

***IGEM/UP/3 Edition 3
Communication 1781***

Gas fuelled spark ignition and dual-fuel engines



*Founded 1863
Royal Charter 1929
Patron: Her Majesty the Queen*

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Communication 1781**

Gas fuelled spark ignition and dual-fuel engines



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SECTION 1 : INTRODUCTION

- 1.1 This Standard supersedes IGE/UP/3 Edition 2, Communication 1720, which is obsolete.
- 1.2 This Standard has been drafted by an Institution of Gas Engineers and Managers (IGEM) Panel, appointed by the Gas Utilization Committee, subsequently approved by that Committee and by IGEM's Technical Co-ordinating Committee on behalf of the Council of IGEM.
- 1.3 This Standard provides guidance on the installation of gas fuelled spark ignition and dual-fuel engines. It has been compiled taking into account international Standards and the experience gained during many years of operation and testing of engines in Great Britain (GB).
- 1.4 Terms such as "maximum operating pressure" (MOP), "maximum incidental pressure" (MIP) and "operating pressure" (OP) have been introduced to reflect gas pressure terminology used in European Standards. These terms will arise in all relevant IGEM Standards and, possibly, in other Standards.

Note: Referring to Figure 1, OP is shown to oscillate about the set point (SP). MOP can be declared at any value from OP upwards to a limit below MIP.

- 1.5 This Standard makes use of the terms, "must", "shall" and "should" when prescribing particular requirements. Notwithstanding Sub-Section 1.8:
- 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 Health and Safety Executive (HSE) Approved Codes of Practice (ACoPs) or guidance, and reference needs to be made to such statutory legislation or official guidance for information on legal obligations.

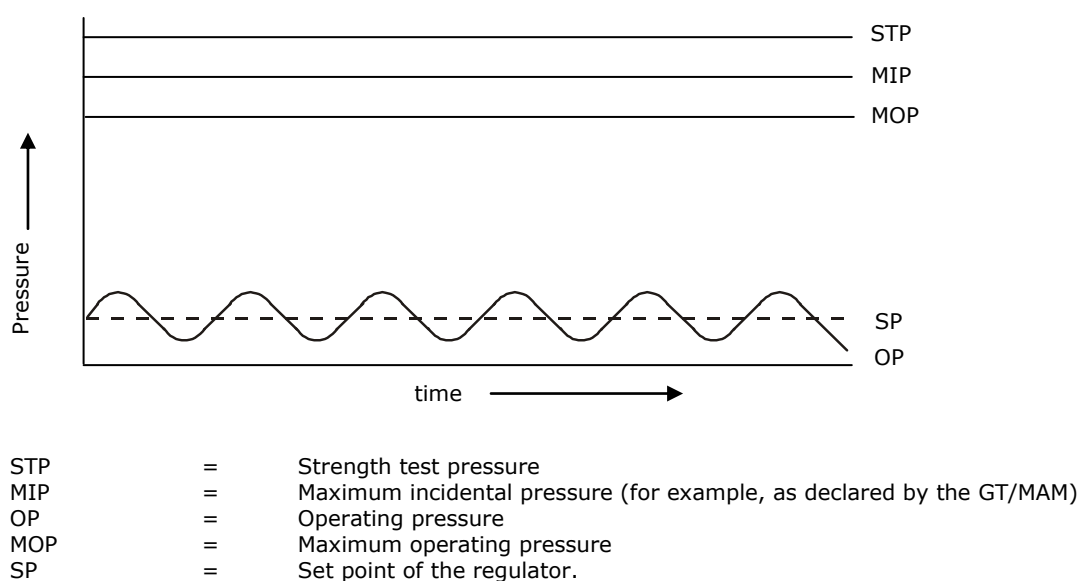
- 1.6 The primary responsibility for compliance with legal duties rests with the employer. The fact that certain employees, for example "responsible engineers", are allowed to exercise their professional judgement does not allow employers to abrogate their primary responsibilities. Employers are required to:
- have done everything to ensure, so far as it 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 It is now widely accepted that the majority of accidents in industry generally are in some measure attributable to human as well as technical factors in the sense that actions by people initiated or contributed to the accidents, or people might have acted in a more appropriate manner to avert them.

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

- 1.8 Notwithstanding Sub-Section 1.5, this Standard does not attempt to make the use of any method or specification obligatory against the judgement of the responsible engineer. Where new and better techniques are developed and proved, they are to be adopted without waiting for modification to these requirements. Amendments to this Standard will be issued when necessary, and their publication will be announced in the Journal of the Institution and other publications as appropriate.

- 1.9 Requests for interpretation of this Standard in relation to matters within their scope, but not precisely covered by the current text, is to be addressed in writing to Technical Services, IGEN, IGEN 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 IGEN, this does not relieve the responsible engineer of any of his or her obligations.



