Challenges

in

Managing Integrity

of

Un-Piggable Pipeline

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Pipeline Integrity Assessment

- ASME B31.8S
  - In-Line Inspection (ILI)
  - Hydrostatic Pressure Test
  - Direct Assessment (DA)
- PNGRB IMS
  - In-Line Inspection
  - Direct Assessment
  - Other techniques having higher level of integrity assurance

- So, in India only ILI and DA is acceptable methods for assessing the pipeline Integrity

In-Line Inspection

- Most reliable and proven technique to assess the integrity of pipeline without interruption of pipeline normal operations through intelligent pigging tools like
  - Magnetic Flux Leakage (MFL) tool
    - Axial field MFL
    - Circumferential Field
  - Ultrasonic Testing (UT) tool
- Can detect and size anomalies like metal loss, geometric anomalies, mechanical damage and manufacturing defects etc.. Have capability to detect features like valves, tapping's and weld anomalies etc.

But all pipelines can’t be pigged in conventional way due to un-piggability

UN-PIGGABILITY OF PIPELINES

- Mechanical cause:
  - No access, meaning launcher and receiver are missing.
  - Geometry (such as plug valves, 90° miter bends, dead ends, off-takes, etc.
  - Multi-diameter pipelines
- Un-piggable due to Flow Problems:
  - Low flow, low pressure, no flow
  - High velocity flow within a pipeline affects pigging data collection.

Integrity of un-piggable pipelines can assessed by

Advanced ILI tools

Direct Assessment

ADVANCEMENT IN ILI TECHNOLOGY

- Modern ILI tools are able to cope with following un-piggability issues-
  - High speed in gas lines; High pressure and temperature
  - Tight 1.5D bends; Multi-diameter; Heavy wall thickness
  - Long distances etc.
- Still many pipelines remain unpiggable due to
  - No launcher & receiver facilities
  - Restrictions due to medium & operating conditions
  - Narrow or miter bends, Back-to-back bends, Wrinkles in bends
  - Reduced bore valves
  - Un-barred tees & off-takes, U connections
  - Unknown reductions and diameter changes, Dead ends

Collapsible ILI tool

- Tool to inspect multi-diameter pipelines having following features
  - Collapsible MFL sensor rings (magnet sensors collapsing and expanding)
  - Yokes and magnets mounted on flexible arms (Free & Smooth Movement)
  - Pull unit (Sealing effect to drive the tool)
  - Additional cups (for Compensating Pull Unit)
  - Flexible sealing elements, wheel support (Moderate friction)
  - Special Cup Design (Polyurethane) for ensuring Sealing Effect
  - Special mechanical property of the arms (to ensures C.L aligning w.r.t pipeline) & to avoid Nose Down Effect & hence Tool Lodging

ILI of low flow pipelines

- Pipelines having low flow and pressure can be inspected ILI tool with following modifications:
  - Enhanced sealing configuration to ensure bypass is reduced to an absolute minimum
  - Extended battery life to ensure the complete line is recorded in one pass
  - Customized electronics setting to ensure data recording at low speed.
- A low friction magnetizer is required to reduce the risk of a stationary tool in case of significant bypass
- For MFL measurement at low speed & internal / external discrimination, eddy current based sensors can be used which is capable to work in a static case also

Bi-directional ILI tool

- Used for pipelines that have only access from one end
- don’t require tether and are therefore not restricted in inspection length and can pass an unlimited number of bends
- Can inserted through 3-way valves
- Following **propulsion methods** are employed to bring the ILI tool to the turn-around point and back to the entry point
  - Reversed flow
  - Push against product pressure
  - Gravity based
  - Pump in – pull out

