Integrity Assessments of In-Line Isolation Tools: How to gain Assurance on New Technologies, Approval, Testing and Live Trials

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Abstract

National Gas Transmission own and operate the National Transmission System (NTS), the backbone of British Energy. The NTS feeds homes and businesses the essential gas required for life today in the UK. When operating above 70 bar(g), like most of the network does, the potential of failure or downtime of these pipelines has a critical impact on how interventions are carried out. However, changing how we do these interventions isn't as simple, but why can’t we just make it so?

In line isolation tools have never been used on downstream onshore pipelines in the UK before. Regardless of the experience of others, National Gas must assure itself through a process of due diligence that the new technologies and techniques do not create an immediate threat, or future integrity threats to the remaining life of the pipeline. National Gas has developed an approval process, and has been trialling and testing tools, to develop an unbiased viewpoint built on evidence on the operational acceptance and integrity implications for the pipeline.

National Gas has conducted an Isolation Joint replacement using a Pipeline Isolation Tool, instead of traditional venting (emissions reduction) and the need for recompression operations or alternative more invasive options (stoppling and bypass). The technology provided a fail-safe, leak tight double block, and monitor isolation, keeping a 48” pipeline fully pressurized at 56bar for 56km to the nearest block valve upstream. This method can help to reduce National Gas’s emissions and operators’ exposure to high hazard methods.

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Introduction

National Gas owns and operates the National Transmission System (NTS), a network of high-pressure gas transmission pipelines covering the United Kingdom (UK), balancing the flow of high-pressure natural gas between import terminals and the regional gas distribution networks, gas storage facilities, international interconnectors, power stations and other large industrial customers. The NTS consists of over 7500 km of buried pipelines and over 650 Above Ground Installations (AGIs).

As part of the innovation fund incentive on regulated gas transmission companies, National Gas explored the opportunity to investigate and where viable, trial inline isolation tools for onshore pipeline use. Such tools propose to provide a non-intrusive method to interrupt product flow and isolate pipeline sections which require repair or maintenance, removing the necessity to perform hot work on a live pipeline. Product flow in the pipeline is halted using an expanding packer to seal in the pressure and a series of mechanical grips to maintain the necessary resistive force and prevent tool slippage. The technology has been used commercially offshore, however offshore pipelines are designed with heavier wall thicknesses, such that the pipe-wall stresses induced by the tools when active remain acceptable. The acceptability of the tools for thin-walled onshore pipeline use has not yet been confirmed for use in the UK.

With a significant volume of remedial work planned on the NTS, particularly associated with valves and isolation joints, National Gas view inline isolation tools as potentially providing considerable benefit (carbon footprint and financial). If the technology can be verified for onshore use, it will be considered the preferred method for pipeline maintenance going forward.

Research has previously been completed by the Pipeline Research Council International (PRCI) in the USA, reviewing tools on the market, National Gas required this work to be extended to available technologies available in the UK market considering the use on more relevant pipeline sections which are operating in the UK today. The ultimate decision and output of the work will require changes to National Gas policies and procedures to support the operation of in-line isolation tools in business-as-usual operation.

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Background Research

A review was carried out, aimed at understanding the current range of inline isolation tools and their applicability for use on National Gas Transmission pipelines; and assessing the potential impact inline isolation tool operation would have on current policies and procedures. The studies were split between five individual sections and detail specifically:

- A state-of-the-art review of the PRCI onshore inline isolation tool research work.
- A detailed summary of National Gas's initial requirements for inline isolation.
- A review of the capabilities of inline isolation tool vendors with respect to National Gas's requirements.
- An assessment of the impact of inline isolation tools on National Gas's policies and procedures.
- An outline of the requirements for field trials of inline isolation tools in an onshore setting.

The previous PRCI study shows that inline isolation tools from three different manufacturers can be used to isolate a 610 mm diameter, 9.525 mm wall thickness, grade X70 pipe at 108.6 bar(g) pressure, under laboratory conditions, for a period of 2 hours, with no slippage of the tool or leaks past the pressure seal. Additionally, there was no plastic deformation of the pipe recorded.

Consequently, the study provides a promising outlook for the future use of inline isolation tools on thin-walled onshore pipelines. The study however left several questions unanswered, which required further consideration before the tools can be considered validated for onshore use.

