

IGEM/SR/14 Edition 2
Communication 1742

Fixed volume storage for lighter than air gases



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

***IGEM/SR/14 Edition 2
Communication 1742***

Fixed volume storage for lighter than air gases



Price Code: C4S
© The Institution of Gas Engineers and Managers
IGEM House
High Street
Kegworth
Derbyshire, DE74 2DA
Tel: 0844 375 4436
Fax: 01509 678198

Email: general@igem.org.uk



Documents

Document Sharing Hub

Copyright © 2009, IGEM. All rights reserved
Registered charity number 214001

All content in this publication is, unless stated otherwise, the property of IGEM. Copyright laws protect this publication. Reproduction or retransmission in whole or in part, in any manner, without the prior written consent of the copyright holder, is a violation of copyright law.

ISBN 978 1 905903 17 7
ISSN 0367 7850

Published by the Institution of Gas Engineers and Managers

Previous Publications:

Communication 1600 (1993) – 1st Edition - Part 1

Communication 1601 (1993) – 1st Edition - Part 2

For information on other IGEM Standards please visit our website, www.igem.org.uk

CONTENTS

SECTION		PAGE
1	Introduction	1
2	Scope	3
3	Legal and allied considerations	5
	• 3.1 General	5
	• 3.2 Health and Safety at Work etc. Act (HSWA)	5
	• 3.3 Management of Health and Safety at Work Regulations (MHSWR)	5
	• 3.4 Electricity at Work Regulations	5
	• 3.5 Control of Substances Hazardous to Health Regulations (COSHH)	5
	• 3.6 Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR)	6
	• 3.7 Provision and Use of Work Equipment Regulations (PUWER)	6
	• 3.8 Confined Spaces Regulations	6
	• 3.9 Building Regulations	7
	• 3.9.1 England and Wales, as amended	7
	• 3.9.2 Building Standards (Scotland) Regulations and Amendments	7
	• 3.10 Construction (Design and Management) Regulations (CDM)	7
	• 3.11 Pressure Systems Safety Regulations (PSSR)	7
	• 3.12 Dangerous Substances and Explosive Atmospheres Regulations (DSEAR)	8
	• 3.13 Pressure Equipment Regulations (PER)	8
	• 3.14 The Planning (Hazardous Substances) Act and the Planning (Hazardous Substances) Regulations as Amended by the Planning Control of Major Accidents Hazards Regulations	9
	• 3.15 Control of Major Accident Hazards Regulations (COMAH), as amended	9
	• 3.16 Regulatory Reform (Fire Safety) Order and Fire (Scotland) Act	9
	• 3.17 Pipelines Safety Regulations (PSR)	10
4	Site location and layout	11
	• 4.1 General	11
	• 4.2 Proximities	12
5	Fire prevention and precautions	14
	• 5.1 General	14
	• 5.2 Fire prevention within the installation	14
	• 5.3 Fires upon adjacent sites (above-ground plant only)	14
	• 5.4 Fire protection	16
	• 5.5 Emergency procedures	17
6	Security	18

7	Design	19
	• 7.1 Overall design	19
	• 7.2 General design requirements (vessels only)	20
	• 7.3 Fatigue design life and pressure cycling	20
	• 7.4 Bedding and backfill (arrays only)	21
	• 7.5 Corrosion protection	21
8	Pipework, valves and fittings	22
	• 8.1 Overall design	22
	• 8.2 Pipework	22
	• 8.3 Valves	22
	• 8.4 Over and under pressure protection	23
	• 8.5 Bellows	24
9	Noise	25
10	Electrical and instrumentation	26
	• 10.1 General	26
	• 10.2 Electrical	26
	• 10.3 Instrumentation	27
11	Construction	29
12	Testing	30
	• 12.1 General	30
	• 12.2 Hydrostatic testing	30
	• 12.3 Pneumatic testing	30
	• 12.4 Non-destructive testing	30
13	Commissioning and decommissioning	31
	• 13.1 General	31
	• 13.2 Commissioning procedures	32
	• 13.3 Decommissioning procedures	32
	• 13.4 Intermediate purging	33
	• 13.5 Purging air to inert gas or purging flammable gas to inert gas	33
	• 13.6 Purging inert gas to flammable gas	33
	• 13.7 Purging inert gas to air	34
	• 13.8 Purging air to water or gas to water	34
14	Operation	35
15	Inspection and maintenance	37
16	Repairs and modifications	40
17	Records	41

