Much of the UK’s original 250,000 km-long gas pipeline network consists of iron pipes and is over a hundred years old, says Jonathan Callighan, Construction and Procurement Director of Cadent Gas, the largest regional gas distributor in the country. Pipeline age, risk and safety lie at the heart of the current gas mains replacement programme initiated by Britain’s national safety regulator, The Health and Safety Executive (HSE).

Under the HSE’s leadership, the Iron Mains Risk Reduction Programme (IMRRP) addresses the potential risk of failure of ‘at-risk’ iron gas mains and potential consequences, such as injuries, fatalities and damage to buildings. A significant benefit of the decommissioning of all at-risk iron pipes, identified from a risk prioritisation model, is to reduce the possibility of gas explosions by a significant 60% on pre-2005 levels.

Britain has now reached the mid-point of its gas mains replacement programme. Started in 2002, the replacement work is progressing at the rate of about 3,500 km a year and will be paid for by 23mn gas customers through their bills.

The stakeholders
Around 80% of British homes are connected to the UK’s gas pipeline network, which has two components. The national transmission network, owned and operated by the National Grid, transmits gas throughout the country to the eight regional Gas Distribution Networks (GDNs), which supply customers directly. The regional distributors are natural monopolies and are regulated at national level by the Office of the Gas and Electricity Markets (Ofgem).

Cadent, in which National Grid has a minority stake, is the largest distributor, supplying gas to 10.9mn customers across four regions namely, the West Midlands, North West England, East of England and North London. Given its size, it is also responsible for the largest portion of pipe replacement work, nearly 13,000 km.

The 5.9mn homes and businesses in the south of England and Scotland are served by SGN (Scotia Gas Networks), while the Northern Gas Network delivers gas to 2.7mn customers across the North East, Northern Cumbria and much of Yorkshire. Wales and the West of England’s 7.5mn gas customers are supplied by the Wales and the West of England distribution networks.

The current stage of the nationwide gas pipeline replacement programme ending in March 2021 is being delivered by the eight regional gas distribution network operators and their contractors, suppliers and local councils, under agreements between Ofgem and the HSE.

The replacement programme
The replacement programme (REPEX) began in 2002 and is scheduled for completion in 2032. To complete the programme in 25 years would have meant replacing some 4,300 km of pipe per year and this was not seen as practicable in Britain’s densely populated island. At the same time, it was recognised that a 35-year programme would be impossibly slow. The choice of a 30-year programme requires a rate of replacement of 3,580 km of pipe per year.

After consultation with the industry, the HSE decided that during this current phase running from April 2013 until 2021, the at risk iron pipes would be replaced with polyurethane at the rate of 3,185 km a year in the low pressure parts of the network. Each regional distribution network is working to targets set by the HSE for replacement of their Tier 1 pipes (less than 8 inches in diameter) and Tiers 2 and 3 pipes (over 8 inches in diameter) – see Table 1.

‘Before any work is decided, preconstruction surveys locate and prioritise what needs to be done and where,’ said Mark Fitch, an Energy Specialist at PA Consulting Group. In order to minimise disruption to the public, the replacement of all cast-iron and ductile mains is restricted to

We have all seen the barriers, trenches, and closed streets that indicate the replacement of old iron gas distribution pipelines, part of a nationwide programme. Nicholas Newman has been taking a look at progress.

### Table 1. Annual pipeline replacement targets set by Ofgem for each GDN

<table>
<thead>
<tr>
<th>Network operator</th>
<th>Targets (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadent Gas</td>
<td>12,742</td>
</tr>
<tr>
<td>Northern Gas Networks</td>
<td>1,760</td>
</tr>
<tr>
<td>Scotland Gas Networks</td>
<td>1,736</td>
</tr>
<tr>
<td>Southern Gas Networks</td>
<td>4,944</td>
</tr>
<tr>
<td>Wales and West</td>
<td>2,537</td>
</tr>
</tbody>
</table>

Source: Ofgem
within 30 m of buildings. To gain public acceptance or licence to operate, the five GDNs have mounted a wide-ranging public awareness campaign, providing information on works and schedules via social media, the local press, on-site posting and short videos explaining the works to those living or passing affected areas. The companies have reached out to local communities, holding public meetings in which project managers have addressed the public and answered questions about specific details on local work.