It was therefore recommended that further work should be considered regarding:

- The use of the tools in the field, outside of laboratory conditions, paying particular attention to the presence of stresses (construction, thermal, ground loading etc.) which could occur in addition to internal pressure loading.
- The maximum length of time an isolation tool can safely be used in any one application.
- Whether the level of internal damage to the pipe wall is affected by the length of time the tool is in use.
- The use of the tool on pipelines with different diameters, wall thicknesses, grades, and pressures and how this affects stresses, damage and plastic deformation.
- Whether the damage caused by the tool to the internal pipe wall could contain microcracking or otherwise grow under the normal cyclic stresses of pipeline operation and what effect his has on the fatigue life.

- Whether internal pipe damage could occur in combination with plastic deformation in certain pipelines following tool use and what effect this would have on the burst strength and fatigue life of the pipeline.
- Whether the tool can be used effectively on pipe sections with pre-existing damage, including low quality seal welds, and what the limits for this would be.
- Whether the tool can be used effectively in the same place on multiple occasions and what effect this would have on the level of plastic deformation, damage, burst strength and fatigue life.

Pipelines

A detailed summary was made by PIE of the initial requirements National Gas have for inline isolation, in terms of the pipe geometries, isolation pressures, materials and construction the tools must be compatible with, the required range of the tools and the time periods the pressure must be isolated for. As it is required that the use of isolation tools does not lead to a safety risk, consideration was also given to data indicating the condition of potential pipe sections to be isolated.

This data will allow an assessment to be made as to whether any given pipe section can safely accommodate the stresses due to tool operation. At this stage, National Gas's requirements do not relate to the NTS in its entirety but are instead determined from a representative data set of 23 insulation joints which have been allocated for repair in the near future.

It was concluded that National Gas's initial requirements for inline isolation tools are to be able to operate in pipelines potentially with:

- Pipeline outside diameter between 24" (609.6 mm) and 48" (1219.2 mm).
- Pipeline nominal wall thickness between 9.5 mm and 15.9 mm.
- Pipe material grades API 5L X52 to X80.
- Alternating brittle and "crack stopper" pipe spools.
- Charpy v-notch impact energies as low as 24 J.
- Operating pressures between 70 barg and 94 barg.
- LSAW seam welds.
- P2 standard girth welds.
- An operating temperature between 0 and 5 degrees Celsius.
- Epoxy Resin or Red Lead internal coatings.
- Coal Tar, Epoxy Resin or FBE external coatings.
- A hydrotest level as low as 83.9% SMYS.

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- A remaining fatigue life of less than 51%.
- Pressure cycling equivalent to a maximum of 146 cycles of 125 N/mm2 per year.
- A required isolation location 137.5 km away from the tool launch point.

Technology

PIE undertook a conversation with both TDW and STATS group. Contact with the third company involved in the reviewed PRCI report, PPIG, was also considered, however no evidence of operations outside the USA could be found and no global offices uncovered. It was determined that an exclusively USA based company would not be of benefit to National Gas and their UK operations.

Both vendors were requested by e-mail to answer a simple set of questions based on National Gas's initial data requirements. The vendors replied and agreed to further interrogation through online meetings. Both vendors were accommodating and appeared open regarding their respective tool capabilities. Neither vendor was disqualified from the process or demonstrated that they would not be of use within National Gas's requirements.

However, it was stated that for each proposed tool operation a pipeline specific review would be required to assess suitability for tool deployment. Tool deployment is essentially the same as the launch of an inline inspection tool and therefore carries the same risks. Treating each deployment in the same way as an inline inspection tool would help manage and mitigate the risk of not only the launch and recovery, but deployment (locking and pressure control) on the pipeline's integrity.

Further clarification from both vendors is needed and more off-field investigative testing may be necessary to understand which assets will fall under this requirement. Vendors were presented with information for the 23 pipelines sections with insulation joints requiring repair and asked to indicate if an isolation of each section would therefore be possible, in principle, based on that information. It is acknowledged that additional data regarding potential pipeline damage in the area of tool operation and pressure and flow constraints is not available at this stage and would be required as part of the vendor assessment to ultimately determine if isolation would be possible.

