

IGEM/UP/12 Edition 2
Communication 1778

Application of burners and controls to gas fired process plant



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Communication 1778

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Application of burners and controls to gas fired process plant



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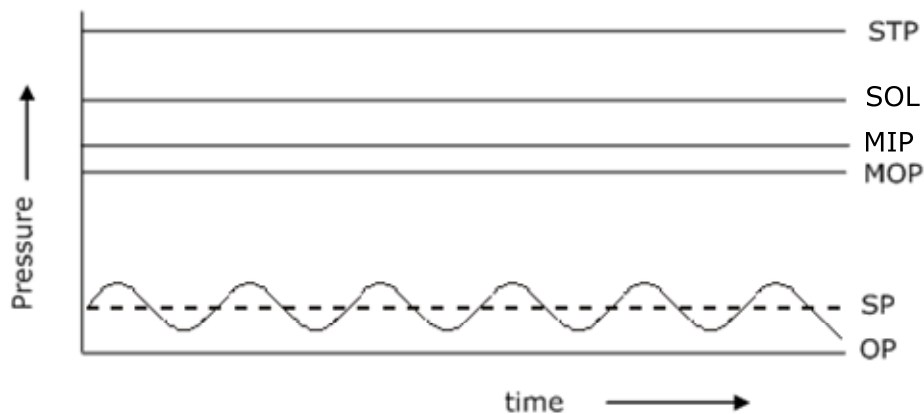
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SECTION 1 : INTRODUCTION

- 1.1 This Standard supersedes IGE/UP/12, Communication 1713, which is obsolete.
- 1.2 This Standard has been drafted by an Institution of Gas Engineers and Managers (IGEM) Panel, appointed by IGEM's Gas Utilization Committee and has been approved by IGEM's Technical Co-ordinating Committee on behalf of the Council of IGEM.
- 1.3 It is recognised that many combustion systems use forced draught burners that comply with BS 5885 and BS EN 676. Such installations now have to comply with BS EN 746-2 and this Standard covers all such systems, as well as those using full pre-mix, partial pre-mix and natural draught aeration systems.
- 1.4 This Standard embraces the major requirements of the withdrawn Health and Safety Executive (HSE) publication HS(G)16.
- 1.5 It is important that those involved in the design, installation and maintenance of gas-fired plant are competent and suitably trained to ensure safety. In general, process plant is not in the scope of the Gas Safety (Installation and Use) Regulations (GS(I&U)R). However, compliance with the intent of GS(I&U)R is recommended. In this respect, employers' attention is drawn to the requirements of IGEM/IG/1.
- 1.6 It is recognised that many items of existing plant may not comply with current Standards. This Standard may be used as a basis for updating. The degree of updating will depend upon the capital available and the risks associated with the operation of the plant.
- 1.7 As far as is practicable, gas fired plant needs to be fitted with flame safeguards and the fuel/air ratio controlled such that rich firing does not occur. For high temperature plant where the operating temperature exceeds 750°C and flame protection is not practicable, a minimum of a weep by-pass pressure proving check (see Appendix 11) is recommended.
- 1.8 Terms such as "maximum operating pressure" (MOP), "maximum incidental pressure" (MIP) and "operating pressure" (OP) "lowest operating pressure" (LOP) and "design minimum pressure" (DmP) were introduced in IGEM/UP/2 Edition 2 to reflect gas pressure terminology used in European standards.

Other terms were introduced to assist in recognition of design information to be transferred between interested parties.

Referring to Figure 1, attention is drawn to how operating pressure oscillates about the set point (SP). Note also that MOP can be declared at a higher value than OP. The strength test pressure (STP) has to exceed MIP. This means that, at least with respect to integrity, the installation will withstand a fault pressure from the upstream system. Safe operating limit (SOL) is a requirement of the Pressure Systems Safety Regulations (where applicable).



STP	=	Strength test pressure
SOL	=	Safe operating limit
MIP	=	Maximum incidental pressure
MOP	=	Maximum operating pressure
SP	=	Maximum set point of, typically, the active regulator
OP	=	Operating pressure.

FIGURE 1 - OPERATIONAL PRESSURE LIMITS

This Standard makes use of the terms “must”, “shall” and “should” when prescribing particular requirements. Notwithstanding Sub-Section 1.12:

- the term “must” identifies a requirement by law in Great Britain (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.

1.9

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 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.

1.10

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.

- 1.11 Notwithstanding Sub-Section 1.9, 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 ought to be adopted without waiting for modification to this Standard. 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.
- 1.12 Requests for interpretation of this Standard in relation to matters within its scope, but not precisely covered by the current text, need to be addressed in writing to Technical Services, IGEM, IGEM House, High Street, Kegworth, Derbyshire, DE74 2DA 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.
- 1.13 This Standard was published in June 2015.

SECTION 2 : SCOPE

- 2.1 This Standard provides the minimum requirements for combustion systems in respect of safety in start-up, operation and shut-down of gas-fired process plant. It does not provide a complete specification for burners, plant and control equipment.
- 2.2 This Standard applies to the use of gas in plant in industrial and commercial premises and nothing in this Standard implies any requirement for burners or appliances for other applications, for example for gas turbines (see IGE/UP/9) or for appliances constructed to recognised European standards such as hot water boilers and air heaters for space heating.
- 2.3 This Standard applies to relevant plant using Natural Gas (NG). It may also be applied for other gases and fuels where no other guidance is available, provided due allowance is made for the different combustion qualities and fuel characteristics.
- 2.4 This Standard applies to dual fuel and multi-fuel plant when operating on NG. Further advice on dual fuel and multi-fuel firing is given in Section 10.
- 2.5 It is recognised that, for specialised gas fired processes, it is permissible to use procedures which differ from those given in this Standard but which, nevertheless, comply with the intent. Similarly, new systems or procedures resulting from advances in technology may be applied to give equal or improved safety. It is not intended that this Standard prohibit the development or use of such systems, but any departure from this Standard is not recommended except when on the basis of sound engineering judgement, experience and subject to a risk assessment.
- 2.6 This Standard does not apply to:
- burners firing in the open and under constant manual supervision, for example Bunsen burners, gas rings, small open ended furnaces, etc.
 - small industrial plant and appliances of heat input not exceeding 7.5 kW (25000 Btu/h), for example soldering irons, glue pots, small lead pots
 - burners, appliances or plant covered by specific manufacturing standards, for example BS 5885, BS 5990 and BS 5978. However, they do include application requirements for such burners when applied to process plant
 - plant covered by specific British or European manufacturing standards, for example BS EN 676. However, they do include the application of such plant
 - heating plant such as boilers and air heaters supplied complete with matched burners
 - gas turbines, for which reference should be made to IGE/UP/9
 - spark ignition and dual-fuel engines, for which reference should be made to IGE/UP/3 Edition 2
 - the distribution and use of protective atmosphere gases, for which reference should be made to BS EN 746-3. However, for atmosphere gas burner control and safety systems, this Standard applies.
- 2.7 This Standard assumes that plant is designed and installed in accordance with good engineering practice and having due regard to GS(I&U)R and the Management of Health and Safety at Work Regulations (MHSWR).
- 2.8 Gas-fired process plant is required to comply with the Supply of Machinery (Safety) Regulations and, where appropriate, the requirements of the Pressure Systems Safety Regulations (PSSR) and the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR).

