Pipeline Inspection and Integrity Management in the Caspian Sea

Hydro14 - Aberdeen

Pipeline Integrity Review
(A personal perspective...)

28th – 30th October 2014
Eric Primeau
Ultra High Resolution Acoustic Inspection, its performance and place in the pipeline inspection program.

1. Performance of vessel mounted Dual Head Multibeam system in shallow water to acquire pipeline integrity data.
2. The role of High Resolution Acoustic data in Pipeline Integrity Management
3. Combining data sets to provide full information content pertaining to pipeline condition (Acoustic, General Visual Inspection, In-Line Inspection).

*Eric Primeau, BP, Azerbaijan*
Where is Azerbaijan?
Total pipeline kilometers 12 < 25m 708.5km, 8 pipelines.
Challenges:

- Total length of the pipelines that fall between the 0m to 25m contour is approximately 740 km.
- Total Subsea pipeline network 1232km.
- Exposed pipelines / Multiple crossings
- Largely uncontrolled shipping / Anchoring
- Construction Activities (BP and Others)
- 80% Azerbaijan GDP focussed on Hydrocarbon export
- Reputation risk
- Surveillance of Marine Traffic (VTS)
- Emergency Response
- Vessel Availability
- Water Visibility
Challenges: Productivity vs. cost

2011 – 2013 annual GVI program vs. Dual Head MBE costs:

- 2011 - 48 Days GVI  352 pipeline km inspected
- 2012 – 22 Days GVI  81 pipeline km inspected
- 2013 – 28 days GVI  125 pipeline km inspected

GVI at cost approximating $80K* / day, average rate  = $14/m

Completing 740 pipeline km in 10 days from lower logistic Vessel (inc 15 day mob / demob + reporting) = $1.5M  = $ 2 /m

So, is it all about Cost?

No, We have responsibilities & Accountabilities:

* Significant change to vessel costs since 2013. Now > $220 / day.
Responsibilities & Accountabilities

**AGT Region**

**Offshore Pipelines PIMS**

**(Pipeline Integrity Management System)**

**AZ-GP 43-49-2**

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**Revision History and Approval**

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**AGT Region**

**SITE TECHNICAL PRACTICES**

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**Legislation**

Legal documentation pertaining to AGT Region offshore pipeline systems (Vanuatu / Man)  

**International Codes**

Offshore pipeline designed, constructed and operated in accordance with international codes:  

- ASME B31.8, Gas Transmission and Distribution Piping Systems  
- ASME B31.4, Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids

**BP procedures and practices**

PIMS developed to comply with the BP requirements of:  

- Group Defined Practice for Pipeline Integrity Management Systems (PIMS), GP 43-49  
- Guidance on Practice for Pipeline Risk Management, GP 43-17  
- Guidance on Practice for Pigging, Pig Launchers and Receivers, GP 43-50  
- Guidance on Practice for Inspection and Integrity Assessment of Pipeline Systems GP 43-52  
- Guidance on Practice for Pipeline Repair, GP 43-53  
- Many Other Group Practices.

**AGT Region documents**

Key documents that form part of the AGT Region supporting implementation of PIMS:  

- Practice for Assessment, Prioritization, and Management of HSSE\&O Risks  
- Incident Investigation and Reporting  
- HSE Reporting, Action Tracking and Performance Monitoring  
- Lesson Learned Communication Process  
- Offshore Operations Lessons Learned Procedure  
- Incident Management System (IMS) Manual  
- Offshore and Sangachal Terminal Subsea Pipeline Emergency Response Plan  
- Oil Spill Response Plan  
- Preparedness Response Scheme  
- Technical Document Control and Management Procedure  
- Engineering Data Management Procedure for Operations  
- Procedure Engineering Information Handover to Operations  
- Site Technical Practice Control Procedure  
- Azeri Pipelines Inspection and Corrosion Management Strategy  
- Azeri Phase 3 Pipelines Inspection Strategy  
- Shah Deniz Pipelines Inspection Strategy  
- Chirag 1 Pipeline Inspection and Maintenance Routine  
- Safety Critical Equipment (SCE) Management Strategy
Pipeline inspection programs are based on an Risk Based Assessment delivered through an Annual Integrity Review:

- Review of Previous Years inspection Program
- Develop a plan for next years program

Components:

- Review of Inspection Results
- Composition of Hydrocarbons (water?) delivered
- Review of efficiency of Chemical Injection Plan
- Assessment of Internal Corrosion management
- Wax & Hydrate Remediation
- Newly installed assets
2013 / 2014 Acoustic Inspection Program

2013 Acoustic Pipeline Inspection Program:

- AUV Sangachal Landfall Inspection (3 – 12m) : 16th Sept to 1st Oct 2013
- Dual Head MBE Inspection (12 – 25m) : 21st Aug to 6th Sept 2013
- ROTV Pipeline Inspection: (25m – Full Field) : 12th Oct to 26th Nov
- AUV Pipeline Inspection Trial – (Sangachal Pipeline) 7th Dec to 17th Dec.

2014 Inspection Program:

- Dual Head MBE Inspection (12 – 25m) : September 2014
- HUGIN 1000 AUV Pipeline Inspection: (200m Infield) : March 2014
- ROV GVI – East Azeri - Infield 6” pipelines (200m) : May 2014

Augmented with (↔) ROV GVI & ILI Programs.
ROTV - FOCUS 2

- Mobilised with deck winch and fibre optic multiplexor
- Steerable in all axis – with ‘Auto Functions’
- Operated from Low Logistic Vessel.
- EdgeTech 4200-FS side scan sonar
- Kongsberg EM3002 system
- The total length of the pipelines that fall within the between the 25m < 200m water depth range is approximately 410 km.
- **Requires Integrated INS DVL Navigation**
AUV Pipeline Inspection

**GAVIA & HUGIN 1000**

HUGIN 1000 utilised for 44 pipeline kilometers between 120m to 200m employing Kongsberg 2040 MBE, Edgetech 2020 SSS, ‘TileCam’ Underwater Camera system.

Gavia utilised for 48 pipeline kilometers between 3m – 12m Sangachal nearshore pipeline inspection & numerous seabed mapping projects.
Dual Head Multi-beam system in shallow water to acquire pipeline integrity data.
Operating Modes

Combination modes – Equi-angle and Equi-distant

- Equi-Angle Mode
  - Typically up to 256 beams (0.5°)
  - Variable Sounding Density

- Equi-Distant Mode
  - 512 beams uniform density (0.5°)
  - More hits per target
  - Only suitable option for high resolution grids
Flexmode

- 1024 beam returns operating 10 Hz yields > 10,000 returns / sec.
- Equi-Angle beams concentrated onto pipeline sector while Equi-Distant beams either side
- Ultra high definition pipeline and seabed features better identified

FlexMode Screen Example

- Below example displays high density equal angle centre sector with underlying full swath equal-distance sector
Span & Shallow Depression (26” pipeline)
Shah Deniz 26" Gas Export

2013
Year on Year integrity assessment
Pipeline Crossing
26” Pipeline in 200m water Depth (Trial)
Viewing, editing and event listing package
In Line Inspection (ILI – Intelligent Pigging)
Features Affecting Pipelines

**Geometric Deformation**
- Pressure Fluctuation
- Extreme mechanical Loading
- 3\textsuperscript{rd} Party works

**Metal Loss**
- Corrosion
- Erosion & Abrasion
- Gouging

**Cracking**
- Geological Stresses
- Cyclic Loading (Climate & operations)

Above focussed on pipeline wall integrity. But most pipeline systems are weight coated.
Pipeline Monitoring / Maintenance

Monitoring

• 24 hour – Sensors / Alarms dP vs. Valve Op etc.
• CPM – Computational Pipeline Monitoring
• Acoustic Surveillance (‘sound’ of mal-operation)

Testing

• Hydro testing (150% M.A.O.P.)
• Non Destructive Testing (Eddy Current, Magnetic Flux, Ultrasonic Testing, Electro Magnetic Acoustic Transducer (EMAT))

Inspection

• ROV (Visual)
• ILI carrying NDT equipment
• Acoustic – External geometry / Influencing factors
Can all Pipelines have Inline Inspection?

**NO!**

**Pipeline must be designed with an Inline Inspection program built into maintenance cycles:**

- Pig Launchers / Receivers in place
- No pipeline restrictions: change diameters
- Clearance through all engineering features (Valves)
- Pipeline bend radius capable of allowing passage of Pig Train
- ‘Clean’ Pipeline – No Wax / Hydrate build up
- Different requirements / Gas, Oil, Water pipelines.
NDT Principles

Eddy Current Testing

The EC principle: changes in the flow patterns of magnetic fields indicate metal loss.

Magnetic Flux Leakage

Ultrasonic Testing

The UT principle: ultrasound echoes from the internal and external pipe walls are used to determine the wall thickness.

Electro Magnetic Acoustic Transducer

The EMAT principle: magnetic excitation is used to induce an ultrasonic signal in metal without need for a liquid couplant.
‘Standard’ Intelligent Pig...

Inertial Platform (referred to as XYZ Mapping tool)

Single-bodied metal loss ILI tool with MFL sensors.
How big? How small? How fast?

**Top** – 3inch ILI tool  
**Bottom** – 56inch ILI tool.  
Both equipped with NDT equipment

Speed Control via onboard monitored & controlled ByPass Valve.
Axial Flaw Detection employing MFL

Radiography image (Top) and corresponding MFL results view (Below)

Single Bodied Axial Flaw Detection tool based on Circumferential MFL.
EMAT in Dual Bodied Pig train

Electro-Magnetic Acoustic Transducer for crack & Coating dis-bondment detection

Pipeline SCC (Stress Corrosion Cracking) colonies detected using EMAT (Visual & detected).
Combinations?

Combination ILI Technologies

ILI Tool with two inspection modules behind a propulsion module
Onshore Pipelines - there may be magnetic pick up points at intervals (up to 1km) along the pipeline. Each reference station will potentially have a GPS receiver – especially in high risk zones such as steep lateral gradients / river crossings etc.

Offshore Pipelines - very little external referencing is performed. This complicates reduction of raw inertial data to XYZ data and hence referencing to real world co-ordinates. Pipeline features detected, but no knowledge of potential pipeline movement.

Business Opportunity?
• ROV GVI provides great visual imagery of the pipeline. However it does not allow access to the pipe wall and therefore is of limited information content relative to actual pipeline integrity.

• ROV may provide ‘most’ accurate method of defining pipeline span lengths, however level of support at touchdown is variable so observed span length may not equal unsupported length. Complicated by poor visibility.

• ROV in deep water may not detect lateral movements of pipeline and in poor visibility even major integrity items may be missed.

• ROV does, however, still provide the only robust method of obtaining Cathodic Potential readings. This last may be considered the ‘grail’ of developing a non ROV (AUV) solution for pipeline inspection.
Bringing it all together

http://www.pods.org/
The PODS Association is a not-for-profit, vendor-neutral, pipeline data standards association. The association was created to develop and maintain open data storage and interchange standards to support the needs of the pipeline industry.

PODS (Pipeline Open Data Standard) is a database schema.

Schema - the structured organization of data to create a blueprint of how a database will be constructed - divided into database tables.

Each table within the database is in a specific format that is universally recognized.

BP has designed a “Golden Build data model (Version 2)” on the basis of PODS Version 5.1 with some additional tables.
Web Access – Silverlight Viewer
Viewing PODS data in Silverlight
Accessing a feature
Review Anode Information
Review Anode Information
Review Span History
PODS Summary

- Fundamentally, PODS is a Database that may be accessed via GIS.

- Building and maintaining a PODS compliant pipeline GIS is an investment in gathering and maintaining quality data, creating manageable workflows, building and supporting software.

- Since the data records are linked to the pipe segment, re-route, change of service, asset transfer or sale, abandonment, removal, repair, and replacement are all managed within the PODS database.

- **A PODS compliant database WILL increase the value of your asset**

- **A PODS database WILL reduce risk through increased Pipeline Integrity Management features**
Questions?