IGEM/UP/21
Communication 1818

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LIQUEFIED NATURAL GAS FUELLING STATIONS

Draft for Comment

1 This draft Standard IGEM/UP/21 has been prepared by a Panel Chaired by Mr Steven Lua.

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

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Attached is the Draft for Comment of IGEM/UP/21 and the associated comment form.

We wish to make it as easy as possible for those of you representing industry bodies to issue the draft to your Members. You can either forward this email with attachment complete or forward it without the attachment and invite them to visit our website via where the Draft and http://www.igem.org.uk/technical-standards/standards-development/drafts-for-comment.aspx Comment Form are posted.

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SECTION 1 : INTRODUCTION

1.1 This Standard covers Liquefied Natural Gas (LNG) and Liquefied Compressed Natural Gas (LCNG) Fuelling Stations.

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

1.3 The intent of this Standard is to provide requirements for design, construction, testing, commissioning, and guidelines on general operation and maintenance of LNG and LCNG fuelling stations and facilities.

It is addressed to designers, manufacturers, installers and operators, for whom this document provides the basic principles for the design and installation of facilities and parts thereof, and to operators, for whom the minimum requirements for safe operation are given. It also serves as a basis for the inspection of LNG and LCNG fuelling stations.

It is necessary to ensure, through the use of Standards and compliant and fit for purpose components and materials, that LNG and LCNG fuelling stations and their components, when correctly constructed, operated and maintained are permanently safe while in operation and prior to de-commissioning. Preventive measures are required to prevent fire and explosion and to provide protection against their effects.

1.4 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 someone's actions initiated or contributed to the accidents or someone could have acted better to avert them. It is therefore necessary to give proper consideration to the management of these human factors and the control of risk. See for instance HSG48 and HSG65.

1.5 The document makes use of the terms "should", "shall" and "must" when prescribing particular requirements:

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

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 Requests for interpretation of this Standard in relation to matters within its scope, but not precisely covered by the current text, should be addressed in writing to Technical Services, IGEM, IGEM House, High Street, Kegworth, Leicestershire, 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 engineer of his or her obligations.

1.7 This Standard was published on xxxx.

SECTION 2 : SCOPE

2.1 This Standard covers all aspects of planning, design, construction, installation, testing, commissioning, operation, maintenance and decommissioning of fuelling stations which deliver:

- LNG intended for use as a vehicle fuel; or
- CNG derived from LNG intended for use as a vehicle fuel.

Note 1: This Standard predominately addresses the requirements associated with the fuelling of road vehicles but can also cater for marine, rail, and aerospace applications providing the relevant sector-specific safety codes are followed.

Note 2: This Standard may be used as general guidance for applications where natural gas is not necessarily intended for use as a vehicle fuel (e.g. industrial systems for combustion).

Note 3: CNG fuelling stations are covered by IGEM/UP/20.

2.2 This Standard applies to all LNG and LCNG fuelling stations.

Note 1: Natural gas quality specifications can vary significantly and compatibility with all intended systems need to be considered. Certain grades of natural gas can adversely affect certain combustion systems due to pre-ignition. Certain trace elements can lead to premature equipment failure due to unanticipated material degradation.

Note 2: Biomethane is a widely-accepted substitute for fossil natural gas. Other natural gas blends such as hydrogen-enriched natural gas (also known as hythane) are of growing interest but any such delivery systems are likely to have additional safety requirements beyond the scope of this Standard.

Note 3: The "methane number" is a property of natural gas that can help to determine its suitability for use in engines (such as whether it may lead undesirably to "engine knocking"). There are various different methods of calculation leading to slightly different results. For more information, refer to ISO/TR 22302.

Note 4: Natural gas engines generally require fuel being delivered to it at a given pressure under saturation conditions, thus it is commonly expected that LNG fuelling stations deliver fuel at a given pressure in its saturated state. Some LNG fuelling stations may opt to provide LNG in its sub-cooled state. Both cases fall within the Scope of this Standard.

2.3 This Standard applies to LNG fuelling stations operating at a maximum operating pressure (MOP) not exceeding 31 bar.

Note 1: This Standard may be used as general guidance for LNG stations designed for higher MOPs providing due cognisance is given to all and any additional safety requirements.

Note 2: The aforementioned maximum operating pressure falls in line with the requirements of LNG refuelling connectors as defined by BS ISO 12617.

2.4 This Standard applies to LCNG fuelling stations operating at a maximum operating pressure (MOP) not exceeding 300 bar.

Note: This Standard may be used as general guidance for LCNG stations designed for higher MOPs providing due cognisance is given to all and any additional safety requirements.

2.5 This Standard includes fuelling stations of the following types:

- public access (self-service or assisted)
- private access (self-service or assisted)
- fuelling stations supplying mobile storage units
- fuelling stations supplied from mobile storage units
- mobile fuelling stations

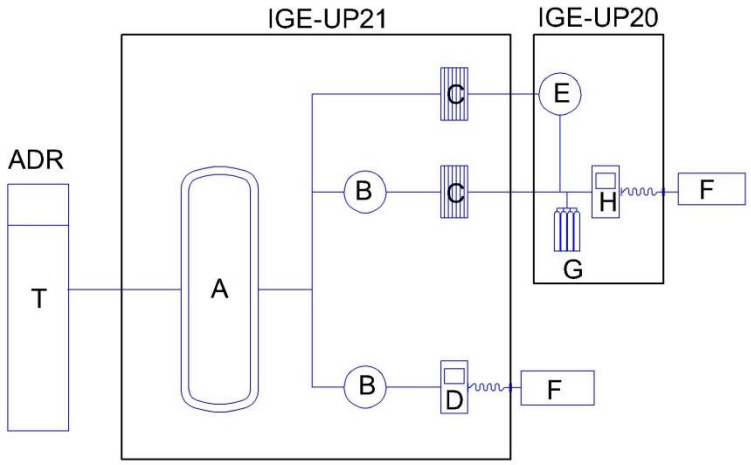
2.6 This Standard applies to private and commercial fuelling stations. If fuelling stations are intended to be used by the general public, due regard needs to be taken to any additional public safety, security and trading Standards issues.

2.7 Under the guidance of this Standard, fuelling stations may be integrated with new or existing fuelling facilities for other fuels, noting that by doing so this may impact the site licensing conditions.

2.8 Guidance on the operation and maintenance of fuelling stations is given in Section 6.2.2.

2.9 All pressures quoted are gauge pressures, unless otherwise stated.

2.10 A diagrammatic representation of the scope can be depicted as below:



Scope & Boundaries of IGE-UP21

Legend

A	LNG Storage Tank
B	Pump
C	Vaporiser
D	LNG Dispenser
E	Compressor
F	Motor Vehicle
G	CNG Buffer
H	CNG Dispenser
T	LNG Delivery Tanker

FIGURE 1 – SCOPE AND BOUNDARIES OF IGEM/UP/21

SECTION 3 : LEGAL CONSIDERATIONS

3.1 GENERAL

3.1.1 This Standard is set out against a background of legislation in force in GB at the time of publication. Similar considerations are likely to apply in other countries and reference to the appropriate national legislation will be necessary. The following legal considerations outlined are particularly relevant.

3.1.2 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.

3.2 PRIMARY LEGISLATION

3.2.1 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, maintenance and alteration of in scope gas systems must be competent to carry out such work. Competency is achieved by an appropriate combination of education, training and practical experience.

3.2.2 Pressure Equipment Directive (PED)

PED applies to the design of systems of MOP exceeding 0.5 bar which is designed and installed for a site user, for example a factory occupier. PED is implemented in the United Kingdom (UK) by the Pressure Equipment Regulations (PER) and the Pressure Systems Safety Regulations (PSSR).

Compliance with PED can be demonstrated by the use of a harmonised Standard. BS EN 15001-1 and BS EN 15001-2 have been specially prepared for the gas industry and include a wide range of materials. Systems falling within the scope of PED must display a CE mark and this must only be affixed by an approved person or body.

Guidance on the selection of competent persons is given in HSL122. 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.

3.3 SECONDARY LEGISLATION

3.3.1 Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations

These regulations implement and enforce in the UK provisions from the European Agreement concerning the International Carriage of Dangerous Goods

by Road (ADR). ADR is intended to increase the safety of international transport of dangerous goods by road including gases (including compressed, liquefied and dissolved under pressure gases and vapours).

3.3.2 Confined Spaces Regulations

These Regulations apply to a large range of confined spaces. The supplier, designer or operator 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.

3.3.3 Construction (Design and Management) Regulations (CDM)

CDM impose duties on designers, clients (and their agents), developers, planning supervisors and principal contractors. Not all the regulations apply to all construction projects. Further information is given in HSL144. For a notifiable project (as defined in CDM) the planning supervisor 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.

3.3.4 Control of Major Accident Hazard Regulations (COMAH)

COMAH apply to industrial installations where certain quantities of specified substances are stored and relate to the measures in place in order to identify and mitigate the risks involved in storing such substances. This may be applicable to an LNG storage facility.

3.3.5 Control of 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.

3.3.6 Dangerous Substances and Explosive Atmospheres Regulations (DSEAR)

DSEAR is concerned with protection against risks from fire, explosion and similar events arising from dangerous substances used or present in the workplace. DSEAR 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. DSEAR also require the identification of pipelines and containers containing hazardous substances.

Details of DSEAR and their application are contained in INDG 370 and 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 0.5 bar do not require the use of certified electrical components if correctly installed, tested and maintained.

3.3.7 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: HSR25 provides guidance on the Regulations.

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

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

Note: GS(I&U)R do not apply to certain premises (see HSL56 Guidance Notes 28 and 29). However, where they do not apply, the principles of GS(I&U)R need to be applied.

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. 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 Gas Safe registered.

The installer must check the safety of any appliance or pipework they install or work on and take appropriate action where they find faults. Where the premises are let or hired out, the landlord or hirer has special responsibilities to ensure that any 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 must inform both the landlord/hirer, as well as the user, so that such faults can be rectified before further use.

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

Linked closely with specific duties under GS(I&U)R (see Sub-Section 3.4) 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.

3.3.10 Pressure Equipment Regulations (PER)

PER are intended to allow the free trade of pressure equipment throughout the European Union (EU). PER deal with the manufacture, design and supply of pressure equipment. They impose duties on the responsible person.

Note 1: 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."

Note 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."

Note 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 is, in fact, safe.*

Note 4: Not all pressure equipment is covered by PER. There are 21 categories of exceptions, detailed in Schedule 1 of PER.

Note 5: The relevant conformity assessment procedure is determined by the classification of the pressure equipment according to criteria laid down in PER.

The classification system results in equipment being placed in one of 5 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 or type testing.

3.3.11 Pressure Systems Safety Regulations (PSSR)

3.3.11.1 PSSR 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 the correct design installation and maintenance, provision of information, operation within safe operating limits and, where applicable, examination in accordance with a written scheme of examination drawn up or approved by a competent person (as defined in PSSR).

3.3.11.2 Relevant fluids include NG at a pressure greater than 0.5 bar i.e. above atmospheric pressure. A pressure system would include bulk storage tanks, pipelines and protective devices. Once the pressure in the pipework drops below 0.5 bar, and the user/owner can show clear evidence that the system does not contain, and is not liable to contain, a relevant fluid under foreseeable operating conditions, then that part of the system is no longer covered by PSSR. This is likely to be the case after the pressure relief valve associated with a pressure reducing valve which takes the pressure to below 0.5 bar, for example at the entry to a building but note the special requirements placed on protective devices in such systems (see paragraph 110b of HSL122). PSSR also apply to pipelines and their protective devices in which the pressure exceeds 2 bar (see Schedule 1 part 1 item 5 of HSL122).

3.3.11.3 More information is available in HSL122 and some information is presented in INDG 261 and INDG 178.

3.3.12 Provision and Use of Work Equipment Regulations (PUWER)

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

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

3.3.12.3 More information on PUWER can be found in HSL22. Free leaflets include INDG 291 and INDG 229.

3.3.13 **Regulations Concerning the International Carriage of Dangerous Goods by Rail (RID)**

These regulations implement and enforce in the UK provisions from the International Carriage of Dangerous Goods by Rail (OTIF) including movement of dangerous goods including gases by rail.

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

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

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

- death or major injury arising out of the distribution, filling, import or supply of NG or LPG should 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".

3.3.14.3 Major injuries, death and dangerous occurrences must be notified immediately, for example by telephone, to the enforcing authority by the "responsible person" as defined by RIDDOR. Reports 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.

This 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 should be made as soon as practicable and within 10 days of the incident.

3.3.14.4 HS(L)73 contains detailed guidance on RIDDOR, including a full list of injuries etc. that need reporting.

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

3.3.15 Supply of Machinery (Safety) Regulations

These Regulations set out "essential requirements" written in general terms, which must 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 that went into the design of the product.

SECTION 4 : RISK MANAGEMENT

This section addresses risk management and its applicability to LNG fuelling stations and LCNG fuelling stations. Risk assessments are an important part of the risk management process but these are only broadly addressed within this Section.

4.1 GENERAL REQUIREMENTS

4.1.1 Risk management shall be in accordance with recognised codes of practice.

Note 1: Refer to BS ISO 31000, BS EN 31010, BS 31100 for general risk-management principles.

Note 2: Refer to BS EN 62305-2 for risk-management of lightning.

4.2 RISK CONTEXT

Risks and their potential consequences shall be considered and contextualised with respect to all foreseeable stakeholders and their views, including:

- the Institution of Gas Engineers and Managers (IGEM)
- the Health and Safety Executive (HSE)
- designers and manufacturers of facilities and related equipment
- facility operators (including employees directly involved on-site)
- facility users (e.g. vehicle drivers)
- facility neighbours
- local authority
- fire and rescue services
- environmental agencies
- the general public.

4.3 RISK ASSESSMENT TECHNIQUES

4.3.1 Risk assessments shall be used to determine the adequacy of proposed systems and procedures to mitigate harm or damage to acceptable levels.

4.3.2 Risks shall be identified, analysed, and evaluated in accordance with appropriate recognised risk assessments. Examples of such risk assessments may include one or more of the following:

- Hazard and operability studies (HAZOPS)
- Failure mode and effect analysis (FMEA)
- Fault tree analysis (FTA)
- Event tree analysis (ETA)
- Layers of protection analysis (LOPA)
- Bow tie analysis.

Note 1: A more comprehensive list of risk assessment techniques can be found in BS EN 31010.

Note 2: Guidance on risk assessment techniques can be found in IGEM/G/7.

Note 3: Refer to BS EN ISO 12100 for risk assessment regarding safety of machinery.

4.3.3 Risks assessments shall be conducted by competent persons or organisations and should be independently verified and undersigned by other competent persons or organisations.

4.3.4 Risks assessments shall be re-conducted whenever there is any significant modification to any facility which could foreseeably invalidate previous risk assessments, such as:

- changes to plant equipment
- changes in operations or the environment
- changes in industrial standards and codes.

4.4 RISK TREATMENT

4.4.1 Intolerable risks where identified shall be treated with immediate effect.

4.4.2 Measures to reduce risks shall be considered, including as a minimum:

- the need for over-pressurisation relief
- the risk of explosive atmosphere generated by potential leaks or releases
- prevention of static charge build-up
- avoidance of ignition sources
- mitigation of the effects of a fire or explosion
- asphyxiation hazard in case of oxygen-depleted gases accumulating in confined spaces.

4.5 RISK MONITORING AND REVIEW

4.5.1 Risks should be reviewed on a periodic basis.

4.5.2 The latest publications in the codes of practice for risk management should be referenced and applied whenever available.

4.5.3 The latest advancements in technology should be considered for implementation during any risk-mitigation strategy review.

4.6 RISK DOCUMENTATION

4.6.1 Risk documentation shall be in accordance with Section 4.6 of this Standard.

4.6.2 Risk documentation should be readily available at request.

SECTION 5 : PLANNING

This section addresses all planning aspects which need to be taken prior to the onset of any detailed design or construction activities. In some cases, it may not be possible to install an LNG fuelling station or an LCNG fuelling station. For instance, this could be due to challenges in obtaining the necessary planning permits or because of inadequate space.

5.1 TECHNICAL ASSESSMENT

5.1.1 Design Parameters

The following design criteria shall be established:

- type of fuelling station (i.e. LNG, LCNG, LNG and LCNG)
- nature of fuelling station (i.e. public or private)
- size of fuelling station (e.g. 50 tonne capacity)
- frequency of use of fuelling station (e.g. vehicles per day).