In general, The Gas Appliances (Safety) Regulations are not relevant as they apply to appliances for cooking, heating, hot water production (at temperatures not exceeding 105°C) refrigeration, lighting and washing. Appliances designed for industrial processes on industrial premises are also excluded from the scope of the Regulations. Certain process plant, such as hot water boilers not specifically designed for process applications but used in conjunction with process equipment, may fall within the scope of the Regulations.

- 2.9 This Standard applies to both high temperature plant (defined as having a normal working temperature sufficient to ignite the fuel, that is above 750°C at the working chamber walls) and low temperature plant (defined as having a normal working temperature at or below 750°C). High temperature plant will also operate in the low temperature mode at some time in its operation and this has to be taken into account when assessing safety issues.
- 2.10 This Standard applies to new plant and it is not the intention to apply any requirements retrospectively. However, if existing plant is being upgraded, it is recommended that the intent of this Standard is to be followed as far as possible. A risk assessment is to be made whenever any changes are proposed for any plant (see IGE/SR/24).
- 2.11 All pressures are gauge pressures unless otherwise stated.
- 2.12 All heat inputs are net heat inputs unless otherwise stated.
- 2.13 Italicised text is informative and does not represent formal requirements.
- 2.14 Appendices are informative but can represent formal requirements if referred to via the prescriptive terms "should", "shall" or "must".

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, 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 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.

All persons engaged in the design, construction, commissioning, operation, testing, servicing, maintenance, alteration, disconnection and decommissioning of pipework must be competent to carry out such work. Competency is achieved by an appropriate combination of education, training, practical experience and exhibiting appropriate behaviours.

3.2 BUILDING REGULATIONS

a) England and Wales (as Amended)

Building Regulations are Statutory Instruments that must be followed when engaged in any building work. They are written in a format of broad Regulations, setting out simple requirements in a Separate Schedule. Suggested ways of complying with these Regulations are contained in Approved Documents (ADs).

The ADs that apply to gas work are:

- A Structure
- B Fire safety
- F Ventilation
- G3 Hot water storage
- J Heat producing appliances
- L Conservation of fuel and power
- M Access to and use of buildings
- P Electrical safety in dwellings.

b) **Building Standards (Scotland) Regulations and Amendments**

The Building Standards (Scotland) are 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.

c) **Equivalent Regulations and Standards, Northern Ireland and Isle of Man**

Equivalent Regulations and ADs apply in Northern Ireland and the Isle of Man and an awareness of these is required (see <http://www.dfpni.gov.uk/index/buildings-energy-efficiency-buildings/building-regulations/br-technical-booklets.htm>).

3.3 **CONFINED SPACES REGULATIONS**

These Regulations apply to a large 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 should 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.

3.4 **CONSTRUCTION, (DESIGN AND MANAGEMENT) REGULATIONS (CDM)**

These Regulations impose duties on designers, clients (and their agents), developers, CDM Coordinator and principal contractors. Not all the regulations apply to all construction projects. Further information is given in L144. For a notifiable project (as defined in CDM) the CDM Coordinator must notify HSE before construction work commences. Construction includes the alterations, repair, redecoration, maintenance, decommissioning or demolition of a structure. It also covers installation, commissioning, maintenance or removal of gas services.

3.5 **CONTROL OF ASBESTOS AT WORK REGULATIONS**

3.5.1 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.

3.5.2 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.

3.5.3 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.

3.5.4 Further information is available in HSG227, and L143.

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

3.6.1 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.

3.6.2 Under COSHH, work must not 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 minimised. In certain cases, control measures such as ventilation or personal protective equipment (PPE) may be necessary and, where provided, they must be used.

3.7 **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. The regulations 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.

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

3.8.1 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 chimneys/flues.

Note: GS(I&U)R do not apply to certain premises (see L56 Guidance Notes 2(3) (8). However, where they do not apply, the principles of GS(I&U)R need to be applied, notwithstanding that the requirement for Gas Safe registration (see clause 3.8.4) need not be applied.

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

- 3.8.3 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.
- 3.8.4 GS(I&U)R defines the gas supplier for both NG and LPG. L56 provides guidance on those definitions, in particular for the more complicated case of LPG supplied from storage vessels and from cylinders.
- 3.8.5 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", for example be on the Gas Safe register.
- 3.8.6 GS(I&U)R requires that the installer checks 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 installer they use for the gas fitting, service or maintenance or safety is a member of an approved class of persons (see clause 3.8.4) and is competent to carry out such work. If any serious fault is found, the installer is to inform both the landlord/hirer, as well as the user, so that such faults can be rectified before further use.
- 3.8.7 GS(I&U)R place responsibilities on LPG suppliers to deal with leaks of LPG. For NG, GS(M)R applies.