Note: This is extracted from IGEN/TD/13 and simplified for the purposes of IGEN/UP/3.

FIGURE 1 – RELATIVE PRESSURE LEVELS

This standard was published in November 2015.

SECTION 2 : SCOPE

- 2.1 This Standard applies to spark ignition and compression ignition engines of both the reciprocating and rotary type, either stationary or portable, for both continuous and standby duties.

Note 1: This Standard is intended for land-based installations but the general principles may be used for offshore installations.

Note 2: At the time of publication, there has been little experience in the design and installation of Sterling engine packages. However, in such cases, it is recommended that the general intent of this Standard be followed. For burner systems, reference may be made to IGEN/UP/12. For associated compressors see also IGEN/UP/6.

This Standard does not apply to engines when used for vehicle or marine propulsion.

- 2.2 This Standard refers, primarily, to essential safety aspects of the engineering, installation and operation of engines using lighter and heavier than air flammable fuel gases such as Manufactured Gas, Natural Gas (NG), Liquefied Petroleum Gas (LPG) and LPG/air mixtures, (1st, 2nd and 3rd family gases are further defined in BS 1179-6). They may be appropriate for other gases such as Landfill, Anaerobic Digester and Mines Recovery Gas, but the particular characteristics of the gas needs to be recognised with respect to consequent effects on materials and operations.

- 2.3 This Standard applies to gas pipework and control systems downstream of, and including, the engine manual isolation valve.

- 2.4 Sections that do not specifically relate to a particular gas apply to all gaseous fuels in a dual fuel installation.

When dealing with liquid fuel oils, guidance can be found in BS EN 590, BS 2869 and BS 6380 or suitable equivalent standards regarding oil quality, or BS 5410 for oil-fired installations.

- 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 : LEGISLATION AND STANDARDS

This Standard is set out against a background of Legislation in force in GB at the time of publication (see Appendix 2). The devolution of power to the Scottish, 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 and reference to appropriate national Legislation will be necessary.

All relevant Legislation must be complied with and relevant Approved Codes of Practice (ACoPs), official Guidance Notes and referenced codes, standards, etc. shall be taken into account.

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

Appendix 2 lists Legislation, guidance notes and standards etc. which are identified within this Standard as well as further items of Legislation that may be applicable. Where standards are quoted, equivalent national or international standards etc. equally may be appropriate. Unless otherwise stated, the latest version of the referenced document should be used.

3.1 EUROPEAN LEGISLATION

Due account must be taken of relevant European Directives and enforcing Regulations etc. as they become statute including:

- Pressure Equipment Directive, implemented in the UK by The Pressure Equipment Regulations (PER) and The Pressure Systems (Safety) Regulations (PSSR)
- Machinery Directive implemented in the UK by The Supply of Machinery (Safety) Regulations
- Construction Products Directive implemented in the UK by The Construction Products Regulations
- Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres – The ATEX Equipment Directive – implemented in the UK by The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations
- Safety and Health Protection of Workers Potentially at Risk from Explosive Atmospheres – The ATEX Workplace Directive – implemented in the UK by The Dangerous Substances and Explosive Atmospheres Regulations (DSEAR).

3.2 UK LEGISLATION

3.2.1 BUILDING REGULATIONS

3.2.1.1 *England and Wales (as Amended)*

Building Regulations are Statutory Instruments that are to be followed when engaged in any building work. They are written in a format of broad Regulations, setting out simple technical requirements in a separate schedule. Suggested ways of complying with these Regulations are contained in Approved Documents.

The Approved Documents that apply to gas work are:

- A (Structure)
- B (Safety in Fire)
- F (Ventilation)
- J (Combustion appliances and fuel storage systems).

3.2.1.2 *Building Standards (Scotland) Regulations and Amendments*

The Building Standards (Scotland) have the technical requirements written directly as Regulations within the Statutory Instrument. The Regulations can be satisfied:

- by compliance with Technical Standards published by the Scottish office
- conforming with the provisions of "deemed to satisfy" documents, for example British Standards
- other equivalent means.

3.2.2 **CONFINED SPACES REGULATIONS**

3.2.2.1 In general, an acoustic enclosure used for an engine is deemed an enclosed space for the purposes of these Regulations.

3.2.2.2 These Regulations apply to a whole range of confined spaces. The supplier or designer 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.

Employers need to:

- establish safe systems of work for entry to, or carrying out work in, or leaving, a confined space that renders the activities safe and without risks to health
- establish suitable and sufficient arrangements for rescue of people in the confined space in the event of an emergency
- ensure compliance, so far as is reasonably practicable, with the provisions of the Regulations in respect of any work carried out by employees, or other people within the employer's control.