5.1.2 Site Selection

5.1.2.1 *Adequacy of Utilities*

Site suitability shall be assessed with respect to availability and adequacy of utilities, including:

- gas supply
- electricity supply
- telecommunications
- water supply.

5.1.2.2 *Adequacy of Space*

Site suitability shall be assessed with respect to availability and adequacy of space, and shall be deemed inappropriate if:

- minimum separation distances of prospective fuelling stations according to Appendix 8 of this Standard cannot be met
- the working area for installation, construction, operation, inspection, and maintenance is insufficient.

5.1.2.3 *Adequacy of Ventilation*

Site suitability shall be assessed with respect to adequacy of ventilation, including the impact of any security fences, barriers or fire walls. The fuelling station should be in the open air and in a well ventilated location.

5.1.2.4 *Extreme Weather*

Site suitability shall be assessed with respect to extreme weather, and shall be deemed inappropriate if there is a significant risk (which cannot be sufficiently mitigated) from the following:

- flooding
- thunderstorms
- earthquakes
- tornadoes
- landslides.

5.1.2.5 *Neighbours*

Site suitability shall be assessed with respect to neighbours (e.g. hospitals, prisons, schools, residence), and shall be deemed inappropriate if consensus cannot be found with respect to:

- general safety (especially with respect to fire and explosion)
- noise levels (especially from pumps or compressors)
- visual impact (especially from tall vertical storage)
- road use and traffic (especially from refuelling HGVs and LNG tankers).

5.2 LEGAL ASSESSMENT

5.2.1 Planning Regulations

Where required planning regulations and local authority permits shall be followed to ensure the correct permissions are in place prior to the construction of the installation.

5.3 OPERATIONAL ASSESSMENT

5.3.1 Traffic Management

5.3.1.1 Consideration shall be given to the flow of vehicles on the fuelling station premises. Greater levels of access may be required where the station is supplied by a mobile storage facility, or where large vehicles (e.g. HGVs, PSVs) are served.

Note: This may include implementation of one-way traffic flow systems and road markings.

5.3.1.2 Consideration shall be given to manage the speed of vehicles within the facility.

Note: For instance, through driver training, erection of maximum speed signs, etc.

5.3.1.3 Mobile storage vehicles not undertaking supply shall not be permitted to park in the fuelling station unless in a specially designated area.

5.3.2 Emergency Planning

5.3.2.1 *Emergency Procedures*

These shall be provided in accordance with Section 6.2.3.

5.3.2.2 *Emergency Contact*

Consideration shall be given to the provision of emergency contact details at the site, which shall include as a minimum

- emergency contact name (e.g. company and/or person)
- emergency contact number (e.g. telephone).

5.3.2.3 *Emergency Access/Escape*

5.3.2.3.1 Consideration shall be given to accessibility and intervention by emergency services and their equipment, including:

- fire services
- ambulance services.

5.3.2.3.2 For any enclosed area there shall be an adequate means of escape in the event of an emergency.

5.3.2.3.3 For enclosed areas, a minimum of two emergency exits as escape routes shall be provided and strategically located to optimise coverage.

5.3.2.3.4 Any emergency gate shall be outward-opening and be at least 0.8 metres wide.

5.3.3 **Security Measures**

5.3.3.1 *Unauthorised Access*

There shall be adequate means provided such that from the safe operation of the installation is safeguarded from unauthorised interference.

Note: For instance, construction of a security fence around the compound.

5.3.3.2 *Unauthorised Usage*

LNG fuelling stations and LCNG fuelling stations shall be restricted from unauthorised usage. In particular, security measures should be used to control the access and use of dispensing equipment.

Note: At a public access station the customers may be authorised to use the dispensers and to access other appropriate areas.

5.3.3.3 *Protection of Equipment*

Equipment shall be suitably protected to deter unauthorised access and to minimise the effects of interference, damage and vandalism. Additional precautions may be necessary to protect mobile storage units during supply operations.

5.3.4 **Training Program**

5.3.4.1 The fuelling station operators and staff shall be suitably trained and instructed in the operation of equipment and in the emergency procedures (see Section 6.2.3).

5.3.4.2 Training shall be provided by competent persons that have an innate understanding of the systems and processes and all related safety issues for a specific LNG or LCNG installation.

5.3.4.3 Recipients of training shall be assessed on their understanding of the training received and shall not be permitted to operate in or on any fuelling station unless such understanding is deemed satisfactory.

5.3.4.4 Training on-the-job shall incorporate aspects of shadowing, whereby the trainee shall be trained by someone already familiar with the system to be operated.

5.3.4.5 Training shall be provided to drivers (e.g. of HGVs, LNG road tankers) within the fuelling station in order to prevent hazards arising from the movement of their vehicles.

SECTION 6 : DOCUMENTATION

This section addresses all the relevant documentation regarding LNG and LCNG fuelling stations. The compilation of such documentation is critical to the development of a Technical File which is necessary to demonstrate compliance with the various safety regulations and standards.

Documentation is retained for a variety of reasons, some legislative and some for best practice. Steps need to be taken to discourage the collection of documentation for its own sake – the aim of documentation is to add value to the safe operation of an installation. Irrelevant or inappropriately collected documentation is unlikely to be kept up to date, and large volumes of documentary material may detract from the few crucial items that thereby may become "lost".

6.1 GENERAL REQUIREMENTS

6.1.1 The following documentation must be provided where it is relied upon to ensure that legal obligations are being met:

- Operating and maintenance (O&M) instructions, to equip the installation user with adequate information to enable the safe operation of the installation.
- Information on any residual risks arising from the construction of the installation which are not adequately covered in the O&M instructions. Refer to The Construction (Design and Management) Regulations 2015.

Note: Regulators (e.g. HSE) may insist upon this documentation being made available for inspection.

6.1.2 Where applicable, the Global Conformity Assessment shall be applied.

Note: Conformity assessment guidance can be found at www.gov.uk.

6.1.3 Where CE marking is required, the CE mark on the installation or on its component parts shall be deemed sufficient practical "documentation" to confirm that this requirement is met, provided that it has been properly attached via a suitably authorised party.

6.1.4 The presence and extent of hazardous areas (zones) etc. shall be documented, along with a suitable drawing or plan.

6.1.5 All documentation, drawings, plans and elevations shall be up to date and shall reflect the actual details of the current installation (for example, in its "as constructed" or modified form).

6.1.6 Drawings shall be in accordance with recognised standards and codes of practice. Consistent use of symbol sets and terminology is recommended, in order to remove scope for confusion.

Note 1: Refer to BS ISO 15519 series for the specification of diagrams for the process industry.

Note 2: Refer to BS EN ISO 10628 series for diagrams for the chemical and petrochemical industry.

Note 3: Refer to BS ISO 14617 series for graphical symbols for diagrams.

Note 4: Refer to ANSI/ISA S5.1 for instrumentation symbols and identification.

6.1.7 Where responsibility for the installation passes from one party to another (e.g. at the handover of a completed construction project to an operator or user), a formal process shall be adopted to confirm the transfer of documentation. This transfer shall be recorded in writing.

6.1.8 Requirements for availability of documentation shall be determined by the responsible owner (usually the system user). Depending upon circumstances, options available may include:

- Some or all documentation available in hard copy, on site
- Some or all documentation available electronically (i.e. in digital form, stored on an IT system) on site
- Some or all documentation held off site, for example, at a head office, regional office, supplier's premises or store, etc.
- Some or all documentation held exclusively by suppliers, sub-contractors or other trusted third parties.

The over-riding requirement in determining the location(s) and storage regime for the documentation is in ensuring all persons have sufficient documentation and information available to them in order to operate safely.

6.1.9 In considering the location of documentation, the responsible owner shall take account of the risk of loss. For example, a back-up copy or copies may be considered, subject to suitable document control procedures.

6.1.10 In addition to legally-required documentation, users should consider having available all or some of the following items:

- Site plan / layout including the surrounding locality
- Newly developed O&M instructions and procedures, pending their incorporation into the master O&M documentation (refer to Section 6.2.2)
- Details of site-specific Emergency procedures, if not comprehensively covered in the O&M documentation
- Test certificates and reports from the construction phase of the installation (if available and relevant)
- Maintenance schedule(s) and records
- Risk analyses and risk assessments, including descriptions of the basis for various decisions which may be useful for future reference
- Materials schedules, where these may be useful for future reference
- Competence and training records for key individuals
- Spares and stock information, where not covered by the O&M documentation
- Technical details (where not captured in the O&M documentation) which may be useful for future Engineering Management of Change decisions.

6.2 PROCEDURES

6.2.1 General Requirements

6.2.1.1 Procedures shall be developed and maintained in order to control risk.

6.2.1.2 Procedures shall be reviewed periodically.

6.2.1.3 Procedures should be considered for:

- hot work (including when to allow it, and under what controls)
- Permit to Work controls
- emergency situations, including local off-site events
- station shutdown and maintenance
- specific foreseeable operational circumstances such as fuel delivery by tanker
- confined space and zone management (including entry procedures)
- other items, based on foreseeability or based on risk assessment outcomes.

6.2.2 Operating and Maintenance Procedures

6.2.2.1 *General*

Operating and maintenance procedures shall be produced for all identifiable scenarios which may include:

- LNG supply and transfer
- commissioning and decommissioning
- vehicle fuelling
- maintenance of equipment.

6.2.3 Emergency Procedures

6.2.3.1 *General*

Foreseeable emergency scenarios shall be identified and plans shall be developed to manage these scenarios. Consideration shall be given to the requirements of fire safety legislation and emergency planning requirements of DSEAR, COMAH and/or other relevant regulations.

6.2.3.2 Emergency procedures shall contain the following:

- Emergency contact number
- What to do in an emergency.

6.3 CERTIFICATION

Certification should be discouraged where it adds no value to safety management. Construction-related certification may be useful from time to time (e.g. where installation modification and upgrades are being planned) and it may be useful to have this certification held in a retrieval system, to be obtained when required. Such items may include (if available):

- Originally installed material test certificates
- Welding certificates, procedures and QA
- Pressure system component manufacturer's QA dossiers
- Pressure test certificates
- Hazardous area compliance certificates (e.g. ATEX, IECEx, etc.)
- Third-party inspection certificates
- Other quality-control or risk management documentation.

SECTION 7 : DESIGN

7.1 MATERIAL SPECIFICATION

7.1.1 Material Selection

Materials used for the construction of pressurised parts shall have suitable properties for all operating conditions which are reasonably foreseeable and for all test conditions. In particular, they should be sufficiently ductile and tough. Moreover, due care should be exercised, in particular, in selecting materials in order to prevent brittle-type fracture, where necessary

Note: Carbon steels are generally not acceptable for cryogenic service, as their temperature rating is unsuitable.

7.1.2 Chemical Resistance

Materials shall be chemically-resistant with respect to its general environment and to all fluids with which they may foreseeably come into contact.

Note 1: Refer to BS EN ISO 15156-1 for material resistance to H_2S-containing environments.

Note 2: Refer to BS EN ISO 23936-1 for non-metallic material compatibility with natural gas.

7.1.3 Ageing Resistance

Materials shall not be significantly affected by ageing, or shall be selected such that their aging can be managed through maintenance.

7.1.4 Corrosion Resistance

Materials shall be resistant to corrosion or, alternatively, protected and maintained against corrosion by suitable means.

Note: Refer to BS EN ISO 7384, BS EN ISO 9227 for corrosion testing.

7.1.5 Weather Resistance

Materials shall be resistant against all weather conditions.

7.1.6 Fire Resistance

Materials shall be evaluated for its resistance to fire, particularly in critical applications where the risks of failure due to fire are high.

7.1.7 Material Compatibility

Materials shall be selected in order to avoid significant undesirable effects when the various materials are in direct contact or in close proximity.

7.1.8 Effects of Pressure

Materials shall be evaluated with respect to the intended service pressures, pressure-cycling and the variations thereof.

7.1.9 Effects of Temperature

Materials shall be evaluated with respect to the intended service temperatures, temperature-cycling and the variations thereof.

Note 1: Materials need to be considered with respect to climatic conditions.

Note 2: Temperature-cycling is of particular concern for materials intended for cryogenic service.

Note 3: Materials intended for LNG service will have a minimum operating temperature no higher than −196 °C in order to allow for compatibility with liquid nitrogen.

7.2 EQUIPMENT SPECIFICATION

7.2.1 All equipment, components, pipework and fittings shall be of a type and manufacture and be assembled in such a manner suitable for their intended use, for the full range of pressures, type of gas, temperatures, weather conditions and loadings which may occur under normal, fault and other foreseeable conditions.

7.2.2 Equipment shall be selected for all foreseeable conditions.

7.2.3 Pressure Rating

7.2.3.1 Equipment shall be suitable for the intended pressures, pressure-cycling and the variations thereof and shall have mitigations against pressures outside of the defined acceptable limits.

7.2.4 Temperature Rating

Equipment shall be suitable for the intended temperatures, temperature-cycling and the variations thereof and shall have mitigations against temperatures outside of the defined acceptable limits.

Note: Equipment intended for LNG service will have a minimum operating temperature no higher than −196 °C in order to allow for compatibility with liquid nitrogen.

7.2.5 Use in Hazardous Areas

Equipment shall be suitable for the intended hazardous areas.

Note: Refer to BS EN 60079-10-1 for classification of areas.

7.3 ELECTRICAL SPECIFICATION

7.3.1 General Requirements

7.3.1.1 Electrical requirements must be in accordance with all applicable regulations, and shall be in accordance with all standards and codes of practice.

Note 1: Refer to BS 7671 for IET Wiring Regulations.

Note 2: Refer to BS EN 60445 (or IEC 60445) for identification of equipment terminals, conductor terminations and conductors.

7.3.2 Hazardous Areas

Where the equipment is located in a hazardous area, it shall comply with the appropriate zoning rating as required in BS EN 60079-10-1.

7.3.3 Grounding and Bonding

All electrical equipment, metal frames and structures shall be grounded and bonded in accordance with BS 7671.

7.3.4 Static Electricity

All equipment shall be assessed for risks concerning static electricity.

Note: Refer to PD CLC/TR 60079-32-1.

7.3.5 Lightning Protection

Lightning protection needs shall be assessed and, if required, shall be applied in accordance with relevant design codes.

Note: Refer to BS EN 62305-1, BS EN 62305-2.

7.4 FUNCTIONAL SAFETY SPECIFICATION

7.4.1 General Requirements

7.4.1.1 Functional safety and related safety systems must be in accordance with all applicable regulations, and shall be in accordance with all standards and codes of practice.

Note 1: Refer to all parts of BS EN 61508 (or IEC 61508) for guidance relating to the functional safety of electrical, electronic, and electronic programmable safety-related systems.

Note 2: Refer to all parts of BS EN 61511 (or IEC 61511) for guidance related to safety instrumented systems for the process industry sector.

Note 3: Refer to all parts of BS EN 62061 (or IEC 62061) for guidance related to the functional safety of machinery in terms of safety integral levels (SIL).

Note 4: Refer to BS EN ISO 13849-1 for guidance related to the functional safety of machinery in terms of performance levels (PL).

7.4.1.2 Instrumented Safety devices shall be fully independent of other functions.

7.4.1.3 The facility shall be designed or otherwise have provisions to ensure that any safety function cannot be impaired or otherwise defeated within the remit of ordinary operations where its safety function is relied upon.

Note: This clause prohibits, for instance, the use of isolation valves in series combination with pressure relief devices unless positive action is taken to ensure such valves remain fully-open, such as electromechanically-interlocked (for automatic isolation valves), or using a valve lockout device (for manual isolation valves).

7.4.2 Control system

7.4.2.1 The control system for the fuelling facility shall ensure the safe delivery of LNG and CNG throughout the station. Under all foreseeable conditions it shall not override or adversely affect any of the essential safety devices or emergency shutdown systems.

7.4.2.2 All control system components and wiring shall comply with the hazardous area classification requirements.

7.5 GAS SPECIFICATION

7.5.1 Trim Heating and LNG Saturation System

A system shall be installed, if it is necessary to control the temperature and condition of vaporised LNG. If necessary a trim heater shall be installed to raise the temperature of vaporised LNG to a suitable temperature to prevent low temperature exposure to buffer storage and dispensed gas.