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

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

- 3.9.1 GS(M)R place specific duties on gas transporters (GTs), 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 leaks from gas fittings supplied with gas from pipes on their network. Action on discovery of gas leaking on consumer's premises is limited to turning off the gas supply at the emergency control valve and advising the consumer to repair the source of the leaking by engaging a Gas Safe registered engineer to attend site and repair the leak, if appropriate. In GS(M)R, the term "gas escapes" includes leaks or emissions of carbon monoxide (CO) from gas fittings.
- 3.9.2 GS(M)R place specific duties on gas transporters (GTs) to set out in their safety case the arrangements the consumer has to put in place to prevent their plant or equipment producing a pressure of less than one atmosphere, or injecting extraneous gases (including air) into the GT's network. This may include the need to publicise that such equipment is to be fitted with antifluctuators or non-return valves.
- 3.9.3 Under certain circumstances, including where a "Landlord" distributes gas from the outlet of a bulk meter to consumers in a multi-occupational building, a person may be deemed to be conveying gas in a network such that they have responsibilities under GS(M)R.

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

Linked closely with specific duties under GS(I&U)R, (see Sub-Section 3.8) 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.

3.11 **PRESSURE EQUIPMENT DIRECTIVE (PED)**

- 3.11.1 PED applies to the design of pipework of MOP exceeding 500 mbar which is designed and installed for a site user, for example a factory occupier. PED is implemented in the UK by the Pressure Equipment Regulations (PER) and Pressure Systems Safety Regulations (PSSR). Compliance with PED can be demonstrated by the use of a harmonised standard. Systems falling within the scope of PED have to display a CE mark and this is to be affixed by an approved person or body.

Pipework of diameter not greater than 25 mm nominal size is partially exempt.

Note: Other pipework systems "designed and specified" by the customer which are thereafter installed and tested by a contractor will not normally fall within the scope of PED and sections of pipework designed and manufactured "off-site" will, generally, always fall outside the scope of PED if designed and specified by the contractor.

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

- 3.12.1 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 (SOL) and, where applicable, examination in accordance with a written scheme of examination drawn up or approved by a competent person (as defined by PSSR).

Guidance on the selection of competent persons is given in L122. Users (or owners) of pressure systems are free to select any competent person they wish, but they have to take all reasonable steps to ensure that the competent person selected can actually demonstrate competence i.e. the necessary breadth of knowledge, experience and independence. In judging levels of competence, users or owners may wish to know that a national accreditation scheme has been developed by the United Kingdom Accreditation Service (UKAS) for bodies that provide services of this nature.

- 3.12.2 Relevant fluids for the purpose of this document would be NG, LPG and LPG/Air at a pressure greater than 500 mbar above atmospheric pressure. A pressure system would include bulk storage tanks, pressure vessels, pipework and protective devices. Once the pressure in the pipework drops below 500 mbar, 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 500 mbar, for example at the entry to a building.

Note: A filter housing is considered to be a pressure vessel.

Note the special requirements placed on protective devices in such systems (see para 110b of L122). Pipelines and their protective devices where the pressure does not exceed 2 bar are exempt from PSSR (see Sch 1 part 1 item 5 of L122).

More information is available in L122 and in the HSE free leaflets INDG261 and INDG178.

- 3.12.3 Inspection is the process that ensures that the installation is suitable for further operation within the design or performance limits specified by the designer or competent person.
- 3.12.4 It is required to determine whether an installation is within the scope of PSSR and, if so, safe operating limits are to be specified and written schemes of examinations made available prior to commissioning.

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

- 3.13.1 The Regulations define work equipment as being any machinery, appliance, apparatus, tool or installation for use at work. Examples include spanners, wrenches, welding torches, ladders, lifting equipment and building services in common parts of a building.
- 3.13.2 The Regulations place duties on employers in relation to selection, suitability, maintenance, inspection, installation, instruction and training, prevention of danger and control of equipment.
- 3.13.3 More information on the Regulations can be found in L22. Free leaflets include INDG291 and INDG229.

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

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

- 3.14.2 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.

- 3.14.3 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 appropriate on-line 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.

On-line 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.

3.14.4 INDG453 contains detailed guidance on RIDDOR, including a full list of injuries etc. that need reporting.

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

www.igem.org.uk

SECTION 4 : GENERAL

- 4.1 The design of installed burners, controls and plant shall comply with recognized safety standards and procedures.

A typical schematic burner layout is shown in Figure 2.

- 4.2 Plant shall be accessible for safe operation, maintenance and commissioning. A risk assessment should be performed to ensure that the chosen location for plant is safe.

- 4.3 Where high level access is required, it shall be provided with safe means of access and egress, and safety protection barriers. Adequate illumination shall be provided or made available for work to take place with safety (see PUWER).

Safe means of egress shall be provided from all plant locations, especially confined plant rooms when means of isolating power and fuel to plant shall be considered.

Note: It is recommended that the maximum distance from fired plant to a safe place or means of escape be 12 m.

- 4.4 Where gas is not odourised, the design, operation, maintenance and commissioning of the system shall take account of the need for different procedures which may be highlighted following the performance of a risk assessment. Reference should be made to IGE/SR/25. All persons working on the plant shall be made aware of any additional safety requirements/procedures.

- 4.5 The inclusion of a check meter shall be considered for each item of plant, to enable the commissioning engineer to verify gas flows and for the plant operator to monitor energy consumption.