3.2.3 **CONTROL OF ASBESTOS AT WORK REGULATIONS**

3.2.3.1 These Regulations set out standards for the identification, monitoring and assessment of work that may expose workers to asbestos and the measures needed to control the risk.

3.2.3.2 Employers cannot carry out any work that exposes, or is likely to expose, employees to asbestos unless an assessment of that exposure has been made. Employers have to set out steps to be taken to prevent, or reduce to the lowest level reasonably practicable, that exposure. Employers have to carry out medical surveillance of employees if they work over a certain time limit.

3.2.3.3 The Regulations impose a duty on those with responsibilities for the repair and maintenance of non-domestic premises to find out if there are, or may be, asbestos containing materials within them to record the location and condition of such materials, and assess and manage any risk from them, including passing of any information about their location and condition to anyone likely to disturb them.

Note: Further information is available in HSG227. Other ACoP associated with these Regulations is L143.

3.2.4 **CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH REGULATIONS (COSHH)**

3.2.4.1 These Regulations, which reinforce existing statutory obligations under HSWA, impose a duty on employers to protect employees against risks to health, whether immediate or delayed, arising from exposure to substances hazardous to health, either used or encountered, as a result of a work activity. They also impose certain duties on employees.

3.2.4.2 COSHH requires that work is not to be carried out which is liable to expose employees to hazardous substances unless the employer has made a suitable and sufficient assessment of the risk created by the work and the steps that need to be taken to comply with the Regulations. After assessing the risk, it is necessary to inform employees of the risks and to carry out the appropriate training and instruction to ensure the risks are minimized. In certain cases, control measures such as ventilation or personal protective equipment may be necessary and, where provided, they have to be used.

3.2.5 **CONSTRUCTION (DESIGN AND MANAGEMENT) REGULATIONS (CDM)**

These Regulations apply to the whole construction process on all asset construction projects from concept to completion and beyond. Duty holders include clients, designers, principal designers, principal contractors, contractors and individual workers. Foreseeable risks, such as those that may arise during construction work or in maintaining and using the asset once it is built are required to be eliminated, reduced or controlled.

Note: L153 provides an ACOP and Guidance on CDM.

3.2.6 **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.

They 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.

They 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: Further advice is contained in HSR25.

3.2.7 **GAS SAFETY (INSTALLATION AND USE) REGULATIONS (GS(I&U)R)**

3.2.7.1 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, equipment and exhausts. They may not apply to installations in factories, sewage treatment works, mines and quarries and agricultural premises, but it is recommended that the intent is adopted in all cases.

3.2.7.2 GS(I&U)R addresses both NG and LPG.

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

Note: HSWA places responsibilities on those who design installations.

- 3.2.7.4 GS(I&U)R define the gas supplier for both NG and LPG and L56 provides guidance on those definitions, in particular for the more complicated case of LPG supplied from tanks and from cylinders.
- 3.2.7.5 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", i.e. Gas Safe registered.
- 3.2.7.6 The installer is required to check the safety of any gas fittings 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 installer they use for the gas fitting, service or maintenance or safety is a member of an approved class of persons and is competent to carry out such work. If any serious fault is found, the installer is required to inform both the landlord/hirer, as well as the user, so that such faults can be rectified before further use.
- 3.2.7.7 The Regulations, with respect to fuel gas systems, also require:
- the fitting and maintenance of a supply protection device
 - the need to avoid adversely affecting the upstream network.
- 3.2.7.8 In all premises, the user is required to provide adequate protection for the upstream Network as required by the gas transporter (GT). This includes protection against excess reverse pressures, low inlet pressures, large rates of change of flow and undue pressure/flow perturbations. The GT is permitted to demand suitable protection.
- Note 1: Further advice on this and the use of high pressure machines, particularly those for use with gas turbines or gas engines forming part of a combined heat and power system, is available in IGE/UP/9 or IGEM/UP/6, as appropriate.*
- Note 2: It is essential that the fuel supplier is advised of the anticipated transient flow variations in order that they can be checked for compatibility with the gas metering/supply system.*
- 3.2.7.9 GS(I&U)R place responsibilities on LPG suppliers to deal with escapes of LPG. For NG, the Gas Safety (Management) Regulations (GS(M)R) apply.

Note: Advice on dealing with gas escapes is contained in IGEM/SR/29.

3.2.8 **GAS SAFETY (MANAGEMENT) REGULATIONS (GS(M)R)**

- 3.2.8.1 GS(M)R place specific duties on GTs, or their emergency service providers (ESPs), for dealing with gas escapes from pipes on their Network. 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 carbon monoxide (CO) from gas fittings.

