FIRST USE OF TEMPORARY ISOLATION PLUG TECHNOLOGY ON THE NATIONAL TRANSMISSION SYSTEM

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Overview

National Gas Transmission (NGT), formerly National Grid, own and operate the National Transmission System (NTS), the backbone of British Energy. The NTS feeds homes and businesses the essential gas required for everyday life in the UK. This year, for the first time NGT has conducted an Isolation Joint replacement at the Lochside Multi-Junction Feeder 24 using STATS Remote Tecno Plug (RTP) pipeline isolation pig, instead of traditional venting recompression or line stopping operations. The RTP provided a fail-safe, leak-tight double block and monitor isolation, keeping the 48" pipeline fully pressurised at 56bar for 56km to the nearest block valve upstream. Crucially, the RTP has helped to reduce NGT's emissions and will support the undertaking of critical repair activities more responsibly support them achieve their net-zero ambition.

IJ's

Isolation Joints also known as Insulation Joints (IJ) provide electrical isolation between pipeline sections or between pipelines and connected structures. The IJ's must maintain electrical isolation for the cathodic protection system to work optimally and to ensure the long-term integrity of the pipeline. All the components of an IJ are encased in steel bodies and by design they are a weak point on the pipeline, susceptible over time to failure and damage resulting from pigging activities although this is hard to determine. Failures can be in the form of a gas leak from the pipeline to atmosphere as well as electrical conductivity occurring across the IJ.

Once IJ's fail they are cut out and replaced. The IJ's in the UK have generally performed well over their design life but a proactive program of replacement prior to failure is underway.

48" IJ Removal in Progress

Solutions

Overview

Historically an IJ replacement onshore would be conducted by isolating the pipeline section with available in-line valves. This would be done during the summer months and by taking a short shutdown when demand is lower and/or where sufficient gas can be delivered to the area through alternative flow routes (Feeders). The isolated pipeline would then be depressurised by;

- Venting gas in the isolated section to atmosphere
- Gas recompression and then venting the final 7bar to ambient

Alternatively, the pipeline would not be isolated with in-line valves and the IJ would be locally isolated with line stopping equipment and a short temporary bypass to maintain supply.

Line Stopping

Line Stopping for IJ replacements is less common in onshore UK gas transmission due to costs and risks associated with excavations, in-service welding of tee's, hot tapping (drilling) and leaving buried flanged fittings behind which could become a future leak source. However, line stopping is particularly advantageous in either; large, non piggable, pig access constrained pipeline systems or for mid-line repairs. One such example where access to the pig trap was unachievable due to a passing valve has led National Gas' towards their first 48" line stopping operation (94bar) which will be performed by STATS in 2024. The passing pig trap valve will be isolated for replacement, which will ultimately permit access to the pig launcher for an ILI run.

Venting

National Gas report that ~11% of their total yearly emissions are from pipeline venting workscopes equating to ~542 tonnes of methane discharged[(1)].Venting the entire 48" Feeder 24 pipeline would equate to ~2215 tonnes of methane. While venting may still be used on smaller, lower pressure pipelines the sheer volume meant it was never seriously considered for the Lochside Multi-Junction IJ Replacement.

Gas Recompression

Gas Recompression Units (RCU) have been a valuable option onshore for National Gas and the Gas Distribution Networks for over three decades. RCU's, which are gas powered themselves, work by extracting gas from the isolated section requiring intervention for repair and reinjecting the gas back into an adjacent section. Currently the technology is limited to reducing the pipeline pressure to 7bar so the remaining gas is vented. At 7bar this is not an insignificant volume totaling ~233tonnes of methane in Lochside 48" pipeline. And while figures like this have been vented in the past 'it is now paramount that all vented emissions are avoided or mitigated'[(3)].

National Gas Recompression Unit[2].

National Gas have invested and expect a new RCU to be commissioned in 2025 capable of bringing the pressure down to 1bar. In pipelines of this scale 1bar is not insignificant and thus National Gas have turned to the Remote Tecno Plug isolation pig technology to both reduce emissions and plan more essential workscopes where practical.

So why aren't RCU's used offshore? Simply this comes down to their footprint (they're mobile but transported via HGV on a 12m trailer) and the time taken to recompress. It takes a long time both to recompress the gas and then vent off from 7bar to ambient, which would drive the economic case offshore quickly towards flaring or using pipeline isolation pigs which have been favored offshore now for decades. Existing facilities offshore also make it easy to flare the gas thus converting it to less damaging, but still less than ideal CO_2. Note that methane has a global warming potential 28x that of CO_2 over a 100 year period[3].