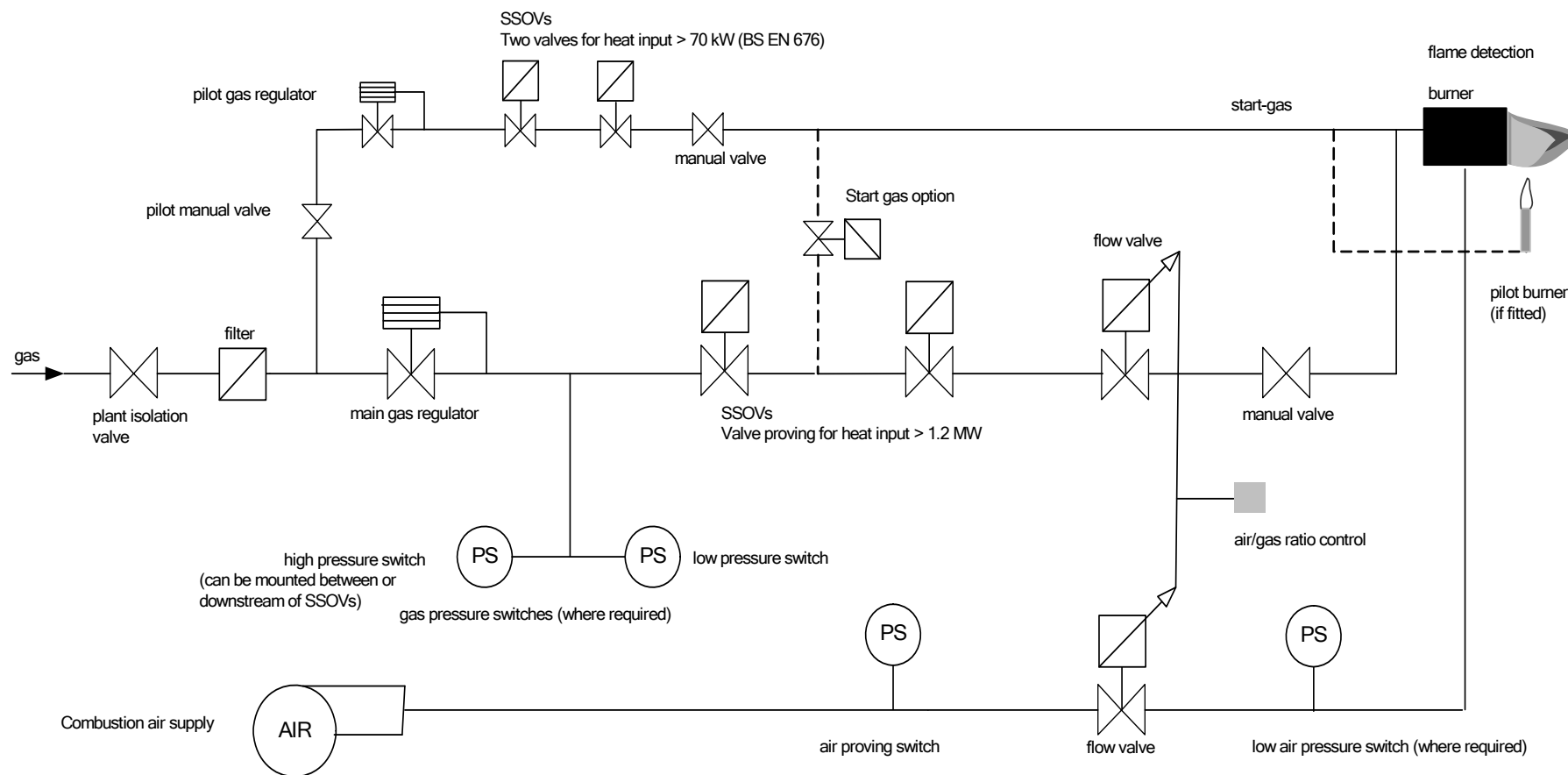


FIGURE 2 - TYPICAL SCHEMATIC BURNER LAYOUT

SECTION 5 : GAS SUPPLIES

5.1 FILTERS AND STRAINERS

5.1.1 Where necessary, filters/strainers shall be installed to protect regulators and other safety controls and to avoid the blockage of burner orifices.

5.1.2 A strainer shall be fitted at the inlet of any safety shut-off valve (SSOV) to prevent the ingress of foreign matter.

Note 1: Normally, filters/strainers are pre-fitted to the inlet of SSOVs complying with BS EN 161.

Note 2: In multiple valve SSOV systems, only one filter/strainer need be fitted, provided it gives adequate protection to all valves. For valves incorporating a self-cleaning or shearing action, the filter/strainer may be omitted.

5.1.3 Any filter/strainer shall have a maximum hole dimension not exceeding 1.5 mm and the mesh shall not pass a 1 mm pin gauge. Due allowance shall be made for the additional pressure drop across the filter/strainer when dirty.

5.1.4 Pressure test points should be fitted to enable checks to be made on the performance of each filter/strainer.

Note: A differential gauge, if fitted, will enable easy visual indication of filter/strainer performance.

5.1.5 Pipework shall be thoroughly cleared of debris, including dust, welding slag and loosely-adhering material prior to commissioning and during and after any pipework installation, modification or servicing.

5.2 PIPEWORK

5.2.1 General

Pipework shall be designed and installed in accordance with relevant British Standards and IGEM/UP/2. The following gives guidance on aspects relevant to plant pipework. Consideration shall be given to the fitting of a line diagram local to large plant, showing the location of any manual isolation valve intended for use in an emergency.

Note: For OP > 50 mbar, it is recommended that both the pressure and direction of flow are indicated on the pipework.

5.2.2 Flexible pipes

5.2.2.1 Pipes should be kept as short as practicable and protected from excess heat, corrosion and mechanical damage, and should be installed so as to be accessible for regular inspection and maintenance.

5.2.2.2 Pipes should not be located upstream of the first plant automatic SSOV unless protected by a further SSOV to BS EN 161.

5.2.2.3 For commercial premises, pipes (other than those used for lighting torches) shall be of metallic construction. They shall be fit for the purpose and the applied pressures. Reference should be made to BS EN ISO 10380 or BS 699-2 as appropriate. However, when selecting flexible pipe, care shall be taken to ensure the appropriate grade is suitable for the duty involved.

Note: Further details are provided in IGEM/UP/2.

5.2.2.4 For industrial premises, pipes shall be made of a material that is fit for purpose and the operating environment.

Note: This may include stainless steel to BS 6501 or a special rubber hose.

- 5.2.2.5 The installation method shall ensure electrical continuity across the hose. Where a stainless steel pipe is installed in a corrosive environment, it shall be suitably protected, for example by an outer cover as specified in BS 669-2.
- 5.2.2.6 For a lighting torch of $OP \leq 25$ mbar, the pipe shall at least be to the standards specified in BS 669-1, 2 or 3, as appropriate.
- 5.2.2.7 A suitable isolation valve (preferably a manual valve) shall be installed in a readily accessible position, upstream of the inlet of any section of pipe. A valve shall not be located within pipes containing air/gas mixtures.
- 5.2.2.8 For pipe that is flexed or disconnected during normal operation of plant, leakage tests should be carried out at least monthly.

Note: An appropriate test would be by the use of a leak detection fluid.

