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In line Inspection (ILI) frequency for Cross Country Pipelines

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ABSTRACT

In line Inspection (ILI) frequency are often based on conditions that are assumed constant over long sections of pipeline – perhaps entire pipeline systems. Many pipeline operators are following the fixed ILI frequency based on statuary requirement irrespective of different local corrosion growth conditions prevailing on the particular pipeline system. Scheduling the ILI based on maximum interval defined in statuary requirement may be very unrealistic and pose threats to the integrity of these pipelines.

This technical paper discusses the importance of ILI frequency, corrosion growth rate analysis, recent development to determine the ILI frequency, an engineering approach to calculate appropriate ILI-Run frequency, mitigation plan to extend the ILI-Run frequency for particular pipeline system. This technical paper would enhance the awareness among the pipeline operators to appropriately calculate the ILI-Run frequency which would cost beneficial to pipeline operators in long term without any integrity threats.

Keywords: ILI, IP Survey, Corrosion Growth, Frequency, Inspection Interval

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INTRODUCTION

In this technical paper, ILI frequency are revisited with respect to the applicable statuary requirements, applicable industry standards, Industry practice, best engineering practices i.e. ASME[1] 31.8S[1], OISD[2] STD-141[2], OISD STD -226[3], OISD SOP-Pipelines[4], NACE[3] SP 0169[5], ISO[4] 15589-1[6] & API[5] RP 1160[7]. In this paper, it is also preferred to consider the results / findings of corrosion growth analysis based two consecutive ILI surveys, previous and existing inspection & monitoring activities to optimize the ILI frequency if possible.

PIPELINE ILI SURVEY

Pipeline in-line inspection is one of the methods to assess the overall integrity of a pipeline for fitness for purpose, to predict the remaining life for safe operations and to take mitigations measures to enhance the pipeline integrity and reliability. Different in-line inspection technologies are exist for detection of different kinds of pipeline anomalies. When in-line inspection is selected to verify the integrity of a pipeline segment, the inspection should be conducted using the appropriate technology to detect anomalies that the operator has reason to believe may exist on a given pipeline. Multiple inspection runs using different tools are prove to be beneficial over running any single tool to detect defects and anomalies.

IMPORTANCE OF ILI INTERVAL

ILI interval is having great importance to a pipeline operator because increase in the ILI interval may lead to pipeline failure / rupture whereas decrease in ILI interval may enhance the operating cost. Therefore, a pipeline operator requires appropriate method to derive a more balanced & cost economical ILI interval which can be adopted to manage the integrity of particular pipeline system without any integrity threat.

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[1] American Society of Mechanical Engineers
[2] Oil Industry Safety Directorate, Govt. of India
[3] National Association of Corrosion Engineers
[4] International Organization of Standardization
[5] American Petroleum Institute

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INDUSTRY STANDARDS OF ILI INTERVAL

Applicable industry / statuary standards for ILI interval are summarized below:

Code / STD / Report	OISD 141-2012	OISD-SOP-2014	API RP 1160-2013	RISK BASED APPROCH
Clause No.	14.4.4	Sr.no. 6 of Table Part-I	9 / Annexure-D	Operator Specific
Min. Required Frequency	**10 yrs for Onshore** **5 yrs for Offshore**	**10 Yrs**	Engineering approach based on Failure pressure Vs Anomaly Size	For Low Risk : **10 Yrs** For Medium Risk : **7.5 Yrs** For High Risk : 5 **Yrs** For Very High Risk : 3 **Yrs**

INDIAN INDUSTRY PRACTICE

Most of Indian pipeline operators follow the maximum frequency of **10 yrs** for onshore pipelines and **5 yrs** for offshore pipelines, following OISD 141-2012.

