

IGEM/TD/13 Edition 2
Communication 1755

Pressure regulating installations for Natural Gas, Liquefied Petroleum Gas and Liquefied Petroleum Gas/Air



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



Documents

Document Sharing Hub

IGEM/TD/13 Edition 2
Communication 1755

***Pressure regulating installations for
Natural Gas, Liquefied Petroleum Gas and
Liquefied Petroleum Gas/Air***



Price Code: C8H
© 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
AVA Document Sharing Hub

Copyright © 2011, 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 30 6

ISSN 0367 7850

Published by the Institution of Gas Engineers and Managers

Previous Publications:

Communication 1672 (2001) – 1st Edition

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

CONTENTS

SECTION

1	Introduction	1
2	Scope	3
3	Competency and quality assurance	7
	• 3.1 Competency	7
	• 3.2 Quality assurance	7
	• 3.2.1 Materials	7
	• 3.2.2 Inspection	7
4	Legal and allied considerations	8
	• 4.1 General	8
	• 4.1.1 European Community (EC) Legislation	8
	• 4.1.2 National and local legislation	8
	• 4.1.3 LPG and LPG/Air	8
	• 4.2 Great Britain (GB)	8
	• 4.2.1 Gas Acts	8
	• 4.2.2 Land and planning	8
	• 4.2.3 Nature conservation	9
	• 4.2.4 Water	9
	• 4.2.5 Pollution	9
	• 4.2.6 Farm animals	10
	• 4.2.7 Health and Safety at Work etc. Act (HSWA)	10
	• 4.2.8 Management of Health and Safety at Work Regulations (MHSWR)	10
	• 4.2.9 Construction (Design and Management) Regulations (CDM)	10
	• 4.2.10 Gas Safety (Management) Regulations (GS(M)R)	10
	• 4.2.11 Pressure Systems Safety Regulations (PSSR)	10
	• 4.2.12 Pipelines Safety Regulations (PSR)	11
	• 4.2.13 Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR)	11
	• 4.2.14 Dangerous Substances and Explosive Atmospheres Regulations (DSEAR)	11
	• 4.2.15 Provision and Use of Work Equipment Regulations (PUWER)	12
	• 4.2.16 Electricity at Work Regulations	12
	• 4.2.17 Control of Substances Hazardous to Health Regulations (COSHH)	12
	• 4.2.18 Pressure Equipment Directive (PED) and Regulations (PER)	13
	• 4.2.19 Gas Safety (Installation and Use) Regulations (GS(I&U)R)	13
5	Planning, location, layout and security	14
	• 5.1 Planning	14
	• 5.2 Location	14
	• 5.2.1 All PRIs	14
	• 5.2.2 Small PRIs supplying domestic premises	15
	• 5.2.3 PRIs supplying commercial or industrial premises	15



Documents

Document Sharing Hub

	• 5.2.4 Below-ground LPG PRIs	16
	• 5.3 PRI station layout	16
	• 5.4 Security	16
6	Housings	17
	• 6.1 General	17
	• 6.1.1 All housings	17
	• 6.1.2 Safety and safe working access	19
	• 6.1.3 Documentation for housings and components	19
	• 6.1.4 Glass reinforced plastic (GRP) housings	20
	• 6.2 Above-ground housings and buildings	21
	• 6.2.1 Foundations, bases and floor mounting	21
	• 6.2.2 Doors	22
	• 6.2.3 Walls	24
	• 6.2.4 Roofs and lift off panels	25
	• 6.2.5 Finish	25
	• 6.2.6 Performance	26
	• 6.2.7 Fire resistance	26
	• 6.2.8 Ventilation of housings	26
	• 6.2.9 Space heating	28
	• 6.2.10 Explosion relief	28
	• 6.2.11 Electrical	31
	• 6.2.12 Wall mounted PRIs	31
	• 6.3 Below-ground housings	32
	• 6.3.1 General	32
	• 6.3.2 Access and egress	32
	• 6.3.3 Construction	32
	• 6.3.4 Cover	32
	• 6.3.5 Ventilation	33
	• 6.3.6 Dimensions	34
	• 6.3.7 Through-wall sealing	34
	• 6.3.8 Drainage/pumping/breather lines	34
	• 6.3.9 Ground water	35
	• 6.3.10 Explosion relief	35
	• 6.4 Vessel-type housings	35
	• 6.4.1 Installation and external loading	35
	• 6.4.2 Corrosion protection	35
	• 6.4.3 Vent stacks	36
	• 6.4.4 Ground water	36
7	Design of a PRI	37
	• 7.1 General principles	37
	• 7.2 Pipework sizing	38
	• 7.3 Design pressure boundaries	38