LNG dispensed to vehicle storage tank may be cold, if it is necessary the condition of the LNG can be "saturated on the fly" to increase the temperature and pressure.

Note: Conditioning of 'warm' vehicle tank gases, boil-off management within the storage system, etc may all require the use of cooling and conditioning system(s).

7.5.2 Filtration

If filtration is required, it shall be sized for the maximum gas flow and have a suitable collection device and a means of removal/exchange.

7.5.3 Odorisation

7.5.3.1 *Requirements for CNG*

7.5.3.1.1 Where it is required to dispense odorised CNG, suitable odorants and odorising equipment shall be installed to re-odorise the gas to the required level before it is dispensed.

Note: Refer to IGEM/SR/16, BS EN ISO 13734, PD ISO/TR 16922.

7.5.3.1.2 Consideration should be given to the nature of the odorant (and the storage and handling implications of this). Any materials selection shall take account of the presence (or proposed presence) of the odorant and its dosing system in accordance with Section 7.1.1 of this Standard.

7.5.3.1.3 Odorisation should occur at the earliest possible point.

Note: For LCNG stations, this is typically at the outlet of any LNG vaporisation process.

7.5.3.2 *Requirements for LNG*

There are no requirements for the odorisation of LNG. However, alternative provisions should be made for its detection, where necessary.

Note 1: Common odorants as used for CNG tend to solidify when brought down to the cryogenic temperatures of LNG making them unsuitable for use in LNG.

Note 2: Alternative means for detection could be methane gas detectors.

7.6 ENVIRONMENTAL SPECIFICATION

7.6.1 Air Pollution

7.6.1.1 *Methane Emissions*

Methane emissions shall be prevented as far as practically possible and under normal operation shall be strictly limited to:

- nozzle connection/disconnection operations
- tanker offloading hose disconnection
- purging operations

Note 1: Issues regarding LNG boil-off to atmosphere should be considered and if possible methods incorporated to minimise or prevent boil-off during normal operation (e.g. by cold-conditioning, condenser fitment, vapour recovery).

Note 2: Flaring may be preferable in order to reduce methane emissions.

7.6.1.2 *Odorant Emissions*

Odorant emissions shall be prevented as far as practically possible.

Note: Gas odorants are typically sulphuric in nature.

7.6.2 Noise Pollution

Noise created during operation and maintenance activities must be managed and controlled in accordance with the Control of Noise at Work Regulations. This includes noise generated by heavy machinery and ventilation systems and from pressure relief and venting operations.

SECTION 8 : CONSTRUCTION

8.1 GENERAL REQUIREMENTS

8.1.1 Building Regulations

Procedures for local building regulations and permits shall be followed.

8.1.2 Foundations

Fixed-installation fuelling stations and their respective components shall be mounted on suitably designed and constructed foundations designed to withstand wind loading and flooding.

8.1.3 Fire Walls

If a fire wall is constructed to provide fire protection of or from equipment, it shall be of at least one hour fire resistance and of solid construction. The wall shall be sized to ensure it provides adequate protection against radiation from the source. The fire wall shall not interfere with the equipment ventilation aspects, maintenance access or escape routes.

8.1.4 Collision Barriers

The facility and all equipment exposed to the risk of vehicle collision shall be adequately protected with suitable heavy-duty barriers or bollards or other protection suitably designed and constructed, with special consideration given to:

- Natural gas storage
- Fuelling dispensers
- Pipework.

Note 1: Refer to BS EN 1991-1-7 for accidental actions on structures.

Note 2: Cranes and forklift trucks may impose special risks, as may HGVs and PSVs.

8.1.5 Security Fencing

Where security fencing is installed, it shall:

- Meet the requirements of emergency access/escape in accordance with Section 5.3.2.3
- be at least 1.8 metres in height
- have a minimum of 0.6 metres clearance between the installation
- be constructed from non-combustible materials.

8.2 LAYOUT OF EQUIPMENT

8.2.1 Equipment shall be suitably separated from other installations and structures by defined separation distances as outlined in Appendix 8.

Note: Where an LNG storage facility is to supply the fuelling station with CNG, that facility's location requirements are separate and additional to the requirements given in this Standard.

8.2.2 Layout shall be planned carefully as most of the site components have location restrictions and minimum separation distances and may be affected by hazardous area requirements.

8.2.3 If the fuelling facility is integrated with new or existing fuelling facilities of other fuels, the requirements of this Standard and those of the other fuelling facilities shall be fully implemented.

8.2.4 **Location of components**

Equipment shall be located either in the open air or in dedicated enclosures. Due consideration shall be given to safety and ventilation requirements.

SECTION 9 : COMMISSIONING

9.1 GENERAL REQUIREMENTS

9.1.1 Commissioning shall only be conducted by competent persons.

Note: Training, information and instruction is an essential part of the understanding process.

9.1.2 Commissioning shall be conducted in accordance with relevant procedures.

9.1.3 Commissioning of specific equipment shall be conducted with respect to the recommendations of the manufacturer.

9.1.4 Commissioning shall be documented where necessary.

9.2 PRESSURE TESTING AND PURGING

9.2.1 All pressurised equipment shall be suitably tested for strength and tightness and adequately purged before use.

Note: It is considered to be good practice to pneumatically "blow through" pressure systems prior to commencing the gas purging intended to manage explosive mixture hazards. This assists in removing fabrication debris, particulate, etc. prior to service. Blow-through is generally considered to be the first part of the purge process, and should be conducted with inert gas e.g. nitrogen, suitably managed.

9.2.2 The design of the pipework system shall be checked to ensure adequate provision has been made to permit safe and effective testing and purging to be undertaken.

9.2.3 Any on-site strength testing shall be undertaken hydrostatically. Specialist drying shall be undertaken to ensure all moisture is removed. Pneumatic testing shall only be permitted subject to a satisfactory risk assessment and where allowed by the design methodology (e.g. as dictated by PER).

Note: Refer to HSE GS4 for safety requirements of pressure testing.

9.2.4 Consideration shall be given to the safety of all persons during strength testing, whether or not involved in the testing.

9.2.5 Documentation of all tests, on and off-site, and purges shall be provided.

SECTION 10 : OPERATION

This section addresses the various operations that are expected to take place at the fuelling station, and the requirements in order to permit those operations. These include LNG bulk transfer between LNG storage vessels (e.g. terminal to tanker, tanker to station) and LNG or CNG vehicle fuelling operations.

10.1 GENERAL REQUIREMENTS

10.1.1 Operation shall only be conducted by competent persons.

Note: Training, information and instruction is an essential part of the understanding process.

10.1.2 Operation shall be conducted in accordance with relevant procedures.

*Note: For more information on procedures, refer to Section 6.2**Error! Reference source not ound.**.*

10.1.3 Operation of specific equipment shall be conducted with respect to the recommendations of the manufacturer.

10.1.4 Operation shall be performed only with suitable tools for the intended purpose.

Note: This includes non-sparking or hazardous-areas certified electrical tools where necessary.

10.2 LNG SUPPLY AND TRANSFER

This section describes the necessary features regarding LNG supply and transfer. More specifically, it considers bulk LNG transfer into and out from fixed and mobile LNG storage which may or may not form the basis of an LNG or LCNG fuelling station, and thus caters for all scenarios of bulk LNG transfer.

Note: Mobile storage includes tankers and intermodal freight containers.

10.2.1 Safety and Risk

10.2.1.1 Transfer shall be subjected to an appropriate risk assessment.

10.2.1.2 Transfer shall follow suitable safety procedures.

10.2.1.3 Transfer safety procedures shall be documented.

10.2.2 Conditions for Transfer

10.2.2.1 Transfer shall only take place in designated transfer areas in accordance with Section 10.2.3 of this Standard.

10.2.2.2 Transfer shall only be permitted when the respective storage and associated hose systems are grounded.

10.2.2.3 Transfer shall only be permitted if the connection system can ensure safe and secure connection and disconnection.

10.2.2.4 Transfer shall only be permitted when the delivery storage, receiving storage and associated hose systems are at equipotential.

10.2.2.5 Transfer shall only be permitted when it is performed under the continuous supervision of a competent person that:

- has been suitably trained with respect to specific safety procedures
- is familiar with the specific operable systems; and
- wears the appropriate personal protective equipment.

10.2.2.6 Transfer shall automatically terminate after a period not exceeding three minutes in absence of any positive manual action to keep the process running.

Note 1: For instance, a 'dead-man' trigger which permits transfer whilst the trigger is squeezed, and automatically terminates transfer when the trigger is released.

Note 2: For instance, a momentary-type push-button that initiates or resets a countdown timer when pressed and released. Transfer is permitted for the set duration of the timer, and is automatically terminated when the timer elapses.

10.2.2.7 Transfer shall not be permitted during severe weather conditions which might adversely affect the activity, and should not commence if there is a risk these conditions could arise during transfer.

Note: This includes thunderstorms, hailstorms, torrential rain, and strong winds.

10.2.2.8 Transfer shall only be permitted when there are mitigations against overfilling and overpressure for the receiving vessel.

10.2.2.9 Transfer shall take place under adequate lighting, ideally during daylight hours.

10.2.2.10 Transfer should only be permitted once it has been cordoned-off.

Note: For instance, with cones, posts and chain, or barriers.

10.2.2.11 Transfer should only be permitted when the appropriate warning signs are displayed within the vicinity.

Note: For instance, placement of a "No entry: Transfer is in progress" warning sign.

10.2.2.12 Transfer should only be permitted when there is an interlink system between the delivery vessel and the receiving vessel that effectively combines the emergency shutdown functions of the two systems.

Note: For instance, an electrical or a pneumatic interlink.

10.2.2.13 Triggering of the emergency shutdown during transfer shall automatically isolate the supply of LNG from the delivery vessel and stop the transfer.

10.2.3 Transfer Areas

10.2.3.1 Transfer areas shall:

- be clearly defined and documented
- be subject to risk-assessment
- be free of ignition sources
- be well lit
- be designed to withstand the worst case loading conditions
- have suitable surfaces and be self-draining
- have mitigations against spillage
- have suitable means for vehicles to exit in a forward-facing direction with minimal manoeuvring
- have suitable means emergency escape
- have sufficient room for operations
- exclude unauthorised personnel

Note: Worst case loading conditions may include, for example, a fully-laden tanker plus snowfall.

10.2.3.2 Transfer areas should:

- have suitable means for designated vehicles to enter in a forward-facing direction with minimal manoeuvring
- be clearly indicated with permanent markings.

Note: For instance, with painted lines.

10.2.4 **Requirements for Mobile Storage**

10.2.4.1 Mobile storage shall be secured to prevent movement during transfer.

Note: For road tankers and intermodal containers on trailers, this includes chocking wheels and disconnecting brake air-lines.

10.2.4.2 Mobile storage intended for use on public roads must comply with the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) as outlined in Section 3.3.1 of this Standard.

Note: Further information is given in BCGA CP29.

SECTION 11 : MAINTENANCE

This section addresses the maintenance.

11.1 GENERAL REQUIREMENTS

11.1.1 Maintenance shall only be conducted by competent persons that have a strong understanding of the specific system or systems to be maintained.

Note: Training is an essential part of the understanding process.

11.1.2 Maintenance shall be conducted in accordance with relevant procedures.

Note: For more information on procedures, refer to Section 6.2.2.

11.1.3 Maintenance of specific equipment shall be conducted with respect to the recommendations of the manufacturer.

11.1.4 Maintenance shall be performed only with suitable tools for the intended purpose.

Note: This includes non-sparking or hazardous-areas certified electrical tools where necessary.

11.1.5 Consideration shall be given to pressurisation and depressurisation of components e.g. for removal for maintenance, draining condensate, by the provision of valves, gauges and vent connections to ensure that sections are depressurised before service interventions.

11.1.6 Maintenance shall ensure that adequate measures are taken to isolate the relevant systems in a safe manner, taking in according to the level of risk.

Note: In some cases, single valve isolation may be adequate (such as for short-duration maintenance) whilst in others, spading or use of double-block-and-bleed valves may be required (such as for long-duration maintenance).

11.1.7 Any maintenance or servicing anticipated during operation of the fuelling station shall not affect adversely the composition of gas dispensed from the station.

11.1.8 Maintenance shall not impair the safety function of the system.

Note: For instance, in order to remove a relief valve for maintenance, the system flow may need to be diverted through an alternative relief valve of equivalent capacity.

SECTION 12 : EMERGENCY SHUTDOWN

This section outlines the activation and operation of emergency shutdown, and well as the requirements for system restart.

12.1 GENERAL REQUIREMENTS

12.1.1 Emergency shutdown systems shall be fail-safe.

Note: For example, normally-closed valves are to be used where isolation is required.

12.1.2 Where power is required to ensure the fail-safe functionality of emergency shutdown devices, these shall be supplied by an uninterruptable power supply

Note: For example, ventilation fans, fire alarms, etc.

12.1.3 The consequences of emergency shutdown shall be evaluated.

12.2 ACTIVATION OF EMERGENCY SHUTDOWN

12.2.1 Emergency shutdown shall be activated when the station operates outside of the system-defined upper and lower set-points as potentially detected by:

- pressure sensors
- temperature sensors
- level sensors
- gas detectors
- flame detectors
- smoke detectors
- proximity sensors
- other sensors.

12.2.2 Emergency shutdown shall also be activated by:

- loss of power
- loss of containment
- loss of odorisation
- failure of instrumentation
- activation of manual emergency stop devices.

Note: Power includes both electric and pneumatic.

12.3 OPERATION OF EMERGENCY SHUTDOWN

12.3.1 Emergency shutdown shall ensure automatic closure of isolation valves at the following locations:

- the liquid inlets and/or outlets of all LNG storage vessels
- the inlets and/or outlets of all CNG and LNG dispensers.

12.3.2 Emergency shutdown shall ensure automatic stopping of the following:

- all LNG and LCNG pumps
- all CNG and LNG dispensers
- all CNG compressors.

Note: This includes on-board tanker pumps used to transfer LNG into LNG station storage.

12.3.3 Emergency shutdown should ensure automatic activation of the following:

- Visual alarms (e.g. warning beacons)

- Audible alarms (e.g. warning sirens)
- Alarm notifications at control panels.

12.4 RESTART OF EMERGENCY SHUTDOWN

A restart procedure shall be provided which will require manual restart by a suitably trained person.

12.5 EMERGENCY SHUTDOWN PROCEDURES

These shall be incorporated into the operational safety management system for the fuelling station alongside the emergency procedures in accordance with Section 6.2.3.

Note: Special attention may be required for unmanned fuelling stations.

SECTION 13 : COMPETENCY AND QUALITY ASSURANCE

13.1 COMPETENCY

Any person engaged in the design, construction, commissioning, inspection, operation, maintenance or alteration of an LNG or LCNG fuelling station shall be competent to carry out such work.

Note: This may be achieved by an appropriate combination of education, training, and supervised practical experience.

13.2 QUALITY ASSURANCE

13.2.1 Materials

All materials and equipment shall be selected to ensure safety and suitability for the conditions of use, in accordance with relevant legislation, technical specifications and Standards.

13.2.2 Inspection

Particular emphasis shall be placed on the inspection of materials (before and after assembly), jointing, coatings, fabrication processes and testing.

13.2.3 Quality Assurance Processes

Formal QA processes should be adopted for each installation to rigorously manage installation aspects and to ensure continuous improvement takes place.

SECTION 14 : NATURAL GAS STORAGE

This section addresses natural gas storage. General guidance on the principles of storing a cryogenic liquid at users' premises and on the principles of operating storage are given in BCGA CP41 and BGCA CP46.

14.1 GENERAL REQUIREMENTS

14.1.1 Natural gas storage shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

14.1.2 Natural gas storage shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

14.1.3 Natural gas storage shall be subjected to an appropriate risk assessment.

14.1.4 Natural gas storage shall have means of isolation.

14.1.5 Sites that contain natural gas storage must comply with the Control of Major Accident Hazard Regulations (COMAH) as outlined in Section 3.3.4 of this Standard if certain capacity thresholds are exceeded when evaluated in conjunction with other onsite hazardous substances.

14.1.6 Natural gas storage shall be permanently marked with at least the following:

- Manufacturer's identification
- Year of manufacture
- Maximum operating pressure
- Maximum fill capacity.

14.2 TRANSPORTATION REQUIREMENTS

14.2.1 Mobile natural gas storage shall be firmly secured to the transporting vehicle either by permanent means such as welding, or by temporary means such as fastenings, or strapping.

