REMOTE monitoring

Kevin Young, United Utilities, UK and Neil Summers, Abriox Limited, UK **discuss the installation and benefits of a remote cathodic protection monitoring system for gas pipelines.**

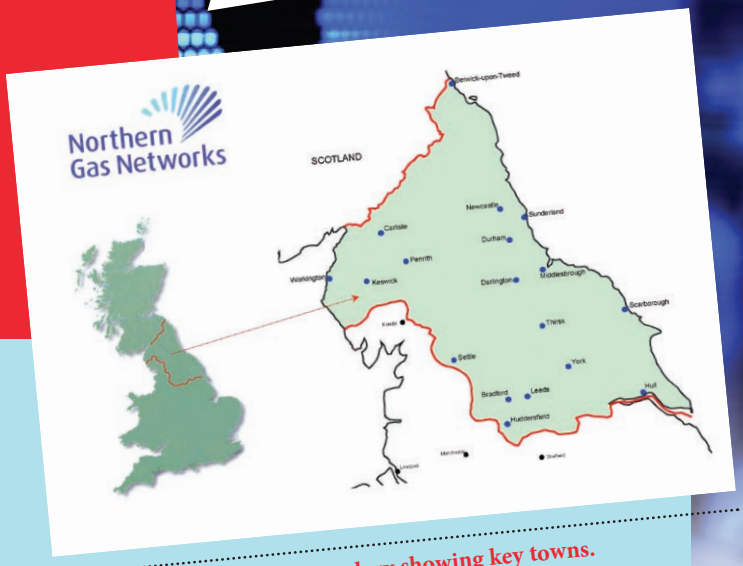

Figure 1. NGN network boundary showing key towns.

Cathodic Protection (CP) measurements are very labour intensive and costly to take manually, only indicating problems after they have occurred. United Utilities, acting as the operator on behalf of Northern Gas Networks, is installing a remote CP monitoring system that will deliver a quick financial payback and is already making operational improvements to the management of the gas pipeline asset.

Northern Gas Networks and United Utilities

Northern Gas Networks is one of the eight regional gas distribution networks in Britain, formed following the restructuring of National Grid in June 2005. Its geographic area extends south from the Scottish border to the boundary between West and South Yorkshire, and has coastlines on both the east and west sides of the region (Figure 1). The network area covers approximately 70 000 ha with a population of 6.7 million, of whom 2.5 million are gas customers.

Northern Gas Networks has separated its asset management and ownership responsibilities from the delivery of operational activity, under a model referred to as strategic asset management. The company retains all the obligations and responsibilities required by its Licence To Operate. It is responsible and accountable for the continued safe and efficient running of the gas network, ensuring the highest possible performance standards, from planning through to asset maintenance and replacement.

United Utilities is the UK's largest outsourced utility management services provider and a member of the consortium that owns Northern Gas Networks. It has been contracted to manage and deliver all Northern Gas Networks' operations including maintenance, repair and capital replacement design.

Figure 2. Pipeline corrosion. Coating (left); weld (right).

Figure 3. CP test post monitor.

The integrity team liaises with statutory bodies (Health and Safety Executive, Local Authorities, etc.) on safety, control of accident hazards, inspection and maintenance issues. This includes cathodic protection compliance, where United Utilities works to Northern Gas Networks' policy and procedures for CP monitoring and maintenance.

Cathodic protection

Corrosion is the action of a metal that has been extracted from ore reverting to its primary state when exposed to oxygen and water. The most common example is the rusting of steel. Corrosion of a pipeline (Figure 2) is very expensive to correct and, at worst, can lead to a pipe failure with unpredictable consequences. Northern Gas Networks' philosophy for the corrosion control of buried steel plant is the integration of high quality factory-applied coatings with the application of CP.

With a proven track record over many decades, CP is now well established as an effective method of protecting metal pipelines at areas of coating damage or imperfection. The preferred technique for high pressure transmission pipeline networks is impressed current cathodic protection, in which transformer rectifiers (T/Rs) provide the direct current power used to energise the CP system. The high current output from a T/R is capable of protecting long lengths of pipeline.

Impressed current systems rely on the continuity of the AC supply to the T/R. Moreover, the level of CP current that they apply is very important. With too little current, the corrosion rate would be unacceptably high. Excessive current can lead to disbonding of the pipe coating and hydrogen embrittlement. For these reasons, impressed current systems require regular monitoring of their voltage and current output. Northern Gas Networks' policy stipulates a monthly check at T/Rs where a single T/R is the only source of CP on a pipeline. Additional measurements (pipe-to-soil potential, instant 'off' potential and current density) are taken less frequently at CP test posts.

Northern Gas Networks has 35 000 km of gas pipelines, supplied from 23 off-takes from the National Transmission System. Approximately 15% of the network (5250 km) consists of high, intermediate and medium pressure pipelines. Most of the HP and IP pipelines are protected against corrosion using impressed current CP systems energised by 208 T/Rs, located at an average spacing of 20 km along the pipeline route and also at above-ground installations.

Abriox and MERLIN system development

Abriox is a high technology company based in Newport, UK, and with its US office in El Paso, Texas. The company's expertise is in the development of robust field instrumentation for utilities, especially the combination of measurement electronics and telecommunications.