Policy

The aim of the policy review was to understand and document the potential impact of the technology upon National Gas's policies and procedures. The documents identified by National Gas as requiring assessment, are:

- T/SP/E/56: Specification for Ancillary Pipeline Equipment (January 2020)
- T/SP/PC/2: Specification for the use of PIGS in Gas Transmission Pipelines (October 2005)
- T/PM/TR/17: Isolation of Above 2 Bar Plant and Equipment (November 2017)

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It was concluded that the impact of inline isolation tool operation on the documents is minimal, with the update of only a small number of sections being required. It is noted however that some sections will require further review after a field trial has taken place.

There are two options to reflecting the inline isolation technology in NG documentation:

a) Draft a specific standalone document, or
b) Detail the supplementary (additional) requirements based on the above documents.

Given that the above 3 documents are minimally impacted by the inline stoppling technology, it is recommended that a field trial is used as a pilot exercise to develop the supplementary requirements. Once the trial has taken place and the requirements updated, they can be incorporated into the next revision of each document.

Field Trial Requirements

It was identified that inline isolation tools have been used on offshore and onshore liquid/gas pipelines. However, given that its application is not widespread, e.g. in comparison to inline inspection, it is considered appropriate to conduct controlled offline and online trails for what would be National Gas's first application of this technology. The lessons learnt and experiences from these trials are to be recorded and documented into National Gas's requirements for future applications.

An offline trial should take place at an isolation tool vendor's facility using a spool which is representative of the planned location of the online trial. Upon completion of the offline trial a report should be issued to detail the trial and indicate whether it is acceptable for the online trial to proceed. Upon completion of the online trial a report should be issued to detail the trial and recommend future use of the technology and procedure requirements.

Discussion

The PRCI research left a number of questions unanswered, which required further consideration before the tools could be considered acceptable for onshore use. National Gas initially require inline isolation of 23 pipeline sections containing insulation joints which require repair. The capabilities of the inline isolation tool vendors T.D. Williamson and STATS were reviewed with respect to these 23 pipeline sections, and it was determined that, in-principle, both vendors have the capability to isolate all 23 sections, however the use of additional external reinforcement may be required in some cases depending on the vendor and the pipeline section.

The impact of inline isolation tool operation on the NTS to National Gas's policies and procedure documents is minimal, with the update of only a small number of sections being required.

Strain Gauge Assessment

Background

National Gas appointed DNV to support them during the factory test with a mock-up installation testing the STATS in-line isolation tool. This involved the installation of several uniaxial strain gauges to the external surface of a 48” diameter grade X65 pipe with nominal wall thickness of 22.5mm. The output from these gauges were then recorded whilst the Tecno Plug was deployed in the pipe. A subsequent repeat test, this time on grade X80 pipe with 15.9mm nominal wall thickness, was conducted for further assessment.

This work was then repeated during field deployment of the STATS pipeline isolation tool at an NG installation to allow for the replacement of an isolation joint. This involved the installation of 14 biaxial strain gauges to the external surface of a 48” diameter grade X80 pipeline section with nominal wall thickness of 22mm. The output from these gauges was recorded whilst the tool was being deployed in the pipe and during the subsequent venting operation. Once this operation was complete the data acquisition system was disconnected from the gauges. DNV returned to site to reconnect the data acquisition system and to record strain data whilst the tool was unset and retrieved from the pipeline.

Equipment

The gauges used for the factory tests were Vishay CEA-06-250UNA-350 type. These are general purpose uniaxial gauges that provide a strain range of +/-5%. The gauges were installed in the hoop direction. The gauges were connected to three Vishay System 8000 StrainSmart data acquisition systems each with 8 input channels. These systems were daisy chained together to give a total of 24 channels. The scan rate was set at one sample per minute to keep the output files to a manageable size.

