national gas transmission

Corrosion Modelling

Value Tracking Case Study

Corrosion Modelling

Background

Many of the sites and associated installations on the National Transmission System (NTS) are at or beyond their original intended design life of 40 years and corrosion is now becoming an issue. As such, National Gas are starting to migrate progressively towards a more proactive asset management approach to reduce risk of failure. Corrosion is a problem faced throughout the NTS, and is an issue at St. Fergus Gas Terminal, one of the UK's most critical gas infrastructure sites. As steel pipework corrodes, wall thickness reduces. This decrease in thickness results in an increase in stress throughout the remaining pipework if the pressure and forces remain constant. This increase in stress means that there is a reduced safety factor against failure. If the corrosion is allowed to continue, the likelihood of a failure increases. National Gas aims to move away from reactive asset maintenance to a proactive approach using predictive corrosion growth and monetised risk scenario modelling to determine and address potential future problematic areas in a controlled manner before they require essential repairs.

What's new?

Extensive data collation and augmentation activities were completed to demonstrate the process by which corrosion modelling of both buried and non-buried pipework components could be completed to support tactical and strategic planning activities at an above ground installation (AGI).

A minimum data specification for corrosion modelling was developed and validated through the use of statistical exploratory analysis and machine learning techniques, to determine which information was of greatest use to understand corrosion defect initiation and growth.

Different parameters have been shown to be of some importance for defect initiation and growth but these include, as might be expected, a mix of intrinsic factors (e.g. material grade, diameter, age), environmental factors (including pit location) and operational factors (e.g. pressure class, plant runtime/cycling). Some site-specific factors were also found to be important, in particular geospatial location. This was included to recognise the importance of capturing historical defect clusters that were not fully explained by other operational or environmental factors included in the model.

The limitations of the current site model and asset register were also explored and partly overcome by geospatial analysis and manual augmentation through inspection of site drawings. Model datasets were augmented with publicly available borehole data to estimate soil corrosivity, and data-driven modelling was supplemented with the use of selected industry norms and empirical data derived from the literature.

The completion of the current development of a more comprehensive site model and the mastering of asset identification at component level will improve the ability to model corrosion in future and reduce the need for significant data manipulation.

A machine learning model has been developed to predict the number of new defects arising at CM/4 Grade 4 to and indicate the year at which subsequent interventions may be required. This was a deliberate choice at as the majority of CM/4 visual defect data is held for components which are defective at Grade 4 or worse, and, as such, a model training set was available for these defect severities.

On non-buried pipework, a method for determining the times at which existing defects reported by CM/4 are likely to move from one category to the next category has been described in detail.

On buried pipework, a probabilistic approach to calculate the likelihood of failure was adopted. As part of this process, two different approaches have been used to predict the number of corrosion defects on the below ground pipework. The first exclusively uses In-Line Inspection (ILI) data from neighbouring feeders plus information on soil corrosivity derived from on-site borehole data; the second also uses indicator data from analysis of the onsite Close Interval Potential Survey (CIPS) dataset.

The benefits

Corrosion and the associated costs for inspection and repair of found defects can incur significant costs especially at sites of strategic importance. Locating and addressing known issues as early as possible can prevent these costs increasing. Clearly, performing a broader range of surveys more frequently is likely to increase the probability of detecting corrosion sooner rather than later, and performing repairs at an early stage is likely to improve the integrity of the system. However, doing things more frequently clearly increases costs. The benefit of this project is to generate a methodology to ensure that inspections and repairs are prioritised such that both safety and financial risks are maintained at an acceptable level whilst managing the cost.

Carrying out proactive rather than reactive maintenance on our key sites could lead to significant savings, an efficiency saving on planned spend has been assumed (of at least 10%) to be £15m at the St Fergus site.

Financial savings

Financial benefits on hold whilst model is developed further and other opportunities are built in to the solution.

Implementation

Following the successful competition of the innovation project all of the relevant modelling files and scripts were sent to National Grid and received by the Data team at National Grid (led at the time by Rachel Hassell). The first stage is to load these models internally and recreate the same information that was generated by the project team at WRc, this will confirm the model has come across successfully. Following confirmation of this, data sources will be updated with current information including defect records. This can only be completed after the latest round of CM/4 surveys have been completed by Operations at St Fergus. At this point the model can be compared to the recorded data to check the efficacy of the model. With this information, assumptons and scripts can be updated in the model to reflect the real world progression of the defects over time and the model re run. At the time of the innovation project, in places, there was only 1 data point for the defect and so prediction of growth was challenging, with more data this can be refined to improve the accuracy of the overall model. This maybe a step where we need support from WRc. Once re-run the model can help to focus maintenance on site where predictions show high defect growth rates.

Additionally through this project we were able to create an offline mapping tool for the CM/4 defect team at site whereby they could navigate a map and find their location showing existing defects logged from Ellipse. With this information, duplicate records can be avoided and having the data on site saved a considerable amount of time for the engineers who would have had to go to paper records to find this information. Pictures were also available to help locate the defect and show growth over time. This tool is also planned to be rolled out at Bacton Terminal and extended at St Fergus.