Integrity Management in an Arctic Environment

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- Operating the Greater Prudhoe Bay Field on Alaska’s North Slope.
Greater Prudhoe Bay (GPB) Field

- Includes multiple smaller satellite fields.
- Covering area of over 217k acres.
- Production peaked in January 1987 at over 1.6 million barrels per day*.
- Field Ownership:
  - ConocoPhilips ≈36%
  - ExxonMobil ≈36%
  - BP (Operator) ≈26%
  - Chevron ≈1%

*Source: AOGCC – www.doa.alaska.gov
Greater Prudhoe Bay (GPB) Field

- Field has produced over 12 billion barrels of oil to date*.
- Original oil in place estimated at 24 billion barrels*.
- Currently processes approximately 7+ billion cubic feet of gas on a daily basis
- Original Gas In Place (OGIP): 40 trillion cubic feet.

So, it is a large field with a healthy future still ahead of it!

* Source: Alaska Oil and Gas Conservation Commission: www.doa.alaska.gov
BPXA’s Corrosion, Inspection and Chemicals (CIC) team operate a sizable Integrity Management program on the North Slope which includes (on average) annual activity sets of:

- ≈ 20 ILI runs
- ≈ 70,000 “internal” inspections – DRT and UT
- ≈ 130,000 “external” inspections – TRT and DRT
- ≈ 1500 tank and vessel inspections (between internal and external)
- ≈ 350 cased crossing inspections – GWT
- ≈ 150 concrete anchor inspections - GWT
The Challenges!
Challenges

Getting supplies and provisions to the North Slope

- All supplies have to be sent to the Slope by transport trailers over the Dalton Highway.
- Highway is susceptible in places to flooding caused by break-up or other events.
- Recent closure of the highway highlighted this ongoing challenge.

Source: Planet BP Alaska
We are not the only living things present on the North Slope!

- The field is home to a wide range of inhabitants including: bears (whether brown, black or polar!), foxes, caribou, and a large number of birds.
- Most wildlife on the field is considered protected and as such should be afforded special consideration. This includes such things as right-of-way when crossing a road.
Challenges

Although piping is mostly above ground, access is still complicated.

Note the lack of a clear access means to this pipeline.

Note the presence of an access road allowing easy access to the adjacent pipe rack.
Challenges

• Instances where access is not straightforward (no access road) require prior scheduling and special permitting for:
  – Environmental approval for tundra travel – this is limited both in timing and the allowances of personnel and equipment
  – Scheduling of special equipment to be used for travel over tundra. This also necessitates the provision of training to utilize this equipment.
Challenges

Procedures

- BPXA’s ability to operate in a very sensitive environment is contingent on safe reliable operation of the facilities.
- Integrity of the facilities is – to a large extent – dependent on the quality of the inspection work performed.
- BPXA has long maintained an extensive set of procedures developed in conjunction with the service providers and updated through a continual review process.
- The intent of these procedures is to ensure that the inspections are performed in a way that builds on the strengths of the individual inspection method.
Challenges

Corrosion Under Insulation

• BPXA manages an extensive CUI program on its piping and pipelines, most of which are not ILI-able.
• Program parameters define areas of interest which require interrogation, interrogation frequency and the interrogation view (azimuth) for each location.
• Parameters are also governed by the type of insulation/jacketing system present on the pipe.
Challenges

Corrosion Under Insulation

• Current general method of choice for CUI detection is Tangential Radiography (TRT). This application is utilized either on a crawler or manually (including the “C-Arm”).