APPENDIX

1	Glossary, acronyms, abbreviations, units and symbols	43
2	References	45
3	Fatigue design life	48
4	Typical routine inspection report	50
5	Typical quarterly inspection report	51
6	Typical annual inspection report	52
7	Typical thorough detailed inspection report	53
8	Typical modification form	58

FIGURE

1	Extent of pipework associated with fixed volume storage vessels	4
2	Table 1 distances applied to a typical site	13

TABLE

1	Minimum distances to vessels/arrays	12
2	Minimum distances between ends and sides of vessels and sources of potential radiant heat	15

SECTION 1 : INTRODUCTION

1.1 IGE/SR/14 Part 1 on above ground storage was published in 1993 as Communication 1600. IGE/SR/14 Part 2 on buried pipe arrays was published in 1993 as Communication 1601. This edition of the Standard supersedes both those editions which are obsolete.

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

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

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

1.4 This Standard makes use of the terms "should," "shall" and "must". Notwithstanding Sub-Section 1.6:

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

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

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

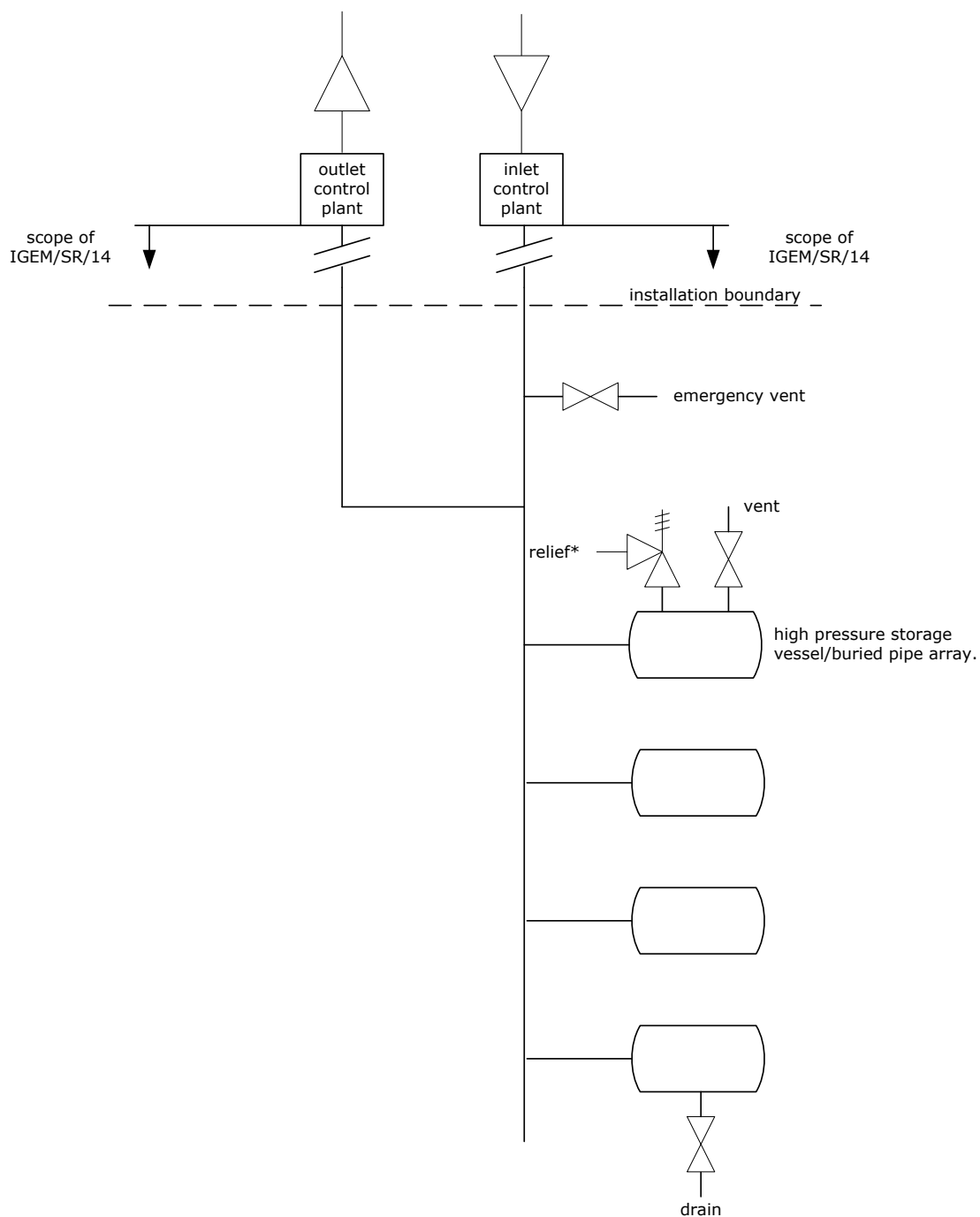
- (a) have done everything to ensure, so far as is reasonably practicable, that there are no better protective measures that can be taken other than relying on the exercise of professional judgement by "responsible engineers".
- (b) have done everything to ensure, so far as is reasonably practicable, that "responsible engineers" have the skills, training, experience and personal qualities necessary for the proper exercise of professional judgement.
- (c) have systems and procedures in place to ensure that the exercise of professional judgement by "responsible engineers" is subject to appropriate monitoring and review.
- (d) not require "responsible engineers" to undertake tasks which would necessitate the exercise of professional judgement that is beyond their competence. There should be written procedures defining the extent to which "responsible engineers" can exercise their judgement. When "responsible engineers" are asked to undertake tasks that deviate from this, they should refer the matter for higher review.