Back onshore, with only 3 Recompression units in National Gas' fleet and around 120 recompression projects completed last year, lead times for access to these units limits essential work that can be planned , further driving National Gas toward alternative methods such as the Remote Tecno Plug on piggable pipeline systems.

Remote Tecno Plug

Ironically this plugging technology was once owned by National Gas over three decades ago but was never utilised, the technology has been developed by STATS for over 25 years with hundreds of successful projects completed for many different customers across the world but was used for the first time this year by National Gas.

Prior to first use and for technology approval, National Gas undertook a Formal Process Safety Assessment of the technology and the RTP pigging/deployment methodology. This was followed by a pigging Factory Acceptance Test (FAT) at STATS facility in Kintore, Aberdeenshire in a purpose-built test-fixture created to replicate the exact pipeline specification onsite. Finally strain gauging of the X65 and X80 pipe was performed at the locks and seals locations to ensure no plastic deformation during the at MAOP conditions covering common National Gas scenarios as well as on site at ~40% reduced pressure. This is not usually required as STATS carry out a pipe stress analysis, but NG needed reassurance for technology approval. Macro photography and measurements of the lock mark indentations left behind after setting of the tool was also taken and National Gas concluded that long term effects of these indentations on their pipeline system were negligible.

48” Remote Tecno Plug on Loading Tray (2)

The Project

Overview

The IJ located at National Gas’ Lochside Multi-Junction Facility (~7miles north of Montrose) had suffered un unknown failure and needed to be cut out and replaced. The IJ was located on the Feeder 24 pipeline (48”, 55bar, 56km) which transports gas south from St Fergus.

Isolation Location

The IJ was located within the Multi-Junction fence and placement of the RTP around the fence boundary was discussed. Since the RTP can be tracked, set and monitored through ground without the need to excavate the pipe, the fence location would have been suitable under normal circumstances. However, with the gauging requirements for this first deployment a pit was required and unfortunately a ravine on the other side of the fence made excavation of a suitable pit unfeasible from a construction safety standpoint. The RTP therefore needed to be pigged ~280m into a nearby field/pit location.

Pigging and Tracking

The RTP was launched on this project with readily available gas from an adjacent pipeline (feeder 13) at slight overpressure which was cheaper, easier and safer to manage for National Gas than a temporary nitrogen spread over the pigging distance. The pressure in the adjacent feeder was increased by National Gas to 5-7bar above the pipeline to be isolated, to provide suitable propulsion (dP) for the RTP with contingency. The RTP was pigged at ~2m/min which was managed efficiently by National Gas using two plug valves in series on existing pipework, reducing the risk of commissioning, or operating a temporary spread. These pigging speeds are much slower than regular pigs or inline inspection (ILI) tools, ensuring precision placement at the isolation location. This was particularly relevant on this scope for positioning at preinstalled external strain gauge locations (as part of the National Gas RTP approval process).

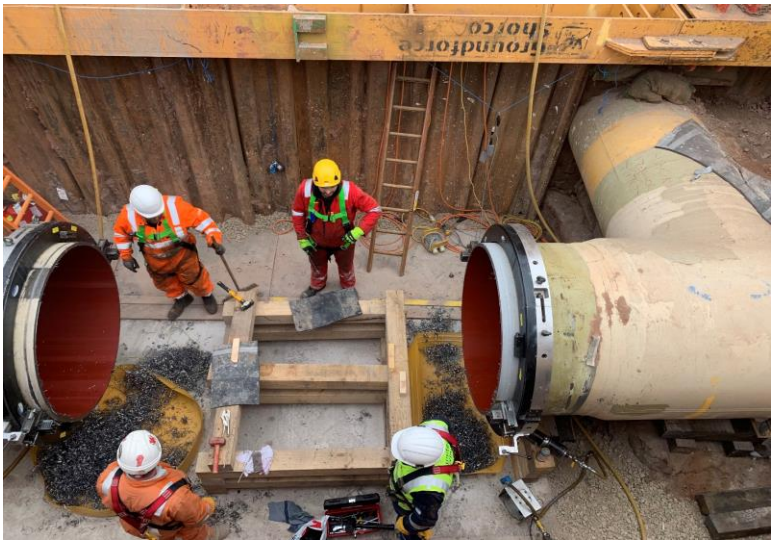
The RTP was accurately tracked throughout the pigging operations into and out of important features such as valves and bends using the onboard beacon function and magnetic pig signalers setup at strategic points (downstream of the valve, ground/below ground transition and downstream of the set location) on the pipeline for backup.