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Integrity Management in an Arctic Environment
Challenges

Corrosion Under Insulation

• Scope carried out using an average of 8 to 10 crews (3 person) on a daily basis.
• Application has proven to be resilient to year-round use.
• Despite all the positive aspects of TRT use, there are some limits.
• Over the past decade, BPXA has been actively seeking alternative applications. In the case of BPXA, the quest is challenged by:
  − Outer metal jacketing is ferromagnetic.
  − Outer metal jacketing is (in most cases) corrugated.
  − Limited spacing between pipes on some racks.
Challenges

Corrosion Under Insulation

Image of crawler developed to perform CUI detection and internal inspection on 60” line.
Challenges

**Slugging Lines**

We have a significant number of lines that are known “sluggers”. These are lines that are known to move from time to time as gaseous/liquid slugs move through.
Challenges

Slugging Lines

- Inspection performed on a known slugging line, or on a pipe located in a rack where a known slugger is present requires special HSE precautions.
- This is a resource-intensive activity and also carries an associated production impact.

BPXA continues to look for/at options that would provide remote monitoring/inspection/screening of the inspection areas within these high consequence areas.
Challenges

Slugging Lines/HCA’s

- System of interest would need to interrogate/screen the full hoop (circumference) along a 1’ axial length of piping (regardless of diameter)
- Ideally, the system would provide 100% (or as near as possible) coverage of the area of interest.
Challenges

Erosion Monitoring

• Extensive program monitoring production wells suspected of containing levels of solids within the flow.

• As with the inspections at HCA’s, this activity is also labor intensive and has potential production impacts.

• Much the same as inspections in HCA’s, intent is to seek a tool that can provide the continuous monitoring on a full hoop 1’ axial length of piping – this may include elbows or other features also.
Challenges

Continuous Monitoring
BPXA Wish List:
A system that can provide 100% area coverage on both a straight run of pipe or a feature (T, elbow, etc).

Technology Survey
Shows that a system with such capabilities is not currently available. Nor is one being developed by any of the companies queried. The main reason is the lack of an economic driver.

The next best thing?
A versatile system that will allow the user to “screen” an area for any wall loss activity (pitting and/or erosion) with minimal number of actual transducers (thus reducing cost).
Challenges

Continuous Monitoring – Current Development Work

• Started working with a vendor by installing a standard multi-sensor monitoring system on a production well.
  – System comprised of 22 total individual straight-beam UT sensors divided into 3 separate groups (channels).
Challenges

Continuous Monitoring – Current Development Work

- Interrogation of system looks at:
  - Individual thickness measurements from each sensor.
  - Understanding the nature of the “cross-bulk wave” communication from sensor to sensor within a single channel.
  - Can this information be correlated back to the change in the volume of metal present in the region between the two sensors?
  - This relationship – if present – would be qualitative (screening), but point to locations where further interrogation is needed while removing the need to interrogate those not showing any change.
Challenges

Concrete Anchor and Cased Crossing Programs

- BPXA manages a total of 1300+ crossing segments on non ILI-able lines managed using GWT.
- Lengths range from 40’ up to 300+ feet.
- Crossings all cased with the piping insulated through the casing length; i.e. casing/earth not in direct contact with the pipe wall.
- BPXA also manages a total of 800+ concrete anchors on non ILI-able lines.
- Lines may or may not be insulated through the concrete segment.
Challenges

Cased Crossings

- BPXA has a target of gaining complete inspection coverage on all cased crossing segments.
- This has resulted in an extensive campaign to install permanent sensors in the middle of crossings where full coverage cannot be achieved through standard applications.
Challenges

Cased Crossings

• In addition to sensors inside casing, BPXA has also campaigned installation of sensors outside casing on select lines to facilitate effective monitoring.

• Systems have proven durable with some operating for over 7 years and allowing surveys to be performed at any time of year.
Challenges

Cased Crossings - Monitoring

- Looking for changes between repeat scans; i.e. the residual signal from the subtraction of two (or more) traces
Challenges

- Simple subtraction is ineffective as some features (such as welds) still appear despite no change.
Challenges

• BP currently working together with a technology partner to develop appropriate algorithms for background subtraction that take into consideration such key elements as:
  - Changes in the pipe – due to changes in GW velocities impacted by temperature and attenuation among others.
  - Changes in the sensors themselves – performance affected by temperature and coupling variations.
Challenges

- Factoring in corrections. Unwanted residuals have been removed.

-40dB (or 1% CSC)
Questions?