- 3.2.8.2 The ESP (see Note below) has specific duties to:
- provide a continuously staffed and free telephone service to enable persons to report gas escapes and
 - pass such reports on to the person who has the responsibility for dealing with the escape.

In addition, there are duties imposed on gas suppliers and GTs to notify the ESP if they, rather than the ESP, receive a report of an escape from the consumer.

3.2.8.3 GS(M)R require GTs to investigate fire and explosion incidents upstream of the emergency control valve (ECV) and to send a report of the investigation to the HSE. GTs are also required to investigate fire and explosion incidents downstream of the ECV, but this is limited to establishing whether the seat of the fire or explosion was in an appliance and, if so, which one, or in the installation pipework.

3.2.8.4 Responsibility for investigating RIDDOR (see clause 3.2.15) reportable incidents as a result of an escape of CO from incomplete combustion of gas from a gas fitting, is placed on gas suppliers. HSE has to be notified before such investigations commence.

Note: Advice on dealing with gas escapes is contained in IGEN/SR/29.

3.2.9 **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 other persons such as members of the public who may be affected by the work activity.

For installations not covered under GS(I&U)R, all persons covered by HSWA must be competent. IGEN/IG/1 sets down a basis for the standards of training in gas work.

3.2.10 **MANAGEMENT OF HEALTH AND SAFETY AT WORK REGULATIONS (MHSWR)**

In addition to specific duties under GS(I&U)R (see clause 3.2.7), 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, HSG65 provides guidance. They also require effective planning and review of protective measures.

3.2.11 **NOISE AT WORK REGULATIONS**

Under these Regulations, the employer is required to identify any potential injurious noise sources and carry out an assessment when an employee is exposed to a level of noise in excess of the first action level of a daily personal exposure of 85 dB(A). Action is then required to reduce noise at source so far as is reasonably practicable. Only then can consideration be given to hearing protection. A duty is also placed on manufacturers and suppliers to provide information on the noise likely to be generated by their product.

3.2.12 **PRESSURE EQUIPMENT REGULATIONS (PER)**

3.2.12.1 These Regulations cover pressure equipment manufactured and sold with a maximum allowable pressure greater than 0.5 bar. The Regulations deal with the manufacture, design and supply of pressure equipment. They impose duties on the responsible person.

Note: A "responsible person" is defined as "the manufacturer or his authorised representative established within the Community or, where neither the manufacturer nor his authorised representative is established within the Community, the person who places the pressure equipment or assembly on the market or puts it into service as the case may be."

3.2.12.2 "Pressure equipment" is defined as "vessels, piping, safety accessories and pressure accessories; where applicable, pressure equipment includes elements attached to pressurised parts, such as flanges, nozzles, couplings, supports, lifting lugs and similar".

- 3.2.12.3 The duties on the “responsible person” are to ensure that pressure equipment:
- satisfies the relevant essential requirements
 - has undergone the relevant conformity assessment procedure, if applicable
 - has had the CE mark affixed by the manufacturer, if applicable
 - has had the declaration of conformity drawn up by the manufacturer that the equipment is, in fact, safe.

Note: Not all pressure equipment is covered by PER. There are 21 categories of exceptions, detailed in Schedule 1 of PER.

- 3.2.12.4 The relevant conformity assessment procedure is determined by the classification of the pressure equipment according to criteria laid down in the Regulations. The classification system results in equipment being placed in one of five categories depending on the inherent level of hazard within the system.

The category then determines the range of conformity assessment modules relevant to that equipment. The modules are designed to allow the manufacturer to choose between a quality assurance route and type testing.

3.2.13 **PRESSURE SYSTEMS SAFETY REGULATIONS (PSSR)**

- 3.2.13.1 These Regulations impose duties on designers, importers, suppliers, installers and user or owners to ensure that pressure systems do not give rise to danger. This is done by 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).

- 3.2.13.2 Relevant fluids for the purpose of this document would be NG at a pressure greater than 0.5 barg (above atmospheric pressure) or LPG (which is a liquid with a vapour pressure greater than 0.5 barg at ambient temperature). A pressure system would include bulk storage tanks, pipelines and protective devices but not an LPG cylinder (transportable pressure receptacle). Once the pressure in the pipework drops below 0.5 barg, 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 the Regulations. 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 barg, for example at the entry to a building.

Note the special requirements placed on protective devices in such systems (see paragraph 110b of L122). The Regulations also apply to pipelines and protective devices in which the pressure exceeds 2 barg (see Sch 1 part 1 item 5 of L122).

- 3.2.13.3 More information is available in L122 and some information is presented in the HSE free leaflets INDG 261 and INDG 178.