Note: Storage that form an integral part of an intermodal freight container (such as those classified by BS ISO 668) can be firmly secured by the frame using twist-lock devices.

14.2.2 Natural gas storage that contains natural gas whilst being transported must comply with the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations as outlined in Section 3.3.1 of this Standard.

14.3 PREVENTATIVE MEASURES

14.3.1 Prevention of Collision

Natural gas storage shall be adequately protected against collision from vehicles using suitable heavy-duty barriers or bollards.

14.3.2 Prevention of Overfilling

Natural gas storage shall be equipped with devices to prevent overfilling.

Note: For LNG storage, the maximum fill level is set such that it takes cryogenic liquid expansion into account.

14.3.3 Prevention of Toppling

Natural gas storage shall be designed to prevent toppling against wind loads.

14.4 MITIGATION MEASURES

14.4.1 Mitigation of Fire

14.4.1.1 Natural gas storage shall be adequately protected against fire.

Note: For cryogenic vessels being used for storage of LNG, refer to Section 15.3.1.

14.4.2 Mitigation of Leakage

Natural gas storage shall be equipped with devices to detect leakage in order to mitigate against them.

Note: For example, with use of gas detectors in accordance with Section 25.1.3 of this Standard.

14.4.3 Mitigation of Overpressure

14.4.3.1 Natural gas storage shall be equipped with at least two safety relief devices in accordance with Section 24.2 of this Standard in order to mitigate against overpressure.

14.4.3.2 In the case of cryogenic vessels being used for the storage of LNG, specific attention shall be paid to the following potential overpressure cases:

- Fire and loss of vacuum
- An over-running interconnected pressure build-up unit (PBU)
- An over-running interconnected pump unit (if a pump is installed).

14.5 CNG STORAGE

CNG storage shall be in accordance with IGEM UP/20.

Note: Refer to IGEM UP/20, Section 12.

14.6 LNG STORAGE

14.6.1 General Requirements

14.6.1.1 Cryogenic vessels that are used for LNG storage shall meet all requirements in accordance with Section 15 of this Standard.

14.6.1.2 LNG storage shall be equipped with at least one vent stack that shall be adequately sized and protected from precipitation.

Note: For further information regarding vents, refer to Section 23.8.

14.6.1.3 LNG storage shall have an automatic safety shut-off valve at the liquid outlet, and all valves and pipework leading up to and including this valve shall be permanently bonded.

Note: For cryogenic vessels, this is generally welded as close as possible to the vessel body.

14.6.2 Instrumentation Requirements

14.6.2.1 LNG storage shall have at least one level indicator.

14.6.3 Operational Requirements

14.6.3.1 Open-to-atmosphere trycock valves should not be used to verify that LNG storage is full.

Note: This is an environmental consideration to prevent unnecessary venting.

14.6.4 Mitigation of Spillage

LNG storage should have mitigations against spillage arising, for instance, from line rupture or cryogenic hose failure.

Note: Bunding of LNG storage is mandated in certain countries whilst outlawed in others. The case for bunding is to effectively contain any LNG spills and associated risk to stop it from spreading to other areas. The case against bunding, however, is that it potentially increases the risk of an LNG pool fire scenario.

14.7 FIXED INSTALLATIONS

14.7.1 All vessels shall meet the minimum load requirements as calculated with respect to wind, earthquakes and any other foreseeable loads.

Note: Refer to BS EN 1991-1-4 for wind loads.

14.8 MOBILE INSTALLATIONS

14.8.1 Mobile installations shall comply with all of the same requirements imposed on fixed installations as far as is practicable.

SECTION 15 : CRYOGENIC VESSELS

Cryogenic vessels are devices which are specifically designed to hold cryogenic liquids such as liquid nitrogen and LNG. These are typically vacuum-insulated in order to significantly reduce the amount of heat ingress into its contents.

15.1 GENERAL REQUIREMENTS

15.1.1 Cryogenic vessels shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note 1: Refer to BS EN 13458-2 and BS ISO 21009-1 for static vacuum-insulated cryogenic vessels.

Note 2: Refer to BS ISO 20421-1 for large transportable vacuum-insulated cryogenic vessels.

15.1.2 Cryogenic vessels shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

Note 1: Refer to BS EN ISO 21009-2 for static vacuum-insulated cryogenic vessels.

Note 2: Refer to BS ISO 20421-2 for large transportable vacuum-insulated cryogenic vessels.

Note 3: Refer to BCGA CP36 for storage of non-flammable cryogenics.

15.1.3 Cryogenic vessels must comply with the Pressure Equipment Directive (PED) as outlined in Section 3.2.2 of this Standard.

15.1.4 Cryogenic couplings used for cryogenic vessels shall meet all requirements in accordance with Section 16 of this Standard.

15.1.5 Safety valves used for cryogenic vessels shall meet all requirements in accordance with Section 24.2 of this Standard.

Note: This includes pressure relief valves and automatic shut-off valves.

15.2 PREVENTATIVE MEASURES

15.2.1 Prevention of Collision

Cryogenic vessels shall be adequately protected against collision from vehicles.

Note: E.g. With use of suitable heavy-duty barriers, bollards, or raised plinths.

15.2.2 Prevention of Overfilling

Cryogenic vessels shall be equipped with devices to prevent overfilling.

Note: The maximum fill level is set such that it takes cryogenic liquid expansion into account.

15.2.3 Prevention of Toppling

Cryogenic vessels shall be designed to prevent toppling against wind loads.

15.3 MITIGATION MEASURES

15.3.1 Mitigation of Fire

15.3.1.1 Cryogenic vessels shall be adequately protected against fire.

Note: This could be inherent to the design (e.g. adequately-rated support legs), or by additional barriers or coatings (e.g. fire-walls, intumescent paint), or by instrumentation such as fire detectors. A combination of these strategies is preferable.

15.3.1.2 Cryogenic vessels, especially of vertical orientation, should have a one-hour fire protection of its legs to prevent toppling in the event of a fire.

Note: Refer to BGCA CP46, HSE L138, BS 476-6.

15.3.1.3 Cryogenic vessels, especially of vertical orientation, should have means to prevent its legs from cryogenic brittle fracture.

Note: E.g. Siting the cryogenic vessel on a plinth; using legs constructed from suitable materials; or using suitable protection.

15.3.2 Mitigation of Overpressure

Cryogenic vessels shall be equipped with safety relief devices in accordance with Section 24.2 of this Standard in order to mitigate against overpressure.

Note: Refer also BS EN ISO 21013-3 for sizing of relief valves for cryogenic vessels or vessel design code.

15.3.3 Mitigation of Spillage

Cryogenic vessels should have mitigations against spillage.

Note: Refer to Section 14 for a more detailed treatise regarding LNG storage.

SECTION 16 : CRYOGENIC COUPLINGS

16.1 GENERAL REQUIREMENTS

16.1.1 Cryogenic couplings shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

16.1.2 Cryogenic couplings shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

16.2 PREVENTATIVE REQUIREMENTS

16.2.1 Prevention of Erroneous Connection

Cryogenic couplings shall be specially-coded in order to prevent erroneous connection to an incorrect mating-half.

Note: This is typically achieved by geometric definition.

SECTION 17 : CRYOGENIC PUMPS

Cryogenic pumps are devices which are specifically designed to move cryogenic liquids such as liquid nitrogen and LNG through mechanical action. Centrifugal cryogenic pumps are often used in LNG fuelling stations for low delivery pressures whist reciprocating cryogenic pumps are often used in LCNG fuelling stations for high delivery pressures.

17.1 GENERAL REQUIREMENTS

17.1.1 Pumps shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note: Refer to ISO 24490 for pumps for cryogenic service.

17.1.2 Pumps shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

17.1.3 Pumps shall be permanently marked with at least the following:

- Manufacturer's identification
- Year of manufacture
- Maximum operating pressure
- Operating temperature range
- Supply voltage (V)
- Rated power (kW).

17.1.4 Pumps should be capable of intensive use.

17.1.5 Suction pipework should be as short as possible with minimum bends.

17.2 PREVENTATIVE MEASURES

17.2.1 Prevention of Cavitation

Pumps should be equipped with devices that can be used to stop the pump in the event of cavitation.

17.2.2 Prevention of Overheating

Pumps should be equipped with devices that can be used to stop the pump in the event of overheating of the motor, the pump bearings and other ancillary parts.

17.2.3 Prevention of Overpressure

Pumps shall be equipped with devices that can be used to stop the pump in order to prevent overpressure.

17.3 MITIGATION MEASURES

17.3.1 Mitigation of Leakage

17.3.1.1 Pumps shall be equipped with devices that can be used to automatically stop the pump in the event of seal leakage.

17.3.1.2 Supply to pumps shall be automatically isolated in the event of seal leakage.

17.3.2 **Mitigation of Overpressure**

Pumps shall be equipped with safety relief devices in accordance with Section 24.2 of this Standard in order to mitigate against overpressure.

17.4 **CENTRIFUGAL PUMPS**

17.4.1 Centrifugal pumps shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note: Refer to BS EN ISO 13709.

17.5 **RECIPROCATING PUMPS**

17.5.1 Reciprocating pumps shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note: Refer to BS EN ISO 13710.

SECTION 18 : CRYOGENIC HOSES

18.1 GENERAL REQUIREMENTS

18.1.1 Cryogenic hoses shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note: Refer to BS 4089, BS EN 12434, BS EN ISO 10380, BS ISO 21012.

18.1.2 Cryogenic hoses shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

18.1.3 Cryogenic hoses shall be permanently marked with at least the following:

- Manufacturer's identification
- Date of manufacture
- Maximum operating pressure
- Operating temperature range.

18.2 PREVENTATIVE MEASURES

18.2.1 Prevention of Rupture

18.2.1.1 Cryogenic hoses shall have a burst pressure of at least 4 times the maximum operating pressure.

18.2.1.2 Cryogenic hoses shall be periodically tested for its suitability at the maximum operating pressure.

18.2.1.3 Cryogenic hoses shall be flexible and resistant to corrosion and mechanical damage and shall be adequately supported to prevent kinking and abrasion.

18.3 MITIGATION MEASURES

18.3.1 Mitigation of Leakage

Facilities shall be equipped with devices that can detect the rupture of any cryogenic hose, which shall trigger an emergency shutdown according to the procedures written in accordance with Section 6.2.3 of this Standard.

SECTION 19 : BREAKAWAY DEVICES

19.1 GENERAL REQUIREMENTS

19.1.1 Breakaway devices shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

19.1.2 Breakaway devices shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

19.1.3 Breakaway devices should be fitted with monitoring devices to detect separation, which should subsequently trigger an emergency shutdown.

Note: For example, a proximity sensor.

19.2 PREVENTATIVE MEASURES

19.2.1 Prevention of Failed Activation

Breakaway devices shall be designed to separate at a force significantly lower than that which would cause a failure in pipework and adjacent systems.

Note: The angle of the pulling force is to be taken into account.

19.2.2 Prevention of Leakage upon Activation

Breakaway devices shall automatically seal on both sides of the device upon activation in order to prevent complete release of the working fluid.

19.3 MITIGATION MEASURES

19.3.1 Mitigation of Surge Pressure upon Activation

Breakaway devices where used for LNG should be assessed for potential risks arising from surge pressure due to sudden closure and, if necessary, implement a slow closing mechanism.

19.3.2 Mitigation of Hose Overpressure upon Activation

Breakaway devices where used as safety devices for cryogenic hoses should have some form of inbuilt relief system to mitigate against any overpressure in the cryogenic hose due to the expansion of trapped cryogenic liquid.

SECTION 20 : VAPORISERS

Vaporisers are devices that facilitate heat-exchange between the working fluid and the surrounding environment. For example, ambient-air vaporisers are commonly used to bring LNG from its liquid state into its gaseous state through heat exchange with atmospheric air.

20.1 GENERAL REQUIREMENTS

20.1.1 Vaporisers shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note: Refer to ASME Section VIII, Division 1.

20.1.2 Vaporisers shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

20.1.3 Vaporisers must comply with the Pressure Equipment Directive (PED) as outlined in Section 3.2.2 of this Standard.

20.1.4 Vaporisers shall be correctly sized for the expected duty.

20.1.5 Vaporisers shall be selected taking into account all foreseeable loads including thermal stressing due to changes in temperature.

20.2 AMBIENT-AIR VAPORISERS

20.2.1 Ambient-air vaporisers shall be located in such a manner that prevents the creation of a hazardous situation arising from the creation of excessive fog leading to poor visibility.

20.2.2 Ambient-air vaporisers shall have interior pipework with a melting temperature high enough to maintain structural integrity in the event of a fire.

Note: It is not uncommon to encounter ambient-air vaporisers of light-alloy metal construction (e.g. aluminium fins) but these typically have interior pipework made of stainless steel.

20.2.3 Ambient-air vaporisers shall be suitable for use in its expected climate.

Note: Cold climates can reduce the overall effectiveness of ambient-air vaporisers.

20.2.4 Ambient-air vaporisers should be located in such a manner that facilitates good solar exposure and free-flowing natural ventilation.

Note: Shadows of tall buildings, trees, and other equipment can reduce solar exposure, which can reduce the overall effectiveness of vaporisers.

20.2.5 Ambient-air vaporisers should not be overworked to the point of zero effectiveness.

Note: Ambient-air vaporisers that are overworked (or are continuous operation for long periods of time) can cause the formation of excessive ice, particularly in humid environments. This can severely reduce the effectiveness of heat exchange.

20.2.6 Ambient-air vaporisers should be given time to defrost in situations where they be can potentially be overworked.

Note: For continuous process, the working fluid can be diverted through an alternate "change-over" vaporiser bank.

20.2.7 Ambient-air vaporisers that have accumulated excessive ice should be carefully-managed for the removal of ice.

20.3 ELECTRICAL VAPORISERS/HEATERS

20.3.1 Electrical vaporisers/heaters shall be designed to prevent overheating.

20.3.2 Electrical vaporisers/heaters shall have a means of automatic isolation of power.

20.3.3 Electrical vaporisers/heaters shall be suitably certified and installed with respect to hazardous area classification.

20.4 WATER BATH VAPORISERS

20.4.1 Water bath vaporisers shall be designed to prevent ice blockage.

20.4.2 Water bath vaporisers shall have a means to automatically isolate the heat source.

SECTION 21 : ODORISERS

Odorisers are devices that introduce an odorant into the working fluid. A sulphuric compound is typically injected into natural gas in order to give it a distinct smell. Refer to Section 7.5.3 for more information on odorisation requirements.

21.1 GENERAL REQUIREMENTS

21.1.1 Odorisers shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note: Refer to ASME Section VIII, Division 1.

21.1.2 Odorisers shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

21.1.3 Odorisers shall use odorants suitable for the expected climate.

Note: Some odorants can begin to freeze at moderately low ambient temperatures.

21.1.4 Odorisers should be installed in a well-ventilated area.

21.1.5 Odorisers should be fitted with a non-return valve on the odorant outlet.

21.2 OPERATIONAL REQUIREMENTS

21.2.1 Odorisers shall have means of indicating the odorant level.

Note: For instance, with a level indicator on the odorant storage.

21.2.2 Odorisers shall have means to monitor the dosing levels.

Note: For instance, with a flow meter on the odorant outlet.

21.2.3 Odorisers shall ensure they can be safely vented into a suitable area, away from persons within the vicinity that could be adversely affected.

Note 1: Special precautions are required for odorisers that use flammable odorants.

Note 2: Venting indoors or in poorly-ventilated areas need to be avoided.

21.2.4 Odorisers should ensure a good mixing of the odorant with the working fluid.

21.2.5 Odorisers should ensure dosing is within the specified range.

21.2.6 Odorisers should have odorant storage that can be easily refilled and drained.

21.3 PREVENTATIVE MEASURES

21.3.1 Prevention of Loss of Odorisation

Odorisers shall be equipped with devices that can be used to indicate when there is a possible loss of odorisation.

Note: A level transmitter could be used to indicate that odorant storage is at low-level.

21.4 MITIGATION MEASURES

21.4.1 Mitigation of Loss of Odorisation

Odorisers shall be equipped with devices that can be used to trigger an emergency shutdown when there is an actual loss of odorisation.

Note: A zero-reading on a flow transmitter could be used to indicate that an odorant dosing pump has failed or that the odorant storage is empty.