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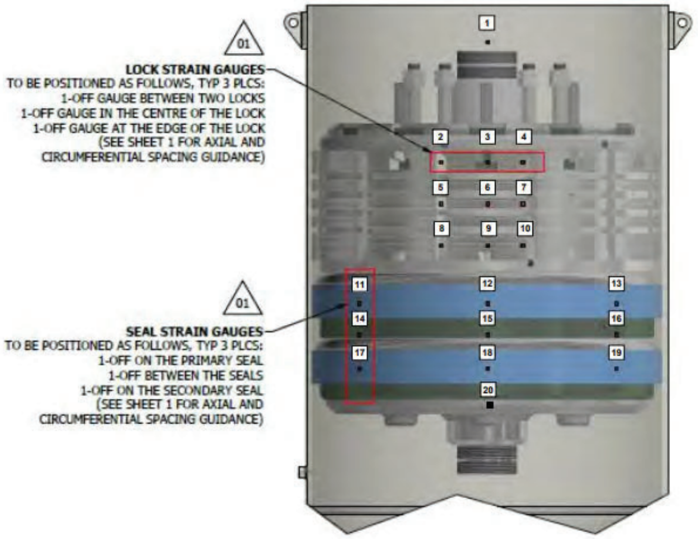

Figure 1. Strain gauge locations during factory testing

The gauges used for the live on-site test were Vishay L2A-06-062LT-350 type. These are general purpose 90° rosette gauges that provide a strain range of +/-3%. The 14 gauges were installed as per the arrangement in **Figure 2**.

The gauges were connected to four Vishay System 8000 StrainSmart data acquisition systems each with 8 input channels. These systems were daisy chained together to give a total of 32 channels (note that each biaxial gauge requires 2 channels) to allow monitoring to occur in both directions rather than only the hoop as per the factory testing. The scan rate was set at six samples per minute to keep the output files to a manageable size.

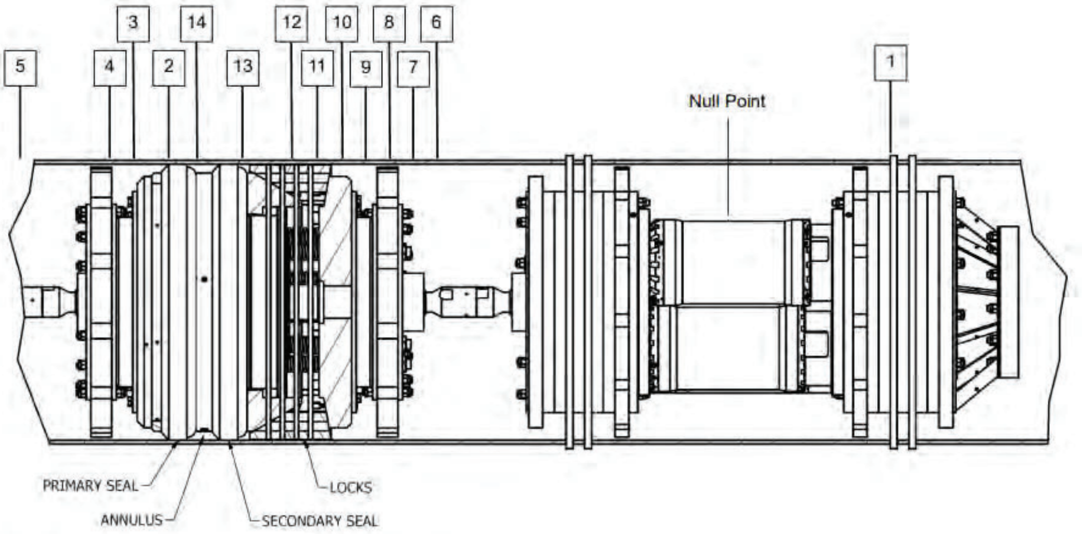

Figure 2. Strain Gauge locations during live trial

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Figure 3. Strain gauges installed at site

Factory Acceptance Test Results

The results from the X65 test showed the highest recorded strain during teeth setting was at location 9. Once pressure was introduced gauges 11, 14, 17 and 18 (the column of gauges to the left of the seals along with the bottom central gauge) became the points of highest strain. The highest strain recorded during the test was at gauge 17 during the pressure test and this measured 1622µE (or 0.16% strain).

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Figure 4. Installation of strain gauges by DNV during FAT

Gauge 10 returned strain behaviour that was not expected and so this should not be considered reliable data without further investigation. All gauges returned to (or very close to) zero strain once mechanical and pressure loading was removed indicating no local plastic behaviour of the pipe material. This would be expected due to the magnitude of the maximum strain during this test.

