GU

GAS UTILISATION

THE MAGAZINE FOR ALL THINGS DOWNSTREAM

OCTOBER 2021

- GRENFELL: WHAT HAVE WE LEARNED?
- UK GAS USERS COULD FACE HYDROGEN LEVY ON HOUSEHOLD BILLS
- UNDERSTANDING THE BASICS OF GAS COMBUSTION AND COMBUSTION ANALYSIS
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GOING BACK TO BASICS

EVERYTHING YOU NEED TO KNOW ABOUT COMBUSTION

IGEM
Institution of Gas Engineers & Managers

WELCOME TO GAS UTILISATION

WITH THANKS TO OUR CONTRIBUTORS...

STEVE CRITCHLOW

Principal Gas Engineer at Health & Safety Executive

Steve Critchlow is a Fellow member of IGEM, having joined the Institution as an EngTech in 2010. He is a Gas Safe-registered engineer and works for the Health and Safety Executive's Science Division.

Having worked for HSE for more than 20 years, Steve now covers the whole of the UK, investigating gas explosions, carbon monoxide incidents and making assessments of poor engineering concerning gas, oil, solid fuel and biomass installations.

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Martyn has been working at Worcester Bosch for over 30 years, having first joined as a Technical Service Engineer in 1986. Martyn represents the boiler manufacturer on a number of industry panels including the Society of British Gas Industries, OFTEC, the HHIC, the Institute of Plumbing and Heating Engineers and the Institute of Domestic Heating Engineers.

RODNEY HANCOX

Director, Gas Distribution Solutions & IGEM/G/5 Panel Chairman

Rodney Hancox joined the Eastern Gas Board in 1970 where he held numerous positions after graduating with a CNAA degree in Mathematics for Business from Enfield College of Technology. In 1991, he took on the role of Senior Training Advisor (Engineering) at British Gas Regional Services.

Following the break-up of British Gas in 1996, he worked as a freelance consultant before joining Exoteric Gas Solutions (EGS) as a Senior Engineering Consultant in 1999. In 2007, he formed his own consultancy company, Gas Distribution Solutions. Rodney has also been active in IGEM panels including IGEM/G/5, IGEM/G/1, IGEM/TD/4, IGEM/GL/4, IGEM/GL/6 and IGEM/UP/2. He was Chairman of IGEM's Eastern Section in 1999/2000.

EDITOR'S LETTER

WELCOME TO THE FIRST edition of our brand-new Gas Utilisation (Gu) supplement, which focuses on all things downstream.

In this edition, Rodney Hancox, Chair of the IGEM/G/5 panel and Director of Gas Distribution Solutions, shares his findings from giving evidence at the Grenfell inquiry, reporting on the legislation, regulations, guidance and industry practice relevant to the gas supply to and within Grenfell Tower.

Steve Critchlow, Principal Gas Engineer at Health & Safety Executive, offers some insight in his article explaining RIDDOR (The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013) and later kicks off our series of technical articles aimed at introducing those in the utilisation sector of the gas industry to some of the fundamental science underpinning their work with a look at understanding the basics of gas combustion and combustion analysis.

Elsewhere, Martyn Bridges, Director of Technical Communication and Product Management at Worcester Bosch, looks at the use of gas and its place in a carbon net zero future and we're also chatting to IGEM EngTech member Adam Madgett, HyDeploy Project Manager at Northern Gas Networks, about his career journey and how IGEM has supported him so far.

We hope you enjoy this edition,

JODIE SHEPHERD

EDITOR
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GOT SOMETHING TO SAY? *If you would like to send any reader's letters or have any comments or feedback, then please get in touch with us. We are also looking for contributors for future editions of Gu so, if you are interested, contact us by emailing jodie@igem.org.uk with details of your proposed contribution.*

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UK GAS USERS COULD FACE HYDROGEN LEVY ON HOUSEHOLD BILLS

THE BRITISH GOVERNMENT is exploring adding a new levy on to household gas bills as a subsidy to hydrogen producers as it attempts to kickstart the fledgling industry, *The Financial Times* reports.

The highly anticipated government "hydrogen strategy" will set out ways to increase the use of the low-emission gas as a part of the UK's plan to reach its 2050 "net zero" carbon target.

The document will launch a consultation on a new type of mechanism to ensure that hydrogen companies can receive a predictable price for future sales.

Households account for nearly a fifth of carbon emissions. The government last year set out plans to upgrade home heating systems, replacing gas boilers with low-carbon heating systems such as hydrogen appliances. Hydrogen is also expected to play a role in hard-to-electrify sectors such as shipping and heavy industry.

The mechanism will be similar to "contracts for difference" which have been used to guarantee the price of energy produced by offshore wind companies and by the Hinkley Point C nuclear reactor being built in Somerset, according to government officials.

The use of "CFDs" has been credited with helping to drive down the price of offshore wind by more than 70 per cent over the past decade, turning it into one of the cheapest forms of electricity generation. But in the short-term, it can carry a higher cost for consumers, as governments look for methods to subsidise support for cleaner forms of fuel and the associated infrastructure.

Prime Minister Boris Johnson recently set out a 10-point green plan which included a new target of 5GW of low-carbon hydrogen production capacity by 2030 and 1GW by 2025.

The oil and gas industry has been a significant supporter of blue hydrogen in Britain, but some environmental groups fear it will secure the long-term future of gas producers and prove less effective at cutting emissions than home-heating solutions such as heat pumps.

Blue hydrogen is seen as more cost effective than its green version, at least initially, as production can use existing infrastructure such as gas pipelines but critics have warned that government or bill-payer support for hydrogen derived from natural gas should be limited on the basis that it is a transitional fuel.

The idea of a new hydrogen charge on bills comes as ministers are braced for a backlash from some backbench MPs about the impact of the 2050 net-zero target on household finances.

At the time of publication, BEIS, the business department, are due to publish a detailed net zero strategy in September while the Treasury will release a simultaneous report examining the cost of reaching the target.

HYDROGEN-READY BOILERS TO COST NO MORE THAN NATURAL GAS VARIANTS

IN A RECENTLY announced hydrogen-ready boiler price promise, four of the UK's largest boiler manufacturers have agreed that hydrogen-ready variants will cost no more than natural gas equivalents, *H2 View* reports.

The joint initiative is set to help consumers reduce carbon emissions from home heating and hot water and assist delivering the UK's net zero commitments.

The four companies involved, Worcester Bosch, Vaillant, Baxi and Ideal, believe that with the price promise it could save consumers up to £2.3bn ($3.2bn) according to modelling.

‘EMPOWER LOCAL GOVERNMENT’ TO DECARBONISE HEAT’, SAYS CCC CHIEF

THE CHAIR OF THE Committee on Climate Change (CCC) argues local government should be given much greater powers to implement and enforce decarbonisation policies for heat and buildings.

Lord Deben said local government and regional authorities have an essential role to play in helping cut and offset carbon emissions from major contributory factors such as transport and the heating of buildings. However, he argued that there is limited support at present to ensure that local authorities and regional governments had the capabilities to drive meaningful change around decarbonisation. The example of the recent provision of £500m in funding that was provided as part of the Green Homes Grant programme was highlighted as an important exception, reports H&V News.

Lord Deben said: “The CCC is absolutely clear that unless local government plays a very much bigger part in the battle which we are fighting, then we are not going to win.”

The claims follow the recent signing of a declaration by more than 30 regional and city authorities in the UK calling on the government to provide them with enhanced powers and support to determine and enforce their own policies to decarbonise heating, transport and energy.

Among the provisions called for by the signatories are for the government to set out clear long-term plans and resources to help tackle emissions in new and existing buildings. They also back the introduction of new regulatory powers or a strategic energy body to address market issues. This could include addressing discrepancies between the cost of higher carbon sources of energy and cleaner alternatives.

Lord Deben argued that a lack of collaboration between local and central government risked undermining efforts to deliver the effective decarbonisation of buildings and infrastructure.

He said: “We have local government on one hand, which is largely committed to very sensible policies to reach net zero and the government on the other – that has certainly got the right policies – not quite so much actual delivery.”

The creation of a centralised national body able to assist local authorities with advice and guidance was cited by Lord Deben as an example of how consistent decarbonisation support could be implemented by local authorities.

He added: “It’s true right across the board that too many authorities are having to paddle their own canoe and reinvent the wheel again, all those things that could so easily be done via central government involvement in helping them and passing on good practice and the like.”

The government’s short-lived Green Homes Grant, which was scrapped just several months after being launched to incentivise work to install lower carbon heat and energy efficiency improvements in homes, was also cited by Lord Deben as highlighting the role local authorities can play in delivering innovative practices around heat.

Additionally, any hydrogen-ready boiler that is installed initially to run off natural gas will have no more than one hour’s labour to convert it to run with hydrogen.

A recent Energy and Utilities Alliance (EUA) report, “Too Close to Home”, revealed that tackling climate change is regarded as a priority for consumers, but the majority are unwilling to pay more than the cost of a new boiler.

Hydrogen-ready boilers, that can be installed to run on natural gas but also can be easily switched to hydrogen, have been successfully tested by the Health and Safety Executive.

Mike Foster, Chief Executive of the EUA, said: “This price-promise from the Big Four ensures that consumers will be able to access an affordable low carbon heat and hot water solution.

“The Committee on Climate Change, which advises the government, assumed that a hydrogen-ready boiler would cost £100 ($139) more than a natural gas boiler and that the total cost to consumers of decarbonising their homes would be £2.3bn ($3.2bn).”

Foster continued: “This is another example of British companies leading the way on net zero. The manufacturers have been very clever in using existing components and technologies to keep the price of hydrogen-ready boilers down.”

GRENFELL
WHAT HAVE WE LEARNED?

On the night of 14 June 2017, a fire broke out in the 24-storey Grenfell Tower block of flats in North Kensington, West London, causing 72 deaths. Given the horrifying death toll, an inquiry was launched to discover what went wrong that fateful night and how we can learn from those mistakes. **Rodney Hancox**, Chair of the IGEM/G/5 panel and Director of Gas Distribution Solutions, gave evidence at the inquiry, reporting on the legislation, regulations, guidance and industry practice relevant to the gas supply to and within Grenfell Tower. Here, he shares his findings

At 00.54hrs on 14 June 2017, the London Fire Brigade (LFB) received a 999 call for a fire in Flat 16 of Grenfell Tower in the Royal Borough of Kensington and Chelsea, West London.

Firefighters reached the Tower at 00.59hrs and proceeded to Flat 16 to put out the fire. At 01.09hrs fire broke out of the flat into the cladding and by 01.27hrs it had reached the roof. The Grenfell Tower Fire Tragedy was unfolding very quickly.

Cadent Gas was called out at 03.22hrs. The on-call Cadent First Call Operative arrived at the site at 03.48hrs and immediately called for assistance.

It was not until 07.45hrs that the LFB confirmed that they wanted the gas isolated. Burning cladding was falling off each side of the tower, making it impossible to access any pipeline isolation valve on any of the services into the tower.

Over time, I examined just over 4,000 documents, photographs and drawings while drafting my report to the inquiry. I had to bear in mind that the bereaved, survivors and relatives (BSRs) were one of the audiences for the report

Consequently, the Cadent engineers worked out a plan to isolate the gas supply to the tower by cutting and capping a 12in ductile iron main, a 4in iron main and a 180mm PE main.

At 08.50hrs, the gas isolation plan was explained to the LFB. The isolation points were identified on the ground, agreed by the LFB and excavations commenced on the 12in ductile iron main at 13.30hrs, and on the 4in iron main and 180mm PE main at 14.30hrs.

By 15.30hrs, the LFB Tactical Command Team was reporting that the remaining fires were gas-fed. On a couple of occasions during the afternoon there were fears that the building would collapse and personnel, including the Cadent team working on the 12in ductile iron main were pulled back from the tower.

The 4in iron main and 180mm PE main were isolated at 20.00hrs and at 21.20hrs the ductile iron main was discovered at a depth of 1.5m and found to be 15in diameter.

The gas flow in the 15in ductile iron main was stopped temporarily at 23.40hrs with an over-inflated 12in flow-stopping bag, at which point the flames in the tower went out.

A permanent cut and cap operation using the correct equipment for a 15in main was completed by 06.15hrs the following morning.

I was engaged to act as the gas expert witness in February 2018 and I visited the tower for the first time at the end of that month. I revisited the tower with an official Metropolitan Police photographer in May 2018. Over time, I examined just over 4,000 documents, photographs and drawings while drafting my report to the inquiry. I had to bear in mind that the bereaved, survivors and relatives (BSRs) were one of the audiences for the report.

The gas evidence to phase 2 of the inquiry was presented over three days in July 2021. I presented my evidence on 14 July.

From my site visits, scrutiny of documents and consideration of the input from other expert witnesses, I believe the following topics will be of particular interest to utilisation personnel and building owners.

LINK BETWEEN FIRE SAFETY ORDER AND DSEAR

Article 12 and Part 4 of Schedule 1 of the Regulatory Reform (Fire Safety) Order 2005, otherwise known as The Fire Safety Order, addresses dangerous substances. The content is virtually the same as that in Regulation 6 of DSEAR. Both pieces of legislation refer to containment of the dangerous substance and to ventilation.

Awareness of this link provides common ground for communication between the gas engineer and the building owner.

Other articles of interest within the Fire Safety Order include Article 22, which places a duty to co-operate onto relevant parties.

ACCESS TO VALVES IN AN EMERGENCY

At Grenfell Tower, there were branch and inlet isolation valves at high level in the basement which could not be accessed without scaffolding.

SIGNAGE

Grenfell Tower had no signage or plan in the vicinity of the valves to indicate their function and what the individual risers were serving.

PIPES NOT SLEEVED THROUGH WALLS AND FLOORS

The original gas supply system was installed when the tower was built between 1972 and 1974. It is not known precisely when installation took place and therefore whether the Gas Safety

Regulations 1972 were in force at the time of installation. In any event, pipes were embedded in concrete floors/ceilings and so were stressed from the extreme heat of the fire and building movement during the fire. In one of the flats one of the risers was ruptured.

Another one of the risers had been cut off for leakage on 30 September 2016. The leak was on the section of pipe embedded in the floor between two flats.

I understand that one of the reasons why sleeves through walls and floors were introduced by the Gas Safety Regulations 1972 was that there had been a number of cases of leaks on pipework embedded in concrete in the late 1960s early 1970s due to the chemical reaction between the concrete and bare steel pipe.

UNVENTILATED VOIDS

Another requirement brought in by the Gas Safety Regulations 1972 was a prohibition on the installation of pipes in unventilated voids. The routes of the risers after they left the basement were through unventilated utility compartments.

DAMAGED COOKERS AND BURNT-OUT COOKER HOSES

Corgi Technical Services, working for the Metropolitan Police, identified at least 14 damaged cookers, each with a missing or burnt-out cooker hose.

Edition 3 of IGEM/G/5 will specify that a new or replacement gas cooker hose for a cooker installed in a multi-occupancy building shall be to BS EN 14800. Gas cooker hoses to BS EN 14800 are fire resistant in accordance with procedure B in Annex A of BS EN 1775.

DAMAGED METER INSTALLATIONS

There were at least 26 damaged meter installations where the emergency control valve was either fully or partially in the 'on' position thereby presenting an 'open end' through which gas could have fed the fire. Of those 26, the meter regulator in 18 instances had either been melted or otherwise badly damaged. The meter or meter regulator in the remaining eight instances had been removed at the time of the inspection.

The meter regulator is made in an aluminium alloy and its specification, IGEM/GM/PRS/3, does not include any reference to fire resistance.

EXCESS FLOW VALVES AND THERMAL CUT OFF DEVICES

Since its first edition, IGEM/G/5 has called for the installation of excess flow valves and/or thermal cut off devices where indicated as being required following risk assessment. There are German standards for both fittings and I have recommended to the inquiry that such devices be the subject of a British or Gas Industry (GIS) Standard.

KNOWLEDGE AND UNDERSTANDING

Evidence to the inquiry has highlighted the need for anyone designing or installing gas infrastructure into multi-occupancy buildings to have knowledge and understanding of key elements of Approved Document B to the Building Regulations. Topics include ventilation, fire compartmentation, fire stopping, firefighting stairs and the difference between reaction to fire tests and tests for fire resistance.

Rodney Hancox's full report, plus additional documents and a transcript of the hearing, can be downloaded from the inquiry's website at www.grenfelltowerinquiry.org.uk

RIDDOR: DISPELLING THE MYTHS

RIDDOR stands for The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 and it applies to all workers and employers in the UK – not just the gas industry

How much do you really know about RIDDOR (The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013)? **Steve Critchlow** is a Fellow of IGEM and Principal Gas Engineer at the Health and Safety Executive Science Division. Here, he explains everything Registered Gas Engineers need to know about this key piece of regulation

"What's the point of RIDDOR, they won't do anything?"

"RIDDOR is another pointless Gas Safe rule."

"RIDDOR is doing the dirty on fellow gas engineers, and tomorrow it could be you."

Do any of the above sound like familiar refrains to you? RIDDOR: most gas engineers have heard of it, but how many of us fully understand what it is and its implications? Did we pay attention when it was mentioned during the boring bits of ACS?

The first thing to understand is that RIDDOR is a law and compliance is therefore not optional. Its requirements are legal and those that do not follow them are therefore breaking the law. As such, you should be aware of what the law is demanding of you.

RIDDOR stands for The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 and it applies to all workers and employers in the UK – not just the gas industry. It places duties on employers to report specific incidents and injuries that occur at work, such that HSE, the regulator of health and safety legislation in the UK, can investigate where appropriate and be made aware of specific trends, whether that is within a particular workplace or reoccurring injuries from a particular cause.

RIDDOR has some industry specific requirements for the gas industry that are quite different to those for other workplaces. RIDDOR 11(1) applies specifically for the gas conveyors, so we don't need to discuss that now, and we certainly don't want to confuse those with the requirements placed on us as gas engineers. RIDDOR 11(2) applies to Registered Gas Engineers - that's us!

As the point of this discussion is to ensure everyone knows exactly what RIDDOR requires, let's not bother ourselves with any of the large number of interpretations that appear in gas industry documents. After all, they are an interpretation and someone else's opinion. Instead, let's go straight to the exact wording of the regulation – the letter of the law.

"(2) Where an approved person has sufficient information to decide that the design, construction, manner of installation, modification or servicing of a gas fitting is or could have been likely to cause the death, loss of consciousness or taking to hospital of a person because of –

(a) the accidental leakage of gas;

(b) the incomplete combustion of gas; or

(c) the inadequate removal of the products of combustion of gas, the approved person must send a report of that information to the Executive in an approved manner within 14 days of acquiring that information.

So, ignore any mythology you may have heard about RIDDOR. The full regulation that applies to Registered Gas Engineers is quoted above. So maybe just take a read through it again and we will break it down.

Firstly, it's all about the condition of 'gas fittings' as defined by the Gas Safety (Installation and Use) Regulations 1998 (GSIUR), which includes appliances, meters, valves and pipework, etc.

Now let's consider the bit that says *"could have been likely to cause the death, loss of consciousness or taking to hospital of a person"*. Does that sound familiar? Well, yes, it's pretty much the definition of Immediately Dangerous isn't it? There's a key difference however, because RIDDOR 11(2) is not concerned with fittings that are immediately dangerous just because they are very old and unmaintained (you'll see this termed 'lack of servicing'). It must be fittings which are immediately dangerous because of the way someone has:

- installed them, or
- adjusted, modified or serviced them, or
- perhaps because the basic design or way it in which it was manufactured is flawed.

But, as mentioned, it does not cover those which are dangerous because they have not been looked after.

Think of it as an immediately dangerous defect which arises as a result of workmanship someone has performed and consider these examples:

1. If a gas leak exceeds the permissible limits set out by the IGEM UP/1 standards, and if that leak was caused by poor workmanship, then it must be reported under RIDDOR 11(2).

2. If someone modifies an appliance and causes it to become unsafe – then it must be reported under RIDDOR 11(2).

MYTH BUSTING

The gas industry is rife with opinion, conjecture and myth – none more so than around the Gas Industry Unsafe Situations Procedure and RIDDOR. Let's look at a few:

"But I heard someone had to go to hospital in an ambulance before it's RIDDOR-reportable."
No, this a common myth. Read the law as above. An ambulance is not mentioned.

"Are 'At Risk' defects reportable?"
No, because, by definition, they are currently not "likely to cause death, loss of consciousness or a person being taken to hospital" – which is what the law states, remember.

"Is illegal gas work reportable?"
Not under RIDDOR itself, but if that illegal work results in an 'Immediately Dangerous' gas fitting, then, yes, it is.

"Oh right, so aren't the powers that be interested in illegal gas work or 'At Risk' defects, then?"
Yes, of course they are, and it's very important that they find out about these things so improvements in safety can be made. However, the wording of RIDDOR 11(2), as quoted above, means such things aren't reportable using RIDDOR. In these situations, you can report such things straight to HSE as a concern or to Gas Safe Register.

So, how does this apply to you? Let's again go back to the wording of the regulation:

"The approved person must send a report of that information to the Executive in an approved manner within 14 days of acquiring that information".

Note: it says "must", not shall or should. The law says that you as a Registered Gas Engineer must report the situation to HSE within 14 days. Reporting is done online, direct to HSE, using an easy and quick form found at: https://www.hse.gov.uk/riddor/report.

Please note you are reporting a dangerous gas fitting, not a flammable gas incident – that's a RIDDOR 11 (1) report, which is for upstream engineers.

When making your report, you should try to look at the situation through the eyes of the person receiving the report. Use clear language, give as much evidence as

If you are unsure whether something meets the RIDDOR criteria, or whether to report elsewhere, please remember that you will not be criticised for submitting a RIDDOR that doesn't meet the criteria

you can so they can make an informed decision on risk and the possibility of action being taken. It's really helpful if you can take and retain measurements and good quality photographs to help the investigation at a later stage.

With 11(2) situations, it's fine for you to make safe and/or proceed to make a repair. This, again, is different to 11(1) incidents, where you must not alter a scene until permission has been given by HSE.

You will notice that so far there has been lots of mention of HSE and none of Gas Safe Register. That's because HSE is the regulator of the industry and they write the law and make prosecutions. Gas Safe runs the register on behalf of HSE and that is all. They do not write legislation, standards or prosecute anyone. But, if the RIDDOR report involves poor workmanship by a registered business, HSE may ask Gas Safe to perform some sort of investigation work on its behalf.

"My mate put in a RIDDOR and nothing happened. It was a waste of time".
Ok, so let's talk about this. It does get said a lot, but it does not have any effect on the legal duties placed upon you. Remember: it's a law, so you must comply with it.

There are many reasons why you might not see progress following your RIDDOR submission, but you should know that each and every RIDDOR report is read and recorded at HSE. This is very important. It allows HSE to build a picture of how safe gas work is.

For example, you may think gas work standards are dropping, but if HSE doesn't have statistics to support that, they cannot make improvements. If a particular engineer or a particular fitting keep appearing on RIDDOR, they may become a priority for investigation where they otherwise were not.

It may be the case that those reviewing your report decide there's no realistic chance of prosecution. This does happen sometimes, especially where the number of witnesses is limited or because the person who has completed the RIDDOR has not provided enough information for the person reviewing it to understand what has happened – there have been reports submitted which simply state "gas leak".

Even though you may believe the "facts", the investigator needs to be able to prove something definitely resulted from the accused person's actions. Remember: this is evidence that could be used in a court. In this respect, the quality of your report and evidence is vital.

Also, once any formal legal investigation has commenced, it is a confidential process, and you have no right to be kept informed. Therefore, it may be right and proper that you hear no more other than being contacted for further evidence or clarification. It is human nature to assume nothing has happened, but the accused has a right to confidentially, too, of course.

Unfortunately, it is the case that limited resourcing means not every RIDDOR infraction that is reported can result in an investigation. This does not affect the legal duty on you to report, and it does not mean the report wasn't important.

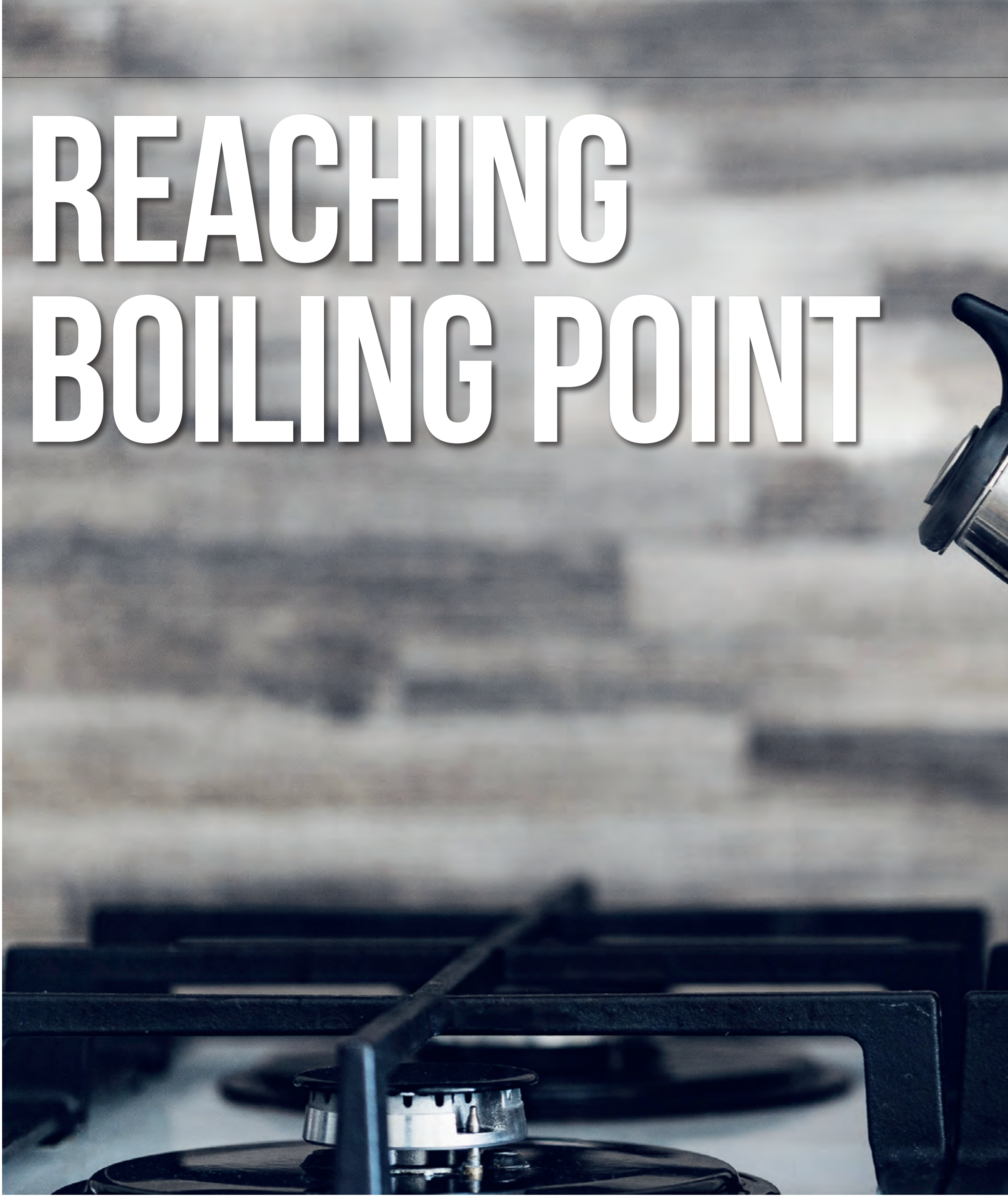
So, what about those other important reports which don't meet the RIDDOR criteria? You can report to HSE via https://www.hse.gov.uk/contact/concerns.htm or go directly to Gas Safe Register via www.gassaferegister.co.uk/engineer/resource-hub/gas-industry-unsafe-sits.

A poorly maintained appliance in a landlord's property, for example, should be reported as a concern to HSE. Poor workmanship from a Registered Gas Engineer should be reported to Gas Safe.

Lastly, if you are unsure whether something meets the RIDDOR criteria, or whether to report elsewhere, please remember that you will not be criticised for submitting a RIDDOR that doesn't meet the criteria. There's a legal duty to report, so you may be criticised if you don't!

Read the full HSE regulations at www.hse.gov.uk/riddor

REACHING BOILING POINT



Martyn Bridges, Director of Technical Communication and Product Management at Worcester Bosch, looks at the use of gas and its place in a carbon net zero future

The road to 2050, with its Europe-wide target of net zero emissions is a long but essential one. As a continent we are reliant on a number of energy sources, in particular gas, to heat our homes and provide us with hot water. Our reliance on this is fundamental to our lives so, understandably, new sources of energy or innovative technology are being researched to ensure that we can continue as we are, but in a more sustainable, environmentally friendly way.

For this article, I will be focusing on the UK, given that I represent a leading manufacturer there, however its sentiment is relevant on an international scale. Not all countries necessarily require heating systems, however for those that do, it takes up a considerable amount of carbon output.

For example, in the UK, heating and hot water accounts for 15 per cent of our carbon footprint. This is unsurprising given our weather cycles.

A large amount of energy is required to power the 23 million homes connected to the gas grid fast and efficiently, which is why natural gas has been the preferred option until now.

GAS ALTERNATIVES

It is still yet to be decided exactly what technology will fuel our future, however we believe it should be a combination of many. There is no one size fits all answer here.

Some argue that we should electrify the heating sector, looking to the automotive industry as an example. They believe that electric heat pumps are the answer. Now they have their purpose, however if we were to fit one on every home on the gas grid in the UK, there is one basic issue. The amount of electricity we would need to generate to run them would be astronomical. Some experts state we would need the equivalent of another 30 nuclear power plants to meet that need, which seems impossible to build in the next 30 years.

The disruption and cost to homeowners would also be a barrier. Heat pump systems require a hot water cylinder and if there is no cylinder already in the house (which is the case for the 17 million homes that have a combi boiler) finding a location for one is going to be a problem. In many cases there won't be space to fit one at all.

THE NEXT GENERATION OF BOILERS

Additionally, the cost can increase greatly in comparison to a simple boiler replacement, particularly as many houses need to be upgraded to a higher energy efficiency level in order for a heat pump to work effectively.

Instead, a good consideration is a hybrid heat pump and a combi boiler. This would allow a carbon reduction of possibly up to 60-70 per cent of the heating system straight away. During spring to autumn and many parts of a mild winter, a heat pump could quite capably heat the house using the existing heating system without radiator changes being necessary. When it gets particularly cold and the heat pump needs support, this is when the boiler would kick in.

What is more, the combi boiler would also be used for the generation of hot water, so would not require a hot water storage cylinder at all. From a disruption perspective to the homeowner, it also looks better than replacing the whole existing heating system.

It's important that we remain technology-agnostic and consider all viable heating options to come to the most beneficial and realistic solution. Hybrids could be a valuable player as part of this.

WHAT DOES THAT MEAN FOR GAS?

So far, I've discussed the end-user side of the scale. But even if we do opt for hybrid solutions for homes, the gas itself will need to change to a carbon-free source. This is where hydrogen fits in.

Hydrogen gas shares many similarities with natural gas and has the potential to be a direct carbon-free replacement, thanks to the fact its only bi-product when burned is water.

Hydrogen offers a lot of potential for all countries and industries as the world looks to a net zero future. With this, the move to hydrogen is currently experiencing unprecedented momentum. Although it is not a silver bullet for global decarbonisation, it will have a direct impact on reducing local emissions as well as boosting demand for renewable energy.

For the heating sector, we believe that this strategy should include a mandate for hydrogen-ready boilers, with a date for when the only boilers allowed to be produced and available on the market are hydrogen-ready. Here at Worcester Bosch, we've certainly tried to stay ahead of that curve when it comes to utilising hydrogen, having unveiled our hydrogen boiler prototype at the start of this year. This prototype has been shown to a number of key officials in the UK, including the All-Party Political Group for Hydrogen, to show that hydrogen can effectively replace our tried and tested natural gas-fired heating systems.

Hydrogen-ready boilers would be similar to HD-ready TVs back in the day. By starting this now, it means that once a decision on hydrogen is finally made in years to come, whole cities won't suddenly have to replace their boilers at once

A hydrogen-ready boiler is very similar to its natural gas predecessors; it is constructed and functions in much the same way as an existing condensing boiler. While some components are different, such as the gas burner and flame detection system, most are identical to those used in natural gas boilers today. Converting a hydrogen-ready boiler from natural gas to hydrogen when it comes online will take around an hour and involve changing a small number of components such as the burner.

Hydrogen-ready boilers would be similar to HD-ready TVs back in the day. By starting this now, it means that once a decision on hydrogen is finally made in years to come, whole cities won't suddenly have to replace their boilers at once. Our investigations have found that hydrogen boilers can run on natural gas until the day hydrogen becomes available and a much smaller conversion of the appliance can then be undertaken. With the boiler market run rate being at around 1.7 million annually we would very quickly populate a huge amount of properties ready for hydrogen. These are replacing boilers that would be replaced anyway as the current boiler is at the end of its life.

This is why it is essential that industry and government take a technology-agnostic view when looking at future fuels. If properties and new builds are taken off the gas grid prematurely, they won't be able to reap the benefits of a carbon-free gas like hydrogen.

WHAT STEPS NEED TO BE MADE?

A number of trials are already underway across the continent, looking to research safety and the possibility of converting homes and gas networks to 100 per cent hydrogen.

One recent example is in the UK, where HyStreet, at DNV GL's Spadeadam facility, has been used to complete over 200 tests in this space and has now become a demonstration site for the possibility of hydrogen heating.

Other industries, such as transport are also making strides, researching hydrogen fuel cells for long-haul transport as well as hydrogen trains.

There is still work to be done, however. National and international strategies need to be put in place to realise a hydrogen future, meaning it is up to industry to communicate better with decision makers and the wider public the evidence for hydrogen as a replacement gas.

All in all, however, if the initial evidence suggests, the future does look bright for hydrogen gas.

***Originally founded in 1962, Worcester became part of the Worldwide Bosch Group in 1996 and is the UK market leader in domestic boilers. For more information, visit:* www.worcester-bosch.co.uk**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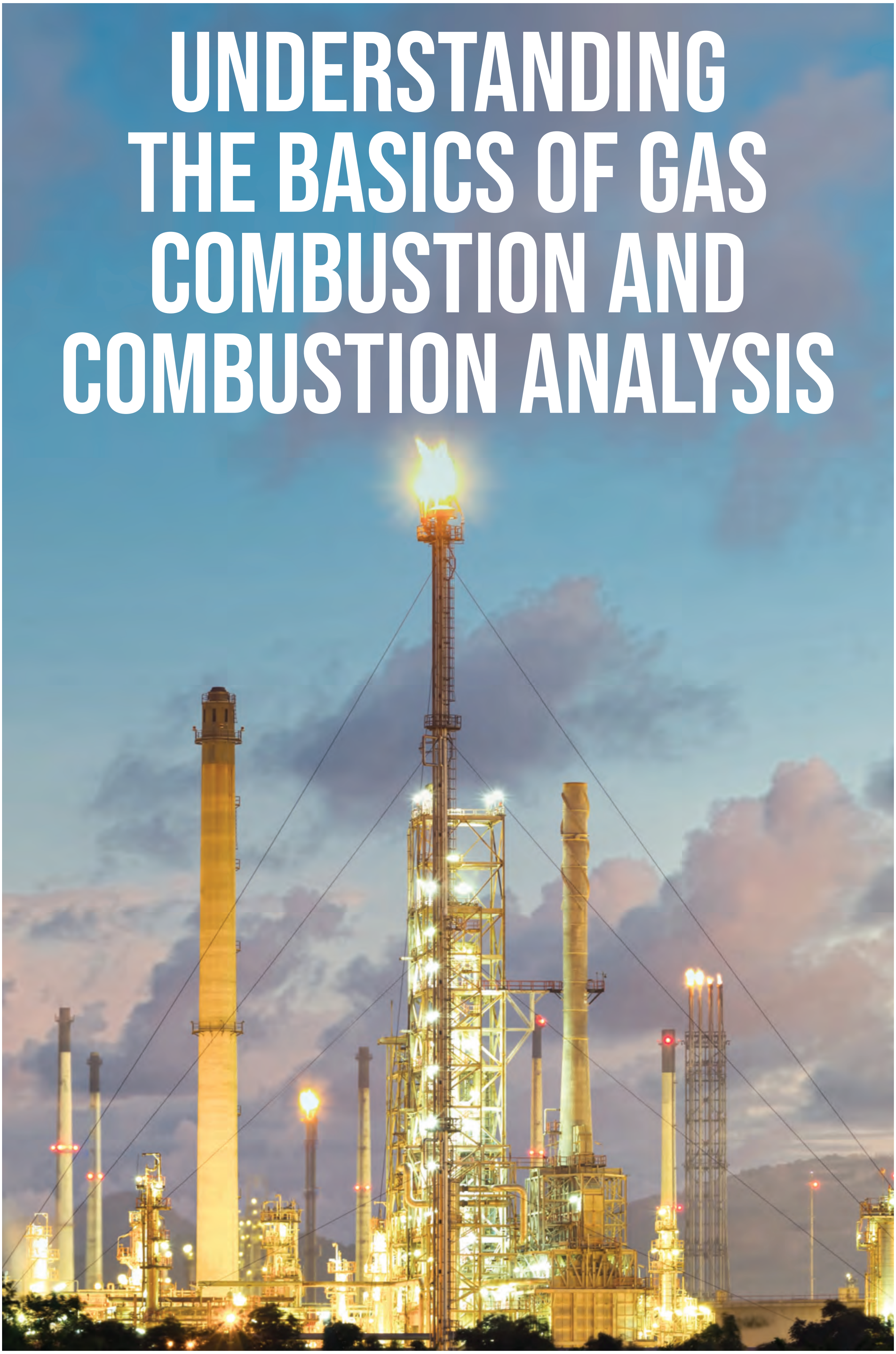
UNDERSTANDING THE BASICS OF GAS COMBUSTION AND COMBUSTION ANALYSIS



This article is the first in a series of technical articles aimed at introducing those in the utilisation sector of the gas industry to some of the fundamental science underpinning their work. **Steve Critchlow** is a Fellow of the Institution of Gas Engineers and Managers, and a Principal Gas engineer at the Health and Safety Executive Science Division. In this article, he considers combustion, including the composition of our fuels and combustion analysis

To start, we need to consider the atoms and molecules which make up our fuels. An atom is the smallest particle into which a substance can be divided up. An atom itself consists of a nucleus at its core with electrons orbiting around it. The electron orbits are referred to as "shells". A shell which has its full allocation of electrons will be very stable and non-reactive, while an incomplete shell means the atom is looking to react with other atoms to complete its shell. A molecule can be thought of as a cluster of two or more atoms, held together by bonds to form the smallest particle of a substance that can exist while remaining as that substance. The reader will no doubt be familiar with the chemical symbol for water H2O. This is telling us that a molecule of water is made up of two hydrogen atoms and a single oxygen atom.

The main constituent of natural gas is methane so we shall start by considering it. Methane has the chemical symbol CH4. This means that its molecule is constructed of one carbon atom bonded with 4 hydrogen atoms. This is usually represented by a drawing like the one in Figure 1; as the molecule is constructed of carbon and hydrogen, these types of molecules are called "hydrocarbons". Propane has the symbol C3H8, and butane C4H10. You can see that these LPG fuels have more atoms and more bonds. This affects the amount of energy within the molecule and the density of the gas relative to air.

However, Figure 1 doesn't represent the bonds between the atoms well. The bonds are not physical material as the figure might suggest. In the case of methane, the type of bond is a covalent bond; the atoms are not stuck together. It's actually a sharing of electrons between atoms within the molecule. It is the mutual attraction of the atoms' nuclei (which are positively charged) for the shared electrons (negatively charged) that hold the bond together. A carbon atom shares one of its electrons with a hydrogen atom to form a covalent bond. The same happens for the other three hydrogen items. So, rather than the atoms being physically stuck together, you can think of them as being attracted to each other. This is represented in Figure 2.

If we put energy into these molecules, we can force the atom apart and break the bonds. We are then left with a number of free atoms which actively want to find other electrons to complete their outer shells. And if oxygen is present when these free atoms are created, the atoms can form bonds with the oxygen to create new molecules. This is the process we call combustion. Why would we want to do this? Well, because the breaking of the bonds and creation of new molecules releases energy which we can use. In combustion the inputting of energy is usually referred to as ignition. You might think of this as a spark or a pilot flame but, actually, it is energy. All fuels have a property called the "auto-ignition" temperature at which the fuel will ignite even without a spark or flame.

You may well have come across this basic equation:

$$CH_4 + 2O_2 \text{ -> } CO_2 + 2H_2O$$

This tells us that, if we combust methane (CH4) in the presence of 2 oxygen molecules (O2) (the reactants), we will produce carbon dioxide (CO2) and 2 water (H2O) molecules (the products of combustion). Notice how all atoms are accounted for. There are four hydrogen atoms on the left and so we have four on the right. We need two oxygen molecules otherwise we won't have enough oxygen to produce CO2. This is described as a "balanced equation". It's important to understand the above equation, but this does raise some confusing questions. For example:

- The equation doesn't show carbon monoxide (CO), but we always see that on a combustion analyser.
- Conversely, water vapour doesn't appear on our combustion analyser.
- We don't use oxygen, we use air, and oxygen is only a fraction of air. What about the rest of the air? And how much air do we need?
- And, perhaps most importantly, natural gas and methane are not the same thing! Natural gas has other components which means the above equation cannot represent it.

FIGURE 1 STANDARD REPRESENTATION OF THE METHANE MOLECULE.

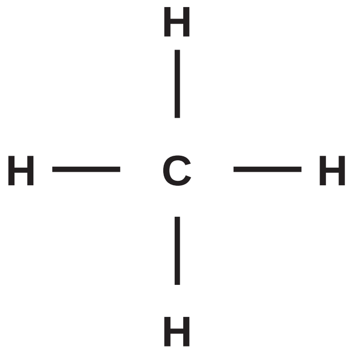
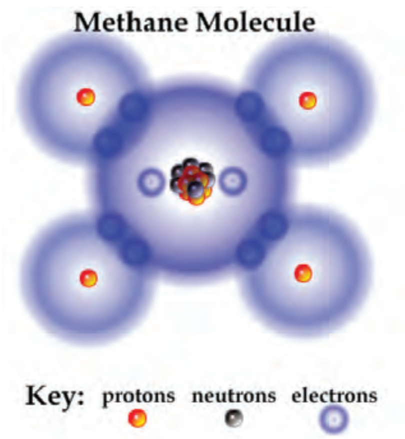
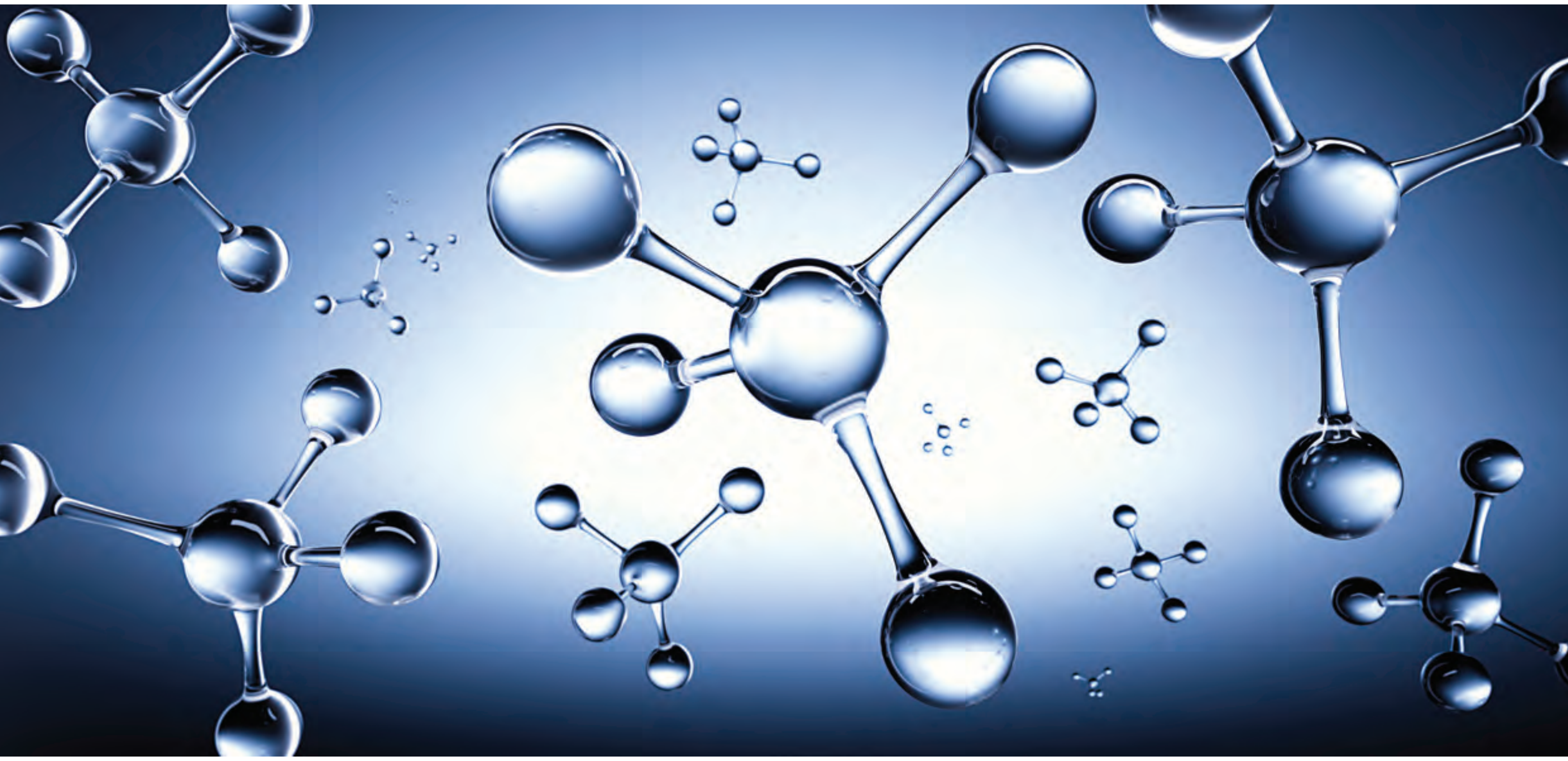


FIGURE 2 THE CARBON AND HYDROGEN ATOMS SHARE ELECTRONS IN A COVALENT BOND



Carbon dioxide and water vapour are the final products in the reaction given in equation 1. However, the combustion process involves many fast reactions and creates some short-lived substances which themselves are subsequently consumed in the combustion process. These are referred to as "intermediate species". They include alcohols (CHOH) and aldehydes (COH). On occasions, when the combustion process cannot complete, these can escape the flame and leave a distinctive smell.

The precise amount of oxygen required for complete combustion, as seen in Equation 1, is called the "stoichiometric" amount. No doubt you will have heard references to stoichiometric combustion. Air is of course made up principally of nitrogen at nominally 78 per cent. Oxygen forms about 21 per cent of our air with the remaining one per cent made up of argon and other gases including CO2. So, it follows that the combustion



equation should really include nitrogen. For simplicity, we will ignore the trace elements and consider nitrogen to be 79 per cent, and therefore the ratio of nitrogen to oxygen in air is (79/21) 3.76.

$$CH_4 + 2O_2 + (2 \times 3.76)\, N_2 \rightarrow CO_2 + 2H_2O + 7.52\, N_2$$

What this now gives us is the ratio of air to fuel, rather than oxygen to fuel. We can see that for stoichiometric combustion we need 9.52 parts of air (that's 7.52 + 2) for every 1 part of gas if considered on a volume/volume basis.

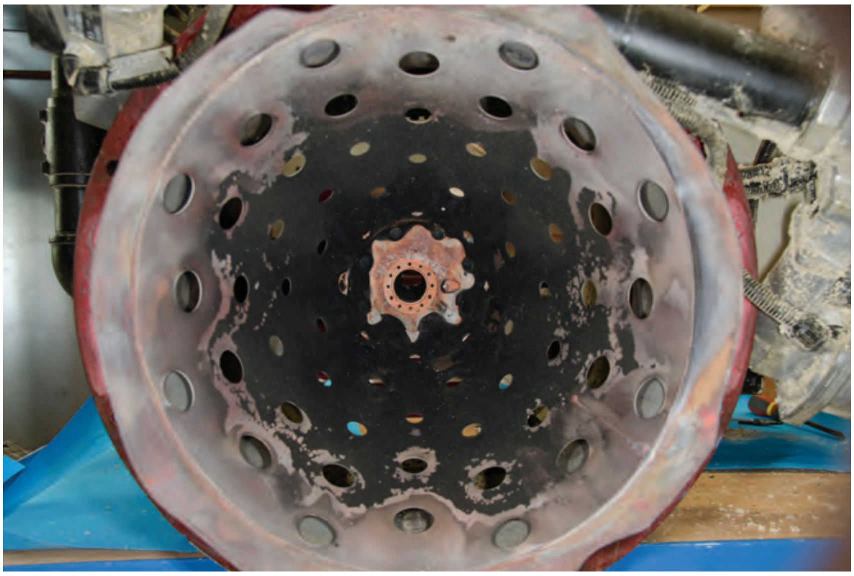
Equation 2 also shows us that for 1m³ of methane gas we produce 10.52 m³ of combustion products (1m³ CO2 + 2m³ H20 + 7.52 m³ Nitrogen). We shall look more at combustion products later.

You may have noticed that the equation above indicates that the nitrogen passes through the combustion product but is completely uninvolved in it. Nitrogen doesn't react readily and is frequently considered to be inert, but at very high temperatures it can be oxidised. Combustion engineers give the collective term NOx to oxides of nitrogen. NOx is considered an environmental problem because it initiates reactions that result in the production of ozone and acid rain. Measurement of NOx by domestic installers is not yet a requirement but burner designers must measure it as must those working with large commercial/industrial plant.

While stoichiometric combustion is an ambition for gas engineers, it's actually pretty much impossible to achieve - except in very controlled laboratory conditions. If we look again at Equation 1, we can see that if the amount of available oxygen is restricted then we won't be able to produce CO2 and will instead produce CO, carbon monoxide. This is far from desirable given its deadly effects on humans, and of course it represents inefficient combustion, so we aren't liberating as much heat as we want to. If we restrict oxygen even further, we will get carbon atoms (soot) leaving the flame.

In practice, a burner will always produce some carbon monoxide. To minimise this, the burner design incorporates more oxygen supply than is necessary for the stoichiometric ratio. This extra oxygen is called "excess air" and it will mean that oxygen will appear in the flue or chimney alongside the combustion products listed in Equation 2. The amount of excess air necessary will depend upon the burner design, specifically how well it mixes the air and gas together, and how long the reactants can remain above 650°C. Burner designers express the amount of excess air required as a fraction or percentage of the stoichiometric

FIGURE 3 SOOT ACCUMULATION WITHIN A PACKAGE BURNER CONE.



amount. If, for example, the amount of excess air is 10 per cent above the stoichiometric amount, the excess air would be said to have a fraction excess, e, of 0.1. This can also be expressed as the "air factor" which is 1 +e. So for 10 per cent excess air where e = 0.1, the air factor would be 1.1.

If we have excess air/excess oxygen present, then the fuel and air mixture is described as being "lean". Gas burners are always set up to be lean. Where the air supplied is less than the stoichiometric amount, the mixture is said to be "rich". Petrol and diesel engines are generally set up to run rich.

So, let's now look at what actually make up natural gas. Remember, natural gas is a naturally occurring substance, and its composition therefore varies with each geographical area from which it is sourced. Table 1 is a typical composition for UK North Sea gas.

Gas may also contain water, and compounds of sulphur such as hydrogen sulphide. The gas transmission and distribution companies will remove these as they are undesirable in the pipes and for combustion.

We need now to consider what combustion looks like, and what the air requirement is, for natural gas rather than just methane. In doing so we can establish the expected composition of our combustion products. Table 2 shows us how to do this for the example of North Sea gas given in Table 1. For each component we write the relevant balanced equation as shown in Eq.1 for methane to derive the necessary oxygen etc. We shall revisit this in future articles to show how to determine important characteristics and parameters for the fuel.

In Table 2 we can see that the air requirement, including the necessary excess air provision, is calculated to be 10.73 m³ for every m³ of natural gas. So let's now consider the combustion products based on these figures. For this, we refer back to the basic stoichiometric equation for each component gas. For example, we know that we get one carbon dioxide and two water molecules per molecule of methane. As methane makes up 94.4 per cent of our gas the CO2 is calculated by 1 x 0.944 and the H2O is calculated by 2 x 0.944 etc. This gives us the combustion products given in Table 3.

Table 3 introduces us for the first time to the concept of wet and dry combustion products. We know from Equation 1 that one of the combustion products is water, so the percentage of carbon dioxide, for example, would be calculated in products including water. Modern electronic combustion analysers cannot cope with water on their internal sensors, so they remove it either by passing the products through a filter and water trap, or by condensing the products in more expensive analysers. The analysis performed therefore would be of dry products only. For the above example, CO2 percentage on wet analysis would be:

$$\left(\frac{1.0385}{11.7545}\ x\,100\right) = 8.83\ \%$$

Whereas, for dry analysis, the CO2 percentage would be:

$$\left(\frac{1.0385}{9.7345}\ x\,100\right) = 10.67\ \%$$

TABLE 1: EXAMPLE OF NATURAL GAS COMPOSITION

COMPONENT OF DRY GAS		% BY VOLUME
COMBUSTIBLE GASES	METHANE, CH_4	94.40
	ETHANE, C_2H_6	3.22
	PROPANE, C_3H_8	0.59
	BUTANE, C_4H_{10}	0.21
NON-COMBUSTIBLES	PENTANE, C_5H_{10}	0.07
	CARBON DIOXIDE, CO_2	0.05
	NITROGEN, N_2	1.46

TABLE 2: CALCULATION OF AIR REQUIREMENT FOR NATURAL GAS EXAMPLE

REACTANT COMPONENTS	% OF COMPOSITION	FRACTION OF COMPOSITION	O2 PER COMPONENT REQUREMENT	ACTUAL O2 FOR FRACTION	
CH_4	94.40	0.944	2	1.888	
C_2H_6	3.22	0.0322	3.5	0.1127	
C_3H_8	0.59	0.0059	5	0.0295	
C_4H_{10}	0.21	0.0021	6.5	0.01365	
C_5H_{12}	0.07	0.0007	8	0.0056	
CO_2	0.05	0.0005	_	-	
N_2 IN FUEL	1.46	0.0146	_	-	
OXYGEN PER M³ OF NATURAL GAS AT STOICHIOMETRIC RATIO					2.0494
EXCESS OXYGEN E+0.1					0.2049M³
TOTAL OXYGEN M³					2.2544
NITROGEN FROM AIR M³					8.4765
TOTAL AIR REQUIREMENT					10.7309

Now, if we were to repeat that calculation without excess air, we would find that the wet CO_2 percentage is 9.6 per cent and dry it is 11.9 per cent . It is very important to realise that the introduction of excess air into the flue will reduce the measured CO_2 percentage. This should be obvious because we are effectively diluting the CO_2 with air /oxygen.

The figure of 11.9 per cent is the maximum CO_2 that can be produced in combustion of natural gas using dry analysis. However, as we have discussed, you should not measure 11.9 per cent; this figure will either be reduced due to being diluted with oxygen (preferably) or will be reduced because poor combustion is occurring, and carbon monoxide is displacing the CO_2. The graph produced below in Figure 4 is very important as it explains the relationship between the three gases (CO, CO_2 and O_2) that you will commonly measure whilst doing dry analysis.

By studying the graph in Figure 4, we can see that, when we have stoichiometric ratios of fuel and air,

TABLE 3: CALCULATION OF COMBUSTION PRODUCTS WITHIN THE FLUE

	CH4	C2H6	C3H8	C4H10	C5H12	CO2	TOTALS
CARBON DIOXIDE	0.9440	0.0644	0.0177	0.0084	0.0035	0.0005	1.0385
WATER	1.8880	0.0966	0.0236	0.0105	0.0042	-	2.0229
OXYGEN (EXCESS)							0.20
NITROGEN (INC. FUEL AND AIR)							8.4911
TOTAL PRODUCTS WET							11.7545
TOTAL PRODUCTS DRY							9.7345
AIR/FUEL RATIO							10.73: 1

we get 11.9 per cent CO2. However, if we reduce the air supply such that combustion is fuel rich, we very quickly get a rise in deadly carbon monoxide. The most efficient and safe combustion occurs in the zone marked with a blue rectangle, where we have some excess air which will show as oxygen within the flue on your combustion analyser. However, even in this zone there will be some low levels of CO due to the fact no burner can mix and combust the gases so perfectly that complete combustion always occurs.

Most importantly, you should realise that you cannot measure combustion by one parameter alone. For example, 10 per cent CO2 could be on either side of the curve and you may be extremely close to deadly levels of CO. It's only when you look at the CO2 with excess oxygen that you can be assured of being on the correct side (lean side) of the curve. Similarly, if you look at the oxygen figure only, you may think that the displayed figure on your analyser indicates excess air but without examining the CO2 and CO levels you cannot be sure you are not drawing in ambient air, say through a leak on your probe or because you're not fully in the product stream. Gas engineers tend to concentrate on CO but, again, you can measure 150 parts per million, for example, on either side of the curve and it is only by understanding that this CO concentration should be accompanied by between 8 and 10 per cent CO2 for natural gas and 4 to 8 per cent O2 that the engineer can be sure that good combustion is occurring.

It is for this reason that the British Standard BS 7967 provides acceptance levels for combustion analysis using the CO/CO2 ratio. While this isn't perfect, it does mean the engineer is automatically considering the relationship between two combustion products. It is very important that gas installers and engineers understand how their electronic combustion analysers work. Only the most expensive will directly measure CO, CO2 and O2. (Analysers suitable for industrial purposes will also contain NOx cells and possibly SO2.) Most domestic and light commercial analysers contain only two gas measurement cells, generally CO and O2 - although some have CO and CO2. From these two measurements the third parameter is calculated. This means, for example, you cannot make ambient measurements of CO2 with an analyser which calculates it. Due to an absence or very low levels of CO and a high level of oxygen, the analyser would mistakenly indicate no CO2 was present.

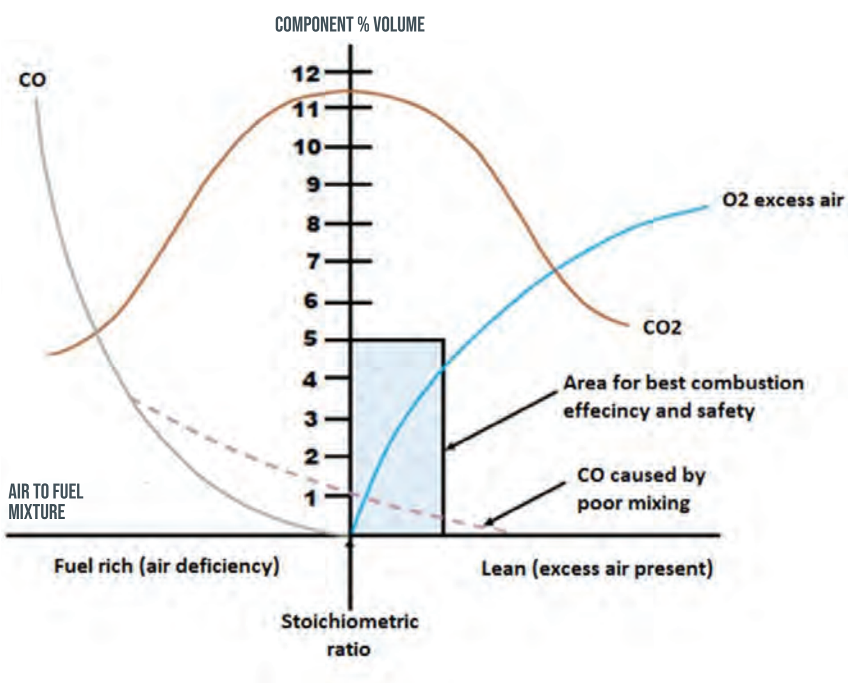
Electronic combustion analysers which calculate the CO2 use the following equation to do so.

$$CO_2 \text{ concentration} = CO_2 \text{ maximum} \times \frac{20.9 - \%O_2 \text{ measured}}{20.9}$$

You can see that a key part of the calculation is the CO2 maximum. For natural gas, this is the 11.9 per cent that we discussed earlier. However, for other fuels, this maximum CO2 figure is different and therefore it is absolutely essential that you set the analyser for the correct fuel of interest, otherwise the displayed CO2 figure will be incorrect.

There are many advantages and disadvantages to the different configurations of combustion analyser. The essential thing is that you understand what it's doing, how to use it and what the readings mean.

FIGURE 4 THE RELATIONSHIP BETWEEN DRY COMBUSTION PRODUCTS



In the next edition of these technical articles we will discuss causes of poor combustion and will explore the various combustion parameters and what they mean. This will lead us onto discussing burner design in future editions.

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STANDARDS G/11

THE SITUATION ROOM

Ahead of the relaunch of IGEM's Gas Industry Unsafe Situations Procedure, **Dave Bendle**, Chair of both the RIDDOR and IGEM/G/11 working groups presents the main changes to the document

THE GAS INDUSTRY Unsafe Situations Procedure (IGEM G/11) is an essential document for competent gas engineers. While others may use it as a reference point, it is the competent engineer on site that must make the final decision based on the site risk assessment of the situation encountered. This is, essentially, their basic duty under both the Health and Safety at Work etc. Act of 1974 (HSWA) and the Gas Safety Installation & Use Regulations (GSIUR).

The requirement to treat each situation individually is covered by the statement "the competent engineer shall be able to justify their rationale based on the situation on site – the examples in this document are generic".

Again, this reinforces the point that the person on site should be competent in assessing the risk and confirming

that the classification applied is appropriate. It is also a reminder that the tables shown within the document are generic examples.

Ahead of the relaunch of this document, here are some of the changes we have made which could affect the way you work:

1 Note added to Section 6 clarifying emergency service providers (ESPs) are those best equipped/trained to deal with gas escapes.

2 New note in Section 6.1 advising the engineer to remain on site where possible if disconnection is refused and the ESP is called. This allows for the situation to be explained to the first call operative (FCO) and avoids them being used as the bearer of bad news.

3 Text revision in Section 6, clauses 6.1e and 6.2.1e for both 'Immediately Dangerous' (ID) and 'At Risk' (AR). This allows for use of electronic records, but stresses the need for a signature to confirm understanding, that regardless of format it shall be issued while on site (to prevent an email being sent later, if using an electronic format) and the importance of leaving a notice on site if no one is present. The document states:

Complete a 'warning notice' which shall emphasise the words 'DANGER DO NOT USE'. Regardless of the format used obtain a signature from the gas user/ responsible person as both a record of receipt and understanding. Before leaving site, a copy shall be issued to the gas user/ responsible person and keep a copy for your records. If no one is present, leave a copy on site to alert any future user to the danger. See clause f) if the user is not the owner/responsible person.

The requirement to treat each situation individually is covered by the statement "the competent engineer shall be able to justify their rationale based on the situation on site – the examples in this document are generic"

4 Clause 8.3: Reaffirmation of RIDDOR criteria in. The wording of RIDDOR 11(2) highlights the triggers for reporting; for example, the situation has caused or is likely to cause:

- Death
- Unconsciousness
- Or a person being taken to hospital

The 'sub requirements' of by design, construction, servicing, etc., leading to an escape of gas/product of combustion, etc., are detailed later in the clause. It was believed the incorrect use of RIDDOR 11(2) was partly due the criteria of gas escape, leakage of combustion products, etc., appearing in the regulation as specific statements (listed a to c), leading the recipient to believe these were the trigger points rather than the likelihood of death, etc.

5 Clauses 8.4 and 8.6: Details on how to report unsafe workmanship to Gas Safe Register. This allows reporting of situations that would previously have been incorrectly reported under RIDDOR. Work has been done with Gas

Safe Register to make the reporting process on their website easier.

6 Clause 8.6: Note added referencing flowchart 7. The flowchart details the reporting route decision process upon discovery of an unsafe situation.

7 Clause 8.7: New section covering reporting theft of gas meter tampering, etc. While not always an unsafe situation, it was thought appropriate to provide advice to engineers here withing the document.

8 Section 9: Tables. A precis of the RIDDOR reporting criteria added to each header as a reminder along with the Gas Safe reporting route.

9 Notable new/revised table examples:

- 3.11: Revised scenario example to include situations where the position or lack of support makes damage, etc., highly foreseeable.
- 6.6: Revised scenario example wording to clarify the defect must be severe enough to make failure a likelihood. Hopefully, this avoids unnecessary 'defecting' just because a single screw is missing which does not affect the flue's integrity.
- 6.7: has been combined into 6.6
- 7.2: Scenario revised to cover missing or damaged test points or seal, highlighting which scenario is RIDDOR reportable – assuming due to 'poor workmanship'.
- 13.9: New scenario covering LPG regulators

10 Updated contacts in Table 2: Contact Details of Gas Emergency Service Providers (ESPs) and Gas Suppliers (GSs) In The British Isles

11 Appendix 5: Visual Risk Assessment. Statement added:

"Generally, a visual risk assessment is for visually apparent defects only and does not require moving an appliance or any building infrastructure unless the engineer has concerns."

SPOTLIGHT ON...

ENGTECHS

We have been asking some of our EngTech members about their careers to date, what the future holds and how IGEM has supported them in their career so far. **Adam Madgett** currently works as HyDeploy Project Manager at Northern Gas Networks

ADAM MADGETT

ADAM JOINED THE gas industry in 2015, after serving 11 years in the Armed Forces as an aircraft technician, where he progressed through the military's award-winning apprenticeship programme. He says the programme tgave him the fundamental building blocks in engineering. He kicked off his career in gas as an Assistant Integrity Engineer at Northern Gas Networks and was "responsible for overseeing metering and gas quality across our offtakes, ensuring compliance with NGN and Ofgem standards".

Adam now leads the HyDeploy project for NGN, which is aiming to demonstrate that hydrogen can be safely blended into the gas network up to 20 per cent by volume, without any changes to customers appliances. He says get involved with the early feasibility work in blending hydrogen in the gas network was the moment that led him to where he is today, saying that this was "a bit of an unknown to me as I was fairly new to the industry when the opportunity presented itself".

On deciding to become a member of IGEM, Adam says: "I liked the idea of joining a professional community that was applicable to the new engineering environment I had migrated to.

"IGEM hold some great events for their member and non-members which help expand your network and learning. Being a member of IGEM has allowed me to expand my professional network and developed my understanding of the industry. EngTech is the first step on the ladder of IGEM's professional registration and it rewards an individual with recognition of their engineering abilities, adding huge value to your credibility as an engineer.

"IGEM have great members and superb resources so don't be afraid to ask for support and help – you will find an abundance of willing volunteers to help you," he says – adding that he believes it is the perfect time to join the industry. "There is a huge amount of exciting work being carried out to repurpose the gas network for hydrogen," he says. 'It's a once in a lifetime opportunity".

"EngTech is the first step on the ladder of IGEM's professional registration and it rewards an individual with recognition of their engineering abilities, adding huge value to your credibility as an engineer"

Looking ahead, Adam believes that low-carbon gases such as biomethane and hydrogen are the future of the gas network and says: "We have a chance to make a significant contribution to reducing UK carbon emissions by repurposing our existing gas network for hydrogen. There are several projects providing critical evidence to support this future and I am fortunate to be involved with some of them."

So, what's next for Adam? "In the next two to three years, I'd like to build up my portfolio and work towards receiving IEng accreditation through IGEM's technical report writing pathway," he says.

"I have learnt so much in such a short time and credit this to never turning down an opportunity. You hear this from great innovators such as Richard Branson, but in my experience it really is true. Never doubt yourself – if someone gives you an opportunity to do something, grasp it with both hands.

"The foundation of my engineering knowledge was formed through the military. The most important value I was taught is integrity. Fast forward 18 years and I apply this to my work and my life. If there was one thing I would say to an aspiring engineer, it would be to apply this throughout your career"

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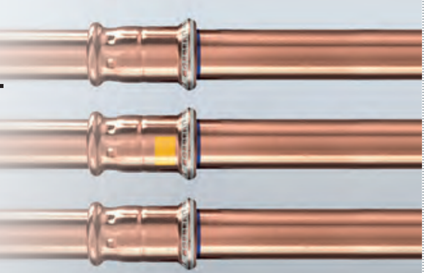

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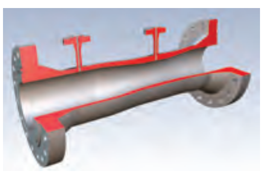

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