- 3.2.13.4 Safe operating limits of plant, belonging both to the user and the GT, are to be established. These limits are to determine the “weakest link” and protect against failure.

Note: Formal communications, between the user and the GT, need to be established and a division of responsibility understood clearly by both parties. The meter asset manager (MAM) may need to be consulted with regard to the meter installation.

- 3.2.13.5 Information is required to be exchanged concerning safe operating limits and schemes of examination for protective devices, to ensure that both parties are aware of each other’s limitations and, consequently, the safe operating limits.

- 3.2.13.6 There are many exceptions and partial exceptions to the Regulations, which are detailed in Schedule 1 Parts 1 and 2.

Note: A schematic diagram showing division of responsibility is recommended.

3.2.14 **PROVISION AND USE OF WORK EQUIPMENT REGULATIONS (PUWER)**

- 3.2.14.1 Work equipment has a wide meaning and includes tools such as hammers, laboratory apparatus, for example Bunsen burners, ladders, photocopiers, lifting equipment and machinery for use at work.

- 3.2.14.2 The Regulations place 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 the Regulations can be found in L22. Free leaflets include INDG 291 and INDG 229.

3.2.15 **REPORTING OF INJURIES, DISEASES AND DANGEROUS OCCURRENCES REGULATIONS (RIDDOR)**

- 3.2.15.1 RIDDOR require employers, self-employed people or those in control of work premises to report certain work related accidents, diseases and dangerous occurrences.

- 3.2.15.2 Other people have duties to report certain gas incidents which may not appear to be work related:

- death, major injury, lost consciousness, or been taken to hospital for treatment to an injury arising out of the distribution, filling, import or supply of NG or LPG are to be reported by the conveyor for NG and the filler, importer or supplier for LPG
- dangerous gas fittings (as defined in RIDDOR) should be reported by a "member of a class of persons". Gas Safe registered engineers are to provide details of any gas appliances or fittings that they consider to be dangerous, to such an extent that people could die, lose consciousness or require hospital treatment. The danger could be due to the design, construction, installation, modification or servicing of that appliance or fitting, which could cause:
 - an accidental leakage of gas
 - incomplete combustion of gas or
 - inadequate removal of products of the combustion of gas.

- 3.2.15.3 Major injuries, death and dangerous occurrences are to be notified immediately, for example by telephone, to the enforcing authority by the "responsible person" as defined by RIDDOR. Report can be made to the Incident Contact Centre:

- for fatal and major injuries only, telephone on 0845 300 9923 (opening hours Monday to Friday 8.30 am to 5 pm) and complete the appropriate online report form
- all other reports at HSE website www.hse.gov.uk.

Complete the appropriate online report form listed below:

- report of an injury
- report of a dangerous occurrence
- report of an injury offshore
- report of a dangerous occurrence offshore
- report of a case of disease
- report of flammable gas incident
- report of a dangerous gas fitting.

The form will then be submitted directly to the RIDDOR database and a copy issued to the person making the report.

Online written reports are to be submitted within the required timescale (10 days, or 14 days for dangerous gas fittings). Other reports need to be made as soon as practicable and within 10 days of the incident.

3.2.15.4 INDG 453 contains detailed guidance on RIDDOR, including a full list of injuries etc. that need reporting.

3.2.15.5 IGEN/GL/8 provides guidance on the reporting and investigation of gas-related incidents.

3.2.16 **SUPPLY OF MACHINERY (SAFETY) REGULATIONS**

These Regulations set out “essential requirements” written in general terms, which are to be met by manufacturers/suppliers before a product may be supplied within the European Community. European standards provide the detail on the essential requirements. Machinery, as defined, once having been verified against the relevant standards, can then be affixed with the CE mark. The manufacturer or importer will have to be able to assemble a technical file detailing information on the health and safety considerations which went into the design of the product.

3.2.17 **THE CONSTRUCTION PRODUCTS REGULATIONS (CPR)**

CPR apply to construction products, which are placed on the market and produced for incorporating in a permanent manner in construction works (which includes both building and civil engineering works). The essential requirements are mechanical, safety and stability, safety in case of fire, hygiene, health and environment, safety in use, protection against noise, energy economy, and heat retention.

3.2.18 **THE DANGEROUS SUBSTANCES AND EXPLOSIVE ATMOSPHERES REGULATIONS (DSEAR)**

These Regulations are concerned with protection against risks from fire, explosion and similar events arising from dangerous substances used or present in the workplace. They require that risks from dangerous substances are assessed, eliminated or reduced. They contain specific requirements to be applied where an explosive atmosphere may be present and require the provision of arrangements to deal with accidents, emergencies, etc. and provision of information, training and use of dangerous substances. The Regulations also require the identification of pipelines and containers containing hazardous substances.