5.2.3 **Purge and test points**

5.2.3.1 *Purge points*

Where long runs of pipework are necessary to distribute gas, consideration shall be given to the provision of a purge point at the extremity of the pipework run, to allow purging both initially and after prolonged shut-down. During normal operation of the plant, such a purge point shall be fitted with a valve, itself fitted with either a plug or cap.

It shall be possible to release gas to a safe place during commissioning etc.

Note: In general, purge points are required either side of manual section isolation valves. See also IGE/UP/1 and IGEM/UP/4.

The pressures being used in purging to gas and to air shall be taken into account when determining the size of purge points for each part of the installation.

Note: Purge points for low pressure purging will, typically, be 25% of the diameter of the main pipework to be purged.

5.2.3.2 *Test points*

Sufficient pressure test points shall be provided on the plant and gas supply(ies) to the plant, to enable pipework and controls to be pressure tested during maintenance and commissioning.

Note: In general, this will require such points to be fitted either side of every valve, regulator and meter.

A valved purge tapping should be fitted immediately upstream of the main plant manual isolation valve (see clause 5.4.1). Typically, this should be not less than 25% of the valve size.

5.2.3.3 *General*

Pressure test and purge points should not be left open ended. A plug or cap should only be used for lower pressures. At higher pressures, to avoid danger upon removal of a plug or cap, consideration shall be given to other means of sealing, for example self-sealing plugs and sockets with dust caps.

5.2.4 Gas boosters, compressors and pre-mix machines

5.2.4.1 The installation of any gas booster, compressor or pre-mix machine shall be in accordance with IGEN/UP/2 Edition 3 or IGEN/UP/6 Edition 2, as appropriate.

5.2.4.2 The inlet and outlet connection of any gas booster shall be fitted with a stainless steel flexible pipe. Reference should be made to BS EN ISO 10380 or BS 699-2 as appropriate. However, when selecting flexible pipe, care shall be taken to ensure the appropriate grade is suitable for the duty involved.

5.2.4.3 Any booster shall be fitted with a low pressure sensing device set to cause the booster to lock out in the event of low inlet pressure. The set pressure shall be agreed with the GT prior to installation.

Note 1: For MOP ≤ 100 mbar, the set pressure is, typically, 50% of normal inlet pressure.

Note 2: It may be permissible for burners to continue to operate at low fire if the booster fails to operate upon demand, provided combustion remains within safe levels. Very high excess air levels may lead to the production of CO, nitrogen oxides (NOx) or aldehydes.

5.2.4.4 Suitable manual isolation valves shall be installed to permit safe maintenance.

5.3 GAS PRESSURE

Gas pressure regulators shall be incorporated where control of the flow rate and pressure is necessary. Gas pressure regulators, when fitted, shall comply with EN 88 or EN 334 as appropriate.

Plant designed for approximately 20 mbar supply pressure shall operate at its declared rating at a pressure of 17.5 mbar at the inlet of the plant isolation valve and continue to operate safely or proceed to safety shut-down at an inlet pressure of 12.5 mbar or below.

For a higher supply pressure, plant shall be designed to operate safely under all inlet pressure conditions. Where MIP of the gas supply exceeds MOP of the appliance, additional safety protection shall be applied, for example an over-pressure protection cut-off valve or a higher pressure-rated regulator and relief valve.

Account shall be taken of the pressure surges that may occur on rapid shut-down of plant.

Note: These could affect metering accuracy and plant safety.

5.4 MANUAL VALVES

5.4.1 A main plant manual isolation valve shall be installed upstream of all other gas controls on the plant, and as close as possible to the plant, in a safe location and in an easily accessible position in the gas supply. Any manual valve shall be clearly marked with its open and closed positions. Consideration shall be given to the use of a valve that can be physically locked in the closed position.

Note: The use of further downstream, gas isolation valves on pilots and main burners, as shown in Figure 2, represents good practice for process equipment to promote safe commissioning and maintenance.

5.4.2 For a multi-burner plant, each burner shall be provided with a manual gas isolation valve in an accessible position but as close as possible to the burner and, preferably, downstream of all other gas controls. However, if the installation of such a manual valve would affect the mixing characteristics of any venturi mixer etc., the valve shall be installed upstream of any such mixer.

5.4.3 On complex plant and plant of OP > 0.5 bar, consideration shall be given to the incorporation of a line diagram that clearly shows the location of all manual gas isolation valves. For such plant, each valve should be clearly identified by means of labels etc.

5.4.4 Any manual gas isolation valve shall, as far as is practicable:

- be of the quick opening and closing type
- have clear indication of position
- have stops at the open and closed positions
- be selected with due regard to thermal hazards.

5.4.5 A multi-turn valve shall not be used as a manual gas isolation valve except on very large plant where there is no alternative. At higher pressures, consideration shall be given to the speed of opening of valves as to prevent fast opening causing pressure surges damaging sensitive components.

Note: In such cases, a small pressurizing valve around the valve in question may be appropriate.

5.4.6 If, under the effect of gravity, vibration etc., the manual valves required by clause 5.4.1 are likely to move from the set position, they shall tend to the closed position.

5.5 GAS SUPPLY CONTROLS

5.5.1 Non-return valves (NRVs)

5.5.1.1 Where any plant or burner is supplied with air, oxygen or any other extraneous gas under pressure or where it may produce pressure fluctuations in the supply pressure, a means shall be installed in the gas supply to each burner, group of burners or the plant, to prevent the admission of air, oxygen or extraneous gas into the Network (as required by GS(I&U)R). This requirement can be met by the installation of a NRV of a type acceptable to the GT (see Appendix 12).

Note 1: The valve may also protect other plant on the same installation pipework.

Note 2: If the oxygen, air or gas operating pressure could, normally, exceed the maximum reverse pressure of the NRV as declared by its manufacturer, an alternative form of protection for the fuel supply is necessary (see Appendix 12).

Note 3: IGEN/UP/2 provides further guidance. In practice, fitting a NRV at each point of use/appliance provides protection to all other items of plant on the site.

Note 4: This procedure would be satisfied if:

- the only extraneous gas is air for combustion, and
- each start-gas and main flame is protected by a flame safeguard having a response time to flame failure complying with clause 8.2.4 or 8.2.8, as appropriate, and
- the gas supplies to the start gas and main flame burners are each under the control of at least one Class A (Class 1) SSOV having a closing time of no more than 1 second and capable of withstanding a reverse flow pressure differential of at least twice the maximum combustion air pressure.