CORROSION GROWTH ANALYSIS (CGA)

Corrosion growth analysis (CGA) for a particular pipeline system can be done by adopting following methods

HOT SPOT MONITORING:

Baseline ILI survey shall be carried out within 1-2 yrs of pipeline commissioning and few hot spot monitoring location comprising ILI defects having internal corrosion as well as external corrosion, general corrosion as well as pitting corrosion, external corrosion lying in highly corrosive soil areas and external corrosion lying in CP unprotected zones, are selected for time based monitoring. Based on the findings of these hot spot monitoring location, minimum & maximum corrosion rates, average corrosion rates can be predicted for the calculation of most balanced ILI interval. A typical example of corrosion growth analysis based on hot spot monitoring is provided below:

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Table 1

Pipeline Section	Year 2015			Year 2016		
	Nº of Defect Location	Max. Internal Pitting Corrosion rate observed	Max. External Pitting Corrosion rate observed	Nº of Defect Location	Max. Internal Pitting Corrosion rate observed	Max. External Pitting Corrosion rate observed
A-B Section	06	8 MPY	5 MPY	06	10 MPY	4 MPY
B-C Section	10	6 MPY	6 MPY	10	7 MPY	3 MPY

1) CGA BASED ON TWO ILI SURVEYS :

Two consecutive ILI surveys shall be compared for corrosion growth analysis of matching ILI defects. Based on the findings of ILI survey comparison, minimum & maximum corrosion rates, average corrosion rates can be predicted for the calculation of most balanced ILI interval. A typical example of corrosion growth analysis based on two ILI is provided below:

Table 2

BASELINE ILI DATA (2012)							FIRST ILI DATA (2016)							Difference			
Log distance (m)	Abs. dist. Feature to USW / DSW	Clock pos.	Length (mm)	Width (mm)	Depth (%)	Surface Loc.	Log distance (m)	Abs. dist. Feature to USW / DSW	Clock pos.	Length (mm)	Width (mm)	Depth (%)	Surface Loc.	ΔLength [mm]	ΔWidth [mm]	ΔDepth [%]	CGR in MPY
48780.754	4.21	2:19	70	18	11	INT	48780.79	4.24	2:15	41	25	17	INT	-29	7	6	3.75
9346.638	3.713	4:30	36	18	9	INT	9346.661	3.74	5:25	25	13	14	INT	-11	-5	5	3.12
12530.444	0.625	3:36	18	18	8	INT	12530.45	0.63	3:30	25	13	12	INT	7	-5	4	2.50
122952.67	10.798	12:19	20	44	16	EXT	122952.7	10.79	11:55	20	20	20	EXT	0	-24	4	2.50
9344.476	1.551	3:58	27	18	11	INT	9344.491	1.57	4:50	23	15	14	INT	-4	-3	3	1.87

ENGINEERING APPROACH FOR ILI INTERVAL:

Failure pressure vs anomaly size model can be plotted based on the appendix-D **API[5] RP 1160[7] – 2013**, considering the leaner growth of corrosion defects in a particular pipeline system. A typical Failure pressure vs anomaly size model for 8.375" dia x 6.35 mm API 5L X-56 Grade pipeline is provided below.