Setting, testing and purging

Once the plug reached the isolation location pigging was halted and the plug was commanded to hydraulically activate engaging the locks and dual elastomer seals against the pipe wall. The locks mechanically restrain the tool in the pipeline and the dual seals provide a double block and monitor isolation.

Once the pipeline was depressurised back towards the pig launcher/receiver the plug becomes self-energised by differential pressure, making it 'fail- safe' in the event of a failure of the hydraulics. Each seal is individually tested to confirm a leak-tight isolation and an isolation certificate was issued by STATS confirming it was safe to break containment. The annulus (void) between the seals was continuously monitored for pressure build-up.

48" IJ Removal



Clamshell Cutting Operation complete, 48” IJ Removed

Once the 48” IJ replacement scope was completed, and the golden weld results were confirmed, the pipeline section was purged with N2, pressure across the plug was equalised and the tool was hydraulically unset, removing the locks and seals from the pipewall. The RTP was then pigged back towards the launcher/receiver in a controlled manner using pipeline gas and by depressurising the pipeline at the launcher / receiver. The RTP is designed and engineered to ensure that it will not swage the pipe, leaving only minimal lock mark indentations behind, this has been independently verified to confirm they will not lead to future corrosion or integrity issues.

Challenges

National Gas purged gas to nitrogen to air before breaking containment, which took longer than expected (~2 weeks) due to suspected condensate in the low point (ravine). This was a project specific issue which is unlikely to occur on future deployments and was due to the nature of the pipeline topography in proximity to the site between the RTP and the pig launcher/receiver and the unusual requirement for an excavation at the isolation location.

Following review of a manufacturing drawing it was discovered that one of the tee’s on the pigging route was oval due to poor manufacturing, luckily this was picked up during detailed engineering and cross checked with ILI caliper data. The RTP was adapted to ensure the hard OD of the plug in the unset condition could traverse the tee resulting in successful execution first time.

Summary

Venting, recompression and line stopping operations onshore will continue to be used in the future however, following the success of this project, National Gas now have another qualified option in the toolbox, with the Remote Tecno Plug.

National Gas are now producing new policy which will formalise the use of this new technology, reducing approval barriers therefore increasing project efficiency and reducing costs on future projects. The policy could also be adopted by the gas distribution networks for applications on the wider UK network.

This case history was presented not to showcase technical challenges and lessons learned but instead to present the RTP's first use on the NTS and highlight the benefits of this technology, in terms of efficiency and emissions savings;

- It took ~24 hours to install, pig, set and test the plug, saving time vs. traditional techniques
- Emissions were reduced 24x, discharging 9.5tonnes of gas (plug) vs. 233tonnes (recompression)
- Gas not discharged using the RTP was the carbon equivalent of switching off 1760 gas boilers for a year or 5,930,000 miles in a ford fiesta, which is the equivalent of removing ~1000cars off UK roads for a year.
- Sales value of gas not vented (saved) by using the plug equated to £125k

Future work

Onshore in the future, especially if legislation around methane emissions becomes stricter relating to CO_2 emissions, emissionless isolations will become more important if not essential as part of the measures required to meet climate targets.

Emissionless pipeline isolations with the RTP could be undertaken using nitrogen for pigging, where practical. Additionally, low pressure/volume vacuum/recompression units smaller than National Gas' planned 1bar RCU's could be deployed for pigging activities. These third-party units prevent methane discharge during launching/receiving activities and have already been deployed successfully in North America in conjunction with STATS line stopping equipment for emissonless midline pipeline isolations.

Final Thought

The United Nations Environment Programme global methane emissions report states that existing technologies can reduce methane emissions by 30% by 2030. The greatest potential for cost saving is in the oil and gas sector, where captured methane adds to revenue instead of being discharged to atmosphere(4).

The technologies the UN refer to don't require innovation funding or development and have an existing track record. These technologies are available now and can have a real impact, technologies like the Remote Tecno Plug and the BISEP. Both tools are qualified and available for use onshore and offshore.

(1) Matthew Williams (2022), 'Reducing Leakage and the Environmental Benefits', IGEM Annual Conference – Engineering the Transition.
(2) National Gas Website (Oct 2023), www.nationalgas.com/land-and-assets/pipelines-maintenance-centre-pmc/recompression
(3) Annex – Recompression Engineering Justification Report September 2020; www.nationalgas .com/document/132951/
(4) United Nations Environment Programme and Climate and Clean Air Coalition (2021). Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions.