidence Level	z_α	z_α^2	X	n	$\hat{n}$	$\hat{p}$	$\hat{p}_{upper}$	Result	Avg Combined Tolerance	Std Dev of Error	Result	Mean of Error	General Result
80%	95%	1.645	2.706	0	-1	1.706	73.3%	100.0%	ACCEPTABLE	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

RPR		
Std Dev of Error	Mean of Error	General Result
#DIV/0!	#DIV/0!	N/A

Normal Distribution Check (Depth)			Normal Distribution Check (RPR)		
Skewness	Kurtosis	Result	Skewness	Kurtosis	Result
#DIV/0!	#DIV/0!	N/A	#DIV/0!	#DIV/0!	N/A

Refresh Validation Analysis

3) Near miss and safety and resource (defined in WI-13) outliers of Preliminary Unity Plot

There are no major outliers reported.

Table 3 Summary of significant outliers of Preliminary Unity plot

GW	ILI		Field		Brief Explanation
	Depth	RPR	Depth	RPR	

4) Is Orientation plot as expected?

☒ Yes

☐ No

5) Unexpected feature type?

☐ Yes

☒ No

6) Change in density (+/- 20%) of features >=40%?

☐ Yes

☒ No

Considering features with depths > 10% NWT, the 2018 GE MFL reported 0 external corrosion features and 2 internal corrosion features with a worst depth of 25% NWT. The 2017 BH GEMINI MFL did not report any corrosion features. The internal corrosion features do not meet any excavation criteria.

Considering features with depths > 10% NWT, the 2018 GE MFL reported 73 external and 20 internal manufacturing defects. The 2017 GEMINI MFL reported 0 external and 8 internal manufacturing defects. This discrepancy in reported manufacturing defects and may be partially attributed to the different technologies. In addition, the 2017 GEMINI MFL was run at a tool velocity (> 2 m/s) which resulted in reduced feature detection and sizing specifications; thus it did not report many minor features. The tables below show the change in specification. When compared with the 2013 MFL, the feature counts are similar (as can be seen in the summary table shown earlier).

2. VECTRA/GEMINI Sizing Specification (0.812" at 1 m/s)

	General	Pitting	Axial Grooving	Circ. Grooving	Pinhole	Axial Slotting	Circ. Slotting
Minimum dimensions for sizing accuracy[1]	W>3A L>3A	W>A L>A	W>A L>2A	W>2A L>A	W>0.7A L>0.7A	W>0.7A L>A	W>A L>0.7A
Depth at POD=90%	0.05t	0.08t	0.10t	0.08t	0.20t	0.20t	0.10t
Depth sizing accuracy at 80% certainty	± 0.10t	± 0.10t	± 0.10t	± 0.10t	± 0.20t	± 0.20t	± 0.20t
Width sizing accuracy at 80% certainty	± 0.4-in. ± 10 mm	± 0.4-in. ± 10 mm	± 0.4-in. ± 10 mm	± 0.4-in. ± 10 mm	± 0.4-in. ± 10 mm	± 0.4-in. ± 10 mm	± 0.4-in. ± 10 mm
Length sizing accuracy at 80% certainty	± 0.4-in. ± 10 mm	± 0.4-in. ± 10 mm	± 0.4-in. ± 10 mm	± 0.4-in. ± 10 mm	± 0.4-in. ± 10 mm	± 0.4-in. ± 10 mm	± 0.4-in. ± 10 mm

3. VECTRA/GEMINI Sizing Specification (0.812" at 2 m/s)

	General	Pitting	Axial Grooving	Circ. Grooving	Pinhole	Axial Slotting	Circ. Slotting
Minimum dimensions for sizing accuracy[1]	W>3A L>3A	W>A L>A	W>A L>2A	W>2A L>A	W>0.7A L>0.7A	W>0.7A L>A	W>A L>0.7A
Depth at POD=90%	0.10t	0.10t	0.30t	0.12t	0.30t	0.30t	0.15t
Depth sizing accuracy at 80% certainty	± 0.13t	± 0.13t	± 0.10t	± 0.10t	± 0.25t	± 0.20t	± 0.20t
Width sizing accuracy at 80% certainty	± 0.5-in. ± 13 mm	± 0.5-in. ± 13 mm	± 0.5-in. ± 13 mm	± 0.5-in. ± 13 mm	± 0.5-in. ± 13 mm	± 0.6-in. ± 16 mm	± 0.6-in. ± 16 mm
Length sizing accuracy at 80% certainty	± 0.5-in. ± 13 mm	± 0.5-in. ± 13 mm	± 0.5-in. ± 13 mm	± 0.5-in. ± 13 mm	± 0.5-in. ± 13 mm	± 0.5-in. ± 13 mm	± 0.5-in. ± 13 mm