- 1.6 Notwithstanding Sub-Section 1.4, this Standard does not attempt to make the use of any method or specification obligatory against the judgement of the responsible engineer. Where new and better techniques are developed and proved, they should be adopted without waiting for modification to this Standard. Amendments to this Standard will be issued when necessary and their publication will be announced in the Journal of IGE and other publications as appropriate.
- 1.7 Requests for interpretation of this Standard in relation to matters within their scope, but not precisely covered by the current text, should be addressed to Technical Services, IGE, IGE House, High Street, Kegworth, Derbyshire, DE74 2DA and will be submitted to the relevant Committee for consideration and advice, but in the context that the final responsibility is that of the engineer concerned. If any advice is given by, or on behalf of, IGE, this does not relieve the responsible engineer of any of his or her obligations.
- 1.8 This Standard was published in January 2010.

SECTION 2 : SCOPE

- 2.1 This Standard covers the safety aspects of design, construction, commissioning, operation, maintenance, decommissioning, inspection, modification and repair of:
- horizontal vessels and
 - buried pipe arrays
- for the storage of fuel gases with a specific gravity of less than 0.7, together with associated pipework and valves. The extent of the installations covered is shown in Figure 1.
- 2.2 This Standard does not cover pressure raising or pressure reduction plant.
- 2.3 There are no upper or lower operating pressure limits imposed by this Standard.
- 2.4 This Standard relates specifically to storage associated with transmission and distribution systems. It is not intended to cover gas storage reservoirs and associated pipework forming part of control and safety equipment.
- 2.5 This Standard draws attention to those aspects of fixed volume storage design, operation and maintenance which have a direct bearing on safety. It does not in itself constitute a design, operation or maintenance manual but is intended to be taken into consideration when preparing such documents.
- 2.6 This Standard applies for all new installations and, although not retrospective, may be applied to existing installations so far as is reasonably practicable.
- 2.7 Unless otherwise stated, the term "vessel" means "fixed volume storage vessel" and the term "array" means "buried pipe array".
- 2.8 All pressures are gauge pressures unless otherwise stated.
- 2.9 Italicised text is informative and does not represent formal requirements.
- 2.10 Appendices are informative and do not represent formal requirements unless specifically referenced in the main sections via the prescriptive terms "should", "shall" or "must".