SECTION 22 : DISPENSERS

22.1 GENERAL REQUIREMENTS

22.1.1 Dispensers shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

22.1.2 Dispensers shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

22.1.3 Dispensers shall have means of isolation.

22.1.4 Dispensers shall be located in a well-ventilated area, preferably in the open air. If not located in the open air, the location shall be subjected to risk analysis.

22.1.5 Dispensers that have a canopy for weather protection shall be designed to prevent the collection of gas.

22.1.6 Dispensers shall have fuelling instructions and warning signs provided within its vicinity.

22.1.7 Dispensers shall be clearly labelled, indicating that it dispenses "CNG" or "LNG" as applicable. The maximum dispensing pressure shall be indicated. Dispensers supplying differing dispensing pressures shall be suitably labelled.

Note: Refer to BS EN 16942.

22.1.8 Dispensers should provide a facility for the safe stowage of fuelling hoses and their nozzles in order to protect them from damage and moisture ingress.

22.2 FUNCTIONAL REQUIREMENTS

22.2.1 Dispensers shall not supply fuel at a pressure higher than the maximum operating pressure of the receiving system.

22.2.2 An automatic system shall be installed for each fuelling hose to shut off the flow if the delivery pressure at the fuelling nozzle reaches the maximum allowable pressure of the vehicle fuel tank or when the fuelling process has ended.

22.2.3 Dispensers shall not automatically restart to permit gas flow following a system reset or return of power.

22.2.4 Dispensers shall be fitted with an emergency stop device in accordance with Section 26.1, and shall trigger an emergency shutdown in accordance with Section 12.3.

22.3 PREVENTATIVE MEASURES

22.3.1 Prevention of Collision

Dispensers shall be adequately protected against collision from vehicles.

Note: E.g. With use of suitable heavy-duty barriers, bollards, or raised plinths.

22.3.2 Prevention of Electrostatic Discharge

Dispensers shall have a means to ensure that the vehicle being fuelled and dispensing equipment is at equipotential.

22.3.3 **Prevention of Erroneous Connection**

Dispensers shall have fuelling nozzles that are specially-coded in order to prevent against erroneous connection to an incorrect mating-half.

Note 1: This is typically achieved by geometric definition.

Note 2: Refer to Section 22.6 for fuelling nozzle requirements.

22.3.4 **Prevention of Rapid Depressurisation**

Dispensers shall be equipped with fuelling nozzles that prevent rapid depressurisation during disconnection.

22.3.5 **Prevention of Unauthorised Use**

Dispensers shall have provisions for preventing unauthorised use, especially in the case when the site is unmanned.

22.4 **MITIGATION MEASURES**

22.4.1 **Mitigation of Collision**

Dispensers shall be fitted with a means of automatic isolation in the event of collision.

22.4.2 **Mitigation of Pull-Away**

Dispensers shall be equipped with a breakaway device in accordance with Section 22.6.3.2 of this Standard, or an equivalent system, that minimises the risk of a hazardous situation caused by the release of LNG due to the vehicle being fuelled "pulling away" with the fuelling hose still connected.

Note: Breakaway devices are typically installed between the fuelling hose and the dispenser body.

22.5 **FUELLING HOSES**

22.5.1 Fuelling hoses used for the dispensing of LNG shall meet all requirements in accordance with Section 18 of this Standard.

22.5.2 Fuelling hoses shall be inspected at specified intervals according to the manufacturer's instructions.

22.5.3 Fuelling hoses should be kept as short as possible.

Note: Typical LNG fuelling hose assemblies are between 3 and 5 metres long.

22.6 **FUELLING NOZZLES**

22.6.1 **General Requirements**

22.6.1.1 Fuelling nozzles shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

22.6.1.2 Fuelling nozzles shall be compatible with the intended fuelling receptacle.

Note 1: LNG fuelling receptacles for road vehicles are typically in accordance with BS EN ISO 12617.

Note 2: CNG fuelling receptacles for road vehicles are typically in accordance with BS EN ISO 14469.

22.6.1.3 Fuelling nozzles shall only permit the flow of fuel if there is an adequate connection between the fuelling nozzle and the fuelling receptacle.

22.6.2 **Requirements for CNG**

22.6.2.1 CNG fuelling nozzles shall be in accordance with IGEM/UP/20.

Note: Refer to IGEM/UP/20, Section 14.4.

22.6.3 **Requirements for LNG**

22.6.3.1 Fuelling nozzles shall be designed for use with LNG.

22.6.3.2 The connection shall prevent the escape of LNG when it is not fully engaged or becomes separated.

22.6.3.3 The fuelling connector either shall be equipped with an interlock device that prevents release while the line is open, or have self-closing ends that automatically close upon disconnection.

22.7 **BREAKAWAY REQUIREMENTS**

22.7.1 Breakaway devices used for the dispensing of LNG shall meet all requirements in accordance with Section 19 of this Standard.

22.7.2 Breakaway devices shall have a disconnection force much less than the pull-out force that would put the fuelling system under severe risk from potential leak or damage.

22.8 **METERING SYSTEMS**

22.8.1 Metering systems shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

22.8.2 Metering systems shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

22.8.3 Metering systems must address the Weights and Measures Act where retail is to the public.

Note: Alternative commercial arrangements may be suitable in certain circumstances.

22.8.4 Metering systems should measure on a mass basis.

22.8.5 Metering systems should be recalibrated as necessary.

22.8.6 Metering systems for LNG should be capable of reconciling two-phase flow.

SECTION 23 : PIPEWORK

Pipework is commonly used for conveying fluids within an industrial process, and is made up of many components including pipes, flanges, gaskets, fittings, and supports. This Section mainly focuses on the requirements of pipework for the conveyance of natural gas, but is equally relevant to other process fluids such as nitrogen.

23.1 GENERAL REQUIREMENTS

23.1.1 Pipework shall be designed, manufactured, inspected, tested, installed, commissioned, used and maintained in accordance with applicable design codes.

Note 1: Refer to BS EN 13480-1 for general requirements of metallic industrial piping.
Refer to BS EN 13480-2 for material requirements of metallic industrial piping.
Refer to BS EN 13480-3 for design and calculation of metallic industrial piping.
Refer to BS EN 13480-4 for fabrication and installation of metallic industrial piping.
Refer to BS EN 13480-5 for inspection and testing of metallic industrial piping.
Refer to BS EN 13480-6 for requirements relating to buried metallic industrial piping.

Note 2: Refer to BS EN 15001-1 and BS EN 15001-2 for design, materials, construction, inspection, testing, commissioning, operation and maintenance of gas installation pipework.

Note 3: Refer to BS ISO 15649 for piping for petroleum and natural gas industries.

Note 4: Refer to BS EN ISO 3183 for steel pipe intended for pipeline transportation systems.

23.1.2 Pipework shall be designed such that it is suitable for the intended service over a specified operating pressure and temperature range.

23.1.3 Pipework shall be subject to stress analysis with respect to all foreseeable loads in order to help validate the suitability of a particular design.

23.1.4 Pipework shall be of materials that have been evaluated and selected in conjunction with Section 7.1 of this Standard.

23.2 PREVENTATIVE MEASURES

23.2.1 Prevention of Overpressure

23.2.1.1 Pipework shall be equipped with safety devices to protect against overpressure.

Note: Refer to Section 24.2 for requirements of safety valves.

23.2.1.2 Pipework shall have at least one thermal relief device fitted to each and every section where LNG can be trapped due to closure at each end (e.g. through valve closure) in order to prevent against overpressure arising from LNG thermal expansion.

23.2.2 Prevention of Corrosion

Pipework shall be protected against corrosion, especially if carbon steel is used.

Note: Stainless steel is often a preferred choice for protection against corrosion.

23.2.3 Prevention of Mechanical Damage

Pipework shall be located and protected to avoid mechanical damage.

Note: For instance, risk of mechanical damage from moving vehicles.

23.2.4 Prevention of Tampering

Pipework shall be protected against unauthorised access and tampering.

23.3 PIPEWORK DESIGN

23.3.1 Joints and Welds

23.3.1.1 Pipework should contain as few mechanical joints as possible.

23.3.1.2 Socket welds should be avoided where possible.

Note: Socket welds are incompatible with the inspection requirements of many pipe design codes.

23.3.2 Flexible Connections

23.3.2.1 Flexible connections should be avoided where possible, and otherwise limited to specific cases of use.

Note: Flexible connections may be used to prevent stress build-up in rigid pipework due to the transmission of forces from pump vibration or the relative shift between equipment built on different foundations.

23.3.2.2 Flexible connections shall be suitable for the design parameters.

Note: For dispenser fuelling hoses, refer to Section 22.5.

23.4 PIPEWORK TESTING

23.4.1 Non Destructive Testing (NDT)

23.4.1.1 Non-destructive testing (NDT) shall be performed in accordance with the appropriate design code.

Note: Refer to BS EN ISO 15549 for general principles of eddy current testing.
Refer to BS EN ISO 3452-1 for general principles of penetrant testing.
Refer to BS EN ISO 9934-1 general principles of magnetic particle testing.
Refer to BS EN ISO 16810 for general principles of ultrasonic testing.

23.4.1.2 Non-destructive testing (NDT) shall only be conducted by a suitably qualified competent person.

Note: Refer to BS EN ISO 9712 for qualification and certification of NDT personnel.

23.4.2 Testing of Welded Joints

23.4.2.1 Welded joints shall be subjected to non-destructive testing in accordance with the appropriate design code.

Note: Refer to BS EN ISO 17635 for general rules for metallic materials.
Refer to BS EN ISO 17636-1, BS EN ISO 17636-2 for radiographic testing of welds
Refer to BS EN ISO 17637 for visual testing of welds.
Refer to BS EN ISO 17638 for magnetic particle testing of welds.
Refer to BS EN ISO 17640 for ultrasonic testing of welds.

23.4.3 Pressure Testing

The complete installation shall be suitably tested for strength and tightness using an approved method.

23.5 PIPEWORK INSPECTION

23.5.1 Pipework shall be inspected on a regular basis, e.g. as detailed in the Written Scheme of Examination or by general maintenance schedules. This shall be defined in the operation and maintenance procedure as described in

23.5.2 Pipework periodical inspection shall be specified in the operational and maintenance procedures.

23.5.3 Mechanical joints shall be accessible for inspection and leakage detection.

23.6 PIPEWORK INSTALLATION

23.6.1 Pipework and fittings shall be suitably secured to prevent disconnection during normal operation.

23.7 PIPEWORK ANCILLIARIES

23.7.1 Pipework Flanges

Pipework flanges shall be designed, manufactured, inspected, tested, installed, commissioned, used and maintained in accordance with applicable design codes.

Note: Refer to BS EN 1092-1 for steel flanges.

23.7.2 Pipework Gaskets

Pipework gaskets shall be designed, manufactured, inspected, tested, installed, commissioned, used and maintained in accordance with applicable design codes.

Note: Refer to BS EN 1514-2, BS EN 1514-4 for gaskets used with steel flanges.

23.7.3 Pipework Bolting

Pipework bolting shall be designed, manufactured, inspected, tested, installed, commissioned, used and maintained in accordance with applicable design codes.

Note: Refer to BS EN 1515-1 for selection of bolting.

23.8 VENTS

23.8.1 Vents shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note 1: Refer to IGE/SR/23 – venting of natural gas

Note 2: Refer to BS EN ISO 23251, API 521 for pressure-relieving and depressuring systems.

23.8.2 Venting shall be via a suitably designed vent stack and vent terminal, and sized appropriately taking into account pressure losses using relevant codes of practice.

23.8.3 Vents shall be located in suitable locations in accordance with the outcomes of radiation and dispersion studies.

Note: Extremely cold vapour arising from LNG has the potential to be heavier than air, which could cause a vapour cloud.

23.8.4 Certain fuelling station equipment may contain control devices which require vents terminating in non-hazardous areas. A hazardous area assessment shall be applied to the termination points which may affect their position in relation to ignition sources, air intakes and boundaries. This shall be accounted for in the layout of equipment.

23.8.5 Where relief valve vents are connected together on a manifold, operation of any relief valve shall not be impeded, flow-restricted or obstructed by the operation of any other valve(s).

23.8.6 Manifolded vents (e.g. from similar equipment being connected together) shall be permitted only on the basis that suitable backpressure calculations are undertaken to demonstrate that it is within relief valve capacity of the system.

23.8.7 Relief vent lines shall not be impeded or obstructed.

23.8.8 Permanent or temporary ignition sources shall not be permitted within the vent terminal hazardous area.

23.8.9 Vents shall terminate directly to the atmosphere and the vent pipe end point shall:

- be facing upward and unimpeded, and
- be located at a non-hazardous area outdoors at a height of at least 3 m above the ground, and at least 1 m higher than any building roof level within the calculated area, and
- be fitted with a vent terminal designed to take account of the adverse effects of rain, condensation and, foreign bodies.

SECTION 24 : VALVES

24.1 GENERAL REQUIREMENTS

24.1.1 All valves shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note 1: Refer to BS EN 13942, ISO 14313 for pipeline valves.

Note 2: Refer to BS ISO 21011 for cryogenic valves.

Note 3: Refer to BS EN ISO 10497 for testing of fire-type valves.

24.1.2 All valves shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

24.1.3 All valves shall be labelled with suitable identification tags with numbering that can be cross-referenced against the relevant P&ID.

24.1.4 All valves should be permanently marked with an indication of the flow direction.

24.2 SAFETY VALVES

24.2.1 Safety valves shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note 1: Refer to BS EN ISO 4126-1 for safety devices for protection against excessive pressure.

Note 2: Refer to BS ISO 21013-1 for cryogenic re-closable pressure relief valves.

24.2.2 Safety valves shall be correctly sized for the intended duty.

Note 1: Refer to API 520-1 for sizing, selection and installation of pressure-relieving devices.

Note 2: Refer to BS ISO 4126-10 for sizing of two-phase flow safety valves.

Note 3: Refer to BS EN ISO 21013-3 for sizing of cryogenic pressure relief valves.

24.2.3 Safety valves shall prevent overpressure in any part of the fuelling station and its pipework (including piping systems which have a potential to become blocked), and the uncontrolled release of pressurised gas.

24.2.4 Safety valves shall be installed to ensure operation in all conditions.

24.2.5 Safety valves for LNG should be installed in a manner to prevent cold tracking.

SECTION 25 : INSTRUMENTATION

25.1 SENSORS AND DETECTORS

25.1.1 Sensors shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note: Refer to BS EN 60751 for platinum temperature sensors.

25.1.2 Sensors shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

25.1.3 Gas Detectors

25.1.3.1 Gas detectors shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note: Refer to BS EN 60079-29-1, BS EN ISO 10156.

25.1.3.2 Gas detectors shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

Note: Refer to BS EN 60079-29-2 for additional guidance.

25.1.3.3 Gas detectors should be calibrated on a regular basis.

25.2 INDICATORS AND GAUGES

25.2.1 General Requirements

25.2.1.1 Indicators and gauges shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note: Refer to BS EN ISO 5171 for Bourdon-tube pressure gauges.

25.2.1.2 Indicators and gauges shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

25.2.1.3 Indicators and gauges throughout the facility shall have the same system of units of measurement for each type of parameter being indicated (i.e. pressure, temperature, volume, flow, etc.)

Note 1: For instance, imperial and metric units are not to be mixed

Note 2: Different orders of magnitude in the same unit system are acceptable

25.2.2 Pressure Indicators and Gauges

25.2.2.1 Pressure gauges shall be calibrated with a full-scale reading of at least 1.2 times the maximum operating pressure of the system they intend to measure.

25.2.2.2 Where appropriate, adequate monitoring devices, e.g. pressure gauges shall be installed to enable adequate action to be taken either automatically or manually to keep the pressure equipment within the allowable limits.

25.3 TRANSMITTERS

25.3.1 Transmitters shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

25.3.2 Transmitters shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

SECTION 26 : AUTOMATION, SWITCH GEAR AND CONTROL GEAR

26.1 EMERGENCY STOP DEVICES

26.1.1 General Requirements

26.1.1.1 Emergency stop devices shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note: Refer to BS EN 60947-5-5.

26.1.1.2 Emergency stop devices shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

Note: Refer to BS EN ISO 13850.

26.2 WARNING SIRENS

26.2.1 General Requirements

26.2.1.1 Warning sirens shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note: Refer to BS 5839-1, ISO 8201 for audible alarm tones.