The results from the X80 test also show the highest recorded strain during teeth setting was at location 9. The strain at gauges 3 and 6 were also high during this step – these are located in the central column of gauges adjacent to the locks. The strains indicated in the columns either side of gauges 3, 6 and 9 suggest these areas were in compression after the teeth had been set (tensile strains are positive, compressive strains are negative). This may indicate the pipe had a degree of ovality prior to the test and may warrant further investigation.

During the pressure test these three gauges all experienced an increase in indicated strain and remained the locations with the highest strains, which was not consistent with the results from the X65 test.

The highest strain recorded during the test was at gauge 6 during the pressure test and this measured 3128µE (or 0.31% strain). Although these are local strain indications, strains of this magnitude could be considered high for operation of pipelines designed using stress-based criteria. That notwithstanding, all gauges returned to (or very close to) zero strain once mechanical and pressure loading was removed indicating no local plastic behaviour of the pipe material.

Live Trial Results

During the initial setting of the tool the pipe behaved as would be expected – the gauges indicating the highest hoop strain were 2 and 11 – 14 inclusive which were positioned adjacent to the teeth and seals. The axial strains were small but still tended to be where they would be expected – those located adjacent to the seals exhibited slight compressive strains as the primary seal moved toward the secondary seal during deployment. During venting it could be seen that the gauges in the vented section of pipeline (1, 6, 7 and 9) exhibited negative (i.e. compressive) hoop strain. This is not strictly a compressive strain; it is the relaxing of the tensile strain already present in the pipe due to the internal pressure of 56.9 barg.

The maximum compressive strain indicated was 912µE at gauge 9. Assuming a pipe OD of 1219.2mm and a wall thickness of 22mm, and using thin cylinder theory, the hoop stress in the pipe is calculated to be 157.7MPa. Using a Young's Modulus of 210GPa this suggests a strain due to internal pressure of approximately 750µE. This is comparable to the measured reduction in strains in the vented section of pipe. When the gauges were reconnected to the data acquisition system, for tool retrieval, the gauges in the depressurised section of pipe were reading very similar values to those in the setting process.

Gauges 3, 4 and 5 were exhibiting very slightly higher hoop strain (in the region of 50 – 150µE). Gauge 14 (adjacent to the primary seal) was reading hoop strain approximately 250µE lower than previously but gauges 11, 12 and 13 were between 140µE and 175µE higher. This could possibly be due to some slight relaxation of the primary seal lowering the strain in that area with the contraction of the pipe taken up by gauges 11, 12 and 13 adjacent to the teeth and secondary seal. In addition, gauges 2 and 14 exhibited a notable increase in axial strain between the completion of the venting for tool setting, to when they were reconnected for retrieval, of approximately 300µE and 550µE respectively. These were adjacent to the primary seal, and it is possible the strain accumulated over time as this seal was bearing the load of the locked in line pressure.

The ambient temperature during re-pressurisation was between 20 and 22°C, whereas during the tool setting it was between 17 and 19°C. This may also have contributed slightly to the differences in strain. Once the tool is fully unset the strains quickly tended towards the neutral axis and there did not appear to be any areas of permanent strain. In particular, the gauge that indicated the highest strain was gauge 13 during the tool setting period (763µE). This gauge was indicating -16µE at the

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end of the operation which suggested no permanent strain was introduced during the tool deployment.

It is worth noting again that the strains stated in this report are in addition to the pressure strains already present in the pipe therefore it is reasonable to state the worst-case maximum strain imposed on the pipe during this deployment is in the region of 1675µE (or 0.17% strain).

It would be recommended that the isolation pressure when using an isolation tool should be limited as it appears stresses are approximately doubled when the tool is engaged. If there was to be an isolation occurring in a high stressed section of pipeline (such as 0.72 design factor) it could elevate the stress levels substantially.

Tool Damage Assessment

The isolation tool locates in the pipe by expanding grooved steel grips to the pipe walls where they are fixed by pressurisation. The pressure applied has been found to force the steel grips into the pipe walls. The extent of this damage and its possible effect on long term operation was not known. The isolation was deployed in both X65 and X80 pipes, in a factory setting, and the loading on the pipe walls was assessed by strain gauges. Sections of these pipe with the groove-like damage resulting from pressurisation of the grips were then sent to the DNV Laboratory in Loughborough to allow a metallurgical assessment of the damage arising from the use of the grips.