The following publications contain details of the Regulations and their application:

- INDG370
- L138.

All gas systems except those in domestic parts of buildings fall within the scope of DSEAR. This requires that a risk assessment be completed for each premise to determine if any hazardous area exists and its extent. Normally, systems of MOP not exceeding 500 mbar do not require the use of certified electrical components or restrictions on sources of ignition if correctly installed, tested and maintained.

3.2.19 **THE EQUIPMENT AND PROTECTIVE SYSTEMS INTENDED FOR USE IN POTENTIALLY EXPLOSIVE ATMOSPHERES REGULATIONS (AS AMENDED)**

The ATEX Directives provide an integrated regime for the design, selection, testing and use of equipment in hazardous areas, and for the prevention of explosions thereby. There are two sets of Regulations, to implement these directives.

The first set of Regulations, the Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations place duties on the suppliers of equipment who are required to ensure that it complies with the essential health and safety requirements, generally by compliance with the relevant harmonised European standards, prior to CE marking.

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SECTION 4 : ENGINE INSTALLATION

- 4.1 The installation of any engine shall comply with good engineering practice and with the manufacturer's detailed requirements regarding, for example, any necessary foundations. At the design stage, risk assessments shall be performed on the engine package and on the chosen location to ensure that all safety issues are competently handled and DSEAR is complied with.
- 4.2 Adequate space shall be provided around any engine (or its enclosure) and its control equipment, to allow access for maintenance and repair.
- 4.3 Whether an engine is located within a building or a specially provided enclosure, natural or forced ventilation shall be provided to ensure an adequate supply of air for combustion, cooling and ventilation while the engine is running. There shall be sufficient ventilation to disperse minor gas leaks when the engine is shut-down (see Section 10). If the engine is fired with a gas, which is heavier than air (a 3rd family gas or a bio-gas with a specific gravity (SG) above 0.8), it shall not be located below ground, nor in an above-ground enclosure where low-level ventilation cannot be provided.
- 4.4 An engine should not be located in the same enclosure as a flammable gas compressor (see IGEN/UP/6) which may generate hazardous areas.

Where a compressor, booster or other associated equipment are installed within an engine enclosure, a risk assessment and hazardous area assessment must be carried out and appropriate equipment installed as they may generate hazardous areas.

Where a flammable gas compressor is driven by an engine and is located in a separate enclosure, the engine enclosure shall be separated from the compressor enclosure by either guaranteed sealing of the drive shafts between the enclosures or a physical break with an externally ventilated air gap between the enclosures, or by ensuring a guaranteed difference in compartment ventilated air pressures such that high pressure gas cannot enter the "safe" enclosure.

Note 1: Compressors for other fluids/gases, for example refrigerants, may need similar considerations. Refrigerants may be corrosive if induced into the engine air supply and subsequent omissions may be hazardous.

Note 2: There may be similar restrictions on the location of boosters as covered by IGEN/UP/2.

- 4.5 Any acoustic hood, weather protection canopy or similar structure, fitted to an outdoor engine, shall be designed to ensure appropriate ventilation (see Section 10).
- 4.6 Any permanently installed engine shall be located securely in accordance with the manufacturer's instructions.

Where movement in use could cause damage to any section of the gas supply pipe, the engine package shall be secured.

Note: Where an engine is mounted on a moveable skid, the use of wheel brakes and/or wheel chocks alone may not be sufficient for this purpose.

