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Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form. The full completed submission should not exceed 6 pages in total.

Network Licensees must publish the required Project Progress information on the Smarter Networks Portal by 31st July 2014 and each year thereafter. The Network Licensee(s) must publish Project Progress information for each NIA Project that has developed new learning in the preceding relevant year.

NIA Project Close Down Report Document

Date of Submission

Jul 2021

Project Reference

NIA_NGGT0126

Project Progress

Project Title

In Pipe NTS Liquid Monitoring Systems

Project Reference

NIA_NGGT0126

Funding Licensee(s)

National Grid - Gas Transmission (GB wide)

Project Start Date

August 2018

Project Duration

2 years and 8 months

Nominated Project Contact(s)

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Scope

Significant liquid contamination can result from a gradual build-up of liquid deposits on pipe surfaces, from components that may even be present normally in the gas phase. Depending on the specific components involved, dew temperature measurements may not predict the potential liquid deposition.
Gas composition may give an indication of increased concentrations of critical components in the gas phase, but these are not routinely monitored by the Gas Network Control Centre (GNCC).

In general on the NTS all sample points and measuring instruments are designed to sample and analyse dry gas. Any liquid contamination picked up by the sample probe causes damage to the analysers. This issue is further exacerbated by the fact it is not an easy process to remove liquids.

There are no instruments in place to monitor the concentrations of some potential liquid contaminants (glycols and methanol) across the NTS.

Objectives

The programe will perform a full review of each system (fixed, mobile) will be presented. If the trials prove successful, the systems will be adopted as a business as usual system for liquid monitoring within the NTS. The necessary procurement and National Grid specification/standards, inclusive of standard design templates, will be amended accordingly.

Success Criteria

The programme will provide in service demonstration of video liquid detection systems for in pipe monitoring of gas transmission networks. The trial will be conducted at a site which has a history of liquid contamination and will thus be an effective validation of the video detection system.

Performance Compared to the Original Project Aims, Objectives and Success Criteria

Progress 2018/2019

A large double block and bleed (DBB) valve was inserted between the LineVu Camera Can and the existing isolation valve. The Camera Can was installed but was unable to illuminate beyond the isolation valve. Therefore, it was agreed that a more efficient method would be to install a vent line in the flange adapter. The DBB valve was subsequently removed and the modified flange adapter fitted. Good images of the isolation valve were evident and a small section of the bottom of the pipeline could be seen. Changes were made to the focus, frame rate, gain and white balance of the camera to enhance the images.

Video footage has now been analysed and some heat haze can be observed. Despite the limitation imposed by viewing through two plug valves, reflections from movement in the pipeline can be seen moving up the vertical section of the pipe. The LineVu system is currently set to record continuously, and further data will be analysed.

Progress 2019/2020

Performance on the project has been good with the original aims and objectives being met, since 18/19 the first LineVu system has been moved to a new location allowing direct access to the pipeline. This has provided a clear field of vision and the camera has now been recording for several months and there have been direct communications between the teams at National Grid on the results. It was also found that the 1.5” field of view was reduced to 1” due to debris in the vertical section of tapping point below the isolation valve. This can be cleaned when the section of pipeline is next out of service.

The second camera which is a mobile solution is currently planned to be fitted to site once the current restrictions are lifted and access to site is provided. This will allow for remote monitoring of the footage without requiring engineers on site.

Closure 2020/2021

Upon project closure the aims and objectives of this project have been met, both varieties of camera (the fixed and mobile) solutions have been fitted on different sites across the NTS and have recorded several months of footage. Process conditions at the time of recording have been overlaid onto the footage to help with the analysis and video extracts have been supplied to National Grid. The fixed camera system has remained on site after the innovation project has concluded with the mobile version being removed and placed in National Grid storage. Discussions are ongoing on the implementation of the system with the relevant internal teams.

Required Modifications to the Planned Approach During the Course of the Project

Progress 2018/2019

Another location was selected for the Camera Can, which is an unused 1.5” flange located in a pit around 6m from the original location. Whilst it is a smaller diameter than normally required, direct access to the pipeline can be made without two plug valves, hence it will provide a better view of the main pipe. Once authority has been given to proceed with the installation at this new location, a new valve and flange adapter will need to be ordered.