In addition, seamless pipe presents conditions which, due to the manufacturing process, vary from location to location. As such, ILI anomaly detection and sizing specifications may be impacted by the level of noise observed in each section of seamless pipe. In high noise sections, the detection and sizing specification may increase up to an additional ±10% WT.

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7) At least 60% of the features are >= 20% deeper or >= 20% shallower than previously reported?

☐ Yes

☒ No

8) Is severity, density or unexpected feature type driving investigative dig program and expedite excavation deadlines?

☐ Yes

☒ No

End of PI-36

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6.0 Consent Decree Excavation Criteria

Prepared by: Mengshan Yu Date: 6/22/2018

Approved by: Samuel Cheng Date: 7/10/2018

Table 4 Consent Decree Corrosion Feature Excavation Selection

Criteria	Unmitigated features are selected for excavation (Y/N/NA)
Any corrosion feature with a depth >80% of the wall thickness of the joint where the feature is located	NA
Any corrosion feature with a Predicted Burst Pressure < the established MOP	NA
Any corrosion feature with a Predicted Burst Pressure < 1.39 MOP	NA
Any corrosion feature with a depth>50% wall thickness but < 80% WT	NA
For Line 3 outside an HCA, any corrosion feature with a depth >65% wall thickness but <80% WT	NA
Any corrosion feature with a remaining life < 5 years (Not applicable to Line 3)	NA
Any corrosion feature with a remaining life < 2 times the planned re-inspection interval	NA

Explain if "N" is selected for any criterion

Table 5 Remaining Unmitigated Features **(Updated on 7/10/2018)**

Remaining Unmitigated Features	
The worst depth (%)	25% NWT
The lowest Safety Factor	4.81
The shortest remaining life (years)	5.6 years

If CMFL, continue to **8.0 Fitness-for-Service calculations CMFL ILI (WI-37) and Remarks**

If not CMFL, go to section **10.0 Consent Decree Threat Integration Excavation Selection**

7.0 Consent Decree Threat Integration Excavation Selection

Prepared by: Mengshan Yu Date: 6/25/2018

Approved by: Samuel Cheng Date: 7/10/2018

Table 6 Consent Decree Threat Integration Excavation Selection

Criteria	Unmitigated features are selected for excavation (Y/N/NA)
Any dent located in the top of the pipeline that has any indication of metal loss, cracking, or a stress riser	NA
Any dent located in bottom of the pipe that has any indication of metal loss, cracking, or stress riser	NA
Any case in which a crack feature intersects or interacts with a corrosion feature and the Predicted Burst Pressure of such interacting or intersecting features determined using the CorLAS ™ model is less	NA

than 1.25 MOP	
Any intersecting or interacting crack/corrosion feature with a remaining life < 5 years	NA
Any intersecting or interacting crack/corrosion feature with a remaining life < 2X planned re-inspection	NA

Explain if "N" is selected for any criterion

From Pipeline Listing

ML+Crack

No interactions between metal loss and crack were reported.

ML+deformation

No interactions between metal loss and deformation were reported.

From Feature Match in Threat Integration

ML+Crack

No interactions between metal loss and crack were reported.

ML+deformation

No interactions between metal loss and crack were reported.

8.0 Summary of Consent Decree Excavation Selection

Table 7 Summary of Consent Decree Excavation Selection

Criteria	Number of Features Issued

9.0 Updates based on Statistical Analysis of field data

Prepared by: _____ Date: _____

Approved by: _____ Date: _____

Are additional digs required based on statistical analysis of field data

☐ Yes

☐ No

If Yes, update Table 4 (Remaining Unmitigated Features) and Table 6 (CMFL Remaining Unmitigated axial slotting and seam weld anomaly A/B Features (if applicable)