IN-LINE INSPECTION: THE STATE OF THE INDUSTRY

Bryce Brown
CRUG Meeting at SES · Houston, TX · December 10, 2014

LOOKING BACK

- Geometry tools run for passage requirements
- Metal Loss reporting depth (grade), length and width
  - Critical Assessment (pressure based) started in the mid-90's
- Proactive pipeline operators, based on experience gained an understanding and determined the advantages of ILI
LOOKING BACK

INTEGRITY THREATS AND ILI

Prescriptive requirements for addressing threats to integrity.

Multiple runs, multiple technologies, as required.
GEOMETRY AND INTEGRITY

• Any dent with a stress riser

GEOMETRY AND INTEGRITY

• High Resolution ID mapping, and data integration
• ECA and dent strain, stress concentration factor and remaining life assessment
METAL LOSS

- High Resolution Metal Loss mapping with Magnetic Flux Leakage (MFL)
- Axial\(^1\) field, Circumferential\(^2\) field MFL

56” Axial and Circumferential MFL tools

METAL LOSS - COMPLEXITY

A = wall thickness or 10 mm (0.39”), whichever value is greater

Courtesy of European Pipeline Operator Forum, "Specification and Requirements for Intelligent Pig Inspection of Pipelines", version 2009
METAL LOSS - COMPLEXITY

• Axial field MFL

LONG, NARROW, AXIAL

• Circumferential field MFL
LONG, NARROW, AXIAL

Reported - Longitudinal Weld Anomaly / Actual - Lack of Fusion (8" Pipeline)

Reported – Longitudinal Weld Anomaly A / Actual - Hook Crack (24" & 12" Pipeline)

LONG, NARROW, AXIAL

- Circumferential field MFL
LONG, NARROW, AXIAL

- Circumferential field MFL

CRACKING

Crack Morphologies to Detect and Characterize

- SCC Colonies
- Cracks in Corrosion
- ERW Defects
  - At the toe of the ERW weld
  - In the center of the ERW
  - Hook Cracks
- Single cracks in the pipe body
- Mid wall cracks in the pipe body
- DSAW Defects
  - At the toe of the weld
  - Non perpendicular to the surface
  - In the center of the weld
CRACKING

- High Resolution inspection for Cracking
- EMAT (Electro-Magnetic Acoustic Transducer) and Ultrasonic (USCD) Crack inspection

EMAT
(Electro-Magnetic Acoustic Transducer)
CRACKING

EMAT
(Electro-Magnetic Acoustic Transducer)

Deeper Cracks:
- Reflect more energy (higher amplitude)
- Reduce transmission energy

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CRACKING

Pipeline Integrity Management Program

Operator

Secondary Information

Verification NDT / DT

Preliminary Report

Feedback Loop

Final Report

Data Analysis

Result Validation ROSEN NDT Technician Onsite

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### Table: CRACKING

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* Wheel design
A “un-piggable” pipeline is defined as one that cannot be inspected with current technologies and procedures.

“Un-piggable” is a function of time and market need.

- Gas velocities up to 5 ft/s become possible.
- 30 mi. in a Single run becomes possible.
- Tools become 1.5D capable.
- Active Speed Control allows for gas velocities up to 40 ft/s.
- Pressures up to 300 bar possible.
- Temperatures up to 300˚F possible.
- Self-Propelled Tools
- Extra Heavy Wall

- Multi-Diameter
- Bi-Directional
- Low Flow / Low Pressure

- Multi-Diameter 14”x20” 30”x36”
CHALLENGING PIPELINES

- Tailored solutions
- "Tool box"

Questionnaire

- Pipeline Modification?
- Tool Modification?
- New Development

Time & Effort

- Standard Tool
- New Application
- Tailored solutions based on tool box concept
CHALLENGING PIPELINES

10" ROBOTIC MFL CRAWLER
Metal Loss (corrosion) inspection of 6 ea. @ 10" gas storage laterals

- Wall thickness: 0.280" / 0.500"
- Length: 60 ft. to 450 ft. (1275 ft. total)
- Traps: none

Boundary conditions:
- Data quality - ensure optimum inspection performance
- Lean operation - avoid bulky equipment and exposure
- Minimized risk - ensure equipment will come out

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CHALLENGING PIPELINES

10" ROBOTIC MFL CRAWLER
The self-propelled RoCorr MFL/BiDi/MTC inspection solution consists of the following elements:

- Inspection technology: MFL
- Carrier: Bi-directional / low friction
- Propulsion: Multi-Trotter Crawler
- Power: Onboard accumulators
- Operation & control: External via wire line
- Fail safe: Cable
CHALLENGING PIPELINES

10" ROBOTIC MFL CRAWLER

- Single body (24" up to 42" currently)
- Rotating measurement system based on MFL
- Light weight
- Easy to handle
- Front & rear camera system

ROBOTIC “HELIX” TOOL

Single Tractor & Inspection Unit
WHAT IS IN THE GROUND?

- **Traceable** – originating from specific sources containing all information for MAOP calculation.
- **Verifiable** – confirmed by other complementary, but separate, documentation.
- **Complete** – finalized and evidenced by signature, date or other appropriate marking.

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WHAT IS IN THE GROUND?

- **Step 6** – ECA consists of material documentation, assessment, and analysis to establish material condition of pipeline and MAOP, commensurate with segment-specific issues and documentation shortcomings.

Assessment could include, as appropriate: ILI Program, CIS, Coating Survey, Interference Survey Remaining Life Fatigue Analysis, etc.
WHAT IS IN THE GROUND?

- **Step 11** – of the IVP, “Detail of Material Documentation Process” requires the operator to review design and material documents that address chemical and mechanical properties.

The program to test pipe samples to establish material properties using a “long term statistical sampling program” has great uncertainty, because every joint in between the sampling remains unknown.

Alone a statistical sampling program presents fundamental challenges that can immediately be mitigated using an ILI solution.

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WHAT IS IN THE GROUND?

- **Existing Data**
- **ILI Solution**

**PIPE PROPERTIES & MAOP VALIDATION**

- **EXISTING PIPELINE INFORMATION**
  - review and alignment

- **EXISTING ILI DATA**
  - application of different analysis model

- **PIPE GRADE DETERMINATION**
  - novel ILI technology

**GIS & IMS Data Integration**
WHAT IS IN THE GROUND?

• ILI Solution

Color Scan

Line plot

WHAT IS IN THE GROUND?

OPERATORS INCOMPLETE RECORDS
WHAT IS IN THE GROUND?

PIPE GRADE DATA, RECORDS CONFIRMED AND SUPPLEMENTED

INDUSTRY CONSENSUS STANDARDS

ILI System = Tool(s) + Personnel + Process
ESTABLISHING CONFIDENCE

- Duty of care requires full capability for development and testing
- Process driven, guided by ISO and API 1163

INDUSTRY PARTICIPATION AND CONTRIBUTION
THANK YOU FOR JOINING THIS PRESENTATION.