Remote cathodic protection monitoring on SGN's high pressure pipeline network

By Stuart Bishop, Team Leader at SGN and YPPC 2014 finalist

Scotland Gas Networks is part of the UK's second biggest gas distribution company, Scotia Gas Networks (SGN). Scotland Gas Networks operates, maintains and develops its gas network throughout Scotland to ensure that gas is delivered safely and efficiently to its 1.8 million customers. Scotland Gas Networks is subject to RIIO, Ofgem's framework for setting price controls and, as such, faces an unprecedented challenge to reduce network costs through innovative new engineering solutions.

Installation at a TR

THE NEED FOR REMOTE MONITORING

One of the primary issues facing Scotland Gas Networks is the maintenance and monitoring of their impressed current cathodic protection systems. Cathodic protection (CP) is the industry preferred corrosion prevention method for buried metallic pipelines and is applied to all of Scotland Gas Networks' >7bar pressure network. CP is an electrochemical technique used to mitigate the effects of corrosion on the pipe wall should the pipeline's coating system fail. The impressed current protection system is used on the high pressure cross-country pipeline network by Scotland Gas Networks. An external voltage from a transformer rectifier (TR) is used to drive a protective current between a ground bed of anodes and the pipe surface (cathode) in order to ensure that the pipe surface is always the cathode and thus considered cathodically protected.

Regulation 13 of the Pipeline Safety Regulations 1996 states that:

"The operator needs to consider maintenance and inspection requirements for the pipeline. Examination and monitoring of the pipeline are part of routine maintenance. The operator needs to consider both how and when the pipeline should be surveyed and examined to validate and maintain it in a safe condition".

Scotland Gas Networks has a duty to keep up to date with modern methods of monitoring and inspection so as to protect the pipeline from new threats and threats previously considered safe. Only recently has alternating current (AC) corrosion been recognised as a serious threat that can and does occur on pipelines with a CP system. AC corrosion occurs at small coating holidays on pipelines with a good coating system as a result of interaction between the buried pipeline and high voltage overhead power lines. This inductive AC can occur wherever a pipeline runs parallel with a power line. As a

MERLIN monitors AC from power lines

consequence, regulatory bodies are introducing updated guidelines to monitor for and assess the likelihood of AC corrosion. The monitoring and logging of induced AC should now form an integral part of pipeline integrity management and pipeline operators will be increasingly required to utilise remote monitoring to remain in compliance.

The decision was taken to implement a remote monitoring project on SGN impressed current CP systems. This would be undertaken by the pipeline department utilising the latest remote monitoring technologies with the aim of providing enhanced asset protection and, through frequent real time readings, ensuring that Scotland Gas Networks remains in compliance with both health and safety regulations and industry best practice. Additionally the project scope would extend to reduction of operational monitoring costs, reduction of the environmental impact of operations, the improvement of employee safety and to allow for the deployment of skilled labour to other network duties.

Personnel safety was a prime consideration when implementing this project. The remote locations of cross country pipelines can be hazardous, especially during times of inclement weather conditions. Test posts are often located at river crossings, which are prone to flooding, or by roads which expose employees to possible traffic accidents. Electrical safety is also an issue at TR sites, where technicians must be trained and accredited in order to work on them, and at test posts where induced AC electric shocks can be generated from high current levels. Remote monitoring removes employee exposure to these hazards.

High pressure pipelines are almost always located in remote rural areas with the TRs commonly located at the pipeline mid-point. Each pipeline will have one or more TRs and this results in time consuming and costly travel to remote locations, tying up skilled personnel who would be better utilised on other network tasks.