26.2.1.2 Warning sirens shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

26.3 BEACONS

26.3.1 General Requirements

26.3.1.1 Beacons shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

26.3.1.2 Beacons shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

SECTION 27 : CNG EQUIPMENT

CNG equipment may be used in LNG and LCNG fuelling stations, handling LNG that has been brought into its gaseous state.

27.1 GENERAL PROVISIONS

27.1.1 CNG equipment shall be suitably located with respect to LNG equipment, or otherwise adequately protected, to prevent exposure to cryogenic temperatures.

Note: Exposure of CNG equipment to cryogenic temperatures could cause brittle-fracture failure.

27.1.2 Adequate safety measures shall be implemented to ensure vaporised LNG cannot be supplied to CNG equipment at a temperature below the minimum operating temperature of the CNG equipment.

Note: LNG needs to be vaporised to a temperature above −40 °C.

27.2 CNG COMPRESSORS

These shall be in accordance with IGEM/UP/20.

Note: Refer to IGEM/UP/20, Section 11.

27.3 CNG STORAGE

These shall be in accordance with IGEM/UP/20.

27.4 CNG DISPENSERS

These shall be in accordance with IGEM/UP/20 and the relevant parts of Section 21 of this Standard.

Note: Refer to IGEM/UP/20, Section 14.

SECTION 28 : SIGNS, MARKINGS AND INSTRUCTIONS

28.1 SAFETY SIGNS

28.1.1 Safety signs shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note: Refer to BS EN ISO 7010, BS ISO 3864-1, BS 5499-10.

28.1.2 Safety signs shall be installed, commissioned, used and maintained in accordance with manufacturer's instructions and recommendations.

28.2 GENERAL

28.2.1 Signs, markings and literature shall be printed in English and any other required language and shall include the relevant pictograms.

28.2.2 Hazardous area warning signs shall clearly mark the area which is classified as a hazardous area indicating that smoking, naked lights and the use of unprotected electrical equipment are prohibited.

28.2.3 Restricted areas shall be marked accordingly, including those areas requiring special safety equipment (personal protective equipment (PPE) etc.) to be worn.

28.3 MARKING

Fuelling station components shall carry the markings in a durable, legible manner that includes (where applicable) the following:

- identification of the manufacturer
- year of manufacture
- serial number
- essential limits such as MOP and temperature
- operating pressure
- rated power in kVA and supply voltage in V.

SECTION 29 : PERSONAL PROTECTIVE EQUIPMENT (PPE)

29.1 GENERAL REQUIREMENTS

29.1.1 Personal protective equipment shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

29.1.2 Personal protective equipment shall be used and maintained in accordance with manufacturer's instructions and recommendations.

29.1.3 Personal protective equipment shall be worn where it is essential for protection against potential hazards for the specific operational environment.

29.1.4 Personal protective equipment shall be correctly-sized for each individual.

29.2 HEAD PROTECTION

29.2.1 Head protection shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note: Refer to BS EN 397 for industrial safety helmets.

29.2.2 Head protection shall be used and maintained in accordance with manufacturer's instructions and recommendations.

29.3 EYE AND FACE PROTECTION

29.3.1 Eye and face protection shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note: Refer to BS EN 166 for general requirements of eye protection.

29.3.2 Eye and face protection shall be used and maintained in accordance with manufacturer's instructions and recommendations.

29.4 EAR PROTECTION

29.4.1 Ear protection shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note 1: Refer to BS EN 352-1 for ear-muffs.

Note 2: Refer to BS EN 352-2 for ear-plugs.

29.4.2 Ear protection shall be used and maintained in accordance with manufacturer's instructions and recommendations.

29.5 PROTECTIVE CLOTHING

29.5.1 Protective clothing shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note 1: Refer to BS EN ISO 11612 for protective clothing against heat and flame.

Note 2: Refer to BS EN 1149-5 for electrostatic properties of protective clothing.

Note 3: Refer to BS EN ISO 20471 for high visibility clothing.

29.5.2 Protective clothing shall be used and maintained in accordance with manufacturer's instructions and recommendations.

29.6 PROTECTIVE GLOVES

29.6.1 Protective gloves shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note 1: Refer to BS EN 420 for general requirements of protective gloves.

Note 2: Refer to BS EN 388 for protective gloves against mechanical risks.

Note 3: Refer to BS EN 511 for protective gloves against cold.

29.6.2 Protective gloves shall be used and maintained in accordance with manufacturer's instructions and recommendations.

29.7 PROTECTIVE FOOTWEAR

29.7.1 Protective footwear shall be designed, manufactured, inspected, and tested in accordance with applicable design codes.

Note: Refer to BS EN ISO 20345, BS EN ISO 20346 for general requirements of protective footwear.

29.7.2 Protective footwear shall be used and maintained in accordance with manufacturer's instructions and recommendations.

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

GLOSSARY

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

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

biomethane	gas comprising principally methane, obtained from either upgrading of biogas or methanation of bio-syngas.
break-away device	device which under normal circumstances permits flow but, at a predetermined force, separates and stems flow in both directions.
burst pressure	the pressure which causes failure and consequential fluid loss through the component envelope.
canopy	roof, for example a shelter, a hood etc., which affords a degree of weather protection.
competent	having the necessary knowledge, experience, training and authority with respect to the relevant area of expertise.
compressor	a machine which increases the pressure of gas from a low to a higher level.
delivery pressure	the pressure at which Natural Gas is delivered to the vehicle.
dispenser	the equipment through which the Natural Gas is supplied to the vehicle.
dryer	system which decreases the water content of the Natural Gas.
fire wall	wall, screen or separating partition to reduce the effects from radiated heat.
gas conditioning equipment	equipment to filter and/or remove unwanted constituents (moisture, debris, liquid and vapours) from Natural Gas either prior to or after compression.
LCNG fuelling station	facility which provides CNG from an on-site LNG source.
LNG fuelling station	facility which provides LNG from an on-site LNG source.
liquefied natural gas (LNG)	fluid in the cryogenic liquid state that is composed predominantly of methane and that can contain minor quantities of ethane, propane, nitrogen, and other components normally found in natural gas.
liquid separator	device which causes any liquids within the gas to drop out of suspension for collection and can be located after compression of the Natural Gas.

mobile storage	pressure vessel used for storage which is generally mobile and is not fixed to the ground (e.g. as part of a road tanker, ISO container, or sea vessel).
overpressure	pressure above the maximum operational pressure.
recovery vessel	vessel that recovers Natural Gas from the compressor and its ancillaries and which may also serve to damp out pressure pulsations in the compressor inlet.
separation distance	the separation distance between the fuelling station, its components and structures and other installations and structures in the vicinity for protecting people and property and reducing the degree of danger in the case of an incident.
station owner/operator	the person who owns, or is responsible for the operation of the fuelling station.
storage	any number of suitable Natural Gas storage containers designed for the purpose of containing and subsequently releasing Natural Gas.
technical file	compiled documentation that provides sufficient evidence that a product is designed and manufactured in compliance with all relevant regulations and safety standards.
test pressure (TP)	the pressure to which the installation or part of installation is tested. Different levels may be required for storage pressure vessels and other components.

ACRONYMS AND ABBREVIATIONS

ACoPs	Approved Codes of Practice
BCGA	British Compressed Gases Association
BP	burst pressure
CNG	Compressed Natural Gas
EU	European Union
FMEA	Failure Mode and Effects Analysis
GB	Great Britain
HAZID	Hazard Identification
HAZOPS	Hazard and Operability Study
HSE	Health & Safety Executive
IGEM	Institution of Gas Engineers & Managers
LNG	Liquefied Natural Gas
MOP	maximum operating pressure
NG	Natural Gas
NGV	Natural Gas Vehicle
P&ID	Piping and Instrumentation Diagram
PFD	Process Flow Diagram
UK	United Kingdom
UKAS	United Kingdom Accreditation Service.

SYMBOLS

%	percentage

UNITS

dB	decibel
kW	kilowatt
kVA	kilovolt-ampere
l	litre
m	metre
mm	millimetre
mm^2	square millimetre
N	newton
V	voltage
°C	degree Celsius.

APPENDIX 2 : REFERENCES

This Standard is set out against a background of legislation in force in the UK at the time of publication. Similar considerations are likely to apply in other countries and reference to the appropriate national legislation will be necessary.

This Appendix lists legislation, guidance notes and Standards etc. which are identified within this Standard as well as further items of legislation which may be applicable.

Where British 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.

A2.1 IGEM STANDARDS

- IGE/GL/8 Reporting and investigation of gas-related incidents
- IGE/SR/23 Venting of Natural Gas
- IGE/UP/5 Natural Gas Vehicles: Filling Station Operations
- IGEM/G/4 Definitions for the gas industry
- IGEM/G/7 Risk Assessment Techniques
- IGEM/SR/29 Dealing with gas escapes
- IGEM/UP/6 Application of compressors to Natural Gas fuel systems
- IGEM/UP/20 CNG Fuelling Stations

A2.2 BRITISH STANDARDS

- BS 476-6 Fire tests on building materials and structures. Method of test for fire propagation for products
- BS 4089 Specification for metallic hose assemblies for liquid petroleum gases and liquefied natural gases
- BS 5429 Code of practice for safe operation of small-scale storage facilities for cryogenic liquids
- BS 5499-10 Guidance for the selection and use of safety signs and fire safety notices
- BS 5839-1 Fire detection and fire alarm systems for buildings. Code of practice for design, installation, commissioning and maintenance of systems in non-domestic premises
- BS 7671 Requirements for Electrical Installations. IET Wiring Regulations
- BS 31100 Risk management. Code of practice and guidance for the implementation of BS ISO 31000
- BS EN 352-1 Hearing protectors. Safety requirements and testing. Ear-muffs
- BS EN 352-2 Hearing protectors. Safety requirements and testing. Ear-plugs
- BS EN 388 Protective gloves against mechanical risks
- BS EN 397 Industrial safety helmets
- BS EN 420 Protective gloves. General requirements and test methods
- BS EN 511 Protective gloves against cold

- BS EN 1092-1 Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Steel flanges
- BS EN 1127-1 Explosive atmospheres. Explosion prevention and protection. Basic concepts and methodology
- BS EN 1149-5 Protective clothing. Electrostatic properties. Material performance and design requirements
- BS EN 1474-2 Installation and equipment for liquefied natural gas. Design and testing of marine transfer systems. Design and testing of transfer hoses
- BS EN 1514-2 Flanges and their joints. Gaskets for PN-designated flanges. Spiral wound gaskets for use with steel flanges
- BS EN 1514-4 Flanges and their joints. Dimensions of gaskets for PN-designated flanges. Corrugated, flat or grooved metallic and filled metallic gaskets for use with steel flanges
- BS EN 1515-1 Flanges and their joints. Bolting. Selection of bolting
- BS EN 1991-1-4 Eurocode 1. Actions on structures. General actions. Wind actions
- BS EN 1991-1-7 Eurocode 1. Actions on structures. General actions. Accidental actions
- BS EN 12434 Cryogenic vessels. Cryogenic flexible hoses
- BS EN 13458-2 Cryogenic vessels. Static vacuum insulated vessels. Design, fabrication, inspection and testing
- BS EN 13480-1 Metallic industrial piping. General
- BS EN 13480-2 Metallic industrial piping. Materials
- BS EN 13480-3 Metal industrial piping. Design and calculation
- BS EN 13480-4 Metallic industrial piping. Fabrication and installation
- BS EN 13480-5 Metallic industrial piping. Inspection and testing
- BS EN 13480-6 Metallic industrial piping. Additional requirements for buried piping
- BS EN 13942 Petroleum and natural gas industries. Pipeline transportation systems. Pipeline valves
- BS EN 16942 Fuels. Identification of vehicle compatibility. Graphical expression for consumer information
- BS EN 15001-1 Gas infrastructure. Gas installation pipework with an operating pressure greater than 0,5 bar for industrial installations and greater than 5 bar for industrial and non-industrial installations. Detailed functional requirements for design, materials, construction, inspection and testing
- BS EN 15001-2 Gas infrastructure. Gas installation pipework with an operating pressure greater than 0,5 bar for industrial installations and greater than 5 bar for industrial and non-industrial installations. Detailed functional requirements for commissioning, operation and maintenance
- BS EN 31010 Risk management. Risk assessment techniques
- BS EN 60079-10-1 Explosive atmospheres. Classification of areas. Explosive gas atmospheres
- BS EN 60079-29-1 Explosive atmospheres. Gas detectors. Performance requirements of detectors for flammable gases

• BS EN 60079-29-2	Explosive atmospheres. Gas detectors. Selection, installation, use and maintenance of detectors for flammable gases and oxygen
• BS EN 60445	Basic and safety principles for man-machine interface, marking and identification. Identification of equipment terminals, conductor terminations and conductors
• BS EN 60751	Industrial platinum resistance thermometers and platinum temperature sensors
• BS EN 60947-5-5	Low-voltage switchgear and controlgear. Control circuit devices and switching elements. Electrical emergency stop device with mechanical latching function
• BS EN 61508-1	Functional safety of electrical / electronic / programmable electronic safety-related systems. General requirements
• BS EN 61508-2	Functional safety of electrical / electronic / programmable electronic safety-related systems. Requirements for E/E/PE safety-related systems
• BS EN 61511-1	Functional safety. Safety instrumented systems for the process industry sector. Framework, definitions, system, hardware and software requirements
• BS EN 62305-1	Protection against lightning. General principles
• BS EN 62305-2	Protection against lightning. Risk management
• BS EN ISO 3452-1	Non-destructive testing. Penetrant testing. General principles
• BS EN ISO 4126-1	Safety devices for protection against excessive pressure. Safety valves
• BS EN ISO 5171	Gas welding equipment. Pressure gauges used in welding, cutting and allied processes
• BS EN ISO 7010	Graphical symbols. Safety colours and safety signs. Registered safety signs
• BS EN ISO 7384	Corrosion tests in artificial atmospheres. General requirements
• BS EN ISO 9227	Corrosion tests in artificial atmospheres. Salt spray tests
• BS EN ISO 9606-1	Qualification testing of welders. Fusion welding. Steels
• BS EN ISO 9712	Non-destructive testing. Qualification and certification of NDT personnel
• BS EN ISO 9934-1	Non-destructive testing. Magnetic particle testing. General principles
• BS EN ISO 10156	Gases and gas mixtures. Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets
• BS EN ISO 10380	Pipework. Corrugated metal hoses and hose assemblies
• BS EN ISO 10497	Testing of valves. Fire type-testing requirements
• BS EN ISO 10628-1	Diagrams for the chemical and petrochemical industry. Specification of diagrams
• BS EN ISO 10628-2	Diagrams for the chemical and petrochemical industry. Graphical symbols

- BS EN ISO 11612 Protective clothing. Clothing to protect against heat and flame. Minimum performance requirements
- BS EN ISO 12100 Safety of machinery. General principles for design. Risk assessment and risk reduction
- BS EN ISO 12617 Road vehicles. Liquefied natural gas (LNG) refuelling connector. 3,1 MPa connector
- BS EN ISO 13709 Centrifugal pumps for petroleum, petrochemical and natural gas industries
- BS EN ISO 13710 Petroleum, petrochemical and natural gas industries. Reciprocating positive displacement pumps
- BS EN ISO 13734 Natural gas. Organic components used as odorants. Requirements and test methods
- BS EN ISO 13849-1 Safety of machinery. Safety-related parts of control systems. General principles for design
- BS EN ISO 13850 Safety of machinery. Emergency stop function. Principles for design
- BS EN ISO 14469 Road vehicles. Compressed natural gas (CNG) refuelling connector
- BS EN ISO 15156-1 Petroleum and natural gas industries. Materials for use in H2S-containing environments in oil and gas production. General principles for selection of cracking-resistant materials
- BS EN ISO 15549 Non-destructive testing. Eddy current testing. General principles
- BS EN ISO 16810 Non-destructive testing. Ultrasonic testing. General principles
- BS EN ISO 16904 Petroleum and natural gas industries. Design and testing of LNG marine transfer arms for conventional onshore terminals
- BS EN ISO 17635 Non-destructive testing of welds. General rules for metallic materials
- BS EN ISO 17636-1 Non-destructive testing of welds. Radiographic testing. X- and gamma-ray techniques with film
- BS EN ISO 17636-2 Non-destructive testing of welds. Radiographic testing. X- and gamma-ray techniques with digital detectors
- BS EN ISO 17637 Non-destructive testing of welds. Visual testing of fusion-welded joints
- BS EN ISO 17638 Non-destructive testing of welds. Magnetic particle testing
- BS EN ISO 17640 Non-destructive testing of welds. Ultrasonic testing. Techniques, testing levels, and assessment
- BS EN ISO 20345 Personal protective equipment. Safety footwear
- BS EN ISO 20346 Personal protective equipment. Protective footwear
- BS EN ISO 20471 High visibility clothing. Test methods and requirements
- BS EN ISO 21009-2 Cryogenic vessels. Static vacuum insulated vessels. Operational requirements
- BS EN ISO 21013-3 Cryogenic vessels. Pressure-relief accessories for cryogenic service. Sizing and capacity determination