GDN staff have also increased their public profile and good citizen credentials by participating in local community events and campaigns. For example, Cadent’s 5,000-strong workforce has pledged to bake, cycle, run, climb and even skydive in a bid to generate funds for the estimated 850,000 people affected by dementia in the UK.

The GDNs make quarterly progress reports to the HSE and, in case of a schedule failure, must include their plan on recovering their schedule. GDNs are investing heavily in the programme. For example, according to the Northern Gas Networks Business Plan 2017, its total Tier 1 mains Rempex programme is costing some £564mn a year.

Overall, Fitch suggests that: ‘the mains replacement programmes have been a success story.’ Not only are Cadent and the other gas distributors removing old dangerous iron pipes faster than planned, but Ofgem has provided long-term certainty, by setting the GDN’s allowed costs for the whole period of eight years (to 2021). This has allowed the GDNs to engage differently with their supply chain, with greater innovation and efficiency in delivery, notes Fitch.

On site operations
‘On-site staff are trained to communicate with the public and to maintain good relationships,’ states Jonathan Callighan, Construction and Procurement Director of Cadent Gas, and safety for staff and the public is paramount.

Much of the technology currently being used is on the low-tech side, including the basic breaking up of services and live insertions rather than dead insertions. However, the next phase could be accomplished with high-tech equipment. ‘We are looking for game-changing technologies such as use of robots that could either pull plastic pipeline or spray a plastic coating to the inside of existing old pipelines,’ explains Callighan. ‘There is a long horizon ahead of us, so we have opportunities to change and revise the programme in all aspects of the replacement chain.’

This Rempex programme has employed helicopters and drones for aerial surveillance of the network and robots into the interior of the pipework. Mark Simmons, OHL Condition Monitoring Team Leader at National Grid explains that: ‘drones let us look at parts of our network which are difficult and costly to reach and where doing so would expose our engineers to risk.’ Drones equipped with aerial surveillance equipment for thermal imaging, aerial filming and photography are being employed to gather preconstruction information. Aviation surveillance platforms are keeping an eye on 7,700 km of high pressure pipelines and 23 compressor stations.

As for the pipes themselves, technology is helping to avoid the need for complex and deep excavations. National Grid’s Graid robot is extremely flexible, using dedicated specialised modules for different tasks. For instance, the robot is able to collect sufficient real-time data to generate a 3-D model of the actual condition of a gas pipe at a specific location, as well as being able to perform a range of repair tasks including relining.

Meanwhile, CISBOT, the Cast Iron Joint Sealing Robot from SGN and ULC Robotic, facilitates remote repair of older gas mains from inside the pipe, without any interruption to supply and makes major road excavations unnecessary – see photograph below.

The project teams updating the networks have overcome a range of challenges ranging from the expected to the uncommon. As with any planned interruption to public highways, street access is a common problem. In order to reduce road traffic disruption, all GDN’s worked carefully with their local highway authorities and affected land owners. Overseeing the entire programme, Ofgem’s regime of tight deadlines, budgets and performance targets were a real test, especially where geography and topography were not ideal. Essentially, planning and delivery, to time and budget, of what was and is a major engineering programme, has so far been successfully achieved.

Prospects
The UK’s gas transmission and distribution networks will increasingly shift towards a low carbon emissions future. Today, natural gas and LNG dominate the network augmented by small amounts of biogas, a renewable resource that can be expected to grow in importance. To reduce carbon emissions further, gas pipeline operators are currently looking at other options, including the transmission of hydrogen nationwide, notes Callighan. Already, Northern Gas Networks and Keele University have begun a pilot project, supplying hydrogen to 130 homes and businesses in Leeds. By 2050, renewable gas could produce between 68 and 183 TWh/year, sufficient to heat 7mn to 15mn homes, or enough to meet the needs of southeast England, London, and East Anglia.

Nicholas Newman is a freelance writer.