• 7.4	Isolation of PRIs and components	39
• 7.4.1	Principles of isolation	39
• 7.4.2	Provision of isolation valves	41
• 7.4.3	Location and identification of isolation valves	42
• 7.4.4	Selection of valves	42
• 7.4.5	Features of valves and their actuators	43
• 7.5	Gas cleaning	44
• 7.6	Heating of gas	45
• 7.7	Noise and vibration	47
• 7.7.1	Environmental noise	47
• 7.7.2	Vibration and acoustic fatigue	48
• 7.8	Breathers, manual vent lines and relief vent lines	48
• 7.8.1	General	48
• 7.8.2	Breathers	48
• 7.8.3	Manual vent lines	48
• 7.8.4	Relief vent lines	49
• 7.9	Pipe and fittings	49
• 7.9.1	General	49
• 7.9.2	Steel pipe for main PRI pipework	50
• 7.9.3	Fittings	51
• 7.9.4	Gaskets	54
• 7.9.5	Bolting, studs, nuts and washers	54
• 7.9.6	Sensing, instrument and auxiliary pipework	55
• 7.9.7	Screwed pipework and fittings	57
• 7.9.8	Pre-testing	58
• 7.10	Welding	58
• 7.10.1	Preparation	58
• 7.10.2	MOP > 7 bar	58
• 7.10.3	MOP ≤ 7 bar	58
• 7.10.4	Post-weld stress relieving	58
• 7.10.5	PE jointing	58
• 7.11	Stress analysis	59
• 7.11.1	General	59
• 7.11.2	Supports	59
• 7.12	Metering	60
8	Pressure and flow control	61
• 8.1	General	61
• 8.2	Pressure regulating systems	62
• 8.3	Auxiliary systems	63
• 8.4	Sensing and control pipework	63

Copyright Institution of Gas Engineers & Managers
 Provided by IHS Markit under license with IGHM
 No reproduction or networking permitted without license from IHS

• 8.5	Pressure safety systems	64
• 8.5.1	General	64
• 8.5.2	Design of non-venting pressure safety systems	66
• 8.5.3	Design of venting pressure safety systems	70
• 8.5.4	Pressure warning systems	71
• 8.5.5	Pressure safety system instrumentation	71
• 8.6	Arrangement of equipment and safety devices	71
• 8.6.1	General	71
• 8.6.2	PRIs of inlet pressure exceeding 100 mbar and not exceeding 2 bar	71
• 8.6.3	PRIs of inlet pressures exceeding 2 bar and not exceeding 100 bar	73
• 8.6.4	Small regulator installations	75
• 8.6.5	Pre-fabricated skid units for Natural Gas	77
• 8.7	By-passing the regulating equipment and/or the safety system	77
9	Protection against corrosion	78
• 9.1	Cathodic protection (CP)	78
• 9.1.1	General	78
• 9.1.2	Technical considerations	78
• 9.1.3	Types of systems	79
• 9.2	Methods of protection against external corrosion other than CP	79
• 9.2.1	General design considerations	79
• 9.2.2	Surface preparation for coating	79
• 9.2.3	Coating of above-ground pipework and components	80
• 9.2.4	Coating of below-ground pipework	80
• 9.2.5	Backfilling	80
• 9.2.6	Inspection	81
10	Electrical Installation and Instrumentation	82
• 10.1	Electrical installation	82
• 10.1.1	General	82
• 10.1.2	Hazardous areas	82
• 10.1.3	Electrical isolation	82
• 10.1.4	Lightning	83
• 10.1.5	Earthing	83
• 10.1.6	Lighting	83
• 10.2	Instrumentation	84
• 10.2.1	General	84
• 10.2.2	Gas instrumentation pipework	84
• 10.2.3	Telemetry	85
• 10.2.4	Selection of equipment	86
11	Construction	89
• 11.1	Site safety	89
• 11.2	Site environment	89
• 11.2.1	General	89
• 11.2.2	Noise abatement	89
• 11.2.3	Chemicals and fluids	89
• 11.2.4	Traffic	90
• 11.3	Materials, work procedures and records	90