- BS EN ISO 23936-1 Petroleum, petrochemical and natural gas industries. Non-metallic materials in contact with media related to oil and gas production. Thermoplastics
- BS ISO 668 Series 1 freight containers. Classification, dimensions and ratings
- BS ISO 3864-1 Graphical symbols. Safety colours and safety signs. Design principles for safety signs and safety markings
- BS ISO 4126-10 Safety devices for protection against excessive pressure. Sizing of safety valves for gas/liquid two-phase flow
- BS ISO 15519-1 Specification for diagrams for process industry. General rules
- BS ISO 15519-2 Specifications for diagrams for process industry. Measurement and control
- BS ISO 15649 Petroleum and natural gas industries. Piping
- BS EN ISO 17635 Non-destructive testing of welds. General rules for metallic materials
- BS EN ISO 17637 Non-destructive testing of welds. Visual testing of fusion-welded joints
- BS EN ISO 17640 Non-destructive testing of welds. Ultrasonic testing. Techniques, testing levels, and assessment
- BS ISO 20421-1 Cryogenic vessels. Large transportable vacuum-insulated vessels. Design, fabrication, inspection and testing
- BS ISO 20421-2 Cryogenic vessels. Large transportable vacuum-insulated vessels. Operational requirements
- BS ISO 21009-1 Cryogenic vessels. Static vacuum-insulated vessels. Design, fabrication, inspection and tests
- BS ISO 21011 Cryogenic vessels. Valves for cryogenic service
- BS ISO 21012 Cryogenic vessels. Hoses
- BS ISO 21013-1 Cryogenic vessels. Pressure-relief accessories for cryogenic service. Reclosable pressure-relief valves
- BS ISO 31000 Risk management. Principles and guidelines

A2.3 EUROPEAN STANDARDS

- EN 10204 Metallic products – Types of inspection documents
- EN 13445-1 Unfired pressure vessels – Part 1: General
- EN 13445-2 Unfired pressure vessels – Part 2: Materials
- EN 13480-1 Metallic industrial piping – Part 1: General
- EN 13480-2 Metallic industrial piping – Part 2: Materials
- EN 13480-3 Metallic industrial piping – Part 3: Design and calculation
- EN 13480-4 Metallic industrial piping – Part 4: Fabrication and installation
- EN 13480-5 Metallic industrial piping – Part 5: Inspection and testing
- EN 13480-6 Metallic industrial piping – Part 6: Additional requirements for buried piping

A2.4 INTERNATIONAL STANDARDS

• IEC 31010	Risk management – Risk assessment techniques
• IEC 60079-29	Gas detectors – Performance requirements of detectors for flammable gases
• IEC 61508-1	Functional safety of electrical / electronic / programmable electronic safety-related systems – Part 1: General requirements
• IEC 61511-1	Functional safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and application programming requirements
• ISO 4126-1	Safety devices for protection against excessive pressure – Part 1: Safety valves
• ISO 8201	Acoustics. Audible emergency evacuation signal
• ISO 9809-1	Gas Cylinders – Refillable seamless steel gas cylinders – Design, construction and testing
• ISO 14120	Safety of machinery – Guards – General requirements for the design and construction of fixed and movable guards
• ISO 14313	Petroleum and natural gas industries. Pipeline transportation systems. Pipeline valves
• ISO 15501-1	Road vehicles – Compressed Natural Gas (CNG) fuel systems – Part 1: Safety requirements
• ISO 15501-2	Road vehicles – Compressed Natural Gas (CNG) fuel systems – Part 2: Test methods
• ISO 15609-1	Specification and approval of welding procedures for metallic materials – Welding procedure specification – Part 1: Arc welding
• ISO 15609-2	Specification and qualification of welding procedures for metallic materials – Welding procedure specification – Part 2: Gas welding
• ISO 24490	Cryogenic vessels. Pumps for cryogenic service
• ISO/DIS 16924.2	Natural gas fuelling stations – LNG stations for fuelling vehicles
• ISO/TR 22302	Natural gas. Calculation of methane number

A2.5 OTHER INDUSTRY STANDARDS

A2.5.1 American National Standards Institute (ANSI)

• ANSI/IAS NGV 4.1	Dispensing Systems
• ANSI/IAS NGV 4.2	Hoses for NGV and Dispensing System
• ANSI/IAS NGV 4.3	Breakaway Devices for Natural Gas Dispensing System and Hoses
• ANSI/ISA S5.1	Instrumentation Symbols and Identification

A2.5.2 American Petroleum Institute (API)

• API 520-1	Sizing, Selection, and Installation of Pressure-relieving Devices
• API 521	Pressure-relieving and Depressuring Systems

A2.5.3 American Society of Mechanical Engineers (ASME)

- ASME B31.3 Process piping
- ASME VIII-1 Boiler and Pressure Vessel Code - Rules for Construction of Pressure Vessels

A2.5.4 British Compressed Gases Association (BGCA)

- BCGA CP36 Cryogenic liquid storage at users' premises
- BCGA CP41 The design, construction, maintenance and operation of filling stations dispensing gaseous fuels
- BGCA CP46 The storage of cryogenic flammable fluids

A2.5.5 Health and Safety Executive (HSE)

- HSE GS4 Safety requirements for pressure testing
- HSE L138 Dangerous substances and explosive atmospheres

A2.6 LEGISLATION

- Asbestos (Prohibition) Regulations 1992
- Building (Amendment) Regulations (Northern Ireland) 2006
- Building Regulations for England and Wales 2002
- Building Standards (Scotland) Regulations 1990
- Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009
- Confined Spaces Regulations 1997
- Construction (Design and Management) Regulations 2007
- Control of Asbestos Regulations 2006
- Control of Major Accident Hazard Regulations 2005
- Control of Noise at Work Regulations 2006
- Control of Substances Hazardous to Health Regulations 2002
- Dangerous Substances and Explosive Atmospheres Regulations 2002
- Electricity at Work Regulations 1989
- Gas Act 1986 as amended 1995
- Gas Appliances (Safety) Regulations 1995
- Gas Cooking Appliances (Safety) Regulations 1995
- Gas Safety (Installation and Use) Regulations 1998
- Gas Safety (Management) Regulations 1996
- Health and Safety at Work etc. Act 1974
- Health and Safety (Safety Signs and Signals) Regulations 1996
- Heating Appliances (Fireguards) Regulations 1991
- Management of Health and Safety at Work Regulations 1999
- Pressure Equipment Regulations 1999
- Pressure Systems Safety Regulations 2000
- Provision and Use of Work Equipment Regulations 1992
- Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995

- Regulations Concerning the International Carriage of Dangerous Goods by Rail
- Supply of Machinery (Safety) Regulations 2008
- Workplace (Health, Safety and Welfare) Regulations 1992.

A2.7 EUROPEAN DIRECTIVES

- Directive 94/9/EC of the European Parliament and the Council of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres
- Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment
- Directive 1999/92/EC of the European Parliament and of the Council of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres (15th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)
- Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast) (Text with EEA relevance)
- Directive 2010/35/EU of the European Parliament and of the Council of 16 June 2010 on transportable pressure equipment and repealing Council Directives 76/767/EEC, 84/525/EEC, 84/526/EEC, 84/527/EEC and 1999/36/EC (Text with EEA relevance)
- Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (Text with EEA relevance)
- Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres (recast) (Text with EEA relevance)
- Directive 2014/94/EU

A2.8 OTHER STANDARDS AND PUBLICATIONS

- BS 6399 Part 2
- Cryogenic Safety Manual (British Cryoengineering Society)
- BS EN 60079-29-2
- G48
- G65
- L56 Guidance Notes 22, 28, 29
- L73
- L122
- L138
- L144

- INDG 178
- INDG 261
- INDG 291
- INDG 229
- INDG 370
- R25
- SI 3864 Part 1
- PD ISO/TR 16922
- PD CLC/TR 60079-32-1.

APPENDIX 3 : LNG HAZARDS AND CONSEQUENCES

To determine the control measures necessary for the safe and reliable operation of an LNG re-fuelling station it is necessary to consider the hazards and potential consequences and causes of failure that can lead to these consequences being realised.

LNG is a cryogenic liquid stored and transported under pressure and at approximately −160 °C. Contact with a cryogenic liquid can cause freeze burns to individuals and brittle failure of equipment depending upon material of construction.

LNG is not toxic however it is an asphyxiant. Acute environmental impacts from a release are usually negligible and limited to the impact of fire or freezing however methane is regarded as a more potent greenhouse gas than carbon dioxide.

The major hazards to be considered with respect to LNG are fire and explosion. As a liquid, LNG will not burn nor explode. For LNG to burn it must first vaporize, which it does rapidly when exposed to ambient conditions, and mix with air in specific proportions. Flammability limits of vapours for methane in air are between approximately 5% and 15% molar.

When spilled LNG will initially produce a cold vapour cloud that is denser than air and will tend to stay close to the ground surface. As this cloud mixes with air, it will warm up, rise and cause dispersion into the atmosphere. The downwind distance that flammable vapours might reach is a function of the LNG spill rate/volume, pressure, the evaporation rate, and the prevailing weather conditions.

If a flammable cloud from an LNG spill is ignited, the combustion results in a flash fire. Inside the cloud, direct contact with the burning vapours may cause injury or fatality, but the relatively short duration of the fire means that thermal radiation effects are not usually significant outside the cloud. Thus, escalation from a flash fire is generally unlikely to occur.

If ignition takes place in a confined or congested environment the generation of heat may be is accompanied by the generation of overpressure and a vapour cloud explosion (VCE) could results. The maximum overpressure is determined by the expansion ratio of the burning gases and can cause damage and collapse of buildings and structures. Methane has been shown not to propagate flame-fronts fast enough to cause detonation and the more severe overpressures associated with these events. Large and sudden releases of LNG can undergo Rapid Phase Transition.

A Jet fire will result from ignited continuous releases of pressurised vapour or saturated liquid. Jet fires have a high flame temperature and can produce very high intensity thermal radiation. If a jet flame impinges upon a sensitive receptor such as a vessel, structure or pipe it is possible for the receptor to fail within a few minutes. Such failures can lead to escalation of the event.

The ignition of the vapours over an evaporating pool will result in a pool fire. Because they are less well aerated, pool fires tend to have lower flame temperatures and produce lower levels of thermal radiation than jet fires. Structural failure is achieved develops more slowly with pool fires than with jet fires. Pool fires are regarded as credible events from large releases as the initial cooling effect of a release on the ground will slow subsequent evaporation rates.

If the flame from a jet or pool fire impinges on a pressure vessel containing a flammable liquid, the temperature of the vessel wall will rise. Heat transfer may cause the liquid to boil, producing more vapour and therefore greater pressure. Eventually there will come a point where the vessel pressure relief system will be overcome and the vessel may fail, resulting in a sudden release of material. The released material may form a fireball which will rise up emitting thermal radiation over long distances. High velocity missiles (i.e. from the fragments of the failed vessel) may also be produced. This type of event is generally referred to as a boiling liquid expanding vapour explosion (BLEVE). Loss of containment and sources of ignition are therefore the main precursors to major accidents.

The causes of loss of containment that need to be considered are:

- Equipment failure due to:
    - Vehicle impact/drive away
    - Overpressure (e.g. due to pressure-relief/vent system failure)
    - Corrosion, fatigue and/or aging
    - Material selection/engineering standards
    - Deliberate act of damage, e.g. vandalism, sabotage, etc.
- Over filling resulting in over pressure
- Human failure
- Seismic activity, weather conditions, flooding, lightning, etc.

Sources of ignition to consider include:

- Spark ignition engines
- Installed electrical equipment
- Portable devices (e.g. phones, lighters, electrical/electronic items, etc.)
- Smoking
- Static electricity
- Lightning
- Effects from nearby equipment (including mechanical items)
- Hot work (sparking tools, welding, etc.)

Controls for consideration are summarised in Appendix 4.

APPENDIX 4 : TABLE OF CONTROLS

The following is a non-exhaustive table of controls which can be used for risk assessments. Each control has a corresponding reference within this Standard.

A4.1 **HAZARD: LOSS OF CONTAINMENT**

A4.1.1 **General Facility**

Table of Controls			
Equipment	**Cause of failure**	**Control measure**	**UP21 Section**
General Facility	Impact from vehicle	Traffic management Driver training Collision barriers Layout of equipment	5.3.1.1 5.3.4.5 8.1.4 8.2
	Brittle fracture	Material selection	7.1.17.1
	Corrosion	Material selection	7.1.4
	Fatigue	Operational procedures	6.2.115.1.2
	Deterioration	Inspection and maintenance policy	3.3.12.2, 13.2.2, **Error! eference source not found.**

A4.1.2 **Cryogenic Vessels (and Natural Gas Storage)**

Table of Controls			
Equipment	**Cause of failure**	**Control measure**	**UP21 Section**
Cryogenic vessels	Impact from vehicle	Crash barriers	14.3.1, 15.1.2
		Traffic management	5.3.1.1
		Driver training	5.3.4.5
	Brittle fracture	Material selection	7.1.1, 7.1.9
	Corrosion	Inspection and maintenance policy	
		Material selection	7.1.4
	Fatigue	Operational procedures	15.1.2
		Design standards	15.1.1
		Inspection and maintenance policy	
		Containment or diversion	14.6.4
	Overpressure	Pressure relief systems	15.3.2
		Operating procedures	15.2.2
		Remote monitoring	
	Effect of supporting structure failure	Material selection	15.2.3
	External forces	Design standards	14.3.3, 14.7.1, 15.2.3

A4.1.3 **Pipework**

Table of Controls			
Equipment	**Cause of failure**	**Control measure**	**UP21 Section**
Pipework	Impact from vehicle	Crash barriers	
		Traffic management	5.3.1.1
		Driver training	5.3.4.5
	Brittle fracture	Material selection	7.1.1, 7.1.9
	Corrosion	Inspection and maintenance policy	3.3.12.2, 13.2.2, 23.2.2
		Material selection	7.1.4
	Fatigue	Operational procedures	
		Design standards	23.1.1
		Inspection and maintenance policy	23.5
		Gas detection and shutdown system	
		Containment or diversion system	
	Joint Leak	Controlled bolting	
		Jointing and bolting material selection	
		Training	
	Overpressure	Operational procedures	
		Thermal relief devices	23.2.1.2

A4.1.4 **Valves**

Table of Controls			
Equipment	**Cause of failure**	**Control measure**	**UP21 Section**
Valves	Impact from Vehicle	Crash Barriers	
		Traffic Management	
		Driver training	
		Layout of installation	
	Brittle Fracture	Material selection	
	Corrosion	Inspection & Maintenance policy	
		Material selection	
	Fatigue	Operational procedures	
		Design standards	
		Inspection and maintenance	
		Gas detection and shutdown system	
		Containment or diversion system	
	Joint Leak/gland leak	Controlled bolting	
		Jointing & bolting material selection	
		Training	
	Overpressure	Operational procedures	
		Thermal relief devices	
Relief valves	Seat Leak	Vent design	
	Joint Leak	Controlled bolting	
		Jointing & bolting material selection	
		Training	

A4.1.5 **Hoses (and Dispensers)**

Table of Controls			
Equipment	**Cause of failure**	**Control measure**	**UP21 Section**
Hoses	Impact from Vehicle	Crash Barriers	22.3.1
		Traffic Management	
		Driver training	
		Layout of installation	
		Safe stowage	**Error! eference source not found.**
	Brittle Fracture	Material selection	18.2.1.3
	Corrosion	Inspection and maintenance policy	18.1.2
		Material selection	18.2.1.3
	Fatigue	Operational procedures	
		Design standards	18.1.1
		Inspection and Maintenance	18.1.2
		Gas detection and shutdown system	
		Containment or diversion system	
	Joint Leak	Controlled bolting	
		Jointing & bolting material selection	
		Training	
	Overpressure	Functional specification	22.2.2
		Operational procedures	
		TRV	
	Drive away - refuelling	Break away couplings	22.4.2

Table of Controls			
Equipment	**Cause of failure**	**Control measure**	**UP21 Section**
Pumps	Drive away - transfer	Training	
		Procedures	
		Break away couplings	

A4.2 HUMAN FACTORS

Table of Controls			
	Cause of failure	**Control measure**	**UP21 Section**
	Unauthorised operation	Security fencing	
	Incorrect operation	Training	

A4.3 IGNITION PREVENTION

Table of Controls			
Type	**Cause of failure**	**Control measure**	**UP21 Section**
Static	Fatigue		
	Joint leak/seal		
	Overpressure		
Electrical	Overfilling	Trycock / level control system	
Instrument	Inadvertent draining of the system - Valves open / open ends	Maintenance and operating procedures	
Mechanical		Training & competence	
Third party		Human Factors study?	
		Fenced / locked compound	
		Access control to system?	
	Road tanker	Grounding and bonding requirements	
	Storage equipment	Operational procedures	
	Transfer operations	Maintenance requirements	
	People?		
	Smoking	Safety notices	
		Hazardous area demarcation	
		Compound area locked access	
	Spark ignition engines	Safety notices	
		Hazardous area demarcation	
		Compound area locked access	
	Fixed sources of ignition	Separation distances	

APPENDIX 5 : FIRE AND EXPLOSION

This Appendix considers the key features leading to fire and explosion associated with LNG fuelling stations and LCNG fuelling stations. It is not intended to replace risk analysis, as it cannot adequately cover all foreseeable risk scenarios.