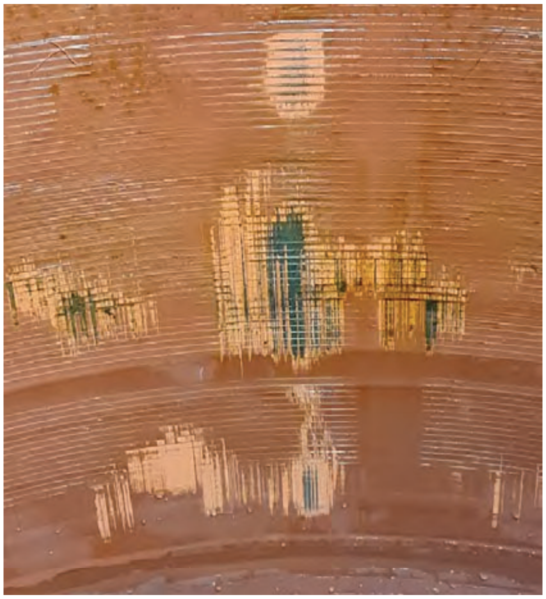

Figure 5. Factory test spool damage example

Material

The grooved areas of the internal plate surface were examined, and it was noted that in some areas a double set of grooves were present in the X65 material, this was due to the repeated tests during the factory tests. The specimens were selected to take in both the double and single grooved and were those areas with the most pronounced damage.

With the X80 material, it was also noted that the heaviest grooving damage was found on the raised weld toe. The specimens were selected to take in the most damaged areas of the parent material and an area of the damaged weld toe.

Metallography

The specimens prepared for the metallography were etched with a dilute acid solution. The bulk microstructures of the of both the X65 and X80 materials were consistent across the specimens.

In both cases the microstructures were made up of ferritic matrices with bands of darker colonies running through them. At higher magnification the darker colonies were still unresolved, but their morphology suggested they were bainitic which is as expected for these grades of steel in the quenched condition.

When examining the grooves in the X80 weld it was noted that there were crack like extensions running parallel to the surface at one of the grooves (Table 1). Closer examination showed that these were laps in the material surface as shown by the deformed material around them and not cracks. The grooves in each specimen, where the hardness traverses, were inspected at increasing magnifications to determine whether there was any micro damage occurring at their tips.

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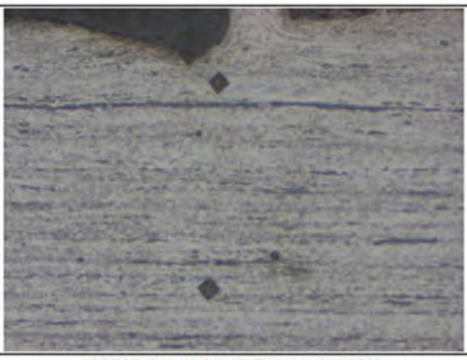
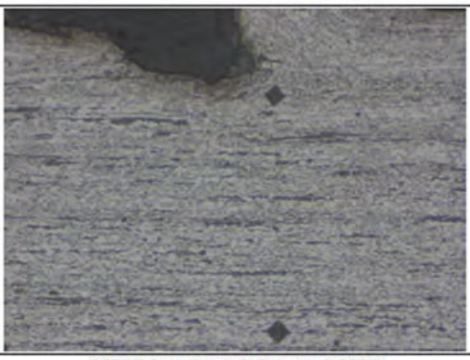
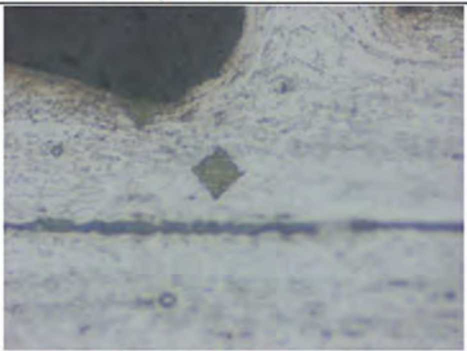
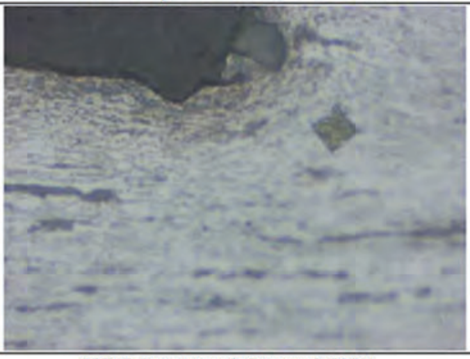
Table 1. Metallography specimens for X80