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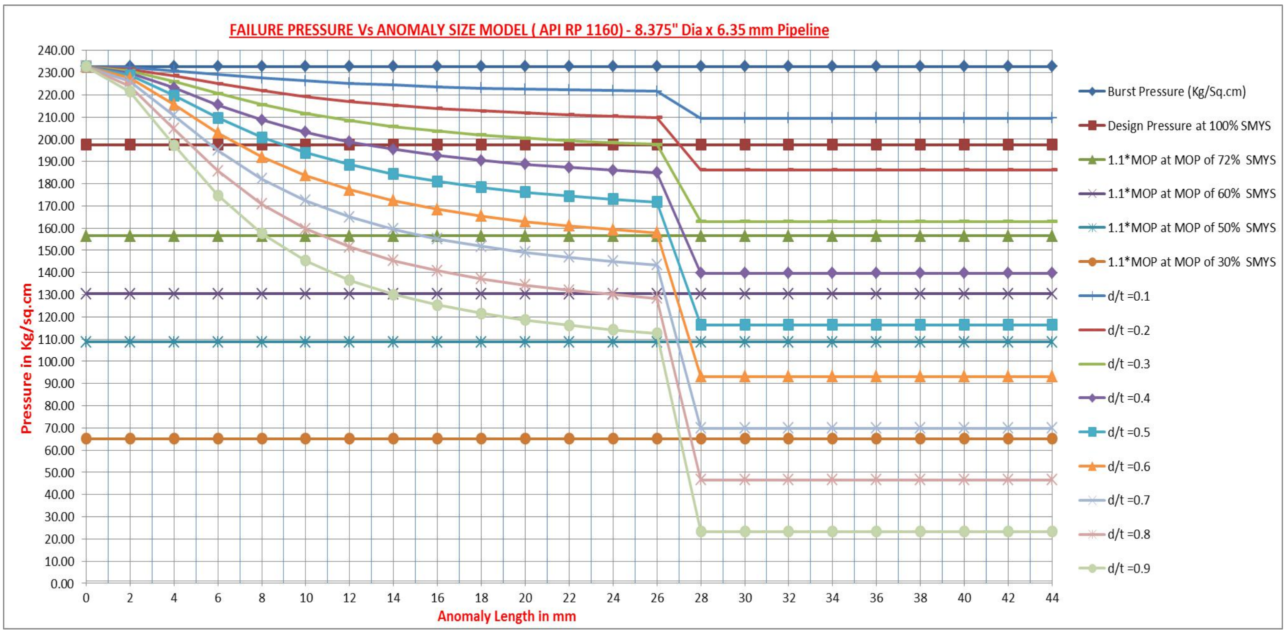

Figure 1: Failure pressure vs anomaly size model for 8.375” x 6.35 mm API 5LX-56 pipeline

Based on the above graph, it can observed that anomaly having length 28 mm & d/t =0.6 (i.e. 60% metal loss) would not survive at the Maximum Operating Pressure (MOP) of 1.1 times of 50% SMYS hoop stress. If this pipeline is being operated at MOP of 50% SMYS hoop stress then this pipeline can survive with worst case remaining anomaly of d/t= 0.30 (i.e. 30% metal loss) after repair of critical anomalies of last ILI Survey and this pipeline is to be reassessed / inspected before the anomaly of d/t=0.30 (i.e. 30% metal loss) will grow to the anomaly of d/t =0.60 (i.e. 60% metal loss) by applying the applicable corrosion growth rate derived from above discussed methods or methods which are more reliable than discussed in this paper. In this method, pipeline operator should ensure that all high ERF corrosion defects which are not acceptable in present condition and/or becomes not acceptable during the calculated ILI interval should be verified & removed / repaired if actual field measurement necessitate.

In this typical pipeline, majority of remaining corrosion anomalies are classified as internal pitting corrosion (based on ILI survey) and internal pitting corrosion rate based on hot spot monitoring is considered as 10 MPY and external corrosion rate is considered as 2.50 MPY because pipeline is secondary protection through ICCP system. Internal corrosion can be considered more prevalent in this typical pipeline, hence it can be considered for calculating the ILI interval.

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Now take the worst case anomaly of 30% metal loss which can grow to 60% metal loss considering the linear corrosion growth rate by monitoring the similar flow and feed quality conditions. Below is the typical calculation for ILI interval:

Table 3

Pipeline Name	Initial d/t	Final d/t	Metal Loss in mm	CR=10MPY INT	Response Time in Y	ILI action time in Y	Max. ILI Interval in Y
8" x 6.35 mm A-B Section	0.30	0.60	1.905	0.251	**7.59**	1.00	**6.59**

Based on the above table, ILI interval coms 7.59 Year, however considering the action taking time of one year , next ILI should be carried out at 6.59 Year. Hence, a pipeline operator can kept the maximum interval of 7 Year for next ILI.

CONCLUSIONS

Based on the above, a pipeline operator can calculate the ILI frequency appropriately which would result in a more cost economical approach in the long term without any integrity threats / pipeline failure. This may also be combined with RBI & statuary requirements and least ILI interval among all should be considered for field implementation.

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