5.5.1.2 Where necessary, the gas supply to any air blast lighting torch shall be separately protected by a NRV.

5.5.1.3 A NRV shall be fitted to the gas supply(ies) where the burners are supplied with air or any other extraneous gas under pressure and where the burner is not protected by a separate flame safeguard.

5.5.1.4 A NRV shall be fitted to the gas supply(ies) to any burner supplied with oxygen/oxygen enrichment.

5.5.1.5 Where a NRV is required and, for reasons of space and economy, it is not possible to protect individual burners, for example when a number of oxy-gas burners connected to a common supply pipe are in close proximity, each group of burners should be protected by a NRV. For an automatic glass working machine and similar types of plant, a NRV should be fitted in the fuel gas supply near its inlet to the machine.

5.5.2 Pressure regulators

- 5.5.2.1 Normally, the main and start-gas supplies shall be under the control of a constant pressure regulator(s), in addition to any regulator within the upstream meter installation or Network. However, other equally effective means of control may be provided in which case the means of pressure control shall be suitable for its purpose.
- 5.5.2.2 Any regulator should comply with BS EN 88 or BS EN 334, as appropriate. Where MOP falls outside the scope of these two standards, the regulator shall be suitable for the inlet MOP to the plant/burner and be able to control the pressure to the plant/burner within the required range. It shall be possible to seal or lock the regulator adjusting mechanism (see also Appendix 3).
- 5.5.2.3 A regulator seal shall be provided for any adjusting mechanism, to prevent unauthorised adjustment.
- 5.5.2.4 Any regulator shall be marked with its pressure range.
- 5.5.2.5 Where failure of a regulator could lead to fuel-rich or dangerous conditions, a suitable means of overpressure protection shall be applied. Any pressure relief valve shall be safely terminated, for example to an external position where there are no ignition sources (see also IGEN/SR/25).

Note: This may be satisfied by compliance with clause 5.6.1 or it may be necessary to fit an overpressure cut-off device with a creep pressure relief valve.

- 5.5.2.6 Vents from pressure relief valves shall not be commoned or manifolded with any other vents.
- 5.5.2.7 Pressure tappings shall be fitted to enable the upstream and downstream regulator pressures to be measured.

5.6 HIGH AND LOW GAS PRESSURE PROTECTION

5.6.1 High gas pressure protection

- 5.6.1.1 The design shall prevent pipework and control equipment being subjected to pressure in excess of their maximum design rating.

Note: This can be achieved by designing pipework and control equipment to function safely with the pressures likely to occur under fault conditions, such as meter outlet pressure fault conditions (for example, the set pressure of the SSOV or the monitor regulator set pressure). This information is available to the consumer from the gas supplier.

- 5.6.1.2 If the outlet side of the regulator and/or the following pipe section with control equipment up to the burner is/are not designed for the inlet MIP:

- a high gas pressure shut-off valve shall be applied upstream of the regulator, shutting off the gas supply before an excessively high pressure occurs and
- a safety relief valve shall be installed downstream of the regulator. This valve shall be vented to a safe area (see clause 5.5.2.5).

Note 1: These devices may be integrated in one device.

Note 2: BS EN 676 burners may not meet the requirements for overpressure protection in all cases, as the manufacturer may be unaware of the supply pressure conditions.

- 5.6.1.3 Where an overpressure shut-off valve is fitted, a small capacity relief valve shall be fitted downstream of the regulator to minimise nuisance trips.

5.6.1.4 High gas pressure protection shall be fitted where:

- a burner is not fitted with a flame safeguard
- the pressure drop across the plant regulator is greater than 30% of the normal operating minimum regulator outlet pressure
- regulator failure could lead to an unsafe start-gas rate, for example where there is start-gas flame ignition in accordance with clause 8.4.5.2(a) and regulator failure could result in the ignition rate exceeding the requirements of clause 8.4.5.2(a)
- the equipment capacity exceeds 600 kW and the inlet MOP exceeds 100 mbar
- where a risk assessment determines that regulator failure could lead to unsafe operating conditions
- where specified by designers or other regulations.

5.6.1.5 Where high gas pressure protection is required, the system shall prevent start-up or cause safety shut-down, or non-volatile lockout, in the event of high pressure occurring.

5.6.1.6 Where high gas pressure protection is required, the pressure sensor shall be in operation by the beginning of the main flame establishment period or, for burners ignited in accordance with clause 8.4.5.2(a), at the beginning of the start-gas flame ignition period.

Note 1: High gas pressure protection devices are often fitted between, or downstream of, the two main SSOVs.

Note 2: Where high gas pressure protection is required, the pressure sensor will, normally, be upstream of the throughput control valve.

5.6.2 Low gas pressure protection

5.6.2.1 Low gas pressure protection shall be fitted in the following circumstances:

- where a burner is not fitted with a flame safeguard
- where a burner is fitted with a flame safeguard but where a reduction in gas pressure may cause the burner to become unstable, or combustion to become unsatisfactory, before the flame safeguard can operate.

5.6.2.2 Where low gas pressure protection is required, the system shall prevent start-up or cause safety shut-down or non-volatile lockout in the event of low gas pressure occurring.

Note 1: It is permissible to have a single re-attempt at ignition after a low pressure condition.

Note 2: BS EN 676 burners meet the requirements for low gas pressure protection.

5.6.2.3 If a gas booster is fitted, a low-pressure cut-off switch must be fitted upstream of the booster. This shall shut-down the booster in the event of reduced pressure and prevent automatic re-start on pressure restoration. The cut-off pressure shall be based on the prevailing distribution pressures and be decided by the GT.

Note: The cut-off pressure is, typically, set to 50% of normal pressure. See also IGEN/UP/2.

5.7 AIR/GAS MIXTURES (PRE-MIX SYSTEMS)

5.7.1 The system shall be designed to provide a sufficiently high mixture velocity to prevent flame propagation in the reverse direction to flow.

Note: Advice is contained in BS EN 746-3, HSG 158 and BS EN 12874.