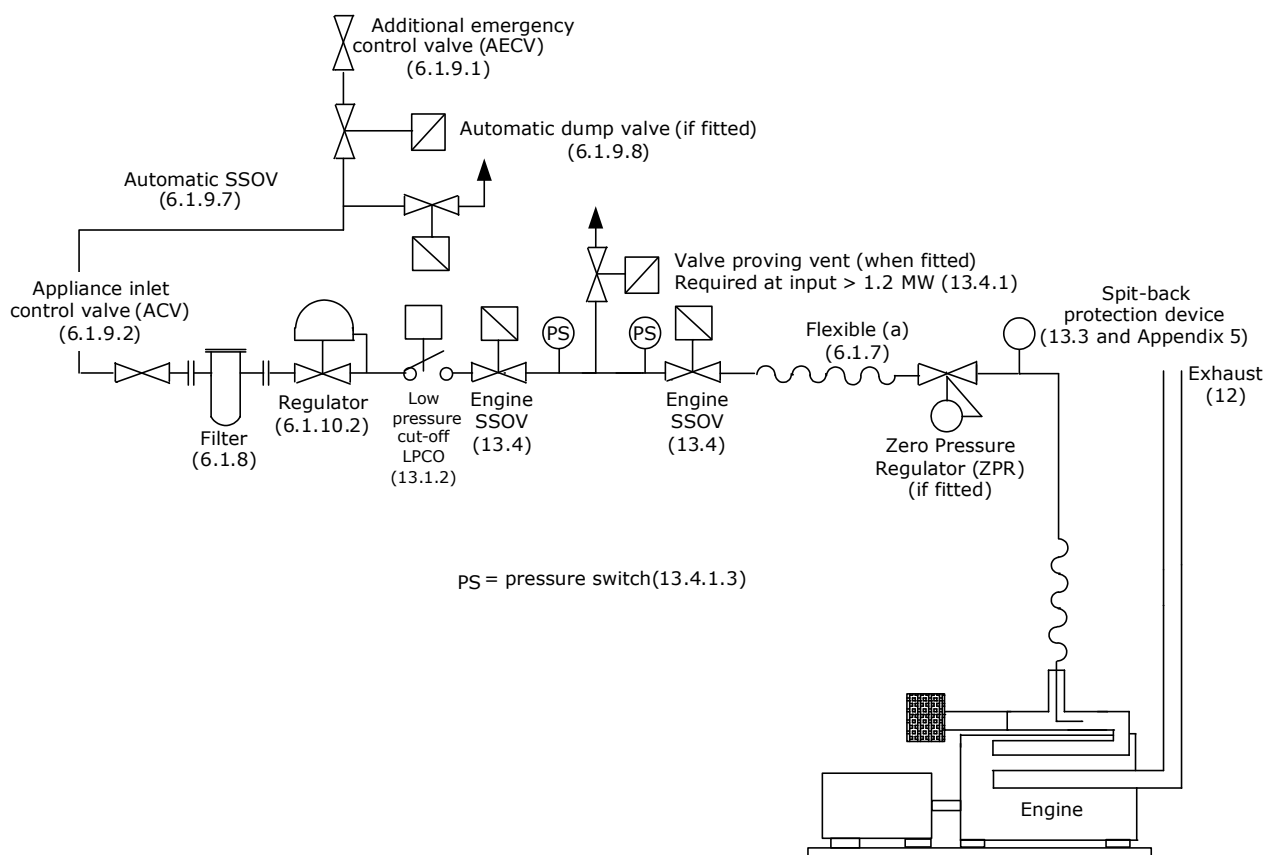
- 4.7 Any engine, and associated hot services and exhausts, shall be installed such that materials used in floors, walls, partitions etc. are not subject to temperatures which may cause damage to, or degradation of, the material.

Note: Suitable shielding may be provided or, alternatively or additionally, a sufficient air gap may be left between the hot surface and the material in question.

4.8

Where a space incorporates exhaust explosion reliefs that may, in turn, lead to a failure of the structure of the space, consideration shall be given to the need for external ducting or explosion reliefs in the structure.

Note: In general, explosion reliefs in engine rooms are not required where the ventilation during shut-down and operation of the engine(s) meets the procedures in Section 10 and control systems and crankcase vents are designed and maintained properly.



Note 1: The spit-back protection device may be on the inlet manifold of the engine.

FIGURE 2 – RELATIVE POSITIONS OF CONTROLS THAT MAY BE REQUIRED IN A TYPICAL GAS SUPPLY TO AN ENGINE

SECTION 5 : GAS SUPPLY PRESSURES

5.1 SYSTEM DESIGN

The system design shall be such as to prevent any pipework and control equipment from being subject to pressures in excess of their maximum design rating.

The installer must provide at least 14 days notice to the GT of the intention to fit an engine and any associated gas booster/compressor.

Note: The GT can be contacted through www.energynetworks.org to access the GTP documents and use the GT1 or GT2 forms.

5.2 GAS PRESSURES

5.2.1 Minimum operating pressure

Engines designed to operate at a lower operating pressure (typically 20 mbar for NG, 37 mbar for propane and 28 mbar for butane) shall continue to operate according to the manufacturer's declared operational specifications (possibly at reduced output) at all pressures down to the minimum supply pressure quoted by the manufacturer/packager.

Note: Information on supply pressure conditions may be obtained from the GT Meter Asset Manager (MAM) or gas supplier.

At inlet pressures below this value, the engine shall either continue to operate according to specification or proceed to safety shut-down.

5.2.2 Design operating pressure

Installations shall be capable of operating at their design rating within a gas pressure range (maximum and minimum) as agreed with the user/specifier.

Note: Operating pressure conditions for landfill and bio-gases may be different.

They shall also operate safely under the declared supply pressure conditions.

5.3 GAS QUALITY

The installation shall be designed to operate on the agreed range of gas qualities specified by the gas supplier/GT.