	
20715 Specimen 3 Groove 1 200X	20715 Specimen 3 Groove 2 200X
	
20715 Specimen 3 Groove 1 500X	20715 Specimen 3 Groove 2 500X

It was concluded that there were no defects associated with the impressed grooves other than the laps mentioned previously. In each case the compressive load has distorted the microstructure at the specimen surface, but the degree of distortion is similar to that of the general surface, caused by the manufacturing processes.

Discussion

The assessment of the damage caused by the isolation tool gripping system was carried out using a series of investigation techniques. The damage was initially sampled based on visual assessment of the worst damaged areas. This examination involved cutting the specimens from these areas in a manner suited to minimising heat and/or frictional damage to the materials so that the results of further work were not influenced. The two materials examined complied in both hardness and microstructure to BS EN ISO 3183:2012 /3/ grade X65 and X80 material.

The hardness tests showed both materials to have very similar hardness, which reflected similar tensile strengths. This was acceptable because the specified tensile strength range, which are relatable to hardness of the two materials overlap. The surface condition of the material showed compression of microstructure in areas unaffected by the plug grips and this was thought to be due to either the forming process or surface cleaning by grit blasting.

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The examination of the grooves at varying magnification showed that there was no suggestion of material tearing or cracking around the grooves arising from the tool grips. The microstructural distortion below the grooves was similar in magnitude to the deformation already present in the pipe wall surfaces arising from manufacture. This was typically less than 0.2mm by observation. The one groove, situated in the X80 weld that showed discontinuities at its base was examined and was shown to have laps at its base. These defects apparently arose from the surface material being compressed and smeared across its own surface by the grips. This resulted in a line discontinuity roughly parallel to the pipe surface surrounded by compressed material. This general surface compression is a desirable feature as it shows a surface with compressive residual stresses at its surface which would make fatigue crack propagation more difficult.

The hardness tests carried out showed that elevated hardness due to work hardening did not extend more than 0.3mm from the groove tips, which in the parent material were typically less than 0.2mm in depth. This depth is less in magnitude than might be expected to be caused to pipe sections during handling, construction and back filling activities.

The overlap in tensile properties and similarities in microstructures of the material meant that the response to grip loading of the two materials was very similar. What was also apparent when viewing areas where double sets of grooves were present, was that the damage affected areas were small enough that even with closely spaced grooves there was no indication of damage interaction.

The outcome of the assessment is that the wall damage caused by the isolation tool in the examined pipe sections did not compromise the integrity of the pipe wall during application. It was also apparent that the level of damage in the pipe walls examined as a result of the application of this device was unlikely to have any effect on the pipeline product. It should however be noted that the defects created may constitute as stress raisers that can have an effect on fatigue life.

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Site Trial

Non-Destructive Examination

To gain confidence, existing inline inspection records were reviewed by National Gas early in the decision process of reviewing the suitability of the isolation tool for this deployment. The tool required a straight 4m section of pipeline for setting, no existing defects were identified by National Gas at this stage.

The NDE included ovality checks of the pipeline and ultrasonic wall thickness checks. The results of the NDE again showed no issue that would defer the setting of the tool. Wall thickness checks were taken at 200 mm intervals along the length of the pipe, at 8 points around the circumference of the pipe.

In Field Deployment

The STATS isolation tool is heavier than the average in line inspection tool (circa 10t), however in terms of deployment, it follows the same, well-established operation, therefore does not present any new challenges. National Gas operate a safe control of operations process which requires the development of a very detailed non routine operations (NRO) process document being established. This document covers every element of the deployment as well as detailed assessment of flow and pressure parameters required to enable the launch, setting and recovery of the tool. The wider complexities of the NRO are not for discussion here, the key element is the co-operation and understanding of the NRO author and the tool suppliers in order to marry existing and competent supplier deployment process with National Gas accepted stage gates and process, this resulted in a substantial document.