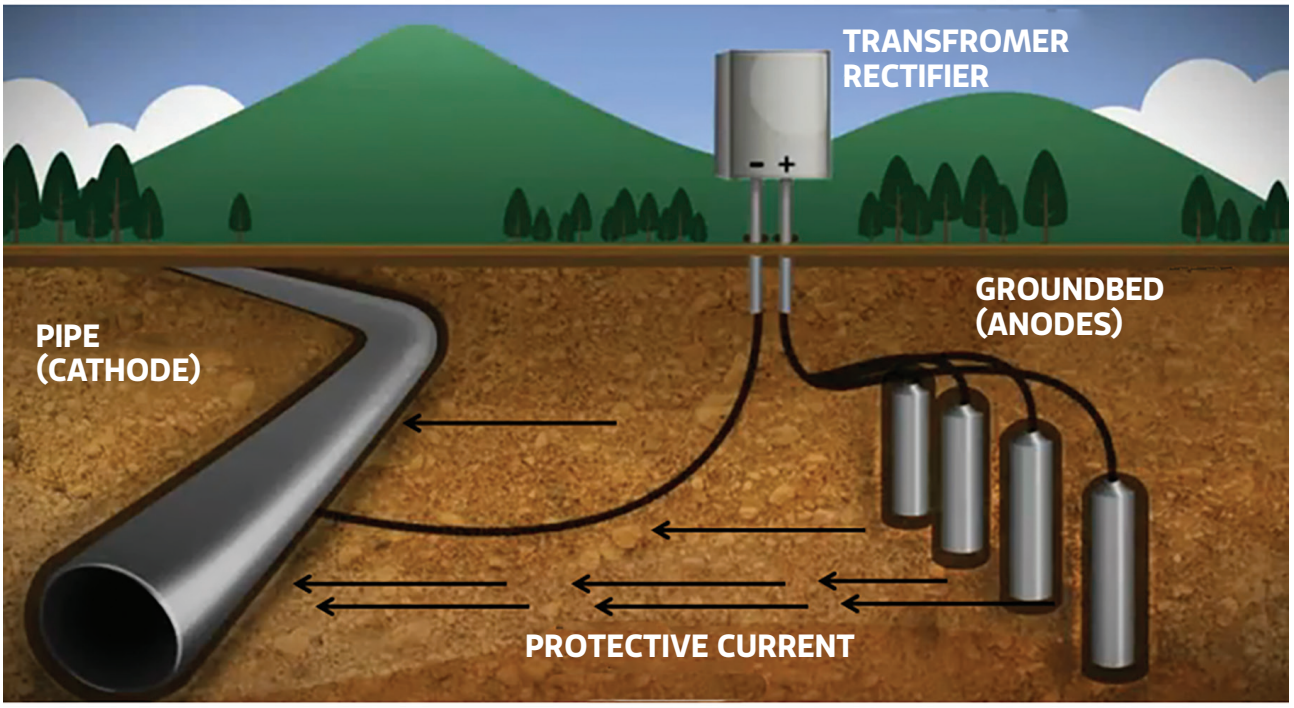
Remote monitoring would also help reduce the company's carbon footprint. SGN implements an environmental management system in line with international environmental standard ISO14000 which encourages the setting of performance indicators to reduce emissions. Under the RIIO price control plan, gas companies are offered incentives to reduce their environmental impact.

Scotland Gas Networks' management procedure for CP, SGN/PL/ECP/2, determines maintenance and inspection frequencies for all pipelines where CP is applied in line with IGEM standards. There are also additional surveys required under the Pressure Systems Safety Regulations 2000. Test posts are checked periodically which is essentially a reactive measure. Faults can go undetected at a TR for a month between checks and several months at certain posts. When the pipeline is left unprotected for significant periods, corrosion can be accelerated, shortening the useful lifetime of the pipeline. Remote monitoring ensures that faults are detected and responded to immediately, allowing financial savings to be made by extending the lifetime of the asset and reducing the amount of corrosion-caused maintenance work.