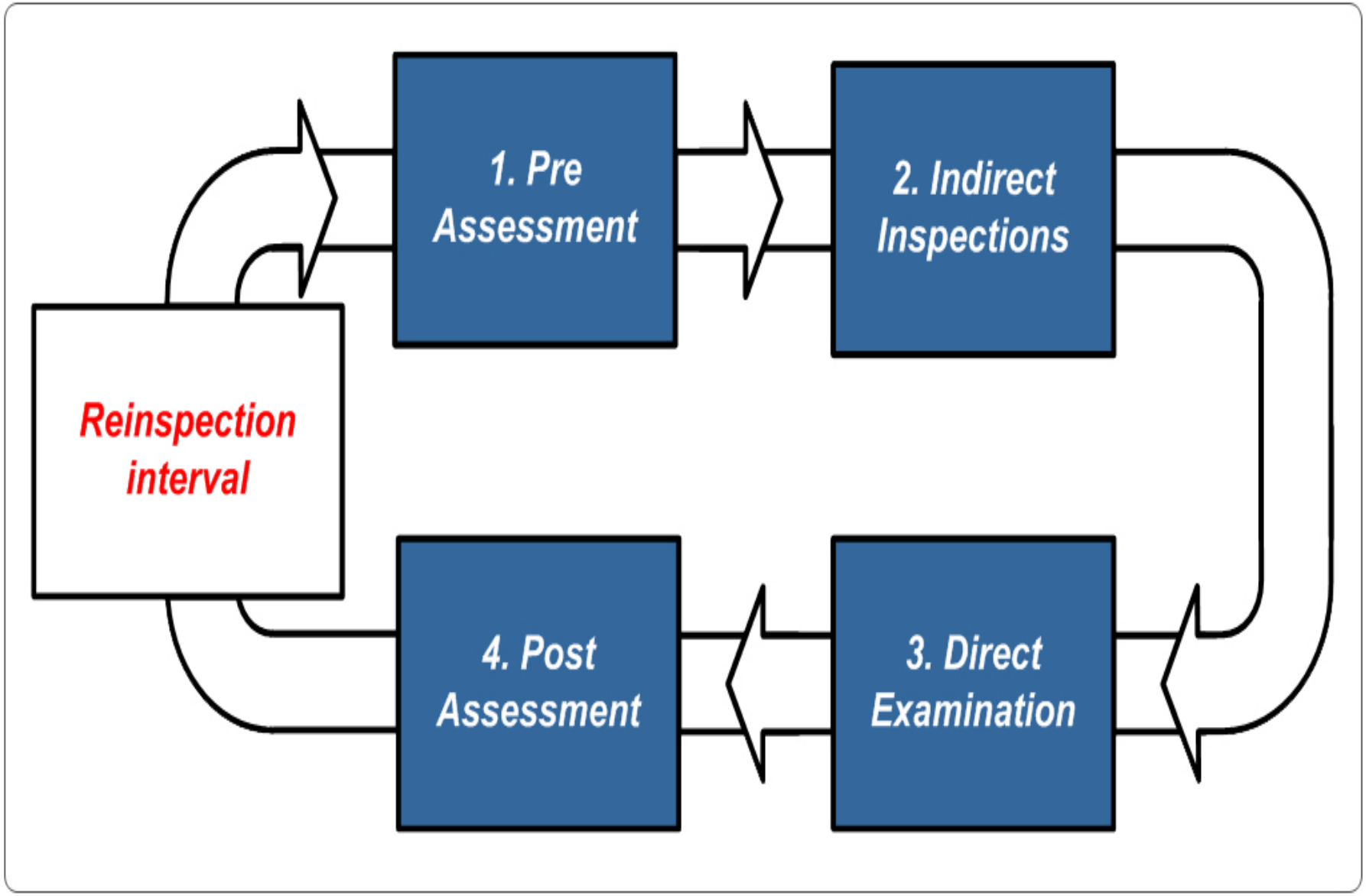
Bi-directional ILI tool

- Reversed flow Propulsion
  - Can be done if a parallel line is available by simply connecting these via flexible hoses or by installing a temporary pump spread on the other side to push the product back in the opposite direction.
- Push against product pressure propulsion
  - pushing the tool against the product pressure into the pipeline up to the turn-around point. The remaining gas volume behind the tool can be used to send the tool back to the entry point by controlled pressure release at the launching facilities.
- Gravity based
  - For the inspection of vertical sections, tool is pushed down the pipeline using the hydrostatic pressure of a storage tank and pumped back by permanently available or temporarily installed pumps.
- Pump in – pull out
  - Another approach of deploying a bi-directional tool is to pump the tool into the pipeline by using product (e.g. nitrogen or air) and then recovering it by pulling it out using a winch and a tether.

