INSTITUTION OF GAS ENGINEERS AND MANAGERS IGEM/TSP/24/254

Founded 1863
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IGEM/SR/29 Edition 3
Communication TBC

Dealing with gas escapes

DRAFT FOR COMMENT

1 This draft Standard IGEM/SR/29 Edition 3 has been prepared by a Panel chaired by Geoff Radley

2 This Draft for Comment is presented to Industry for comments which are required by 20 January 2025, and in accordance with the attached Reply Form.

3 This is a draft document and should not be regarded or used as a fully approved and published Standard. It is anticipated that amendments will be made prior to publication.

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Attached is the Draft for Comment of IGEM/SR/29 Edition 3 – "Dealing with gas escapes" and the associated comment form.

We wish to make it as easy as possible for those of you representing industry bodies to issue the draft to your Members. You can either forward this email with attachment complete or forward it without the attachment and invite them to visit our website via https://www.igem.org.uk/resource-library-search.html?information_type=out-for-comment where the Draft and Comment Form are posted.

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Dealing with gas escapes

DRAFT FOR COMMENT

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IGEM STANDARDS

IGEM/SR/29 Edition 3
Communication TBC

Dealing with gas escapes

DRAFT FOR COMMENT

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SECTION 1 : INTRODUCTION

1.1 This Standard supersedes IGEM/SR/29 Edition 2, Communication 1827, which is obsolete.

This Standard has been drafted by a Panel appointed by the Institution of Gas Engineers and Managers' (IGEM's) Gas Transmission and Distribution Committee, subsequently approved by that Committee and published by the authority of the Council of IGEM.

1.2 This Standard provides requirements for gas transporters (GTs), gas conveyors, shippers, suppliers and information for the likes of local authorities, plant operators, utilities and emergency services on the responsibility, methods and personnel involved in dealing with a gas escape.

1.3 The requirements detailed in this Standard are based on current practices within Great Britain (GB).

Note: The protection of life and property are given priority throughout this Standard.

1.4 The relevant parts of this Standard may be cited in a GT's/IGT's/gas conveyor's safety case, but the Health and Safety Executive (HSE) will need to be satisfied that they are appropriate and have been properly applied in each case.

1.5 This Standard makes use of the terms "must", "shall" and "should" notwithstanding clause 1.7,

- the term "must" identifies a requirement by law in GB at the time of publication
- the term "shall" prescribes a requirement which, it is intended, will be complied with in full and without deviation
- the term "should" prescribes a requirement which, it is intended, will be complied with unless, after prior consideration, deviation is considered to be acceptable.

Such terms may have different meanings when used in Legislation, or HSE Approved Code of Practice (ACoPs) or guidance, and reference needs to be made to such statutory Legislation or official guidance for information on legal obligations.

1.6 The primary responsibility for compliance with legal duties rests with the employer. The fact that certain employees, for example "responsible engineers" are allowed to exercise their professional judgement does not allow employers to abrogate their primary responsibilities. Employers must:

- have done everything to ensure, so far as is reasonably practicable, that there are no better protective measures that can be taken other than relying on the exercise of professional judgement by "responsible engineers"
- have done everything to ensure, so far as is reasonably practicable that "responsible engineers" have the skills, training, experience and personal qualities necessary for the proper exercise of professional judgement
- have systems and procedures in place to ensure that the exercise of professional judgement by "responsible engineers" is subject to appropriate monitoring and review

- not require "responsible engineers" to undertake tasks which would necessitate the exercise of professional judgement that is not within their competence. There should be written procedures defining the extent to which "responsible engineers" can exercise their professional judgement. When "responsible engineers" are asked to undertake tasks which deviate from this they should refer the matter for higher review.

1.7 Notwithstanding clause 1.5, this Standard does not make obligatory the use of any method or specification against the judgement of the "responsible engineer". New and improved practices may be adopted prior to this Standard being updated. Amendments to this Standard will be issued when necessary and their publication will be announced in the Journal of IGEM and elsewhere as appropriate.

1.8 It is now widely accepted that the majority of accidents in industry are in some measure attributable to human as well as technical factors in the sense that people's actions initiated or contributed to the accidents or people might have acted better to avert them.

It is therefore necessary to give proper consideration to the management of these human factors and to the control of risk. To assist in this, it is recommended that due cognisance be taken of HSG48 and HSG65.

1.9 Requests for interpretation of this Standard in relation to matters within its scope, but not precisely covered by the current text, are to be addressed in writing to Technical Services, IGEM, IGEM House, High Street, Kegworth, Derbyshire, DE74 2DA or emailed to technical@igem.org.uk and will be submitted to the relevant Committee for consideration and advice, but in the context that the final responsibility is that of the engineer concerned. If any advice is given by or on behalf of IGEM, this does not relieve the responsible engineer of any of his or her obligations.

1.10 This Standard was published on xx/xx/2025

SECTION 2 : SCOPE

2.1 This Standard sets out the requirements for dealing with gas escapes safely.

2.2 Primarily, this Standard deals with gas escapes from Natural Gas (NG) piped supplies and systems, but also applies to other gases,. Further guidance can be found in appendices.

Note 1: In general, this Standard will not always be appropriate for escaped fuel that remains in a liquid phase, when further or alternative requirements may need to be applied. The Gas Safety (Management) Regulations (GS(M)R) lay down statutory requirements for dealing with reported NG escapes, which include escapes of carbon monoxide (CO). This Standard does not deal with the technical issues involved with reported CO "incidents", nor do the non-technical sections mention CO. However, the principles outlined in the non-technical sections apply to dealing with reported CO "incidents". Further information is provided in IGEM/GL/8.

Note 2: This Standard only deals with unignited gas escapes.

2.3 This Standard provides requirements for gas transporters (GTs), IGTs, gas conveyors, Emergency Service Providers (ESPs), National Gas Emergency Service (NGES), shippers, suppliers and information for the likes of local authorities, plant operators, utilities and emergency services on the responsibility, methods and personnel involved in dealing with a gas escape. Particular attention is drawn to the requirement for competency outlined in Sub-Section 4.6.

2.4 This Standard covers the requirements to take action from the identification of a gas escape to make the situation safe along with appropriate notification to the relevant parties including the HSE.

2.5 All pressures are gauge pressures unless otherwise stated.

2.6 Italicised text is informative and does not represent formal requirements.

2.7 Appendices are informative and do not represent formal requirements unless specifically referenced in the main sections via the prescriptive terms "must", "shall" or "should".

SECTION 3 : LEGAL AND ALLIED CONSIDERATIONS

3.1 GENERAL

3.1.1 This Standard is set out against a background of Legislation in force in GB at the time of publication. The devolution of power to the Scottish Parliament and Welsh and Northern Ireland Assemblies means that there may be variations to the Legislation described below for each of them and consideration of their particular requirements must be made. Similar considerations are likely to apply in other countries where reference to appropriate national Legislation is necessary.

All relevant Legislation must be applied and relevant ACoPs, official Guidance and referenced codes, standards, etc. shall be taken into account.

Note: Appendix 2 is relevant in this respect.

Health and safety Legislation must be observed, especially those requirements which are concerned with the duties of employers, not only to their own employees, but also to members of the public who may be affected.

3.1.2 The Legislation that mainly prescribes the requirements for dealing with gas escapes is the Gas Act and GS(M)R.

3.1.3 Unless otherwise stated, the current editions of Legislation and standards apply.

3.1.4 In the absence of specific Legislation, it is essential that installations are designed, constructed, installed, operated and maintained so as to be safe.

3.1.5 The Legislation appropriate to any installation will depend largely upon its location. Advice will need to be sought from the relevant authorities.

3.1.6 Where British standards, etc. are quoted, equivalent national or international standards, etc. equally may be appropriate.

Care shall be taken to ensure that the latest editions of the relevant documents are used.

3.2 PRIMARY LEGISLATION

3.2.1 Gas Act

3.2.1.1 Public gas transporters (PGTs), that is those GTs who hold a licence under Section 7(2) of the Gas Act 1995, have special conditions imposed on them by their licence with regard to gas escapes (Standard Condition 18 refers).

3.2.1.2 Rights of entry for preventing escapes of gas etc. comes under schedule 2B of the Gas Act 1986, The Gas Code and Rights of Entry (Gas and Electricity Board) Act 1954 as amended:

Gas Act 1995 Schedule 2; Paragraph 21 states:

"*Suspected escapes of gas"*

(1) Where a public gas transporter has reasonable cause to suspect that gas conveyed by him which has escaped has entered, or may enter any premises, the transporter shall take any steps necessary to avert danger to life or property.

(2) If a public gas transporter fails to comply with sub-paragraph (1) above, he shall be guilty of an offence and liable on summary conviction to a fine not exceeding level 3 on the standard scale.

(3) In any proceedings for an offence under sub-paragraph (2) above it shall be a defence for the public gas transporter to prove that he took all such steps to avert danger to life or property as were reasonably practicable'.

Paragraph 22 states:

'*Entry for preventing escapes of gas etc'*

(1) Where a public gas transporter has reasonable cause to suspect:

(a) that gas conveyed by him is escaping, or may escape, in any premises; or

(b) that gas so conveyed which has escaped has entered, or may enter, any premises, any officer authorised by the transporter may, on production of some duly authenticated document showing his authority, enter the premises, inspect the gas fittings, carry out any work necessary to prevent the escape and take any other steps necessary to avert danger to life or property.

(2) Where a public gas transporter has reasonable cause to suspect:

(a) that gas conveyed through pipes by some other person is escaping, or may escape, in any premises in an authorised area of his; or

(b) that gas so conveyed which has escaped has entered, or may enter, any premises in such an area, any officer authorised by the transporter may, on production of some duly authenticated document showing his authority, enter the premises and take any steps necessary to avert danger to life or property.

(3) In this paragraph any reference to any officer authorised by a public gas transporter includes a reference to any officer authorised by another such transporter with whom the transporter has made arrangements for officers authorised by the other transporter to discharge any functions of the transporter under paragraphs 20 and 21 of these Regulations.

3.2.2 Health and Safety at Work etc. Act (HSWA)

HSWA applies to all persons involved with work activities, including employers, the self-employed, employees, designers, manufacturers, suppliers, etc. as well as the owners of premises. It places general duties on such people to ensure, so far as is reasonably practicable, the health, safety and welfare of employees and the health and safety of members of the public who may be affected by the work activity.

3.2.3 New Roads and Street Works Act (NRSWA)

3.2.3.1 NRSWA prohibits (under Section 51) any work being undertaken to place an apparatus in a street or to break up or open a street, or a sewer, drain, or tunnel under it or tunnel or bore under a street, or of changing the position of apparatus or removing it other than in pursuance of a statutory right or a street works licence.

3.2.3.2 NRSWA further details (under Section 52) "emergency works" as works whose execution at the time when they are executed is required in order to put an end to, or to prevent the occurrence of, circumstances then existing or imminent (or which the person responsible for the works believes on reasonable grounds to be existing or imminent) which are likely to cause danger to persons or property.

3.2.3.3 NRSWA details (under Section 57) the requirements to notify the Local Authority of the "emergency works" by a "Notice":

- an undertaker executing emergency works is to give notice as soon as reasonably practicable, and in any event within two hours (or such other period as may be prescribed) of the works being begun, to the persons to whom notice would be required to be given under that section and
- the notice is to state his intention or, as the case may be, the fact that he has begun to execute the works and is to contain such other information as may be prescribed
- an undertaker who fails to give notice in accordance with this section commits an offence and is liable on summary conviction to a fine.

3.2.3.4 NRSWA requires that training and competency assessments are carried out for those who work on the highway.

3.2.3.5 Under the Traffic Management Act (TMA), some Local and Highway Authorities have introduced Permitry schemes, each with their own set of guidance and requirements. These Permitry schemes are to be consulted and complied with wherever they are in place prior to carrying out works which the schemes encompass on designated roads within the Local or Highway Authorities area.

3.3 SECONDARY LEGISLATION

3.3.1 Control of Major Accident Hazards Regulations (COMAH)

These Regulations aim to prevent and mitigate the effects on people and the environment of major accidents involving dangerous substances.
All operators must develop a safety management system, provide basic details of the dangerous substances, location and activity to the competent authority and prepare a major accident prevention policy.
Additional duties may include preparation of a safety report, testing of a site emergency plan and providing information to the local authority for external emergency planning purposes.

3.3.2 Confined Spaces Regulations

These Regulations apply to a whole range of confined spaces. The supplier or designers of an enclosure and equipment within it is required to perform a risk assessment of the enclosure with respect to safe access and egress and to give clear instructions to operators on access/egress as well as to what actions to take in the event of a gas alarm occurring. Employers and the self-employed are required to prevent entry into confined spaces unless avoidance is not reasonably practicable and unless there is a system of work which renders the work safe. They are also required to have specific emergency arrangements in place.

3.3.3 Control of Substances Hazardous to Health Regulations (COSHH)

These Regulations require employers to assess the health risks associated with the use of and exposure to substances which are hazardous to health. Primarily, they relate to health and safety at work but chemical data gathered for COSHH may also be useful when assessing environmental effects.

COSHH require:

- a written risk assessment prior to using substances which may be hazardous to health
- consideration to the properties, health effects and form of these substances. Various amendments have required specific attention be given to carcinogens, asthmogens and biological agents.

The 2004 amendments implement a new framework for occupational exposure limits and bring together eight principles of good practice.

3.3.4 Electricity at Work Regulations

These Regulations apply to a wide range of electrical work, from overhead power lines to the use of office computers and batteries and include work on gas equipment using electrical energy.

The Regulations are concerned with the prevention of danger from electric shock, electric burn, electrical explosion or arcing or from fire or explosion initiated by electrical energy.

The Regulations impose duties on every employer, employee and self-employed person and require that persons engaged in electrical work be competent or be supervised by competent persons.

Note: HSR25 provides guidance on the Regulations.

3.3.5 Gas Safety (Installation and Use) Regulations (GS(I&U)R)

3.3.5.1 GS(I&U)R are relevant statutory provisions of HSWA setting out general and detailed requirements dealing with the safe installation, maintenance and use of gas systems, including gas fittings, appliances and flues.

Note: GS(I&U)R do not apply to certain premises (see L56 Guidance Notes 28 and 29). However, where they do not apply, the principles of GS(I&U)R need to be applied, notwithstanding that the requirements for Gas Safe registration need not be applied.

3.3.5.2 GS(I&U)R address both Natural Gas and LPG.

3.3.5.3 GS(I&U)R place responsibilities on those installing, servicing, maintaining or repairing gas appliances, pipework etc. as well as suppliers and users of gas.

3.3.5.4 GS(I&U)R define the gas supplier for both Natural Gas and LPG. L56 provides guidance on those definitions, in particular for the more complicated case of LPG supplied from storage vessels and from cylinders.

3.3.5.5 GS(I&U)R define the type of work that requires persons carrying out such work, or their employers, to be an "approved class of person". In the GB this means registration under the Gas Safe Register scheme.

3.3.5.6 The gas operative is required to check the safety of any appliance or pipework they install or work on and take appropriate action where they find faults. Where the premises are let or hired out, the landlord or hirer has special responsibilities to ensure that any operative they use for the gas fitting, service or maintenance of safety is a member of an approved class of persons (see clause 3.3.4.5) and is competent to carry out such work. If any serious fault is found, the operative is required to inform both the landlord/hirer, as well as the user, so that such faults can be rectified before further use. Reference is to be made to the requirements contained in IGEM/G/11 - The Gas Industry Unsafe Situations Procedure (GIUSP) (details are available through Gas Safe Register and the IGEM website).

Note: Operatives working for ESPs may have limited responsibilities in this area.

3.3.5.7 GS(I&U)R place responsibilities on LPG suppliers to deal with escapes of LPG. For Natural Gas, GS(M)R apply (see Sub-Section 3.3.5).

Note: Further advice on GS(I&U)R is provided in L56.

3.3.6 Gas Safety (Management) Regulations (GS(M)R)

3.3.6.1 These Regulations are intended to cover the transport of NG to the public. They do not cover gases such as LPG, coke oven gases etc. (see L80 Regulation 2(1)).

3.3.6.2 Regulation 8 of GS(M)R places an obligation on GTs/gas conveyors not to convey gas in a network unless the gas conforms with the requirements of Part I of Schedule 3 of the Regulations (include a stenching agent) except that this paragraph shall not apply where the gas is at a pressure above 7 bar.

3.3.6.3 GS(M)R (Regulations 7(4); 7(5); 7(6) and 7(10)) place specific duties on GTs/gas conveyors, or their emergency service providers (ESPs), for dealing with gas escapes from pipes on their networks. Their primary duty is to make the situation safe. They are responsible not only for dealing with escapes from their own pipes, but also for dealing with escapes from gas fittings supplied with gas from pipes on their network. In GS(M)R, the term "gas escapes" includes escapes or emissions of CO from an appliance as a product of incomplete combustion.

Where a gas escape is confirmed following the report of a gas escape, GS(M)R require that the gas escape be prevented within 12 hours of receipt of the initial reported escape. However, GS(M)R allow a GT/gas conveyor a defence to this duty on the grounds of reasonable practicability. Further information on repairs to gas escapes is provided on the gas supply section of HSE's website. If the gas conveyor is able to prove that this defence applies to a gas escape, the work necessary to prevent it may be deferred beyond 12 hours.

Where a GT/gas conveyor has made a decision not to prevent a gas escape within 12 hours of receipt, this is known as either a "deferred" or "programmed" gas escape. The decision making process by which the repair of a gas escape is deferred or programmed is in effect a "risk based prioritisation system" (see clause 5.9.1).

The principles that a GT/gas conveyor is to consider when determining whether or not to defer the prevention of a gas escape beyond 12 hours are:

- genuine problems were encountered when attempting to locate the escape
- difficulties were experienced in gaining access to the location of the escape, either by geography or by other risks such as fire, explosion, building instability, roads and traffic etc
- the size and/or complexity of the escape meant that a repair could not be completed within 12 hours
- there was unforeseen demand on first call operatives and escape, locate and repair (ELR) teams at the time of the gas escape in question
- ELR resources were diverted to other more serious and immediate risks that arose at the same time as the gas escape in question.

The above list is not exhaustive.

Where GS(M)R Regulation 7(4) has been breached, the application of the prioritisation system can be used to provide a defence under GS(M)R Regulation 7(10). The defence will be in three parts:

- the prioritisation system was adequate to deliver the prevention of the gas escape within 12 hours unless it was not reasonably practicable for this to be achieved; and

- the training, competence assurance, supervision and monitoring of the individuals who decided not to prevent the gas escape within 12 hours was sufficient to ensure that they applied the prioritisation system correctly; and
- the prioritisation system was followed correctly by the individuals who decided not to prevent the gas escape within 12 hours.

3.3.6.4 Regulation 7 of GS(M)R places a duty on British Gas PLC (this duty now rests with Cadent Gas Ltd) to:

- provide a continuously staffed national 0800 111 999 Freephone number for use by the public, consumer and the emergency services, in the event of a gas escape (gas escapes include actual or suspected emission of CO from gas appliances), or a fire or explosion where gas is suspected to have been involved and
- contact the relevant GT, or their ESP (where different), immediately when an emergency arises from a gas escape or suspected emission of CO.

3.3.6.5 There are also duties imposed on gas suppliers, ESPs and GTs to notify the person who has the responsibility for dealing with the escape when they receive a report of an escape from the consumer (Regulation 7(3) of GS(M)R).

3.3.6.6 GS(M)R require GTs to investigate gas related fire and explosion incidents downstream of the consumer's emergency control valve (ECV) and to send a report of the investigation to HSE. Regulation 7(12) states:

"Where an escape of gas from a gas fitting on domestic premises has resulted in a fire or explosion, the person conveying the gas in the part of the network immediately upstream of the emergency control for the supply of gas to that fitting shall, as soon as is reasonably practicable after receiving notice of the fire or explosion, cause an investigation to be carried out so as to establish, so far as is reasonably practicable, whether the escape was from installation pipework or from an appliance, and if so which, appliance".

The responsibility for investigating CO poisoning incidents from incomplete combustion is placed on gas suppliers (see Regulation 7(14)). HSE is to be notified before such investigations commence. GS(I&U)R place legal duties on LPG suppliers to deal with escapes of LPG.

3.3.7 Gas Safety (Rights of Entry) Regulations 1996

3.3.7.1 Under regulations 4 and 5 of The Gas Safety (Rights of Entry) Regulations 1996, Authorised Officers (AOs) of the ESP have extensive powers to enter premises in respect of suspected escapes of gas or dangerous appliances. The specific powers are detailed below. These rights can only be exercised without either notice or the consent of the owner or occupiers where an AO has reasonable cause to believe that circumstances exist which are likely to endanger life or property, and that immediate entry to the premises is necessary to verify the existence of those circumstances or to ascertain their cause or to effect a remedy.

3.3.7.2 Entry for preventing gas escapes - Regulation 4

If the ESP has reasonable cause to suspect that gas is escaping or may escape in a premises or that gas which has escaped has or may enter premises, an AO may enter premises to carry out any work necessary to prevent the escape and take any other steps necessary to avert danger to life or property.

3.3.7.3 Access to premises to inspect gas fitting - Regulation 5

An AO has rights to enter premises to inspect gas fittings on premises including appliances, meters, flues or means of ventilation or any part of the gas system on the premises (including the service pipe) and may test any such item including verifying what suitable ventilation provision is available for it.

On entering the premises the AO may disconnect and seal off the appliance/fitting or part of the gas system or even disconnect the whole premise if the AO considers it necessary to do so "for the purpose of averting danger to life or property". This action can also include isolation of the gas supply by physical disconnection at the ECV if considered necessary.

3.3.7.4 **Notification to Customer**

When an AO exercises powers to disconnect under Regulation 5, a notice is to be affixed as near as possible to the point of disconnection stating that the ESP has disconnected the appliance, fitting or premises as the case may be and that other than with the consent of the ESP or a direction by the Secretary of State, it should not be reconnected unless steps have been taken to remedy the defect and prevent reoccurrence.

Additionally, within 5 clear working days, the customer is to be given written notice stating the nature of the defect, what action was taken and why. The notice is to also set out their entitlement to appeal the decision to disconnect to the Secretary of State.

3.3.8 **General Data Protection Regulation (GDPR)**

The application of rules for retention and disposal ensures that the organisation meets it's legal and regulatory obligations for keeping records for certain minimum periods of time, whilst also safely disposing of records when they are no longer required or in line with the General Data Protection Regulation (GDPR) requirements which came into effect in the UK on 25 May 2018.

3.3.9 **Management of Health and Safety at Work Regulations (MHSWR)**

MHSWR impose a duty on employers and the self-employed to make assessments of risks to the health and safety of employees and non-employees affected by their work. They also require effective planning and review of protective measures.

Protective and preventative measures are required to be implemented on the basis of the principles specified in Schedule 1 to these Regulations. These include:

- avoiding risks
- evaluating the risks which cannot be avoided
- combating the risks at source
- giving collective protective measures priority over individual protective measures and
- giving appropriate instructions to employees.

3.3.10 **Pipelines Safety Regulations (PSR)**

PSR provides a means of securing pipeline integrity by ensuring that a pipeline is designed, constructed and operated safely. They apply to all Network pipes operated by a GT. Installations can vary in size and complexity, and installation designers need to give due consideration to the operating pressure (OP) and required gas flows.

Note: L81 provides an ACoP and guidance and L82 provides guidance on PSR.

In particular, PSR require that the operator ensures no fluid is conveyed in a pipeline unless the pipeline has been designed so that, as far as is reasonably practicable, examination and maintenance may be carried out safely. PSR also

require that the operator ensures that a pipeline is maintained in an efficient state, in efficient order and in good repair.

Under (PSR), any person operating a gas pipeline at gauge pressures exceeding 7 bar has additional requirements imposed on them with regard to emergencies such as loss of integrity. Reference is to be made to the Regulations.

3.3.11 Pressure Systems Safety Regulations (PSSR)

3.3.11.1 PSSR impose duties on designers, importers, suppliers, installers and users or owners to ensure that pressure systems do not give rise to danger. This is done by the correct design, installation and maintenance, provision of information, operation within safe operating limits and, where applicable, examination in accordance with a written scheme of examination drawn up or approved by a competent person (as defined by PSSR).

3.3.11.2 Relevant fluids for the purpose of this document would be natural gas at a pressure greater than 0.5 bar above atmospheric pressure. A pressure system would include bulk storage tanks, pressure vessels, pipelines and protective devices. Once the pressure in the pipework drops below 0.5 bar, and the user/owner can show clear evidence that the system does not contain, and is not liable to contain, a relevant fluid under foreseeable operating conditions, then that part of the system is no longer covered by PSSR. This is likely to be the case after the pressure relief valve associated with a pressure reducing valve which takes the pressure to below 0.5 bar, for example at the entry to a building.

3.3.11.3 Note the special requirements placed on protective devices in such systems (see para 110b of L122). PSSR also apply to pipelines and their protective devices in which the pressure exceeds 2 bar (see Schedule 1 part 1 item 5 of L122).

Note: More information is available in L122 and some information is presented in the HSE free leaflets INDG261 and INDG178.

3.3.12 Personal Protective Equipment Regulations

3.3.12.1 These Regulations place duties on employers to ensure that work equipment is so constructed or adapted as to be suitable for the purpose for which it is used or provided. In selecting work equipment, every employer is to have regard to the working conditions and to the risks to the health and safety of persons which exist in the premises or undertaking in which that work equipment is to be used and any additional risk posed by the use of that work equipment.

3.3.12.2 There are also duties on employers to take measures to ensure that the exposure of a person using work equipment to any risk to his health or safety from any hazard is either prevented, or where that is not reasonably practicable, adequately controlled, for example intrinsically safe equipment being available as appropriate.

3.3.13 Provision and Use of Work Equipment Regulations (PUWER)

3.3.13.1 PUWER places duties on employers in relation to selection, suitability, maintenance, inspection, installation, instruction and training, prevention of danger and control of equipment.

Note: More information on PUWER can be found in L22. Free leaflets include INDG291 and INDG229.

3.3.13.2 The term "work equipment" includes all fixed plant and machinery as well as portable tools for use at work. This includes gas/plant/cable detection equipment, digging tools, ladders, lifting equipment and hand tools.

3.3.14 Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR)

3.3.14.1 RIDDOR is the law that requires employers, and other people in control of work premises, to report and keep records of certain work related accidents, diseases and dangerous occurrences.

3.3.14.2 There are also special requirements for gas related incidents. If a distributor, filler, importer or supplier of flammable gas learns, either directly or indirectly, that someone has died, lost consciousness, or been taken to hospital for treatment to an injury arising in connection with the gas distributed, filled, imported or supplied, this must be reported.

3.3.14.3 Gas Safe Registered engineers are required to provide details of any gas appliances or fittings considered to be dangerous to the extent that people could die, lose consciousness or require hospital treatment. This may be due to the design, construction, installation, modification or servicing, and could result in:

- an accidental leakage of gas
- inadequate combustion of gas or
- inadequate removal of products of the combustion of gas.

Note: Further guidance is available in IGEM/G/11.

3.3.14.4 All incidents can be reported online but a telephone service remains for reporting fatal and specified injuries only. Call the Incident Contact Centre on 0345 300 9923 (opening hours Monday to Friday 8.30 am to 5 pm). HSE has an out-of-hours duty officer. Circumstances where HSE may need to respond out of hours include:

- a work-related death or situation where there is a strong likelihood of death following an incident at, or connected with work
- a serious accident at a workplace so that HSE can gather details of physical evidence that would be lost with time
- following a major incident at a workplace where the severity of the incident, or the degree of public concern, requires an immediate public statement from either HSE or government ministers.

Note: Further guidance is available in IGEM/G/11.

INDG453 contains detailed guidance on RIDDOR reporting (available via the HSE website).

SECTION 4 : PROCEDURES AND COMMUNICATION

4.1 LEGISLATION AND BEST PRACTICE

GS(M)R stipulate requirements for the receipt, recording, progressing and dealing with reported gas escapes from piped NG supply systems.

Similar arrangements should be made for any other piped fuel gas supply, for example of LPG (see Sub-Section 3.2).

All personnel engaged in the emergency process shall have the skills, knowledge and resources to competently carry out their duties.

4.2 NATIONAL GAS EMERGENCY SERVICE (NGES)

A centre designated as a National Gas Emergency Service to receive reports of gas escapes should have:

- adequate telephone answering facilities to receive reports of gas escapes
- sufficient staff present to answer calls promptly. Such staff should be trained in the advice to be given to callers with respect to appropriate safety precautions (see details provided in L80 under Regulation 7(1))
- a facility to attend promptly to reports made by means other than the telephone, for example by email or other correspondence
- adequate resources to ensure that the ESP is notified immediately of any reported gas escape
- take sufficient details of the reported gas escape to enable it to prioritise site attendance by the ESP. For example controlled or uncontrolled gas escapes (see definitions in Appendix 1)
- telephone calls monitored for reference and training purposes.

Note: These requirements also apply to other independently operated 24 hour helpdesks.

4.3 COMMUNICATIONS

4.3.1 Organisations responsible for receiving reports of gas escapes, and those responsible for dealing with them, should have in place efficient and reliable channels of communication with all other organisations involved in action subsequent to the report, as well as with others who may become involved, for example local authorities, utilities and the emergency services. These communication channels also receive reports of loss of pressure, or no gas, both of which are not within scope of this document.

4.3.2 If a report is made to a supplier, ESP, IGT, GT or gas conveyor, or their dedicated emergency response service, it must be recorded then forwarded to the national gas emergency service by telephone. These organisations shall have staff trained in the advice to be given to callers with respect to appropriate safety precautions.

4.4 GAS EMERGENCY SERVICE PROVIDER (ESP)

The ESP:

- shall have adequate communication facilities to receive reports of gas escapes from the National Gas Emergency Service and the public
- shall have a procedure in place, and sufficient resource available, to ensure that an appropriate number of competent personnel attend as soon as reasonably practicable the location of the reported escape to investigate and make safe in accordance with agreed performance measures

Note: See Appendix 1.

- should seek information and advice from relevant third parties such as utility companies, Civil Aviation Authority, Local Authorities etc.

4.5 RECORDING RESPONSE TO REPORTED GAS ESCAPES

4.5.1 Any organisation receiving a report of a gas escape (and having a responsibility in law or under this Standard to take subsequent action) should record and retain the following details:

4.5.1.1 National Gas Emergency Service (see Sub-Section 4.2)

- name and contact telephone number of the person reporting the escape
- location of the reported escape
- date and time of report
- confirmation that appropriate advice on safety and the precautions to be taken was given, and the nature of that advice and any questions asked
- time of passing the report details to the gas emergency service provider.

Safety advice consistent with the nature of the emergency shall be given including:

- how to turn off the gas at the emergency control valve and confirm that this has been done where practicable (for LPG the advice should also include turning off at the storage tank where possible)
- where the emergency control valve is in a cellar or confined space and there is also a smell of gas, the advice given shall be not to enter the cellar but to vacate the premises
- to open doors and windows to ventilate the property unless gas is entering from outside
- not to operate any electrical appliances, not to smoke and to avoid using anything that could be a possible source of ignition
- where fumes are suspected to immediately turn off all appliances that may be emitting fumes, to ventilate property and not to use any appliances until they have been checked by the ESP.

4.5.1.2 Organisations other than the National Gas Emergency Service (see clause 4.3.2)

- name and contact telephone number of person reporting the escape
- location of the reported escape
- date and time of report
- for those having a duty under GS(M)R, confirmation that appropriate advice on safety and the precautions to be taken was given, and the nature of that advice, and any questions asked
- time of reporting the details to the National Gas Emergency Service.

4.5.1.3 ESP

- date and time of receipt of the report
- date and time attendance was arranged
- date and time of arrival on site
- details of subsequent events including actions and tests undertaken
- detail of other organisation informed (see Sub-Section 4.2 and Section 7)
- time when event was considered over
- date and time of leaving site

- confirmation that statutory or other reporting requirements were carried out.

Note: IGEM/GL/8 deals with the reporting and investigation of gas-related incidents.

4.6 COMPETENCY TO DEAL WITH ESCAPES

Further guidance is available in IGEM/G/14

4.6.1 Gas emergency service provider

4.6.1.1 The levels of competency in the ESP shall be as stipulated in the GT's/gas conveyor's safety case.

4.6.1.2 Persons engaged in activities relating to suspected gas escapes must be competent in the particular activity.

SECTION 5 : ACTIONS ON SITE

5.1 HIERARCHY OF PRIORITIES

The following hierarchy of priorities must be applied in all cases of dealing with suspected gas escapes:

- safeguard life
- safeguard property
- find and secure all gas escapes
- complete a final investigation before leaving the site.

If other parties, for example other emergency services, local authorities etc. are first to arrive on site, priority should be given to the safeguarding of life and property, including your own.

5.2 INITIAL ACTIONS

5.2.1 Upon arrival on site, the priority to safeguard life and property shall be assessed and any necessary action taken including checking surrounding properties as appropriate. Consideration shall be given to checking for the presence of gas at any point where services enter premises.

5.2.2 Consideration should be given for suspected downstream gas escapes for the supply to be isolated at the ECV. This is normally located adjacent to the meter (see Sub-Section 5.3.2).

Note: Consideration should be given to avoid isolation of downstream networks unnecessarily.

5.2.3 If an escape of gas is found on the gas consumer's side, that is downstream of an ECV, the ESP must make safe the situation (as stipulated in GS(M)R) then should advise the consumer of the situation and the action to be taken by the consumer.

Note: Initial site conditions and circumstances will determine the action to be taken and the decision will be assisted by experience, training and the ESP's operational procedures.

5.3 SUBSEQUENT ACTIONS

5.3.1 Considerations

If the escape of gas cannot be brought under immediate control (and the situation made safe) by any of the steps outlined in Sub-Section 5.2, the following options for further action shall be considered and implemented as appropriate, to include:

- isolation of any gas escape
- removal of obvious sources of ignition, for example naked flames, including cigarettes etc.
- ventilation of property and plant.

A thorough site investigation shall be undertaken bearing in mind the following considerations in clauses 5.3.1.1 to 5.3.1.13 inclusive.

5.3.1.1 *Safety precautions*

Every escape has the potential to be different. Learning from incidents has suggested that the following shall be considered:

- Complex buildings could include false wall voids.
- Refurbished buildings could have sealed voids
- For multiple occupancy buildings, consider the presence of numerous gas service entries and the positions of valves.

- Sealed service ducts could be present.
- Ducts installed during construction might not be immediately visible.
- Gas can migrate large distances and enter buildings, then cellars and voids in foundations.

Note: See Sub-Section 6.1.

- Gas can be unodorised, for example on transmission sites, landfill sites and biogas production facilities.
- High volume gas escapes require special consideration.
- Shared roof spaces could be present, for example in terraced housing.
- Where the main or service is known (or suspected) to be polyethylene (PE), consideration shall be given to the possibility that the escape may have been caused by a faulty electrical cable (see clause 6.3.1). Where a faulty electrical cable is suspected, the electricity network operator should be contacted.

- Where there is a suspected gas escape in a large or complex building, request advice from the responsible person e.g. building owner or landlord to assist decision making. Question the responsible person and those present (the reporter of the escape, occupiers of the premises etc.) on the specific circumstances and the details of gas installations including:
  - other persons who may be present
  - the layout of the property (for example detailed plans)
  - confined spaces
  - method of access, for example location of keys.

- Provide safety advice to occupiers and check that suspect areas have been ventilated (see Sub-Section 5.2). These may include cellars and other structures below ground level, voids, riser ducts and sub-divided properties.

Note 1: In particular, this is relevant for heavier than air gases. Although windows and doors need to be opened, opening a hatch or a door in a below-ground space may allow gas to flow into a space which could be difficult to ventilate. Suitable air moving equipment will assist in ventilating such areas before, during and after any repair of leaks.

Note 2: Do not enter confined spaces, for example cellars unless appropriate work arrangements are in place see Sub-Section 6.5.2.

5.3.1.2 *Evacuating affected properties*

Properties shall be evacuated if:

- the safety of any occupier(s) is/are at risk or
- any person has been overcome by gas or products of combustion or
- gas concentration exceeds 20% lower explosive limit (LEL).

Note: Gas flammability limits are detailed in Appendix 3.

Evacuation should be to a safe place and due consideration shall be given to the potential consequences of an explosion occurring, for example safe distances from blast overpressures, missile throw and the potential for gas to enter adjacent properties. Consideration shall also be given to the welfare of evacuees, including consultation with the local authority and community services. A record should be kept of where the evacuees have been sent.

5.3.1.3 *Evacuating properties surrounding the area affected*

Special considerations shall be given to suspected gas escape in properties such as flats, complex converted buildings and terraced houses (see clause 5.3.1.1)

and if these properties are to be evacuated, the principles outlined in clause 5.3.1.2 shall be adopted.

5.3.1.4 *Re-entering evacuated properties*

An evacuated property shall not be re-entered other than to carry out essential monitoring that does not involve any undue risk, until any source of gas escape has been prevented, secured or the natural ventilation has been shown to be sufficient to keep gas concentrations below the levels given in clause 5.3.1.2.

5.3.1.5 *Isolating electrical supply to evacuated or unoccupied premises*

The main electrical isolation switch shall only be operated if:

- gas concentration immediately above and below the switch does not exceed 70% LEL (see Appendix 3) and if it is in a safe condition and not obviously damaged
- evacuation is not delayed as a result.

5.3.1.6 *Avoiding other potential ignition sources*

Other potential sources of ignition shall be determined and, provided gas concentrations in the vicinity of the source exceed those given in 5.3.1.2 above, these actions should be considered:

- extinguish fires
- isolate electrical apparatus, such as freezers and refrigerators (if electricity has not already been isolated)
- avoid the use of battery operated equipment (see Sub-Section 6.3)
- avoid use of vehicles.

5.3.1.7 *Accessing locked or vacant (empty) or potentially unoccupied premises*

If there is reason to suspect gas/CO is accumulating/escaping in, or has passed into, an enclosed space, for example a building, that cannot be accessed immediately, a forced entry should be considered. This should cause the minimum of damage possible, ignoring intruder alarms. The Gas Safety (Rights of Entry) Regulations apply in these circumstances.

Note: It is desirable to have a witness, preferably a police officer, present when making a forced entry.

Where there are locked premises associated with the underground plant, such as sub-stations, these may need to be opened. The key holder should be contacted.

After entry to a property has been forced, the Police should be notified. The ESP should maintain site attendance until the property has been made secure or responsibility has been accepted by a third party e.g. a local authority or housing association.

A notification should be left in the property advising the owner / occupier of the reason for gaining access and the action taken to make the situation safe.

5.3.1.8 *Ventilation of underground plant*

Where gas is present in underground plant, the plant shall be ventilated and the gas dispersed as quickly as possible, after which the source of gas can be located and steps taken to prevent the gas entering the plant.

Note: The source of the gas entering the plant may be difficult to locate because the point of entry of gas into the plant may be distant from where the gas is actually detected.

In order to assist in reducing the concentration of gas in underground plant, in localising the affected area and in reducing the hazard, any pit covers, joint boxes and manholes shall be raised and other points of access opened. Utility ducts should not be broken without consulting the utility operator.

Such activities should be carried out using correct keys and lifting equipment and exercising care to avoid creating sparks, damaging frames and covers, exposing the underground plant and leaving such plant unprotected.

Note: Special consideration is advised when ventilating heavier than air gases especially if the gas is likely to accumulate elsewhere in the building.

5.3.1.9 *Localising escapes of gas into underground plant*

Once the plant chambers etc. have been ventilated, tests shall be carried out at each duct line in turn to establish the route by which gas is entering the enclosure.

Similar tests shall then be carried out, after ventilation, in other chambers etc. where gas was detected, until the approximate location of the gas entry point is established, for example between two manholes.

Numerous channels/ducts may be available for gas migration from a source of leakage to a potential source of ignition. The existence of such channels/ducts may be extremely difficult to identify by visual means and, hence, where possible consultation between plant and building owners and gas operatives shall be undertaken.

5.3.1.10 *Pinpointing escapes of gas into underground plant*

Having localised an escape, techniques shall be used, for example along lines of ducts and gas pipes (if piped gas is the source of gas) to pinpoint the escape.

Note: Where practicable a duct probe may be used to locate any points of gas ingress into ducts between manholes.

5.3.1.11 *Protection of openings to underground plant*

Where covers are opened, precautions shall be taken to prevent unauthorised interference with underground plant and to protect pedestrians and vehicular traffic from any dangers created by opening the covers (see Sub-Section 6.2).

Openings shall be adequately protected. If appropriate, the owner of the underground plant or the relevant authorities should be advised of the actions taken in respect of protection of openings.

5.3.1.12 *Diversion of traffic and pedestrians*

If necessary, traffic and pedestrians shall be diverted away from the area of the reported gas escape.

5.3.1.13 *Monitoring gas concentrations in the vicinity of an escape*

Having due regard for other priorities and associated risks, gas concentrations shall be measured at regular intervals (for example every 15 minutes may be appropriate) in affected and adjacent properties. The readings shall be recorded along with their location and the times when they were taken.

Note 1: Consider where gas can travel and build up, checking points of ingress, ducts, services and voids.

Note 2: Frequency of measurements is to be determined by the complexity of the situation and be reviewed as the escape progresses.

5.3.2 Persons responsible for premises

Whenever any of the actions outlined in Sub-Section 5.3.1 need to be taken, and if any delay can be accommodated without compromising the principles outlined in Sub-Section 5.1, they should be taken in consultation with persons responsible for premises and plant as appropriate, for example works engineers of commercial or industrial premises.

Note: Isolation of gas supply may have a significant effect on the operations on the site, for example in a hospital.

5.3.3 Contact with ESP line manager/operations centre

5.3.3.1 Measures shall be readily available to establish contact with the line manager/operations centre during the actions on site.

5.3.3.2 If the situation on site demands additional assistance, it shall be requested without delay.

5.3.3.3 Regular contact shall be made with the line manager/operations centre.

5.3.3.4 The line manager/operations centre shall be advised in the event of any of the following:

- an explosion, fire, asphyxiation, poisoning or injury to persons
- an evacuation
- substantial escape of gas, for example through fractures of a pipe of operating pressure (OP) exceeding 75 mbar
- involvement of outside agencies, for example other emergency services, government inspectorate and HSE
- where the source of an escape has not been located within two hours of arrival, an assessment should be made whether further assistance is required
- if circumstances on site become more complex.

In the event of any of the above, and if appropriate, arrangements should be made, by the line manager/operations centre, for further assistance to be made available on site.

5.4 MEASURING AND MONITORING GAS CONCENTRATIONS

5.4.1 Instrumentation

5.4.1.1 This Standard sets out requirements which depend upon the availability and correct use of calibrated instruments that shall be capable of:

- detecting the presence of flammable gas and/or
- measuring the atmospheric concentration of the flammable gas involved.

Note: When testing for the presence of gas, it may be considered sufficient to use an instrument designed for use on one gas when another gas is expected to be found, that is although the level indicated may be inaccurate, it is the detection of presence of a gas that is important. However, when measuring the level of concentration of gas, the instrument's ability to provide an accurate reading becomes more relevant.

5.4.1.2 Any instrument should be maintained as specified by the manufacturer.

5.4.1.3 Where there is any doubt about the type of gas contained in the vicinity, or if there could be gases of more than one family present (see Appendix 3), additional instrumentation should be used and additional monitoring should be carried out if appropriate.

5.4.2 Monitoring gas concentrations in enclosed spaces

5.4.2.1 The probe of the instrument shall be positioned to sample the potentially highest concentration of gas, where safe and practicable to do so.

5.4.2.2 For a lighter than air gas, samples shall be taken at varying heights, but paying particular attention to positions where the gas is likely to accumulate, for example at a high level in enclosed space such as rooms, chambers, cellars, under floors and in roof spaces. In addition, consider the possibility of voids and sealed compartments within the enclosed spaces (see Sub-Section 5.3.1.1).

5.4.2.3 For a heavier than air gas, samples shall be taken at varying heights, but paying particular attention to positions where the gas is likely to accumulate, for example at a low level outside and in rooms, cellars, under floors and in ducts. Consider the possibility of voids and sealed compartments (see Sub-Section 5.3.1.1).

Note: The above gives broad guidance which will be accurate for the majority of gases likely to be encountered. For example, Natural Gas tends to rise and LPG tends to fall. However, there may be installations, or situations, where the gas has unusual constituents and whose relative density is close to that of air (see Appendix 3).

5.4.2.4 When measuring gas concentrations through an opening, such as a window or letterbox, into a building, the probe should be pointed upwards to detect lighter than air gas and downwards when expecting to detect heavier than air gas.

5.4.2.5 Any entry by a competent person into an underground chamber shall be subject to a safe system of work, and should have the permission of the owner of the plant, where possible.

Note: The Confined Spaces Regulations and associated Code of Practice provide further information.

5.4.2.6 Where gas is not detected, consideration shall be given (by a responsible person) to further action and a second method of detection, for example by using an alternative, or more sensitive instrument.

When the conclusion to any investigation is that gas has not been detected, the owner of the plant/property should be advised, if appropriate.

5.4.3 Monitoring gas concentrations in open air situations

Due regard shall be taken of the potential migration of gas from the source of escape due to the presence of underground plant, for example ducts.

Note: In the open air, a source of a lighter than air gas will be difficult to detect at anything above ground level. A heavier than air gas will be detected at ground level. The Note to clause 5.4.2.3 is particularly relevant to such as landfill sites where the relative density of gas can vary between considerably lighter than air to considerably heavier than air. If the relative density is close to that of air, special care is needed to ensure that atmospheres at all heights are checked.

5.5 REPAIRING THE SOURCE OF ESCAPES OF GAS

5.5.1 If gas is present due to an escape from a contained system, for example a pipeline, suitable repairs shall be undertaken, after which further tests shall be carried out to confirm that there is no other source of gas escape.

5.5.2 If gas is present due to migration from other than a contained system, for example from a landfill site, which may cause greater difficulty in pinpointing the source of gas, further action shall be taken to prevent the gas entering enclosed spaces. Advice on appropriate action should be sought by contacting the owner/operator of the relevant site.

Note 1: The following publications may assist:

- *Environment Agency Guide LFTGN 03*
- *Chartered Institution of Wastes Management – Monitoring of Landfill Gas.*

Note 2: Appropriate actions may include capping of the source, sinking of boreholes and permanent ventilation of shafts etc.

5.6 UNODORISED GAS

None of the foregoing discusses the use of the sense of smell to help pinpoint sources of escapes. Although this natural ability will assist, reliance shall not be put on the sense of smell to conclude that an area does not contain gas.

Note: In the vast majority of cases, gas will have a distinctive smell. However, it is possible that the gas will not be odorised. For example, Natural Gas at a pressure exceeding 7 bar upstream of a district pressure regulating installation (PRI), at some power stations and on some large industrial sites, may be unodorised as may biogas production facilities and LPG used for special processes such as in the food industry.

5.7 PRODUCTS OF COMBUSTION

A smell of fumes indicates spillage or leakage of combustion products which may contain CO or other potentially hazardous substances.

If it is suspected that spillage or leakage of combustion products is taking place, action must be taken in line with the requirements of GS(M)R and IGEM/G/11 (GIUSP). The requirements of RIDDOR for reporting an incident and GS(I&U)R/GS(M)R for investigation and reporting responsibilities must be observed.

Owners of such appliances must be advised of the need to have the appliances checked by a Class of Persons (that is Gas Safe registered) as defined in GS(I&U)R (see clause 3.3.4.5).

5.8 LEAVING SITE

5.8.1 The decision to leave the site of a gas escape shall be determined by a number of factors, the overriding one being the safety of the public and employees.

The ESP shall be informed when the competent person is leaving the site of a gas escape.

5.8.2 The decision to leave site shall be taken by the competent person when:

- no trace of gas has been detected
- the gas escape has been secured and investigations show that the site is clear of gas
- following repair of the escape, the gas concentration in any room, cellar, wall cavity or any other enclosed space which has been tested as part of the normal investigation is less than 5% LEL and falling, provided that this is achieved by natural ventilation rather than by air moving devices
- initial site investigations indicate that an uncontrolled escape is considered not to be immediately hazardous and future work is to be carried out in accordance with requirements for programming of escape work, or they are relieved on site by another ESP or other competent person who will become responsible for the site.

5.9 FURTHER ACTIONS AND RESPONSIBILITIES

5.9.1 If initial site investigations indicate that an uncontrolled escape is not potentially hazardous i.e. where "Immediate Action" is not required to locate and secure an escape on the Network, it can be programmed for subsequent remedial activity (see clause 3.3.5.3).

Escapes shall be programmed and prioritised for action in accordance with the calculated risk which is based on the following elements:

- mains – material, size, pressure and proximity to property
- buildings – cellars, modified, converted and the number of people
- ducts – whether gas is present in ducts
- ground conditions – whether ground is sealed or open
- types of gas, 3rd party networks.

Programming of repair work shall also take into account the social and environmental considerations including: Excessive traffic and potential congestion, noise during late evening/early morning, pedestrian access/egress to offices/public buildings, access by the emergency services etc. and extreme weather conditions, flooding, snow, landslip etc.

A system shall be in place to monitor, on a daily basis, all gas escapes which have been programmed for further action e.g. a daily desktop check to review the prioritization of further action.

5.9.2 The interests of other emergency services, the highway authority and members of the public shall also be taken into consideration.

As a result of these considerations, it may be decided to programme further action as a priority within normal work schedules, when the most appropriate and effective location and repair techniques, as recognised by the industry, can be used. In this case, arrangements shall be made to monitor site conditions at suitable intervals. A record of all site visits and findings shall be maintained until the escape is secured.

Records must be retained in line with the General Data Protection Regulation (GDPR) requirements.

5.9.3 Following the completion of a repair of a gas escape, where there are significant amounts of residual gas in the ground, the site shall be monitored at suitable intervals until the site is cleared and a record made of the action taken.

5.9.4 Where gas supplies have been interrupted, arrangements shall be made to restore the gas supply safely (see IGE/UP/1, IGE/UP/1A, IGEM/UP/1B, IGEM/UP/1C, IGEM/GL/9 and UKLPG Code of Practice 22 as appropriate).

SECTION 6 : SAFE WORKING PRACTICES

6.1 MIGRATION OF GASES

Numerous channels/ducts may be available for gas migration from a source of escape to a potential source of ignition. The existence of such channels/ducts may be extremely difficult to identify by visual means and there should be effective consultation between the Utility Operator and ESP.

Underground plant into which gas can migrate includes:

- telecommunications networks
- electricity networks
- sewage systems
- water and drainage pipes
- service tunnels
- railway installations.

Gases can migrate considerable distances and the following characteristics shall be taken into account:

- **Natural Gas**

  Natural Gas (and similar lighter than air gases) which has escaped from buried pipes will follow the easiest path to the ground surface. This could include the gas travelling a considerable distance before surfacing, for example via a drain near to the source of leaking gas, along the line of the buried pipe etc. For sealed surfaces such as roads and footpaths, and during inclement weather when surfaces are very wet or frozen, gas can migrate and enter property, voids and/or underground plant.

- **LPG**

  LPG vapours, being heavier than air, do not disperse easily and will follow the ground contours to flow along natural paths and fill depressions and ditches etc.

  Gas escapes from buried pipelines may be detected above ground level. However, because it is heavier than air, it is possible for escaping LPG to enter into underground voids and ducts.

  Liquid leaks, because of the potentially high volume discharge, are a much greater potential hazard than vapour leaks. Where large volumes of liquid are suddenly discharged from a container, the released liquid/gas will cool any material with which it comes in contact since vaporisation will occur immediately. The liquid gas will flow across the ground until it has absorbed sufficient heat for vaporisation. During this process, very large volumes of vapour will be released. Vapours may be seen as a light mist above ground which will gradually become invisible as the temperature of the mist rises to that of the surrounding atmosphere.

- **Landfill gas (biomethane, biogases) and mine gas**

  The level of migration will depend on a number of factors, including the geological characteristics of the area and man-made features such as mine shafts, drains and ducting.

Gas migration can result in gas reaching the surface some distance from the site. For example, where there are no site-based gas control measures, gas can migrate laterally for hundreds of metres.

The quantity generated in landfill gas is dependent mainly on the level of microbial activity and the permeability of the surrounding material, but can be affected by changes in atmospheric pressure and the water table level outside the site.

When collected and piped outside the site boundaries, any gas escaping from these systems will migrate according to the criteria for Natural Gas as appropriate.

Where mine gas is suspected to be the cause, contact The Coal Authority 01623 646333.

6.2 SAFETY OF PEOPLE

6.2.1 Safety of people (the general public and all involved in dealing with gas escapes) shall be the main priority. Appropriate PPE (see Sub-Section 3.3.11), for example, protective clothing and safety equipment, shall be provided and used as required by those dealing with the gas escape. Additional protective equipment such as breathing apparatus and personal atmosphere monitors should be provided as appropriate.

6.2.2 Attention shall be given to the risk of cold burns associated with leaks of liquefied gas.

6.2.3 Consideration shall be given to establishing appropriate exclusion zones, which shall be conservative at the start of the investigation.

6.2.4 Whenever there is a substantial escape of gas which cannot be reduced without risk to personal safety, further assistance shall be sought (see clause 5.3.3.4). The site, including the exclusion zone shall be monitored and appropriate action taken to minimise the potential hazard.

6.2.5 The following precautions shall be taken when opening and ventilating underground ducts, manholes, boxes etc:

- use of safe lifting techniques and equipment when moving heavy underground plant covers, to avoid injury to personnel
- suitable signs, fences and lighting to safeguard the public, particularly with regard to traffic management, vehicular and pedestrian access, to be provided to comply with the relevant Legislation and Codes of Practice (see Appendix 2).

6.2.6 If when attending a reported smell of gas, a terror attack, suicide or attempted suicide is suspected, inform the emergency service immediately.

6.3 SOURCES OF IGNITION

6.3.1 Potential sources of ignition within the affected area (exclusion zone) shall be identified and, where possible and safe to do so, isolated or removed. If this is not possible, monitor the atmosphere and carry out a continuous hazard assessment to account for changes in site circumstances.

If the level of gas concentration in atmosphere is above the LEL (see Appendix 3), then provisions shall be made to reduce the levels and consideration shall be given to reducing gas pressures to enable safer working conditions.

When dealing with a large/high volume gas escape, assess the proximity of people i.e. site personnel, passers-by, occupants of buildings, places of public assembly, etc. taking account of the potential ignition of the gas and apply an appropriate extended exclusion zone.

6.3.2 When excavating on gas escapes where the pipe is known (or suspected) to be PE, consideration shall be given to the possibility that the escape has been caused by a faulty electrical cable.

Factors to consider are:

- loss of electricity supplies or intermittent supply in the area
- burning or arcing smell
- cracking or popping noise
- heat on the surface or in the excavation
- visible signs of electrical arcing.

When excavation work begins, oxygen is able to reach the area and ignition will likely occur.

6.3.3 The use of cable detection equipment in all modes shall be undertaken to indicate the presence of the cable.

Note: Faulty electric cables can also be the cause of failure of metal pipe.

6.3.4 Where a damaged or faulty cable is suspected, the Electricity Network Operator shall be contacted to isolate the cable before any further work is undertaken. Confirmation of isolation of the cable should be made by a competent person, e.g. a representative of the cable operator/owner.

6.3.5 The proximity of above ground sources of ignition shall be considered, for example fires and overhead power cables.

6.3.6 Only suitable tools and equipment provided for use in potentially gaseous atmospheres shall be used. This may include the provision of intrinsically safe equipment if appropriate. Non-intrinsically safe equipment may be used, but such equipment shall not be used inside buildings unless, prior to its introduction, certified equipment is used to establish that the concentration is less than 20% LEL and is not rising.

6.3.7 The risks associated with the use of electrical equipment shall be understood and appropriately mitigated whilst any potentially gaseous atmosphere exists.

6.3.8 The source of power for floodlights and any other equipment likely to cause ignition shall be placed outside the area affected (exclusion zone) by escaping gas. For LPG escapes, this distance may be much greater than for Natural Gas escapes. The atmosphere should be monitored and recorded regularly. Reassess the affected area and reposition ignition sources and essential equipment as required.

6.3.9 The wind direction should be monitored to ensure that persons and ignition sources are sited up-wind of the gas escape and gaseous atmosphere.

6.3.10 Appropriate fencing and/or warning signs and barriers shall be erected to prevent public entry or to warn the public of the actual or potential problem, including "No smoking" and/or "No naked lights" signs posted at the extremities of the affected area.

6.3.11 Sufficient static charge to cause a spark that could ignite gas can be built up on plastic pipe by handling and cleaning. The flow of dusty gas will also generate

static charges on the internal surface of PE pipe and, although it is generally considered non-conducting, the charge can be transferred through the pipe wall to create high potential on the outside surface.

6.4 LIVE GAS WORKING

6.4.1 Where reasonably practicable, the gas escape shall be isolated remotely e.g. close fire valve, close above ground entry or squeeze off etc. Isolating the source of leakage may require the use of a bypass or reconfiguring the network where possible.

Consideration shall be given to both the risks to employees/members of the public from a gas escape and to the potential impact on gas supply when determining whether it is reasonably practicable to isolate the source of leakage.

6.4.2 There are circumstances when it is necessary to carry out work in flammable gaseous, or potentially flammable gaseous atmospheres. Precautions shall be taken to minimise the associated risks identified above, for example:

• electrocution	use voltsticks and cable locators
• asphyxiation	use of respiratory protective equipment (RPE), atmosphere monitoring, first aid training and resuscitation and due consideration of the Confined Spaces Regulations (see clause 3.3.1)
• fire	control of ignition sources, provision of fire extinguishers (dry powder), fire suits, flame retardant PPE, electrical continuity bonds
• thermal hazard	use of thermal hazard chart/modelling software
• slip trips and falls	removal of minor hazards from the work area
• obstructions	ensure safe access and egress
• high volume gas escape	reduce volume of escaping gas
• ground conditions	appropriate protective devices, for example trench supports, water removal equipment
• entry into cellars	cellars may be classified as confined spaces. Prior to entering a cellar, consideration shall be given to: • access and egress and their protection • gas concentration (NG, CO, Carbon Dioxide (CO_2), Oxygen (O_2) etc.) • lighting (see Sub-Section 6.3).

6.4.3 In addition, the following precautions shall be taken:

- not wearing spark-creating footwear
- clothing, not to be removed or put on/near gas that is escaping or venting
- prior to cutting metal or PE pipe, firmly fixing continuity bonds to a brightly cleaned surface. It may be necessary to utilise an earth pin for additional safety. It may also be necessary for cathodic protection (CP) impressed current systems to be isolated
- reducing the generation of static and sparks from tools being used in the work by adequate wetting of the work area and the use of spark reducing tools (special provisions may apply in very cold weather as water will freeze).

Breathing apparatus shall be available on site, ready for use and, where circumstances require, it shall be used in accordance with established procedures (see HSG53).

6.4.4 The extent of landfill sites shall be studied so that the necessary precautions can be taken when considering what work may be carried out on site (see Section 8). These considerations shall be taken into account when monitoring and pumping equipment is to be used.

6.4.5 Due account shall be taken of IGEM/SR/18 (see Appendix 2) when working in the vicinity of gas pipelines and gas installations.

6.5 UNDERGROUND PLANT

6.5.1 Avoiding dangers from underground plant

Detailed guidance is available in HSG47 (also see Appendix 4).

6.5.1.1 Any underground plant such as cables, water mains and sewers, can be damaged during excavation or other work involving ground penetration, with personnel injured as a result. In order to protect personnel, plant and equipment, safe systems of work shall be adopted and all concerned shall be competent in procedures and use of equipment.

6.5.1.2 Personnel shall be trained and competent in safe use of any equipment used such as rock drills, percussion searcher bars, hand held probes, pipe and cable locators.

6.5.1.3 Equipment shall be of an approved type and be used in accordance with manufacturer's instructions.

6.5.1.4 Suitable personal protective equipment shall be provided to personnel carrying out ground penetration activities.

6.5.1.5 Underground services are widespread and it shall be assumed that they are present until it is proved otherwise. Therefore, excavation should be carried out as though there were underground services in the vicinity and account should be taken of visual indications, for example street lighting, chamber covers, reinstatement scars and marker posts that such underground services exist. If possible, plans or other suitable information about all underground plant in the area should be obtained including use of "one call systems" before excavation work starts.

6.5.1.6 Suitable pipe and cable locating devices shall be used in all modes, in conjunction with available plans, to determine, as accurately as possible, the position of the underground services in or near the proposed work area.

6.5.1.7 Any excavation work or barholing shall be carried out carefully and following recognised safe practices.

6.5.1.8 The underground plant may already be damaged and awareness of the risks from high pressure pipelines and high voltage cables shall be considered.

6.5.2 Working in enclosed spaces/chambers

6.5.2.1 The requirements of the Confined Spaces Regulations and the associated Code of Practice (L101) must be complied with where applicable.

6.5.2.2 Where the level of gas present in the enclosed space is less than 20% LEL and not rising, an entry may be made but it shall be subject to the following conditions:

- appropriate safety equipment (in particular, breathing apparatus) is available and ready for use
- a second operative is present in a proven safe area and able to assist or, if assistance is not practicable, able to summon additional assistance

- all operatives are competent in the basic skills of first aid and resuscitation
- the level of gas within the enclosed space is monitored at regular intervals. If the concentration rises above 20% LEL, all personnel shall leave. If subsequent attempts to reduce the concentration fail, appropriate action should be taken.

6.5.2.3 The presence of harmful substances other than flammable gas e.g. carbon monoxide (CO) and hydrogen sulphide shall be considered before entering enclosed/confined spaces.

6.5.2.4 For a confined space, that is one that encloses an area where means of access and egress are restricted thus presenting a high degree of difficulty in rescuing disabled persons, the Confined Spaces Regulations must be complied with where applicable.

SECTION 7 : GAS ESCAPES FROM NON-GAS TRANSPORTER NETWORKS

7.1 SAFEGUARDING LIFE AND PROPERTY

Where a site investigation shows that gas is being transported by a party to which the ESP is not contracted, under GS(M)R the latter must continue to provide the service (see Sub-Section 5.1) until such time as the appropriate party assumes responsibility. This principle should be applied for all situations, including those not covered by GS(M)R.

7.2 NOTIFICATION TO THIRD PARTIES

Any ESP shall have procedures in place to notify the party responsible for dealing with the escaping gas. These should include:

- any other GT/gas conveyor which has a different ESP
- the local authority (for naturally-occurring gas)
- other responsible authorities, for example industrial process plant or mine owner
- other parties, for example owners of landfill sites.

7.3 IDENTIFICATION OF GASES

7.3.1 It shall be noted that the following installations and situations may contain gases that have a smell similar to that of piped and odorised 2nd and 3rd family gases as transported and supplied under the Gas Act:

- refineries and other manufacturing processors, for example coke oven gas or animal by-product works, sewage treatment or sewerage works etc.
- hydrocarbon product pipelines
- existing or former mine workings
- landfill gas sites
- rotting vegetation, refuse, or farm slurry
- newly treated wood
- vapours from liquid fuels, for example at bus stations or petrol filling stations
- vent pipes from sewers
- biogas
- biomethane
- hydrogen trial projects.

Note: Gas from such sources may, or may not, result in a reading on gas detection equipment. This emphasises the need to exercise care in selecting instruments (see Sub-Section 5.4).

7.3.2 The ESP should have suitable arrangements for sampling and analysing escaping gas to identify its source and composition.

7.3.3 If it is reasonably certain that another party is responsible for dealing with the gas escape, the competent person should advise the operations centre without delay.

The operations centre shall advise the other party, or its known gas emergency provider, of such a report, as soon as is reasonably practical.

SECTION 8 : LANDFILL BIOGAS

8.1 The following properties and characteristics of landfill sites shall be considered.

8.1.1 The gas produced from a landfill site can be either heavier or lighter than air, depending on its composition (see Appendix 3). Gas may accumulate in properties having service ducts, basements, underfloor cavities and in cupboards, or in spaces under manholes, cable chambers, soakaways, settlement cavities, drains and sewers.

8.1.2 The composition of landfill gas can change over time. Initially, H_2 entrapped in waste is replaced by CO_2 (up to 80% by volume) and hydrogen (up to 20% by volume). Typically, some 6 to 12 months after deposition, methane starts to form in increasing proportions until it eventually constitutes about 65% of the landfill gas generated, the remainder being predominantly CO_2. These proportions could remain stable for many years.

8.1.3 The main problems associated with landfill gas include:

- build-up of flammable mixtures
- asphyxiation
- toxic effects of certain constituents, for example hydrogen sulphide (H_2S) and CO
- damage to vegetation and crops
- odour.

8.2 Prompt and accurate identification of escape sources shall be promoted. Operators of these gas sites and associated pipelines should notify local GT(s) with details of site locations; pipeline route, depth and diameter; the system pressure; gas composition and its characteristics.

8.3 Where the presence of landfill gas is suspected, additional care should be exercised due to the potential risks from its non-flammable characteristics, for example properties of CO_2.

8.4 Techniques to locate and quantify landfill biogas should include both high and low level search patterns (see clauses 5.4.1 and 5.4.2).

Note: The behaviour of the gas may be governed by the natural air flows and ventilation within a property.

8.5 It should be borne in mind that a wide variation in gas composition or mixtures is possible, leading to the risk of misinterpretation of readings. Although the range from upper explosive limit (UEL) to LEL can be calculated for any mixture concentration of landfill gas, this assumes a detailed knowledge of its composition. Specialist advice should be sought if required.

8.6 There are a number of different instruments for detecting and measuring landfill gas. Reference should be made to more specialised publications on landfill gas (see Appendix 2.5).

8.7 If it is suspected that landfill gas is present outside a landfill site's boundary, assistance shall be sought from the relevant operator and/or public health authorities. If landfill gas is affecting properties, a decision will have to be made about the need for evacuation. A detailed survey should be carried out to identify the gas and its source. If it is confirmed that landfill gas is the problem, measures may have to be taken to isolate the affected area. Measures to control the gas migration may need to be taken and gas monitoring equipment installed.

APPENDIX 1 : GLOSSARY, ACRONYMS AND ABBREVIATIONS, UNITS AND SYMBOLS

GLOSSARY

All other definitions are given in IGEM/G/4 which is freely available by downloading a printable version from IGEM's website, www.igem.org.uk.

Recommended and legacy gas metering arrangements are given in IGEM/G/1 which is freely available by downloading a printable version from IGEM's website, www.igem.org.uk.

controlled gas escape A gas escape that has been stopped by turning off the meter emergency control valve and confirming that the smell of gas has dissipated (usually attended within 2 hours).

uncontrolled gas escape A gas escape where it cannot be ascertained that the gas escape is controlled (usually attended within 1 hour).

natural ventilation Ventilation through an enclosed space where the flow of air is motivated by wind and/or buoyancy.

operations centre An organisation's facility for the management of reported gas emergencies received from the NGES.

ACRONYMS AND ABBREVIATIONS

AO	authorised officers
CNG	compressed Natural Gas
CO	carbon monoxide
COMAH	Control of Major Accident Hazards Regulations
CP	cathodic protection
CV	calorific value
ECV	emergency control valve
ELR	escape locate and repair
ESP	emergency service provider
GB	Great Britain
GDPR	General Data Protection Regulation
GIA	gas in air
GS(I&U)R	Gas Safety (Installation and Use) Regulations
GS(M)R	Gas Safety (Management) Regulations
GT	gas transporter
HSE	Health and Safety Executive
IGEM	Institution of Gas Engineers and Managers
LEL	lower explosive limit
LFL	lower flammability limit
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MHSWR	Management of Health & Safety at Work Regulations
NG	Natural Gas
NGES	National Gas Emergency Service
Ofgem	Office of Gas and Electricity Markets
OP	operating pressure
PE	polyethylene
PPE	personal protective equipment
PRI	pressure regulating installation
PSR	Pipelines Safety Regulations
PSSR	Pressure Systems Safety Regulations
PUWER	Provision and Use of Work Equipment Regulations
RPE	respiratory protective equipment
SG	specific gravity
TMA	Traffic Management Act

UEL	upper explosive limit
UK	United Kingdom.

UNITS

m	metre
m^3	cubic metre
mbar	millibar
MJ m^{-3}	megajoule per cubic metre
M s^{-1}	metre per second
°C	degree Celsius.

SYMBOLS

<	less than
≤	less than or equal to
≥	greater than or equal to
CH_4	methane
C_3H_8	propane
C_4H_{10}	butane
CO	carbon monoxide
CO_2	carbon dioxide
H_2	hydrogen
H_2S	hydrogen sulphide
N_2	nitrogen
%	percent.

APPENDIX 2 : REFERENCES

A2.1 LEGISLATION (GENERAL)

- Control of Pollution (Amendment) Act 1989
- Environmental Protection Act 1990
- Factories Act 1961
- Gas Act 1995
- Health and Safety at Work etc. Act 1974
- New Roads and Street Works Act 1991
- Offices, Shops and Railway Premises Act 1963
- Oil and Pipelines Act 1985
- Water Resources Act 1991
- Confined Spaces Regulations 1997
- Construction (Design and Management) Regulations 2015
- Control of Lead at Work Regulations 2002
- Control of Major Accident Hazards Regulations 2015
- Control of Pollution (Licensing of Waste Disposal) (Amendment) Regulations 1977
- Control of Substances Hazardous to Health Regulations 2002, as amended 2004
- Electricity at Work Regulations 1989
- Gas Safety (Installation and Use) (Amendment) Regulations 2018
- Gas Safety (Management) (Amendment) Regulations 2023
- Gas Safety (Rights of Entry) Regulations 1996
- Health and Safety (Emissions into Atmosphere) Regulations 1989
- Health and Safety (First Aid) Regulations 1981
- Health and Safety (Safety Signs and Signals) Regulations 1996
- Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972
- Ionising Radiations Regulations 2017
- Lifting Operations and Lifting Equipment Regulations 1998
- Management of Health and Safety at Work (Amendment) Regulations 2006
- Manual Handling Operations Regulations 1992
- Control of Noise at Work Regulations 2005
- Personal Protective Equipment Regulations 2002
- Pipelines Safety Regulations 1996 (as amended 2003)
- Provision and Use of Work Equipment Regulations 1998
- Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013
- Special Waste Regulations 1996
- Traffic Signs Manual, Chapter 8 Traffic Safety Measures and Signs for Road Works and Temporary Situations 1991
- Traffic Signs Regulations and General Directions 2016.

A2.2 HSE APPROVED CODES OF PRACTICE AND GUIDANCE

- HSEH40 Workplace exposure limits
- HSG47 Avoiding danger from underground services
- HSG48 Reducing error and influencing behaviour

- HSG53 Respiration protective equipment at work. A practical guide
- HSG65 Successful Health and Safety Management
- HSG150 Health and Safety in Construction
- HSG151 Protecting the public – your next move
- L5 COSHH Approved Code of Practice and guidance
- L56 Safety in the installation and use of gas systems and appliances. Approved code of practice and guidance
- INDG453 Guide to RIDDOR
- L80 Guide to Gas Safety (Management) Regulations
- L82 Guide to Pipeline Safety Regulations
- L101 Safe work in confined spaces. Approved code of practice
- L143 Work with materials containing asbestos. Approved code of practice and guidance
- MDHS Series Methods for the determination of hazardous substances in air
- HSE Website Deferred repairs to public reported gas escapes.

A2.3 **IGEM**

- IGEM/G/1 Edition 2 Defining the end of the network
- IGE/SR/18 Edition 2 Safe working in the vicinity of gas pipelines
- IGEM/GL/4 Edition 3 Gas system assets – risk management
- IGEM/GL/6 Edition 3 Permitry for the safe flow of gas
- IGEM/GL/8 Edition 3 Reporting and investigation of gas-related incidents
- IGEM/G/11 Gas Industry Unsafe Situations Procedure
- IGEM/G/14 Competency framework
- IGEM/GM/7B Edition 2 Hazardous area classification for gas metering equipment
- IGEM/SR/25 Edition 2 Hazardous area classification of Natural Gas installations
- IGE/UP/1 Edition 2 Strength testing, tightness testing and direct purging of industrial and commercial gas installations
- IGE/UP/1A Edition 2 Strength and tightness testing and direct purging of small low pressure industrial and commercial Natural Gas installations
- IGEM/UP/1B Edition 3 Tightness testing and direct purging of small Liquefied Petroleum Gas/Air, Natural Gas and Liquefied Petroleum Gas installations
- IGEM/UP/1C Strength testing, tightness testing and direct purging of Natural Gas and LPG meter installations
- IGEM/UP/16 Design for Natural Gas installations on industrial and commercial premises with respect to hazardous area classification and preparation of risk assessments.

A2.4 **Liquid Gas UK**

- LGUK CoP 1 Bulk LPG Storage at Fixed Installations
- LGUK CoP 3 Recommendations for Prevention and Control of Fire Involving LPG
- LGUK CoP 7 Storage of Full and Empty LPG Cylinders and Cartridges
- LGUK CoP 20 Liquid LPG Dispensing Facilities
- LGUK CoP 22 Design, Installation and Testing of LPG Piping Systems
- LGUK CoP 25 LPG Central Storage and Distribution Infrastructure for Multiple Consumers
- LGUK CoP 27 The Carriage of LPG Cylinders by Road & Hazard Information Labelling Requirements
- LGUK CoP 33 Use of LPG Cylinders
- LGUK GN3 A Guide to the preparation of Major Accident Prevention Policies (MAPP's)

The documents listed above can be found at www.liquidgasuk.org

A2.5 **MISCELLANEOUS**

- Department of the Environment – Waste management papers
  - Environment Agency Guide LFTGN 03
  - Chartered Institution of Wastes Management – Monitoring of Landfill Gas.
- Her Majesty's Inspectorate of Pollution
  - Waste management paper No 27 – The control of landfill gas (1989)
- Institute of Wastes Management – Monitoring of landfill gas (1990).

APPENDIX 3 : RELEVANT PROPERTIES OF GASES

This Appendix deals primarily with Natural Gas (a 2nd family gas) and LPG (a 3rd family gas) which are the most likely to be involved in reported gas escapes. Some attention is given to landfill gas.

A3.1 BASIC PROPERTIES

BASIC PROPERTY	METHANE (NATURAL GAS)	PROPANE (LPG)	BUTANE (LPG)
Chemical formula	CH_4	C_3H_8	C_4H_{10}
Relative density (air = 1)	0.6	1.5	2.0
Ignition temperature (°C)	704	530	372
Boiling point (°C)	-160	-40	-2

TABLE 1 - PROPERTIES OF COMMERCIAL METHANE, PROPANE AND BUTANE - A BROAD GUIDE

COMPONENT	% VOLUME
CH_4	$\geq 60 \leq 65$
CO_2	$\geq 30 \leq 35$
O_2	< 0.2
N_2	$\geq 2 \leq 2.5$
H	< 0.1
CO	< 0.0001
H_2S	< 0.00002

TABLE 2 - COMPOSITION OF LANDFILL GAS IN THE PSEUDO STEADY STATE - A BROAD GUIDE

A3.1.1 Natural Gas

- an asphyxiant and is flammable
- no characteristic odour (but normally is odorised unless source is from NTS network)
- lighter than air
- disperses upwards
- migrates through the ground and along ducts for considerable distances horizontally.

A3.1.2 LPG

- an asphyxiant and is flammable
- normally stored as liquid under pressure but will vaporise at ambient temperature and atmospheric pressure
- escapes can be liquid or vapour from liquid storage containers or vapour from piped gas system
- no characteristic odour (but is normally odorised)
- evaporation of liquid causes a cooling effect on surroundings, visible as frosting at the point of release
- heavier than air
- flows along ground, into drains, and can be ignited at a considerable distance from the point of release
- can accumulate to high concentrations in excavations or depressions
- vapour disperses slowly in still air.

A3.1.3 **Landfill gas**

- mixture of asphyxiants and toxic gases and is flammable
- major constituents are CH_4 and CO_2
- both CH_4 and CO_2 are colourless and odourless
- other constituents may have an odour
- smell, if any, is not readily identifiable or consistent
- usually saturated with moisture
- relative density varies but usually approximates to that of air
- migration from sites can have environmental consequences ranging from nuisance to injury to persons and damage to property
- little risk of explosion in open spaces but danger of flash fires where air movement is poor.

A3.1.4

A3.1.5 **Mains gas-operating pressure Guernsey/Jersey**

Because of frictional resistance in the gas pipework between the meter and appliance, the meter regulator is set to provide an operating pressure slightly above the optimum pressure. It is adjusted and sealed by the gas supplier to provide an operating pressure at the meter outlet of 14 mbar ± 2 mbar (low pressure). This is often reduced further at the appliance to provide the required pressure at the burner. On Guernsey and Jersey, there is a possible drop of 2 mbar allowable on an existing installation of 2 mbar so the lowest pressure seen at the inlet of an appliance could be 10 mbar the maximum up to 16 mbar.

A3.1.6 **Explosive mixtures**

Generally, gas will only burn if mixed in correct proportions with air. The percentage of gas to air needs to be 2-10% for LPG/Air (mains gas) and propane and 2-9% for butane for combustion to take place.

Note: The ignition temperature of mains gas would depend on whether propane or butane is being used, then the approximate ignition temperature will apply, propane ignites at about 530°C and butane ignites at about 408°C.

A3.2 **FLAMMABILITY**

The major hazard from the gases is flammability (although the potential toxicity of gases containing carbon monoxide, hydrogen sulphide etc. is also important).

The gases can either burn or explode, depending on the flammable limits, the gas/air ratio and the degree of confinement. If ignition occurs in a confined location, significant pressures can be generated resulting in structural damage.

GAS OR VAPOUR	LFL (%) GAS IN AIR
Carbon Monoxide	12.3
Methane	4.9
Natural Gas	5
Biomethane	4.5
Gasoline vapour	1.0
Propane (LPG)	2.0
Butane (LPG)	1.5
Coal gas	5.0

TABLE 3 - LOWER FLAMMABLE LIMITS OF GASES (IN COMMERCIALLY AVAILABLE STATE)

Note: LFL (Lower Flammable Limit) is the term generally used in standards when describing the hazards associated with gas, however, LEL (Lower Explosive Limit) is used throughout this Standard as it is the term most commonly used to determine action levels on site e.g. evacuation criteria when investigating gas escapes. The values of LFL and LEL are the same.

Note 2: The actual LFL for NG is variable and can be as low as 4.5%, but the figure of 5% is universally used.

APPENDIX 4 : DESCRIPTION OF UNDERGROUND PLANT

This Appendix provides guidance on the numerous routes available for gas to migrate, for example from a source of escape to a source of potential ignition or atmosphere. In many cases, it is difficult to recognise the existence of these routes by simple visual means and this reinforces the need for effective consultation between the parties involved. In addition, a wide range of materials and conduits may have been used to facilitate the laying of the different types of underground plant thus there is a need to determine the particular plant encountered.

Determining the ownership of such plant may be complex. Assistance is available by reference to IGEM/SR/18.

A4.1 UNDERGROUND GAS PIPES

A4.1.1 Gas transmission systems

- usually located in rural areas
- typically steel (protected, for example by coating/wrapping with coal tar, bitumen, epoxy resin, PE, often also with cathodic protection systems)
- reinforced thermoplastic pipelines may be present
- usually have above-ground markers and aerial survey posts
- often indicated by valve boxes, marker posts and CP test points.

A4.1.2 Gas distribution systems

- usually located in urban areas in carriageways or adjacent footways/verges. Also laid in dedicated service strips on newer estates
- usually of steel, cast iron, ductile iron or PE
- ductile iron pipe is sometimes wrapped in polythene sleeving
- PE pipe may be inserted in redundant metallic pipes or dedicated ducting
- often located by valve boxes, CP test points and may have visible markers in special locations such as bridge crossings
- if laid in reduced cover may be protected by a steel plate or other physical barrier
- usually, PE pipe is laid in a selected fill surround and has a coloured marker tape above it, but where laid by trenchless techniques this marker tape will be absent.

A4.1.3 Gas services

- connect the distribution system to the users system/meter
- steel or PE, but may occasionally be of copper or lead pipe PE (and copper). PE pipe may be inserted in redundant metallic pipes PE pipe may be enclosed in convoluted ducting close to property and may be of corrugated PE construction.

A4.1.4 Gas installation pipes

- connect the meter to points of use of gas
- pressures vary – commercial and industrial premises may contain high pressure in gas pipework
- steel, copper or lead in buildings
- steel, copper, lead or PE outside buildings.

A4.1.5 Jointing

- transmission systems – welded, flanged

- distribution mains/services – welded, screwed, flanged, electrofused, butt fused etc.
- installation pipe – welded, screwed, flanged, soldered, etc.
- cast iron and ductile iron pipe joints – spigot/socket with yarn/plastic seals are particularly susceptible to damage and corrosion causing gas leakage.

A4.1.6 **Cover to buried pipe**

Buried pipes are laid directly in the ground but selected backfill may have been used. Pipes may be protected, for example by protective slabs.

A4.2 **UNDERGROUND TELECOMMUNICATIONS NETWORKS (including Cable TV and fibre optic networks)**

- usually installed in duct lines of jointed steel, plastic or earthenware pipes
- ducts are single, fabricated multiway or multiple laid adjacent to one another
- joints may restrict water entry but seldom are sufficiently tight to prevent the entry of gas
- continuous duct lines interconnect at joint pits or other underground chambers – gas entering the duct system may spread rapidly and far from the source of gas escape
- motorway and trunk road traffic advice cables are normally laid in purple convoluted ducts, which may run for considerable distances between access points.

In general, the existence of underground duct systems can be confirmed visually by looking for pit or chamber cover above ground.

A4.3 **UNDERGROUND ELECTRICITY NETWORKS**

- cables can be buried directly in the ground. However, at locations where re-opening trench work would be difficult, for example at road crossings, in busy streets etc., cables may be inserted in ducts or pipes made of earthenware, plastic etc
- cables laid directly in the ground are usually surrounded by fine soil, sand or cement-bound sand
- joints in pipes and ducts may restrict water entry but seldom are sufficiently tight to prevent the entry of gas
- cables and their carriers may have a layer of tiles, slabs or a coloured plastic marker tape laid above them (but this is not to be used as a guarantee of an accurate location)
- gas entering a pipe or duct system may spread rapidly and far from the source of gas escape
- cables may be found within other redundant services.

A4.4 **PREMISES CONNECTED TO GAS, TELECOMMUNICATIONS AND ELECTRICITY NETWORKS**

A4.4.1 Reliance cannot be put on the seal at the entry of the service to premises as a means of preventing the ingress of gas.

A4.4.2 Underground gas, telecommunications and electricity services in roadways or footpaths may be detected visually by distinctive entry covers (sometimes allied to adjacent ventilation stacks). Reliance cannot be put on the lack of such evidence as indicating the absence of such services.

A4.4.3 Services to domestic, commercial and industrial premises may traverse private ground in pipes, covered trench lines or dedicated or shared ducts or channels (closed circuit radio or television networks are similarly installed). Reliance cannot be put on surface markings to indicate subterranean installations.

A4.5 SEWERAGE, WATER DRAINAGE, SERVICE TUNNELS, DISTRICT HEATING SCHEMES AND RAILWAYS

A4.5.1 All services

- usually at a greater depth than gas pipes (important for heavier than air gases)
- gas may ingress at access points under certain conditions of geography or of air movement
- many deep laid services have connections to ground level, for example via ventilation methods
- many have access chambers, or junction/valve chambers with covers, which may be a place where escaping gas can collect.

A4.5.2 Underground rail systems

- gas drawn in is quickly dispersed over large distances
- individual special arrangements between rail system owners and gas emergency service providers are advisable to promote safety and to prevent the need for widespread closure of rail systems.

A4.5.3 Tunnels

- gas escapes into tunnels, for example road tunnels, can quickly disperse over large distances and may be relevant when assessing escape situations.

A4.6 ABANDONED UNDERGROUND PLANT

- redundant services often are not removed and evidence of the existence of such services is not generally apparent
- conversely, redundant services are often used to "sleeve" live services
- redundant services of one utility may be used as a carrier for a live service of another utility
- records for redundant plant are less likely to be available than for live plant.

A4.7 UNPIPED GAS

An awareness of the existence of such as landfill gas sites is necessary when investigating suspected gas releases into underground plant.

APPENDIX 5 : SAFETY ADVICE FOR EMERGENCY SERVICES ATTENDING GAS ESCAPES

Safety advice is available to download from IGEM's website free of charge at https://www.igem.org.uk/resource/safety-advice-for-emergency-services-attending-gas-escapes-pdf.html