SELECTION

The initial stage of the project involved selection of the equipment that would be used to implement the remote monitoring system. The decision was taken to use a Merlin TR Logger Unit with an associated Merlin Interrupter unit, both produced by a company called Abriox. Abriox CP monitoring units would also be installed in a number of pipeline CP posts to monitor levels. The decision was based on several factors. The units would be required to:

- **Automatically take voltage and current output readings from the TR**
- **Measure both 'on' and 'off' potentials at the drain point** When a pipe-to-soil measurement is taken, the potential reading taken at ground level (remote from the pipeline surface) will appear negative to the true pipe-to-soil potential due to a voltage drop (IR drop) caused by the ohmic resistance of the soil. The instant 'off' measurement eliminates these errors by briefly interrupting the current to produce a 'true' pipe-to-soil potential, free from unwanted IR drop effects and before any significant depolarisation has taken place
- **Fit into the TR housing** The unit should be quickly and easily installed and compact so that there is no need to replace or modify the existing cabinet/post
- **Communicate quickly and effectively via the GSM network** GSM is ideal for low cost data communication in areas where mobile phone coverage is high. Readings need to be sent via the mobile phone network to a central computer account to which multiple personnel have access
- **Synchronise and interrupt the output of multiple TRs on a pipeline** This would be required to carry out surveys to assess CP levels along the length of the pipeline and to locate any possible coating defects. The CP monitoring units located in CP posts would also be required to read 'on' and 'off' potentials and communicate these readings via the GSM network.



The selected Abriox units satisfied all of the selection criteria and performed well during initial testing prior to large scale installation.

INSTALLATION

When deciding on an efficient and effective installation method for the units, TR cabinets proved to be a problem during the planning and trial phase. Several methods were considered including fixing the units and associated wiring to a back board in a workshop, which would allow for much easier installation in the field. Additionally, consideration was given to the fact personnel involved in the installation would require a high level of authority and competency as the unit would be connected to an AC current supply.

The installation went ahead by fixing the units to the pre-existing backboard present in all TR cabinets. The units proved small enough to fit securely alongside the existing electrical equipment with extra care taken to keep excess wiring to a minimum. The pipeline department coordinated with the electrical and instrumentation department to assist where the task required a greater level of competency with regard to electrical equipment.

Installation of the CP monitoring units was carried out by pipeline personnel. A specialised permanent half-cell was buried alongside the pipe and connected to an M28 CP post. The compact unit was easily installed and commissioned by the swipe of a magnet and a text command from a mobile phone.

BENEFITS

Recent improvements in the GSM network have meant signal coverage is acceptable over the majority of areas in which the pipeline network operates. This has allowed technicians to have much greater control when in the field. Once installed, the units can easily be commissioned from a mobile phone by sending SMS commands. SMS commands can also be sent to interrupt TR output and determine interruption cycle rates dependent on the survey being carried out. This has saved a considerable amount of set-up time and travel when conducting surveys and increased synchronisation accuracy via satellite signals has enabled better survey results to be achieved.

Readings are collected regularly and stored online in an application run by Abriox called iCPSM (internet-based cathodic protection system manager) which can be accessed quickly from any internet-connected computer. From this, the readings can then be transferred into Scotland Gas Networks' pipeline compliance systems.

AC corrosion levels are now monitored continuously and high level alarms are set which will quickly notify pipeline personnel of unacceptable levels.

The quality of data received on iCPSM has been excellent and is presented in an easily readable format. Pipeline personnel are now able to examine trends and readings can be averaged over a certain timescale, removing spurious readings caused by electrical variations or soil changes. Alarms have been set on all input data specifying acceptable high/low levels and alerting personnel via e-mail or SMS.

The purchase price of the equipment, consumables and cost of labour typically amounted to around £1,000. Expenditure required to carry out manual CP measurements varies, but as an estimate the cost to send a technician 40 miles to take a reading from a rurally-located TR would be around £50. If this TR is read on a monthly basis, then a reasonable pay back can quickly be seen.

CONCLUSIONS

The implementation of the TR remote monitoring units has proved to be successful thus far and has resulted in many operational benefits to the company, not to mention a carbon neutral monitoring method. The primary objectives of the project are being met, particularly the freeing up of manpower and the financial savings this equates to. Data retrieved is now more accurate allowing for greater analysis and effective, efficient improvements to SGN's corrosion management programme. ■