Note: Refer to BS EN 1127-1 for explosion protection and prevention.

A5.1 COMBUSTIBLES

A5.1.1 Gas Sources

- vent stack openings
- relief valves outlets
- equipment leaks (e.g. flanged joints)
- equipment rupture (e.g. hose failure).

A5.1.2 Other Sources

- dust
- wood
- light alloys.

A5.2 IGNITION

A5.2.1 Heat Sources

- fire and naked flames
- hot surfaces
- engines
- friction sparks.

A5.2.2 Electrical Sources

- electrical arc
- short circuits
- earth faults
- lightning strikes
- static discharge.

APPENDIX 6 : LNG/LCNG INSTALLATION EXAMPLE

A typical LNG/LCNG installation is shown in the diagram below.

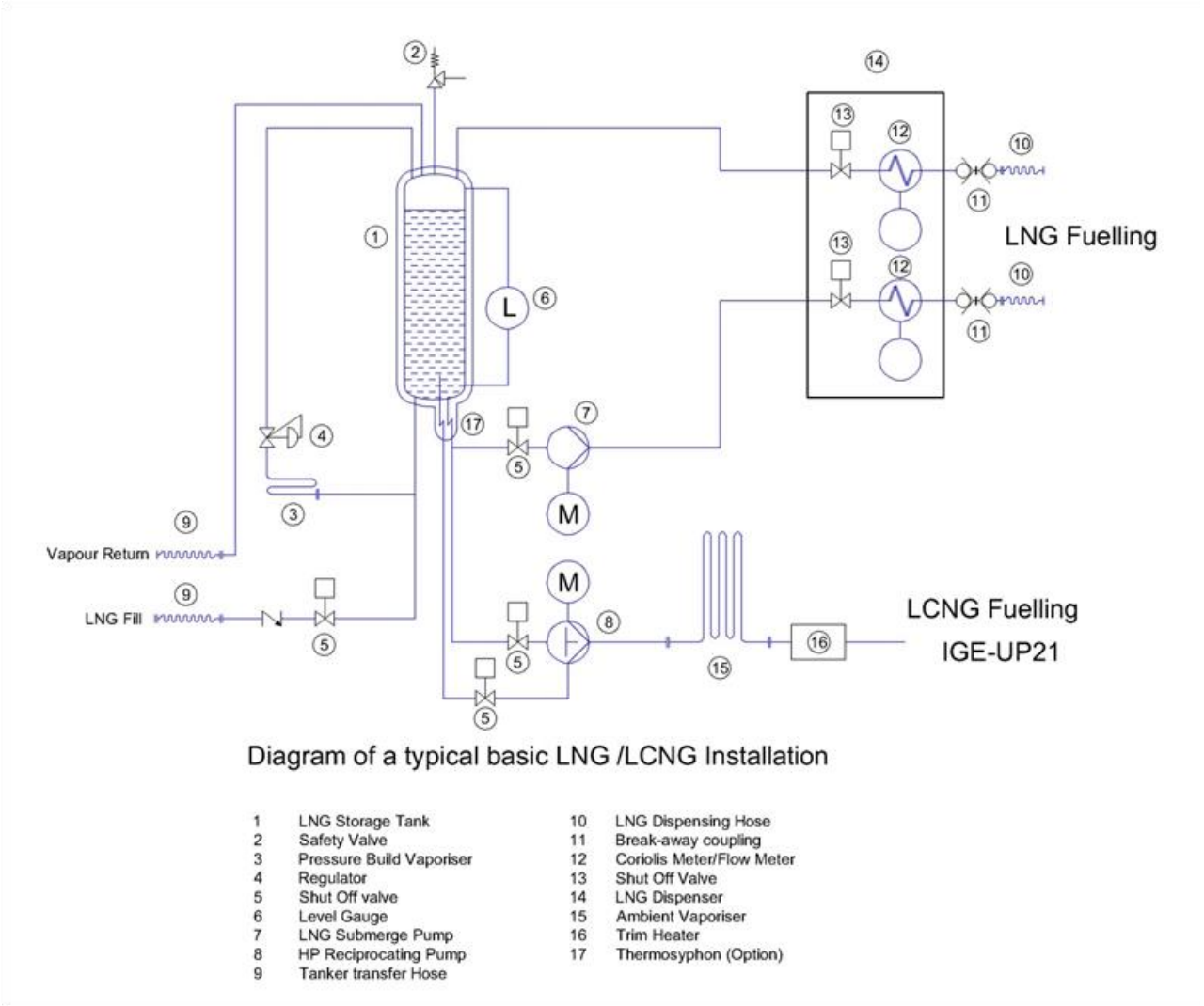


Diagram of a typical basic LNG /LCNG Installation

1	LNG Storage Tank	10	LNG Dispensing Hose
2	Safety Valve	11	Break-away coupling
3	Pressure Build Vaporiser	12	Coriolis Meter/Flow Meter
4	Regulator	13	Shut Off Valve
5	Shut Off valve	14	LNG Dispenser
6	Level Gauge	15	Ambient Vaporiser
7	LNG Submerge Pump	16	Trim Heater
8	HP Reciprocating Pump	17	Thermosyphon (Option)
9	Tanker transfer Hose		

APPENDIX 7 : HAZARDOUS AREA ZONES

Hazardous area classification zone dimensions examples are shown in the table below.

Note: Site specific hazardous area classification of equipment may result in different figures.

Hazardous areas - Installed Equipment			
Where equipment has been Ex certified by a European Notified Body then the certified hazard zones created by that equipment may be used for risk management and site design purposes but without this qualification the hazard zone here will be used by default.			
Equipment	**Zone 2***	**Zone 1***	**Notes**
Dispensers	1 m radius from all openings	None	Hose, nozzle and vehicle are not included.
Compressors	1 m radius from all openings	None	
Cylinder connections	3 m radius from connections	None	Includes connections within control system.
Vents	15 m vertical cone of 60 °	3 m radius from vent	Includes Service blow-down.

Note: Equipment and site specific Hazardous area calculations will have to be undertaken to define actual dimensions.

** As defined by EN 60079.*

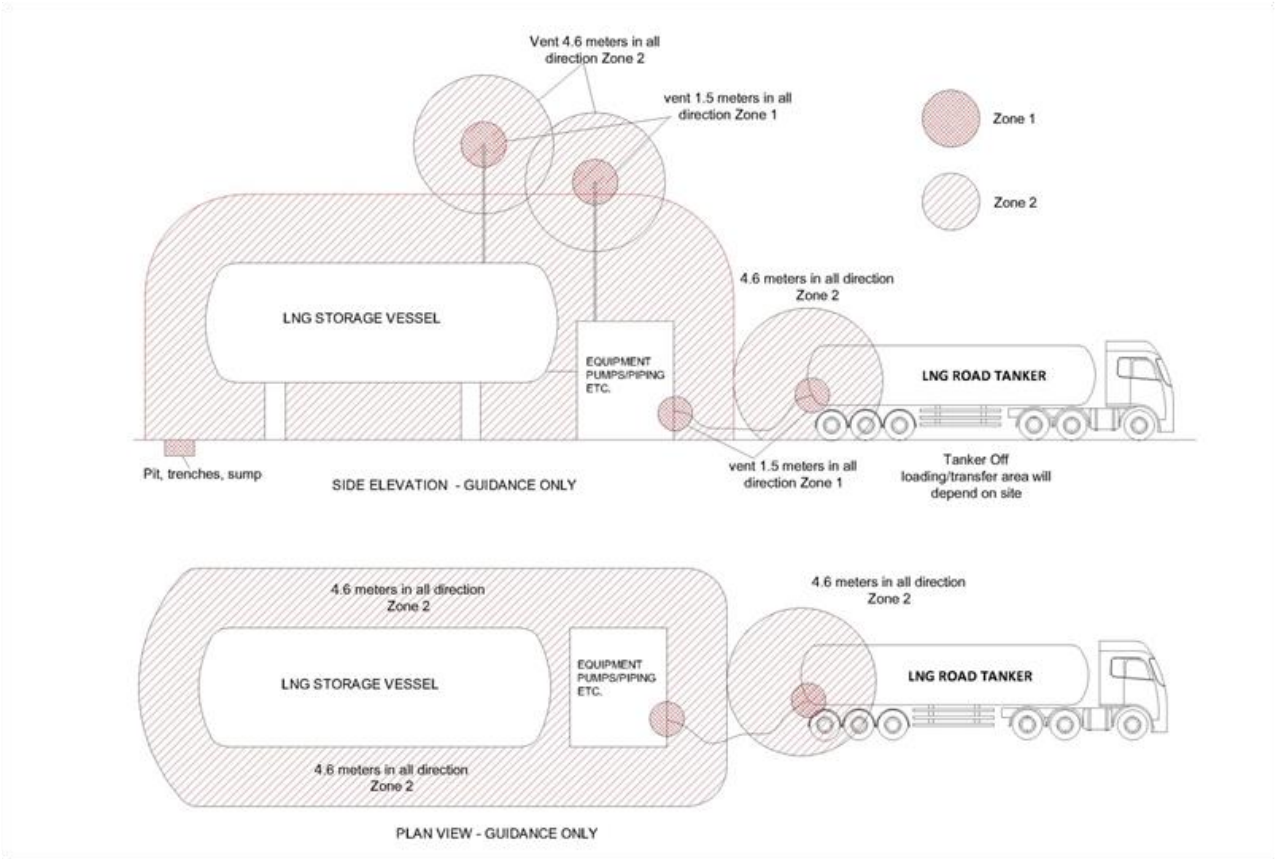


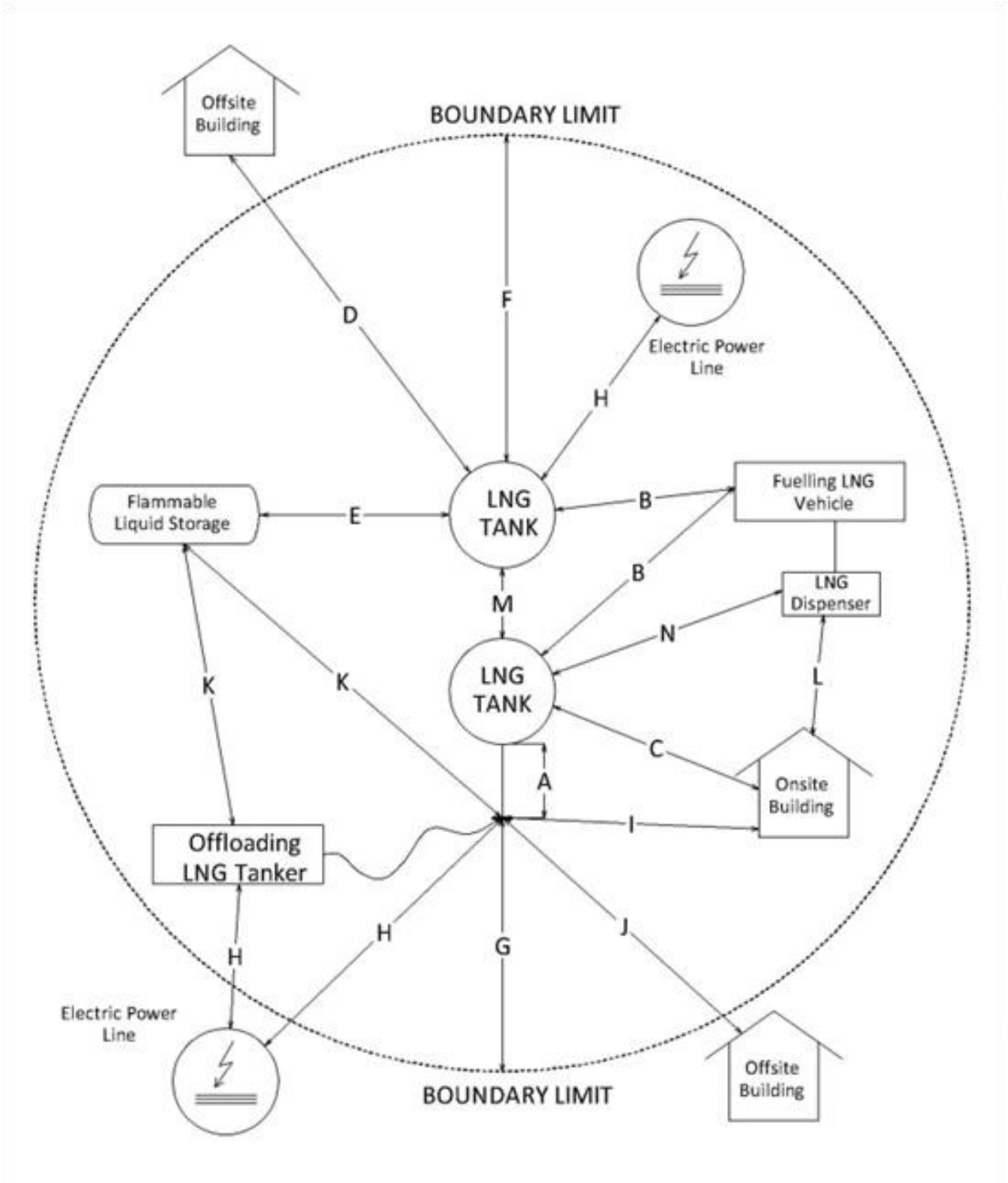
FIGURE 2 – EXAMPLE OF ZONES CLASSIFICATION AROUND A SMALL LNG FUELLING STATION WITH A HORIZONTAL LNG STORAGE TANK ACCORDING TO NFPA 52

APPENDIX 8 : SEPARATION DISTANCES

The following figure and table show separation distances for an LNG installation.

Note 1: These distances may be altered if justified by risk assessment.

Note 2: Where distances for different types of equipment are not shown, they will be determined by risk assessment.



Dimension	Comment	Minimum distance metres
A	Offloading connection – outer shell of LNG tank	0.5
B	Fuelling vehicle – outer shell of LNG tank	4
C	On-site building (e.g. shop) – outer shell of LNG tank. There is no distance to buildings that are part of station installation made of non- flammable material	3
D	Off-site building – outer shell of LNG tank	12
E	On-site tank of flammable liquids and their gas vent – outer shell of LNG tank	5
F	Boundary limit – outer shell of LNG tank	
G	Boundary limit – LNG tank offloading connection	3
H	Overhead electric power line above 600V	10
I	On-site building (see C above) – LNG tank offloading connection	7.5
J	Off-site building – LNG tank offloading connection	7.5
K	On-site tank for flammable liquids and their gas vent – LNG tank offloading connection	5
L	Distance between LNG tanks	1.5

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