In late 2005, Abriox met the Northern Gas Networks Integrity and Standards Manager (and other UK gas and petrochemical pipeline operators) to propose the development of a new system for automated remote monitoring of CP. With the active encouragement of Northern Gas Networks and others, meetings were held with United Utilities and other CP professionals to gather input to the specification of the system and ensure that it met the requirements of the CP community. With support from the Welsh Assembly Government's SMART innovation scheme, the system (now called MERLIN) was developed throughout 2006. It consists of the following:

- A monitor which measures the output of the T/R (voltage and current) and also checks the AC supply to the T/R. Optionally, this monitor can also measure the pipe-to-soil potential at the drain point where the T/R is attached to the pipeline.
- A monitor which takes CP measurements at test posts (Figure 3), including pipe-to-soil potential, instant 'off' potential and coupon current values. An important feature is AC (as well as DC) measurement on all channels.
- Communication of data from field to HQ using GSM/SMS, selected because of its reliability, good coverage and economic cost.

Figure 4. Manual TR checks are labour intensive.

Figure 5. Monitoring a transformer rectifier remotely.

- Software for displaying and archiving/exporting the data, and for controlling the configuration of the monitoring units (e.g. setting alarm thresholds).

The case for remote monitoring

United Utilities carried out a careful financial evaluation of the case for remote CP monitoring. This was primarily based on the cost of monthly 'functional' checks of the T/Rs (Figure 4). However, since one annual inspection is required to comply with electrical safety procedures, only 11 visits/yr were actually considered for the evaluation. Using an average of 1.5 hours of technician time (including travel between T/Rs) for each set of measurements, plus 0.25 hours for uploading/downloading information from the CP database, the annual saving per T/R was calculated to be 19.25 hours. At £35 per hour (including vehicle depreciation, fuel, equipment, etc.) the annual cost per T/R was £674. The average cost of installing a remote monitoring unit, including reference electrodes where required, was £1000. A simple payback could be achieved within 18 months.

However, the case for remote monitoring was not purely economic. In the event of an AC supply or T/R failure, the CP system can remain inoperative, and the pipeline unprotected for up to a month until the fault is detected manually. It is generally accepted that effective CP extends the operating life of a pipeline, while ineffective CP can shorten it. Therefore, there is a clear rationale for ensuring that the CP system is maintained in a fully functioning and effective state. Remote monitoring was seen as a way of Northern Gas Networks taking a more proactive operational approach to corrosion prevention.

Safety was another important factor. Many T/Rs are located on busy roadsides or at relatively inaccessible locations, posing additional risks to lone-working technicians. Working on a T/R exposes staff to two separate earthing systems, so it is necessary for technicians to be trained in electrical isolation and to maintain such qualifications.

Implementation

In early 2007, prototype T/R and test post monitors were trialed by United Utilities on Northern Gas Networks' pipelines in Yorkshire and Durham over a three month period (Figure 5). The MERLIN system worked exactly to specification. Data was checked against measurements taken manually and showed excellent consistency. DC values were found to be accurate even in the presence of induced AC. Communications were very reliable. During the trial period, two interruptions of the power supply to a T/R were identified. One was a test carried out by United Utilities to check the system response to a supply failure, the other was a genuine power cut. On both occasions, the monitoring system immediately generated a user alert (Figure 6).

Resulting from the successful trials, Northern Gas Networks is now implementing a roll-out of remote CP monitoring across its network. Initially, monitors are being installed at all 208 T/Rs (or their drain points). This removes the need for monthly functional checks and provides timely information on T/R performance and CP effectiveness. Faults are identified immediately rather than going undetected for up to a month, thereby reducing the likelihood of corrosion occurring. This will improve pipeline integrity and ultimately reduce the probability of pipeline failure or the need for pipeline repair.

Pipelines running in joint utility corridors are now recognised to be vulnerable to AC interference and the increased risk of AC-induced corrosion.

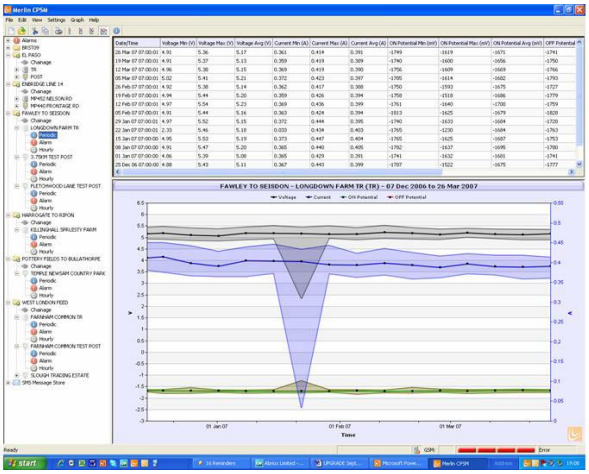

Figure 6. A power failure is clearly identified.

This is of particular concern in the case of new pipelines with high quality (e.g. fusion-bonded epoxy) coatings which run parallel to high-voltage overhead transmission lines. Using the MERLIN system, Northern Gas Networks is now able to remotely monitor AC voltages and current densities at areas of suspected interference. The adaptability of the test post monitor means that it can easily be re-sited at areas of concern, giving vital information on the state of AC and the pipeline's CP system at any moment. The setting of warning parameters will allow United Utilities, on behalf of Northern Gas Networks, to monitor the effects of AC interference instantly rather than collecting this information manually and retrospectively.

The MERLIN unit can be installed easily in remote locations, reducing the frequency of site visits. Other applications include monitoring the 'off' potential at a coupon, as well as coupon current or current density. It has been designed to fit within existing (UK type M28) test posts and, for galvanic (sacrificial anode) CP systems, can be installed in surface boxes in roadways and at points of low potential in urban areas.

Conclusion

Northern Gas Networks, through United Utilities, is deploying remote CP monitoring across its entire network, the first UK gas distribution company to do so on such a large scale. This strategic move has been made possible by new technology which will deliver an attractive return on investment, as well as improving asset management, safety and environmental performance. The MERLIN system is an example of what can be achieved by end users working closely with a technology based company to ensure that the product development meets market requirements.