Progress 2019/2020

No modification to the planned approach although there have been change controls to extend the time that the cameras have been recording in an effort to collect more footage of the gas flow. This has also led to a small increase in the cost of the project to fund internal and external time.

Closure 2020/2021

No further changes within this period.

Lessons Learnt for Future Projects

Progress 2018/2019

Although further modifications are still required before the Camera Can is implemented satisfactory, lessons have been learnt when deciding on the locations of the temporary installation(s) for the LineVu Mobile Unit. These have included ensuring there is a minimum of interference from additional valves which would limit the coverage of the Camera Can.

Progress 2019/2020

There have been several lessons over the past year including:
Moving the equipment to the new location provided a satisfactory implementation, giving a clear view of the pipe floor.
The use of time-lapse video gives a clearer picture of times of interest when being reviewed.
By overlaying the process data on to the video it allowed the visuals provided to be put into better context to understand the results. Whilst this was additional to the original scope it provided greater benefit.

Closure 2020/2021

There have been several lessons over the past year including:

- Improvements to the field of view (FOV) could be made by replacing the stop valve at site two with a full bore valve at the next shutdown period.
- Data from other projects (globally) have shown that the combination of high gas velocity and installation immediately downstream of multiple tight bends creates sufficient turbulence to disturb the image. While the installation at site two is downstream of three bends, there is adequate distance for the turbulence not to obscure contaminant detection.
- It is suspected that when contamination flows are observed at an angle to the pipe direction, it is due to a helical gas flow within the pipeline. This observation could be an additional benefit when installing LineVu at custody transfer points where straight laminar gas flows are required for accurate flow metering.
- Control room operators have suggested that a live feed of pipeline activity would help put other process data into context. A fibreoptic line from the LineVu Controller to the control room will allow live high definition video of pipeline activity. Multiple LineVu systems can be displayed on one screen.
- During the project, gas flow, pressure and temperature were able to be added to sections of footage that gave better perspective of the events observed by linking them with changes in flow rate or other process parameters. The data could be added live if the system was able to read process data via modbus or other digital data system.

Note: The following sections are only required for those projects which have been completed since 1st April 2013, or since the previous Project Progress information was reported.

The Outcomes of the Project

Progress 2018/2019

To provide live data as to the liquid content within a pipe sections a double block and bleed valve was inserted between the LineVu camera can and an existing isolation valve. The installed camera was unable to illuminate pass the isolation valve. However, modification was made by fitting a modified flange adapter, subsequently images were visible.
To allow for a holistic view on liquid content within a pipe section a new location is being selected to carry out the test on a smaller diameter pipeline.

Progress 2019/2020

The project has been a great success to date and has provided a considerable amount of footage that can be analysed further. The technology has been proven in an operational environment having previously only been tested in offline scenarios. The project has also helped to reinforce the need for this type of technology and the benefits that they can add.

Improved monitoring at gas entry points will lead to better accountability and reduce the occurrence of network anomalies resulting in improved operational safety levels. The results of the project will have a broad interest across the gas industry.

Closure 2020/2021

As a brief summary of the camera system, the Camera Can is certified for use in hazardous areas, and designed to mount on top of a gas pipeline. The camera and illumination system is configured to take video and images of the pipeline through the isolation valve. Image processing is used to trip an alarm when contamination is detected. An optional link is available to the control room to provide a live view of pipeline activity.

The standard flange is a Class 900 3” RTJ. The Camera Can has a secondary containment vessel to prevent loss of containment upon a window or seal failure. The secondary containment vessel is constantly monitored for pressure and temperature. The SIM card in the

interface unit allows connection to the mobile phone network and configuration of a virtual private network (VPN) to enable the unit's integration.

The interface unit and LineVu controller are mounted in a safe area, with an ethernet connection between them. During the project, systems were not connected to the site or National Grid networks. All data was saved on-site with sufficient space in the LineVu Controller to save up to a year of data. The alarm thresholds were set at high levels with notification e-mails set up for Process Vision staff.