Direct Assessment (DA)

- For pipelines on which ILI can not be employed, PNGRB 2012 regulations prescribes only Direct Assessment (DA) as Integrity Assessment technique.
- Other proven integrity assessment methods is also acceptable provided that operator documents the validity of alternative approach & confirms that a higher level of integrity or integrity assurance was achieved.
- Since, for an operator to prove that a higher level of integrity or integrity assurance was achieved during inspection other than by ILI or DA is a very difficult proposition, currently pipeline operators in India are resorting to **DA for inspection of unpiggable pipelines**.

DA: Flow Chart



DA: Process

Steps	Key Actions
Pre-assessment	• Data collection • Feasibility study • Identification of ECDA/ICDA regions • Indirect Inspection/assessment tool selection
Indirect Inspection	• Performing Indirect Inspections from selected Tools • Identification of critical sites, i.e. those considered most likely susceptible corrosion • Ranking of sites for Direct examination
Direct Examination	• Excavation of critical sites • Infield data collection, NDT and measurements
Post Assessment	• Fitness-for-purpose/service assessment • Determination of re-assessment interval • Evaluation of DA effectiveness

DA: Applicable Standards

SN	Standard	Title	Defect Types
1	NACE SP0502-2010 (ASME B 31.8S, CL. 6.4.1)	External Corrosion Direct Assessment (ECDA)	General and localized external attack where CP is inadequate and/or coating faults
2	NACE SP0204-2008 (ASME B 31.8S, CL. 6.4.3)	Stress Corrosion Cracking Direct Assessment (SCCDA)	External crack defects that form on pipelines as a result of the presence of the ambient environment beneath disbonded coatings and operating/ residual stresses
3	NACE SP0206-2016 (ASME B 31.8S, CL. 6.4.2)	Dry Gas Internal Corrosion Direct Assessment (DG-ICDA)	General and localized internal attack at water accumulation sites
4	NACE SP0208-2008	Liquid Petroleum Internal Corrosion Direct Assessment (LP-ICDA)	General and localized internal attack at water and solids accumulation sites
5	NACE SP0110-2010	Wet Gas Internal Corrosion Direct Assessment (WG-ICDA)	General and localized internal attack throughout the pipeline region

DA: Limitations

ECDA & Common:

- ECDA of heavily corroded pipeline will be uneconomical. Most suitable for pipeline with isolated corrosion
- Cannot assess pre-service corrosion

ICDA:

- ICDA cannot be normally used for pipelines that:
  - Contain liquids including glycols
  - Have been converted from a different service
  - Have internal flow coatings
  - Have internal corrosion at top of pipe from wet gas (condensing water)
- Cannot always predict internal corrosion in pipelines routinely pigged (pigging can affect distribution of liquids)
- Cannot be used for pipelines with accumulated solids, sludge, biofilm / biomass.
- Model reliability (WG & MP ICDA)
- Pipelines expected to have continuous water phase (DG &LP ICDA)

CONCLUSION

- with the spotlight on risk-reduction, zero tolerance of leakage, and maintenance of total integrity, following are the call of time with regard to integrity of un-piggable pipelines:
  - Due diligence during project stage by using higher thickness pipes, higher corrosion allowance, 100% NDT inspection during construction
  - Replacement of such pipelines immediately after completion of design life.
  - Replacement / modification to make such un-piggable lines piggable.
  - Invest in R&D so that alternative assessment tools such as converse magnetostrictive effect method (MTM), LRUT etc. can develop into a credible alternative.

THANK YOU