	• 11.4 Civil engineering	90
	• 11.4.1 Site assessment	90
	• 11.4.2 Alignment and levels	91
	• 11.5 Fabrication and welding of pipework and components	91
12	Testing	93
	• 12.1 General	93
	• 12.2 Safety - General	93
	• 12.3 Safety	94
	• 12.4 Test method, test pressure and duration	95
	• 12.5 Planning/Preliminary requirements	95
	• 12.6 Hydrostatic strength testing	96
	• 12.6.1 Preparation for testing	96
	• 12.7 Pneumatic testing	96
	• 12.8 Test equipment	97
	• 12.8.1 Instrumentation	97
	• 12.8.2 Measurement of pressure	97
	• 12.8.3 Measurement of volume	97
	• 12.8.4 Measurement of temperature	98
	• 12.8.5 Test ends	98
	• 12.9 Acceptance criteria	98
	• 12.9.1 Air content	98
	• 12.9.2 Temperature variations	99
	• 12.9.3 Test acceptance	99
	• 12.10 Test sections	99
	• 12.11 Fitting of test ends	100
	• 12.12 Water supply	100
	• 12.13 Repair of test failures and leaks	100
	• 12.14 Recording and documentation	100
	• 12.14.1 General	100
	• 12.14.2 Test equipment and instruments	101
	• 12.14.3 Test record	101
	• 12.14.4 Test certificate	102
13	Commissioning and de-commissioning	103
	• 13.1 General	103
	• 13.2 Gas systems	103
	• 13.3 CP systems	104
	• 13.4 Electrical equipment	104
	• 13.5 Instrumentation	104
14	Operation and maintenance	105
	• 14.1 General	105
	• 14.2 Management	105
	• 14.2.1 Organisation	105
	• 14.2.2 Communications	106
	• 14.2.3 Systems of work	106
	• 14.2.4 Emergency arrangements	108
	• 14.2.5 Training and competence	109
	• 14.2.6 Records	109
	• 14.2.7 Site information	110

• 14.3	Maintenance procedures and instructions	111
• 14.4	Maintenance philosophies	112
• 14.4.1	Introduction	112
• 14.4.2	Selection of maintenance philosophy	113
• 14.4.3	Maintenance at regular intervals	113
• 14.4.4	Breakdown maintenance	113
• 14.4.5	Condition-based maintenance (condition monitoring)	114
• 14.5	Safety during maintenance	114
• 14.5.1	General	114
• 14.5.2	Lifting equipment	115
• 14.5.3	Personal protective equipment (PPE)	115
• 14.6	Isolations	115
• 14.6.1	Isolation schemes	115
• 14.6.2	Isolation of gas plant and equipment	116
• 14.6.3	Continuity bonds	117
• 14.6.4	Instrumentation and control systems	117
• 14.6.5	Electrical equipment	117
• 14.6.6	Earth continuity	117
• 14.7	Venting	117
• 14.8	Purging	118
• 14.9	Leakage testing	118
• 14.10	Re-commissioning	118
• 14.11	Maintenance review	119
• 14.12	Operational checks	119
• 14.13	CP systems	121
• 14.14	Corrosion monitoring of exposed pipework	121
• 14.15	Up-rating and down-rating	122
• 14.15.1	Up-rating	122
• 14.15.2	Down-rating	122
• 14.15.3	Design approach	122
• 14.15.4	Altering the maximum design factor, f	122
• 14.15.5	Modification process	123
• 14.15.6	Validation	123
• 14.15.7	Up-rating MOP of a PRI to a level above the previous design pressure	123
15	Records	126
• 15.1	Design	126
• 15.2	Construction	126
• 15.3	Testing	126
• 15.4	Corrosion control	127
• 15.5	Commissioning	127
• 15.6	Operation and maintenance	127

APPENDIX

1	Glossary, acronyms, abbreviations, subscripts, units and symbols	128
2	References	131
3	Example calculations	137
4	Noise assessment and control	148
5	Reducing the frequency of vibration-related failures	152
6	Installation and use of temporary open-ended skirt type strainers	155
7	Performance requirements for stream discrimination NRVs	157
8	Performance tests for GRP housings	158
9	Pressure testing procedures	160

FIGURE

1	Selection of Standards (NG)	4
2	Selection of Standards (LPG)	5
3	Selection of Standards (LPG/Air)	6
4	Access classification	18
5	Provision of exits in long "walk-in" housings	23
6	Housing roof area/height of lift	30
7	Termination of ventilation ducts from a pit	34
8	PRI isolation method examples	39-40
9	Types of branch fittings	54
10	Pressure criteria	61
11	Decision algorithm for minimum number of safety devices	65
12	SSV impulse pressure limits	68
13	Typical slamshut valve and active regulator arrangement	72
14	Typical slamshut valve and active regulator arrangement for LPG	72
15	Typical monitor and active regulator arrangement	73
16	Typical slamshut valve, monitor and active regulator arrangement	74
17	Typical slamshut valve and active regulator arrangement for small PRI's	75
18	Typical slamshut valve and active regulator with integral relief valve arrangement for small PRI's (no stream discrimination)	76