Often when you order a service, everything is covered by the provider, this was the initial expectation when sourcing the tool. This became one the key learning points and while not a technical issue of the tools impact on pipeline integrity, it is a major consideration for in field operations. The core experience of the supplier for offshore operations, where you integrate to a well-established and very constrained environment, where time and space are limited, your sphere of concern is only what you are doing. When operating in the National Gas operational field often the only thing permanently onsite is the asset. The safe deployment of the tool requires a breadth of support functions and equipment which ranged from the expected support of gas operations for valve movements, to accommodation provision for 24/7 supervision of the tool once set.

Where the launch operation differs from standard inspection process is the need to ensure the exact location of the tool is known and tracked from launcher to set location. The tool travels at 2-3m a minute and is constantly tracked and monitored by technicians "walking" the tool and close communication for valve operation. It should be noted the tool was not being deployed any great

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distance, in fact less than 500m. The tool can be deployed in a variety of fluids and the deployment in sales quality natural gas presented no issues in the final set location.

In order to "land" where the line pipe had been cleaned and strain gauges installed (as well as extensive NDE) the flow was throttled, and tool travel slowed. The tool stopped approx. 0.5m from the final required location. The manoeuvre to land in the correct location required the increase in tail pressure which, due to the compressibility of the gas resulted in an overshoot of around 1.2m. This required a rapid relocation of the pre-attached strain gauges based on new locations, although this did ensure a robust and detailed review of the tools final location and set point.

The duration of set was closely monitored operationally as well as described above for the strain reactions. Following from the tool stopping this area of "normal" in line flow stopping operations is an entirely new process for National Gas and while detailed in the NRO, the practicalities of this part in the deployment would highlight the need for potentially more interwoven understanding of both the onshore practices (working time, neighbour relations etc.) and the offshore 24/7 normal practices.

The setting operation combined with the strain gauge installation did offer a rare opportunity to see the line pipe reaction as the stages of the setting process engaged with the pipe wall. Data reviewed confirmed that strains imposed were as expected, and showed similar responses as witnessed in the factory tests.

The deployed tool remained set for a period of 35 days and under constant monitoring for the duration. There was no constant strain monitoring during this period, although they remained in situ to record the un-setting process. The downstream purging operation was carried out as per normal procedures already established.

Following the successful completion of the works which required the isolation of the pipeline, the un-setting process was again witnessed and monitored with the strain gauges collecting data. Following the reintroduction and pressure equalisation of gas to the vented section the un-setting process released the tool from the set point with the strain gauge reaction closely watched as detailed earlier in this paper.

The tool was again walked back the launch site at the very controlled pace with only a minimal section un-trackable due to ground conditions. The weight of the tool also had to be considered, with the speed carefully managed on the approach, so as to ensure the tool travelled back to site but did not land heavy and impact the door closure. The tool was brought to a controlled stop with a high degree of confidence in the correct location, which was confirmed when the door was opened.

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Figure 6. Tool tracking

Figure 7. Close monitoring of tool location at receiver

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Summary

The trialling of the isolation tool enabled additional measures to be undertaken to understand integrity threats from the deployment, setting, un-setting and lasting (potential) defects left on in the pipe wall and structure.

These additional measures have demonstrated and given assurance that the use of the tool has not presented any unacceptable integrity threats to the pipeline from its use. The one exception to this is that there is yet to be an inline inspection of the pipeline section, which will ultimately be used to identify if the internal markings present as defects on the internal pipe wall and would be a final assessment in the sequence of activities.

The operational deployment has room for improvement, it is not felt that this is due to failings in confidence and capabilities, but more likely due to the differing operational experiences of the vendor e.g. normally operations in the offshore industry are 24/7 and restrictions on “own use” equipment (comms, cranes/lifting operations, accommodation etc).

The working process (as detailed by the NRO) should generally be taken as a success and the interactions of the stakeholders did develop a working relationship and overcame issues as identified, to the credit of all involved.

The launch procedure for the isolation tool is broadly in line with established inspection tool deployment processes, with the additional requirements for detailed location confidence in the launcher. The tool travel, setting, un-setting and the final retrieval back to the site are novel to onshore operations. These will require detailed updating of National Gas’s procedural documents. However, at this point, it would be premature to review the procedures and edit/review without engaging or experiencing (at least) a second supplier of such technologies. This would remove the risk of developing supplier specific procedures.

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