5.7.2

Where there is no practical alternative to the distribution of air/gas mixtures around plant:

- the mixture pipe shall be as short, and the contained volume as small, as practicable. Alternatively, the system shall be fitted with a sensor that causes non-volatile lockout should the forward velocity fall below a pre-determined safe level
- means shall be provided to protect the mixing machine from flashback, unless specified otherwise by the manufacturer.

Note: This may require the fitting of a flame arrestor meeting BS 7244. Advice is contained in HSG158 and BS EN 12874.

- when the air/gas mixture produced is outside the flammable range, means shall be provided to prevent the mixing machine from producing a flammable mixture
- the mixing machine shall stop on failure of the inlet gas pressure or blockage of the air inlet, and shall require manual re-setting
- any mixing machine incorporating a booster shall be fitted with a low pressure cut-off device and a NRV in the gas supply
- a valve shall not be placed in an air/gas mixture line from a mixing device, unless specified by the manufacturer.

In all cases, requirements to prevent flash-back, as stated by the manufacturer, should be followed.

Note: Procedures for low pressure cut-off switches and pre-mix machines are given in IGEN/UP/2 Edition 3.

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SECTION 6 : CHIMNEYS/FLUES, COMBUSTION AND VENTILATION AIR SUPPLIES

6.1 GENERAL

6.1.1 Ventilation of a building and contained plant shall be such as to allow an adequate supply of process air and of combustion air to reach the burner(s)/plant under all conditions. Ventilation air into the building shall be sufficient to also maintain the working environment within acceptable and safe levels.

6.1.2 Ventilation shall take account of the safety of persons, all fuel burning plant, heat emitting plant, surfaces, motors etc.

6.1.3 As far as is practicable, ventilation should be provided at both high and low level and be distributed around external walls near to plant locations. Ventilation shall be located as high as reasonably practical within a building, i.e. within 15% of the height of the building at ceiling/roof level.

Note: The scope of IGE/UP/12 embraces NG only. This procedure would be different for a heavier than air gas.

6.1.4 Special consideration shall be given to the requirements arising from the use of complex systems, for example any:

- multi-fan draught system
- multi-burner installation
- chimney/flue gas re-circulation system
- supplementary or auxiliary firing burner in gas turbine or engine exhaust (see IGE/UP/9 and IGE/UP/3, respectively)
- purging of gas turbine and engine exhaust system used in association with other fired plant
- purging of a gas re-cycling fan/duct
- rotary air heater and gas by-pass system
- pre-heated air and recuperative system, including the thermal protection of hot surfaces
- oxygen-enriched system (see Appendix 12)
- other burner system not fitting into the above categories
- electrostatic precipitator or other possible source of ignition within the chimney/flue
- chimney/flue gas analysis trimming system.

6.2 MECHANICAL VENTILATION

6.2.1 Any mechanical ventilation system shall:

- not lead to below-atmospheric conditions
- not adversely affect the operation of any chimney/flue system
- be interlocked with all items of plant whose safe operation depends on the operation of the fan(s).

6.2.2 Failure of the ventilation system shall lead to plant shut-down or non-volatile lockout.

6.3 MECHANICALLY SUPPLIED COMBUSTION AIR

6.3.1 Failure of mechanically-supplied forced or induced combustion air shall prevent start-up or cause safety shut-down or lockout (see also Sub-Section 8.1).

Note: Air flow can be monitored as follows:

- *by static pressure sensing, where it can be shown that it provides satisfactory and reliable proof of air flow during the purge, ignition and subsequent firing*
- *by flow sensing, for example differential pressure measurement, where static flow sensing is inadequate to give unambiguous proof of air flow*
- *by power measurement where the sensing is adequate to prove the correct fan power in relation to the required air flow.*

6.3.2 Any air flow proving device shall prove the “no air” position prior to the combustion air fan starting. For an automatic gas burner, reference should be made to BS EN 676.

Note: Where an air pressure switch is used for flow proving and a combustion air fan is required to start up prior to the commencement of the burner programmer start-up, “no air” proving can be accomplished by use of a three port valve between the pressure switch and the air tapping. The valve is energised from the fan motor start on the burner programmer. The pipe between the switch and the valve needs to be vented to atmosphere when the valve is in its normally-closed position.

6.3.3 The tapping points of any pressure sensing system shall be arranged so that the static pressure difference in a system with a closed damper does not result in an apparent flow signal being given.

Note: For a power measurement system the closure of a system damper may also lead to inadequate proof of air flow.

6.3.4 Consideration shall be given to the inclusion of a fan starter contact interlock, to prove the starter in the correct position during the operation of the burner. Failure of this interlock shall cause safety shut-down or non-volatile lockout.

Note 1: The provision of an air pressure or draught indicator is advisable.

Note 2: BS EN 676 burners meet the requirements for air pressure protection but such burners may need additional system protection.

6.3.5 A combustion air fan should not be located such that variations in combustion air temperature, detrimental to combustion conditions in the plant, will occur.

6.3.6 Any air inlet on a fan and air inlet port on an injector/burner should be protected from blockage or restriction.

In particular, where a small bore air system or bleed system is utilized, consideration should be given to the installation of a filter on any combustion air fan.

6.3.7 Any combustion/ventilation air inlet shall be located such that it will not induce combustion products from plant (unless provided for in the design) nor induce other noxious substances. Special attention shall be given to reverse flows of hot gases into air systems (when plant is shut-down) that might lead to failure of components, damage to fans or danger to persons from hot surfaces.

6.3.8 Combustion air shall not be taken from areas containing flammable vapours, or gases or excessive dust, unless provided for in the design.

6.3.9 Means shall be provided to fix securely any pre-set air damper, valve and air regulation slide fitted to injectors or burners in their set positions. Any air damper or valve shall be fitted so that, under the effects of gravity, vibration, etc, any movement that occurs in the event of failure of the fixing device shall be towards the safe position.

6.3.10 Where combustion air, for example compressed air, is ducted or piped directly from outside, to a burner, adequate provision shall be made for plant ventilation and the safety of persons.

6.3.11 Following safety shut-down due to incorrect air pressure or flow, automatic re-start shall not be permitted unless repetitive re-cycling would not cause a hazard.

- 6.3.12 For a furnace where a deviation in furnace pressure could lead to a hazardous condition, such deviation shall result in safety shut-down.