Particular attention should be paid to levels of contaminants, for example sulphur, etc. and moisture in the fuel gas.

Note 1: Suitable gas filtration will be necessary for most fuels.

Note 2: For low dew point gases, it may be necessary to include drain points and a heated manifold in the gas supply, to control/prevent condensation or liquefaction.

Note 3: Some bio-gases may contain significant levels of toxic CO or hydrogen sulphide, for which special consideration needs to be given to the safety of operatives.

5.4 BOOSTED GAS SUPPLIES

Where gas is available at insufficient pressure for the engine, a booster or compressor will be necessary, and may be driven separately by an electric motor or other suitable prime mover or by the engine itself. Such machines shall be installed in compliance with IGEN/UP/2 or IGEN/UP/6, as appropriate, and any additional requirements of the machine manufacturer. A suitable flexible connection shall be fitted to the inlet and outlet connections of each machine unless specified otherwise by the manufacturer/supplier.

- 5.4.2 Any booster or compressor may be of the centrifugal, rotary, reciprocating, sliding vane or screw type. Whichever type is used, care shall be taken in the selection of a metering system for such an installation. The machine shall be capable of withstanding the range of inlet pressures from any supply system or shall be protected by a suitable Pressure Equipment Directive (PED) certified pressure reduction system.

Note: The GT may refuse to supply gas if this information is not communicated.

- 5.4.3 Regulation 38 of GS(I&U)R requires that gas supplies must be protected from pressure fluctuations that may cause a danger. To ensure this, low-pressure gas protection must be provided at the inlet of machines which may generate a suction condition at their inlet, for example, a reciprocating engine, a compressor or a booster (see Sub-Section 13.1).

- 5.4.4 Where adequate "elevated" pressure gas is available without further compression from the supply, pressure control at the meter may not be necessary. Unregulated supplies are, normally, not permitted under GS(I&U)R. The GT should be consulted where an unregulated supply is required and an exemption will be considered.

SECTION 6 : GAS SUPPLY PIPEWORK

6.1 DESIGN

6.1.1 General

- 6.1.1.1 Pipework shall be designed to meet applicable national Regulations and this shall be achieved using appropriate Standards, for example BS EN 13480 and BS EN 15001 for MOP > 0.5 bar, IGEM/UP/2 for MOP ≤ 60 bar, and ANSI B31.3. Any seal, valve seat, gasket, diaphragm etc. shall be suitable for the fuel being supplied.

Note 1: The standard selected will be dependent upon the intended MOP and any requirement to comply with the PED.

Note 2: A Risk assessment is required to be carried out on the location of the pipework and other components during the design stage to determine if any hazardous area classification needs to be applied. See IGEM/SR/25 and IGEM/UP/16.

- 6.1.1.2 Where an individual pipe section is to be hydrostatically tested, such a section shall not be joined by a weld unless that weld is subsequently hydrostatically tested or subjected to non-destructive examination (NDE).

Note: BS EN 13480 and BS EN 15001 are relevant for MOP > 0.5 bar.

- 6.1.1.3 For systems of MOP > 0.5 bar, the pipe specified minimum yield strength (SMYS) of the pipework under test shall not be less than 110% of the worst case test conditions, taking account of pressure and temperature.

6.1.2 Location of pipework and components

- 6.1.2.1 Pipework and any controls shall be located so that there is minimum risk of accidental damage, for example as caused by cranes, etc. If there is a risk of accidental damage, the pipework and controls shall be protected suitably, for example by a guard rail.

- 6.1.2.2 All gas controls shall be sited where their performance will not be impaired by heat radiated from the engine system and where, in the unlikely event of flames being emitted from the air intake, crankcase and other pressure reliefs or from a broken exhaust pipe, such flames will not impinge upon them.

- 6.1.2.3 A suitable number of drain and correctly sized pressure test and purge points shall be located in accessible positions. Purge points will be required immediately downstream of section isolation valves, at the extremities of pipe sections and should not be less than 25% of the main pipe diameter. Pressure test points are required for pressure testing, fault finding and condition monitoring and may be needed either side of control valves and SSOVs.

- 6.1.2.4 Where the gas is "wet", condensate shall flow freely to drain points and consideration shall be given to the possibility of freezing of the condensate which may prevent the safe operation of the controls system. Special consideration shall be given to the hazardous areas generated by drain points. Reference should be made to IGEM/SR/25.

- 6.1.2.5 An engine installed on anti-vibration mountings (AVMs) usually has a neutral frequency considerably lower than the vibration frequency of the engine alone. In these installations, the forces transmitted to the foundations are usually less than 10% of the free forces of the engine. Where large out-of-balance forces exist, consideration shall be paid to mounting the engine on an inertia block prior to mounting on the AVMs.