The LineVu system was set to store a still shot once a minute automatically. It compiles these shots into a time-lapse video which can be downloaded every 24 hours. This provides extra functionality beyond the detection of contamination. Replaying these videos at 1500x speed highlights and reveals low-level contamination (under alarm threshold) for further investigation.

A wide variety of gas flow types have been observed between the two installations providing a good validation level for the technology. The system was installed at both manned and unmanned locations and were able to communicate threshold and system alarms. The video was of sufficient quality to infer the mechanisms in play.

More generally detecting contamination at the gas entry point of the network could assist with four main issues:

1. Safety and Asset Integrity: Once contamination enters a gas network, there have been examples of it pooling at low points and causing internal corrosion to the point of rupture. There is also the risk that it accumulates to a point sufficient for slugged flow to occur. There have been events where significant damage to compressors and gas turbines are caused by liquids.
2. Compliance with regulations and tariffs: To paraphrase Schedule 3, part 1 of GSMR: "No person shall convey gas in a network if it contains solid or liquid material which may interfere with the integrity or operation of pipes or any gas appliance." With the evidence that LineVu provides, the network can improve its accountability by implementing threshold alarm, similar to existing gas quality parameters, e.g. dewpoint and H2S. It is anticipated that monitoring adherence to GSMR (and tariff agreements) for contamination will lower the frequency and severity of contamination events from licensees or faulty compressors that allow lubrication oil to enter the gas flow. Access to live data enables rapid evidence-based decisions to be made, and the recorded event will support and defend operational decisions made to maintain GSMR.
3. Reduced Contamination: With live data, it is anticipated that network operators and licensees can take immediate and appropriate action. For the licensees, this action will reduce the loss of processing liquids and NGLs; for the network, it prevents contamination entry to the network lowering the frequency of pigging operations to clean-up after an event.
4. Fiscal Flow Measurements: Liquid and solid matter present at a flow meter station will cause errors in the measurement. Unexpected wet gas can generate around a 5% overread on orifice plate and ultrasonic flowmeters. As contamination is unlikely to be pure liquid, the solid material left on the pipe wall is conveyed down the pipeline, causing a permanent reduction in pipeline diameter after an event. If this occurs at the point of flow metering, it results in a permanent over-read on flow measurements through which the contamination has passed. Installation of LineVu systems could, therefore, have a positive impact on financial issues. Using the process details and the contamination observed at site 1, if this level of contamination were present at the flow meter station, it would cause an over-read of 0.335%. (At today's gas prices of $1.2M per year).

The project found that the value of providing engineers with a visual embodiment of pipeline activity puts other process data into better context. In addition, the project data has confirmed that contamination events can occur without other gas quality alarms being activated.

The improved monitoring described in this project will lead to better gas quality, improved safety and it is hoped reduced costs.

Due to the sensitive nature of the results from this project, any further information is available on request to National Grid Gas Transmission via the Smarter Networks Portal.

Data Access

Details on how network or consumption data arising in the course of a NIC or NIA funded Project can be requested by interested parties, and the terms on which such data will be made available by National Grid can be found in our publicly available “Data sharing policy relating to NIC/NIA projects” at www.nationalgrid.com/gasinnovation

National Grid already publishes much of the data arising from our NIC/NIA projects at www.smarternetworks.org. You may wish to check this website before making an application under this policy, in case the data which you are seeking has already been published.

Foreground IPR

There are no instruments in place to monitor the concentration of some potential liquid contaminants across the National Transmission System (NTS). The programme will provide in service demonstration of video liquid detection systems for in pipe monitoring of the NTS. LineVu own the background IPR pertaining to the camera. All foreground IPR will be owned by National Grid and will be made freely available as part of the final technical report on the Project is complete.

Planned Implementation

Following successful competition of this project, implementation will be discussed internally. Initially the view was that a ‘fleet’ of these cameras would be installed around the NTS at key entry and exit sites to create a map of the NTS. This footage could either be viewed on site in relation to the fixed systems or via the secure portal for the mobile systems. Further discussions are needed to understand how feasible this will be, and these are ongoing between National Grid and ProcessVision. One of the camera systems that was fitted during the innovation NIA has been retained on site and footage is being collected following project closure.

Other Comments

n/a

Standards Documents

n/a