6.4 **CHIMNEY OR FLUE/EXTRACT SYSTEMS**

Any chimney/flue or extract system from gas fired plant shall comply with the appropriate procedures in IGE/UP/10. Materials shall be fit for purpose and shall be insulated appropriately to prevent danger to persons and property.

The fan motor should not be fitted with speed control, unless it is integral with the fuel/air ratio control of the burner system.

SECTION 7 : ANCILLARY SUPPLIES

7.1 ELECTRICITY

- 7.1.1 Any electrical supply, equipment and installation shall comply with appropriate standards, for example BS 7671, BS EN 50156-1, BS EN 60204-1, BS EN 60059-10.

Any work on an electrical supply must comply with the Electricity at Work Regulations and reference shall be made to the associated memorandum of guidance.

Electrical equipment on gas-fired plant shall take into account the requirements of low voltage directive (LVD) and electromagnetic compatibility (EMC).

- 7.1.2 Any burner and its associated equipment shall function satisfactorily when the voltage supplied is up to 10% above, and 15% below, the normal voltage, or an equivalent tolerance on the claimed voltage range of the equipment. Outside this range, the equipment shall either continue to function safely or go to safety shut-down.

- 7.1.3 Interruption and/or restoration of electricity supply at any time during the start-up or operation of any burner shall result in continued safe operation or safety shut-down.

Where a burner, plant or product may be damaged upon power failure, for example due to over-heating, consideration shall be given to the design and to the need for standby power supplies or additional thermal protection.

- 7.1.4 Interruption and/or restoration of the electricity supply shall not defeat any safety or volatile lockout condition.

- 7.1.5 Where it is intended to install electrical equipment adjacent to gas-fired plant, a risk assessment must be carried out to assess whether a hazard would exist. If identified as necessary by the assessment, hazardous area classification must be carried out. Where necessary, any electrical equipment shall be selected to meet the appropriate requirements. This assessment shall include potential hazards from extraneous sources.

Note 1: For a supply pressure of approximately 20 mbar, the risk of presence of flammable concentrations of fuel gas in the vicinity of properly-installed burner pipework and control equipment is very low, when explosion-protected equipment would not, normally, be necessary provided plant ventilation is adequate.

Note 2: More specific safety requirements for gas turbines are included in IGE/UP/9.

- 7.1.6 DSEAR requires that a hazardous area classification must be established for all pipework on non-domestic premises. The severity and thus the effects of the classification can be mitigated by good design. Guidance can be found in IGE/SR/25 Edition 2, IGE/UP/16 or Energy Institute's document EI IP-MCSP-P15.

Note: Outlet pipework from air/gas mixing machines will need a separate risk assessment that addresses the contained gas mixture.

- 7.1.7 Any means of isolation of the electricity supply, for example an emergency switch, shall be provided in a safe and accessible area.

- 7.1.8 Where a transformer supplies low voltage to a control circuit, consideration shall be given to the safety of secondary circuits in order to minimise voltage potentials, for example secondary coils centre-tapped to earth or neutral at zero potential.

- 7.1.9 Where necessary, appropriate safety signs shall be incorporated to warn of the presence of high voltage.

7.2 INSTRUMENTS AND CONTROL FLUIDS

- 7.2.1 Undue loss of instrument or control fluid pressure, for example high pressure air, shall result in continued safe operation or safety shut-down. Reference should be made to BS EN 982 and BS EN 983, as appropriate.
- 7.2.2 Where a control fluid operates a safety component that is not fail-safe on loss of fluid, a reservoir, having a NRV on its inlet connection, shall be fitted. The volume of fluid contained in this reservoir shall be such as to safely shut down the plant (see clause 7.2.1).

SECTION 8 : THE SYSTEM

8.1 GENERAL

The control and safeguarding of any plant depends on the mode of operation and, in particular, on the degree of automation or manual operation required. Therefore, the system installed may vary from manual operation with some operations supervised by interlocks, for example semi-automatic, to fully automatic operation.

8.1.1 The control and flame safeguard of plant shall, as far as is reasonably practicable:

- be of a fail-safe design

Note: This can be achieved by the application of certain criteria, for example relays go to the de-energised position for shut-down, lockout and other safety conditions.
- prevent a single fault or failure leading to the main SSOV being permanently energised
- ensure important components and interlocks, where appropriate, are checked in the start-up sequence, for example:
 - the air flow interlock is proved in the "no air" position
 - safety-critical relays and timers are proved in the correct position
- ensure operation of push buttons, switches, etc., incorrectly or out of sequence, will not adversely affect the safety of the system
- where components are of plug-in design and similar appearance, be designed such that inadvertent substitution will not adversely affect the safe operation of the system or, where this is not possible, the components are clearly marked with easily distinguishable labels
- have all circuit diagrams clearly presented with adequate legends to avoid ambiguity, and kept up to date
- have systems designed such that repeated operation of a manual re-set button cannot adversely affect the safety of the system. In this case, users shall be advised that repeated re-set of the system from a lockout condition, without manual investigation, is not recommended
- where a programmable electronic system (PES) is used for burner management, ensure that automatic re-set by the PES from a non-volatile lockout condition, whether by remote or local means, is prevented. This procedure would be satisfied if the system is designed to interrogate itself to ensure that automatic re-set is permissible and will lead to a safe and successful ignition sequence. Reference should be made to IGEM/SR/15, BS EN 61508-1 and BS EN 61511-1.

The principles of this clause should be used to ensure the safe operation of the plant. Fully automatic forced draught (FD) or induced draught (ID) burners shall conform to BS EN 676 or BS EN 746 Part 2 or these Procedures.

8.1.2 Consideration shall be given to controlling the ramp rate of the main flame at start-up and normal shut-down, in order to limit thermal shock to metallic components, welded joints and refractories.

The following sub-sections outline good practice for the safe operation of burners. Modern automatic burner start-up provides a high level of safety but this does not preclude the application of semi-automatic control systems.

Note: In this respect, semi-automatic means that manual intervention is required after the system has been activated. This may be to provide ignition or to open gas valves etc. In all other respects, the criteria for safety are the same as for automatic systems, excepting those rare cases for plant operating above 750°C where flame safeguards are not fitted.