Copyright Institution of Gas Engineers & Managers



* not fitted for buried pipe arrays.

FIGURE 1 - EXTENT OF PIPEWORK ASSOCIATED WITH FIXED VOLUME STORAGE VESSELS/BURIED PIPE ARRAYS

SECTION 3 : LEGAL AND ALLIED CONSIDERATIONS

3.1 GENERAL

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, where reference to appropriate national legislation is necessary.

All relevant legislation must be applied and relevant ACoPs, official Guidance and referenced Codes of Practice (CoPs), standards, etc. shall be taken into account.

Note: Appendix 2 is relevant in this respect.

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

3.2 HEALTH AND SAFETY AT WORK ETC. ACT (HSWA)

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

3.3 MANAGEMENT OF HEALTH AND SAFETY AT WORK REGULATIONS (MHSWR)

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

3.4 ELECTRICITY AT WORK REGULATIONS

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

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: A "Memorandum of Guidance on the Electricity at Work Regulations, 1989" is available from Her Majesty's Stationery Office (HMSO) and gives useful information on the Regulations. Further advice is contained in HSR25.

3.5 CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH REGULATIONS (COSHH)

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

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

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

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

- 3.6.2 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 Natural Gas must be reported by the conveyor
- dangerous gas fittings (as defined in RIDDOR) must be reported by a "member of a class of persons".

- 3.6.3 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 by:

- telephone on 0845 300 9923
- fax on 0845 300 9924
- email to riddor@connaught.plc.uk
- internet at www.riddor.gov.uk
- via a link from HSE website at www.hse.gov.uk.

It is also possible to report to the local HSE office by telephone and then follow up with a written report on the correct F2508 form within the required timescale (10 days, or 14 days for dangerous gas fittings). Other reports must be made as soon as practicable and within 10 days of the incident.

- 3.6.4 HSL73 contains detailed guidance on RIDDOR, including a full list of injuries etc. that need reporting. HSE61 and MISC310 give some information on RIDDOR and how to report.

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

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

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

- 3.7.3 More information on PUWER can be found in HSL22. Free leaflets include INDG291 and INDG229.

3.8 **CONFINED SPACES REGULATIONS**

These Regulations apply to a large range of confined spaces. The supplier or designer of an enclosure and equipment within it is required to perform a risk

assessment of the enclosure with respect to safe access and egress and to give clear instructions to operators on access/egress as well as to what actions to take in the event of a gas alarm occurring. Employers and the self employed should prevent entry into confined spaces unless avoidance is not reasonably practicable and unless there is a system of work which renders the work safe. They are also required to have specific emergency arrangements in place.

3.9 **BUILDING REGULATIONS**

3.9.1 **England and Wales, as amended**

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

The Approved Documents that apply to gas work are:

- A (Structure)
- B (Safety in Fire)
- F (Ventilation).

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

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

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

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

CDM impose duties on designers, clients (and their agents), developers, planning coordinators 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 coordinator must notify HSE before construction work commences. Construction includes the alterations, repair, redecoration, maintenance, decommissioning or demolition of a structure. It also covers installation, commissioning, maintenance or removal of plant.

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

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 by PSSR).

3.11.2 Relevant fluids for the purpose of this document would be Natural Gas at a pressure greater than 0.5 bar above atmospheric pressure. A pressure system would include bulk storage tanks, pressure vessels, pipelines and protective devices. Once the pressure in the pipework drops below 0.5 barg, and the user/owner can show clear evidence that the system does not contain, and is not liable to contain, a relevant fluid under foreseeable operating conditions, then that part of the system is no longer covered by 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 barg, for example at the entry to a building.

Note the special requirements placed on protective devices in such systems (see para 110b of HSL122). The regulations also apply to pipelines and their protective devices in which the pressure exceeds 2 barg (see Sch 1 part 1 item 5 of HSL122).

3.11.3 More information is available in HSL122 and some information is presented in INDG261 and INDG178.

3.12 **DANGEROUS SUBSTANCES AND EXPLOSIVE ATMOSPHERES REGULATIONS (DSEAR)**

DSEAR are 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.

The following publications contain details of DSEAR and their application:

- HSL138
- HSL137
- HSL136
- HSL135
- HSL134
- INDG370.

3.13 **PRESSURE EQUIPMENT REGULATIONS (PER)**

PER cover pressure equipment manufactured and sold throughout the European Community with a maximum allowable pressure greater than 0.5 bar. PER deal with the manufacture, design and supply of pressure equipment. They impose duties on the responsible person.

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

"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."

The duties on the "responsible person" are to ensure that pressure equipment:

- satisfies the relevant essential requirements
- has undergone the relevant conformity assessment procedure, if applicable
- has had the CE mark affixed by the manufacturer, if applicable
- has had the declaration of conformity drawn up by the manufacturer that the equipment is, in fact, safe.

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

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 five categories depending on the inherent level of hazard within the system.

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

3.14 **PLANNING (HAZARDOUS SUBSTANCES) ACT AND THE PLANNING (HAZARDOUS SUBSTANCES) REGULATIONS AS AMENDED BY THE PLANNING CONTROL OF MAJOR ACCIDENTS HAZARDS REGULATIONS**

These controls, for which HSE is statutory consultee, require consent to be obtained from local authorities for the presence of hazardous substances above prescribed quantities.

This enables planning authorities to consider whether the presence of a significant quantity of a hazardous substance is acceptable in a particular location.

3.15 **CONTROL OF MAJOR ACCIDENT HAZARDS REGULATIONS (COMAH) AS AMENDED**

The main aim of COMAH is to prevent and mitigate the effects of those substances, such as chlorine, liquefied petroleum gas, explosives and arsenic pentoxide which can cause serious damage/harm to people and/or the environment. COMAH treat risks to the environment as seriously as those to people.

COMAH is enforced by a "Competent Authority (CA)" consisting of:

- in England and Wales, HSE and the Environment Agency
- in Scotland, HSE and the Scottish Environment Protection Agency.

The CA operates to a Memorandum of Understanding which sets out the arrangements for joint working. COMAH place duties on the CA to inspect activities subject to COMAH and prohibit the operation of an establishment if there is evidence that measures taken for prevention and mitigation of major accidents are seriously deficient. It also has to examine safety reports and inform operators about the conclusions of its examinations within a reasonable time period.

3.16 **REGULATORY REFORM (FIRE SAFETY) ORDER (RRO) AND FIRE (SCOTLAND) ACT**

The RRO (England and Wales) and Scottish Act provide a new legislative framework for fire safety in workplaces. They revoke The Fire Precautions (Workplace) Regulations and The Fire Precautions (Special Premises) Regulations, and repeal other legislation.

The Order and Act introduce a general duty to ensure, so far as is reasonably practicable, the safety of employees; a general duty in relation to relevant non-employees to take such fire precautions as may reasonably be required in the circumstances to ensure that premises are safe; and a duty to carry out a suitable and sufficient risk assessment. Fire certificates are no longer required. They impose a number of specific duties in relation to the fire precautions to be taken and provide for enforcement. This will be by local fire and rescue authority. However, process fire safety will be enforced by HSE.

The Order and Act implement some aspects of the Chemical Agents Directive and the ATEX Workplace Directive with respect to dangerous substances. In doing so, they set out requirements to be considered in risk assessments where dangerous substances are present, and to their mitigation by inventory reduction, prevention of loss of containment, managing sources of ignition, etc.

In general, they emphasise the need to prevent fires and reduce risk. A responsible person should carry out a risk assessment to identify fire hazards; identify people at risk; evaluate risks and remove and reduce risks; record, plan and train; and review risks.

3.17 **PIPELINES SAFETY REGULATIONS (PSR)**

PSR apply to all pipelines and are designed to ensure that pipelines are designed, constructed, operated, maintained and decommissioned safely.

Copyright Institution of Gas Engineers & Managers

SECTION 4 : SITE LOCATION AND LAYOUT

4.1 GENERAL

- 4.1.1 When considering the location of vessels/arrays and their layout on site, a survey of possible locations shall include investigations of propensity to flooding, ground settlement, impact from railways or roads, and potential fire hazards. Wherever possible, sites should not be located at the ends of airport runways or beneath regular flight paths.
- 4.1.2 A responsible environmental approach should be demonstrated in order that the development is welcome in the community. This can be achieved by carrying out an assessment of the likely environmental effects of the location, layout of the site and proposed site operations. The best practicable means should be adopted following the assessment to achieve the highest standard of environmental protection.
- 4.1.3 Background sound level surveys should be undertaken in accordance with an appropriate standard and compared with anticipated sound levels arising from the proposed installation, to assess possible nuisance.
- 4.1.4 The site layout should be such as to minimize the effects of those operations on adjacent sites which are outside the operator's control.
- 4.1.5 Planning authorities may need to be assured that the proposal does not constitute an unacceptable risk to the immediate environment. A risk assessment shall be used to determine the safety considerations in choosing a site.

Note 1: Further guidance may be obtained from the Institution of Chemical Engineers' Publication "Nomenclature for Hazard and Risk Assessment in the Process Industries".

Note 2: HSE issues specific advice on the form of risk assessments and the criteria that they use for land use planning purposes – Planning advice for developments near hazardous installations (PADHI) Guideline. These Guidelines are applicable for new developments or significant changes to existing developments.

Note 3: IGEN publishes IGEN/TD/2 which addresses land use planning for high pressure Natural Gas pipelines.

The main objectives of risk assessment are to:

- review the events which could lead to loss of containment of stored gas during the lifetime of an installation
- provide information on the nature and scale of hazards resulting from such loss of containment
- indicate the likelihood of events.

- 4.1.6 The installation should not be located in close proximity to residential property or high density factory or office units without recourse to a special study, to minimize the risk to third parties. In particular, a survey of locations shall include an appraisal of the proximity of buildings and plant already on each site, those on adjacent sites and possible developments both within the sites and on the adjacent sites. It can then be established whether the minimum proximities given in Table 1 and Sub-Section 4.2 can be attained.
- 4.1.7 The installation shall be located within a secure boundary fence to prevent unauthorized access.
- 4.1.8 The proximity of overhead power lines shall be the subject of a special study to take account of the hazardous area classification (see Section 10) and the construction of the overhead lines.
- 4.1.9 For vessels, when considering their layout, they should not be positioned one above the other and should not be aligned so that their long axis points towards any nearby building or vulnerable structure.

4.2 PROXIMITIES

4.2.1 General

4.2.1.1 The site proximities prescribed in Table 1 should be applied (examples of which are shown collectively in Figure 2).

Note 1: These are based upon experience and judgement rather than calculation, and are directed at avoidance of accidental damage to vessel(s) and arrays.

Note 2: The basic requirement is the provision of an open strip, 8 m wide around vessels/arrays and connecting gas manifolds, completely free from flammable materials or vegetation.

Note 3: Internal service roads are roads associated with the installation and used by authorized personnel only.

Note 4: Internal through roads are roads outside the boundary of the fixed volume storage installation and not requiring authorization for use.

Note 5: In certain situations, for example a block of flats situated just beyond 20 m from the vessels, it would be prudent to carry a risk assessment using the frequency of releases and their consequences to determine the appropriate separation.

FIGURE 2 REF.	PARAMETER	MINIMUM DISTANCE TO VESSELS/ARRAYS (m)
A	Site boundary	20
B	Adjacent fixed volume storage vessel	2
F	Adjacent groups of fixed volume storage vessels	9
C	Internal service roads	8
D	Internal through roads	15* ¹
E	Elevated rail or roadway, measured horizontally	46* ²
	Low pressure gas holder	15* ³

*¹ If the minimum distance recommended cannot be attained, it may be reduced to 8 m subject to the provision of a barrier or series of barriers capable of preventing vehicle impact with the vessel(s)/above ground parts of arrays.

*² Where these are banked, the distance is measured from the bottom of the embankment. If a special study shows that impact and fire barriers will provide adequate protection, this distance may be reduced to not less than 25 m.

*³ The minimum distance between any relief valve vent and the holder is limited to 25 m, each situation being the subject of a separate assessment.

TABLE 1 - MINIMUM DISTANCES TO VESSELS/ARRAYS

4.2.1.2 For vessels, the distance between vessels, including supports and foundations, should take account of the need to locate mobile plant between the vessels during construction and subsequent maintenance. However, arrangements should be made to prevent the passage of unauthorized vehicles between vessels.

4.2.1.3 For buried arrays, the minimum distance between individual array pipes should be calculated from:

$$C = 3Df$$

C = minimum distance between individual arrays (mm)

D = outside diameter of pipe (mm)

f = ratio of the working stress to the yield stress (this is the design factor as given in IGEN/TD/1).

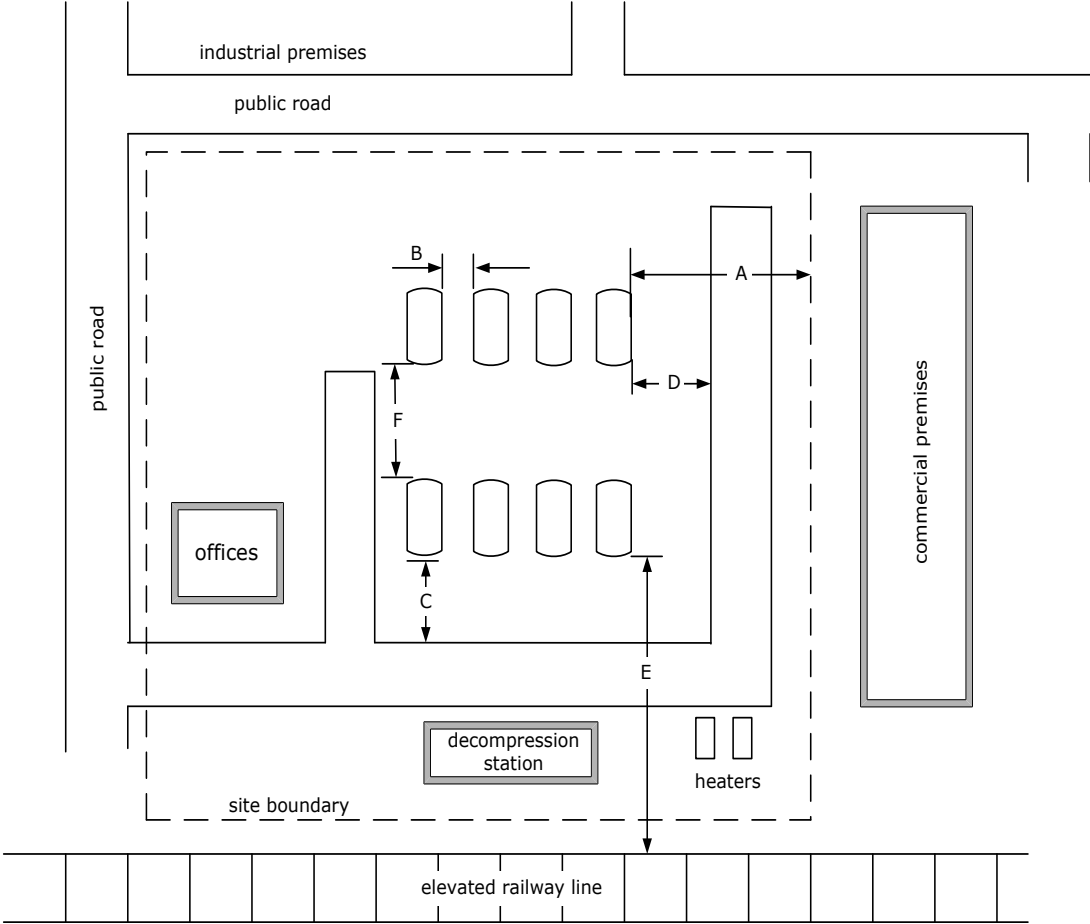


FIGURE 2 - TABLE 1 DISTANCES APPLIED TO A TYPICAL SITE

Note: See Table 1 for distances A to F.

4.2.2 Vessels installed in groups

4.2.2.1 For vessels installed in groups, each group should comprise no more than eight vessels, and a minimum of 9 m should be allowed between groups.

Note: The minimum prescribed distance in Table 1 will allow access for fire-fighting appliances, cranes etc., and applies in both parallel and end-to-end group formations.

4.2.2.2 For an end-to-end group configuration, the interconnecting pipework should be located at the outward facing ends.

Note: This is to minimize the risk of impact from vehicles using such roads.

If the minimum distance recommended cannot be attained, it may be reduced to 8 m, subject to the provision of a barrier or series of barriers capable of preventing vehicle impact with the vessel(s).

Note: Where these are banked, the distance is measured from the bottom of the embankment. If a special study shows that impact and fire barriers will provide adequate protection, this distance may be reduced to not less than 25 m.

4.2.2.3 The minimum distance between any relief valve vent and a gasholder should be 25 m, each situation being the subject of a separate assessment.

4.2.2.4 Other identifiable sources of ignition, not covered by Table 1, should be determined by reference to an appropriate standard, such as IGE/TD/13 and, for arrays, IGE/TD/1.

SECTION 5 : FIRE PREVENTION AND PRECAUTIONS

Radiant heat from fires may adversely affect the strength of vessels, supporting structural steelwork, pipework and equipment and may lead to an increase in the pressure of the gas within a vessel, causing relief valves to operate.

The effects of radiation from fires either inside or outside the site on the buried part of an array are very small and need not be considered. Above ground parts of an array are treated as for vessels and their pipework.

Where the installation comprises more than one vessel, the effect on the increase in pressure in affected vessels resulting from the radiant heat can be minimized by keeping open the interconnecting valves between all vessels.

5.1 GENERAL

5.1.1 Consideration shall be given to a means of reducing the pressure in any vessel/array, in an emergency, by the provision of a facility for rapid but safe disposal of gas stored within the vessel(s)/array.

5.1.2 A fire alarm system should be installed such that actuation from any call point will continue to give an alarm until cancelled. Consideration shall be given to providing a system linked to the local fire services.

5.2 FIRE PREVENTION WITHIN THE INSTALLATION

5.2.1 Prevention of fire is the responsibility of the operator and safeguards shall be rigorously applied. For vessels and all above ground plant, appropriate precautions shall be taken against direct fires and/or flame impingement due to ignited gas leaks from nearby equipment (see clauses 8.2.2 and 8.2.3).

5.2.2 A Permit to Work system shall be employed to control all work, including the use of tools and equipment within the site. Particular care shall be taken with those activities which can generate static electricity.

5.2.3 Smoking and the carrying of smoking materials and the use of naked lights shall not be permitted within the designated hazardous areas on the site (see clause 10.1.2).

5.2.4 The location of any apparatus which can be considered to be an ignition source shall be outside the limits shown on the Hazardous Area Classification Drawing (see clause 10.1.2).

5.3 FIRES UPON ADJACENT SITES (ABOVE-GROUND PLANT ONLY)

5.3.1 Operators of storage installations usually have no control over the activities upon adjacent sites, so vessels and any above-ground plant should be located sufficiently far from the potential source of fire to minimise its effects, or other protective measures shall be taken.

5.3.2 Table 2 should be applied. It gives recommended distances between vessels/other above-ground plant and certain types of potential fire which should safeguard the installation for a limited time.

Note 1: Other types of potential fire may require a special study to be carried out (see clause 4.1.5).

Note 2: The distances decrease with increase in pressure due to the greater mass of gas stored absorbing more heat.