19	Typical slamshut valve and active regulator with integral relief valve arrangement for small PRI's (with stream discrimination)	76
20	Typical slamshut valve and first stage regulator arrangement for LPG	76
21	Typical slamshut valve and second stage regulator arrangement (UPSO fitted) for LPG	77
22	Typical combined first and second stage regulator with slamshut arrangement (UPSO fitted) for LPG	77
23	Measurement of air content	99
24	Schematic illustration of a PRI and related pressure systems	138
25	Recommended maximum equipment settings (example 1)	142
26	Recommended maximum equipment settings (example 2)	145
27	Overlapping ranges of operation (example 3)	146
28	Recommended maximum equipment settings (example 3)	147
29	Recommended impulse pipework configuration to minimise risk of vibration related failures	154
30	Open ended strainer dimensions	156
31	Impact tool	159
32	Pneumatic testing of small bore pipework. Typical test rig arrangement	164

TABLE

1	Scope of IGE/TD/13 Edition 2	1
2	Defining a "small" PRI	1
3	Minimum free area for ventilation apertures for below-ground housings (> 0.5 m ³ volume)	33
4	Differential pressure across regulator stream isolation valves	42
5	Maximum differential pressure across clean filters	44
6	Filtration cut off levels for main regulators	44
7	Filtration cut off level for gas supplies to pilot and auxiliaries	45
8	Selection of maximum design factor (f)	50
9	Minimum wall thickness of steel pipe	51
10	Limitations on the selection and use of fittings	53
11	Selection of sensing, instrument and auxiliary pipework	55
12	Piping and tubing supports	56

13	Minimum internal bend radius for nylon tube	57
14	Limitation on the use of screwed connections	57
15	Relationship between downstream system MOP, peak level OP, TOP and MIP	62
16	Minimum number of safety devices	65
17	Creep relief capacity ($MOP_u \leq 7$ bar)	69
18	Determination of strength test method; STP and STD	95
19	Maintenance philosophies - some advantages and disadvantages	119
20	Functional Tests	120
21	Pressure term definitions	137
22	Open ended strainer dimensions	156

SECTION 1 : INTRODUCTION

- 1.1 This Standard revises and supersedes IGE/TD/13, Communication 1672 which is obsolete.

This Standard now incorporates the updated content of IGE/SR/9 Edition 2, Communication 1654, which is obsolete.

- 1.2 This Standard complements, as far as practicable, the requirements of BS EN 12186 and BS EN 12279, the equivalent European Standards on which IGE/TD/13 provides more specific requirements.

Note: A limited number of the individual requirements prescribe a more stringent standard than BS EN 12186 and BS EN 12279 to reflect United Kingdom (UK) practice.

- 1.3 This Standard has been drafted by a Panel appointed by the Institution of Gas Engineers and Managers' (IGEM's) Gas Transmission and Distribution Committee, and has been approved by IGEM's Technical Co-Ordinating Committee on behalf of the Council of IGEM.

- 1.4 This Standard applies to the safe design, construction, inspection, testing, operation and maintenance of pressure regulating installations (PRIs) in accordance with current knowledge and operational experience.

The Standard reflects the need to ensure adequate reliability and continuity of supply at pressures that are safe for the downstream system and equipment.

- 1.5 This Standard now addresses Natural Gas (NG), Liquefied Petroleum Gas (LPG) and LPG/air. As a result, the scope of this Standard is shown in Table 1.

GAS	MOP (bar)	MAXIMUM CAPACITY (m³ h⁻¹)
Natural	≤ 100	No limit
LPG	≤ 16	No limit
LPG/air	≤ 2	No limit

Note: MOP is maximum operating pressure.

TABLE 1 - SCOPE OF IGE/TD/13 EDITION 2

In addition, significant changes have been made to this Standard including the addition of specific requirements for "small" PRIs as defined in Table 2.

GAS	MOP (bar)	MAXIMUM CAPACITY (m³ h⁻¹)
Natural	≤ 7	200
LPG	≤ 16	80
LPG/air	≤ 2	310

TABLE 2 - DEFINING A "SMALL" PRI

Other changes include:

- additional guidance on housings
- the inclusion of specific information on pipework sizing
- a justification for plug valves
- further clarification on the setting of regulators and safety devices
- new information on uprating and downrating.

- 1.6 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 HSG48.
- 1.7 This Standard makes use of the terms "must", "shall" and "should" when prescribing particular requirements. Notwithstanding Sub-Section 1.9:
- the terms "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.
- 1.8 The primary responsibility for compliance with legal duties rests with the employer. The fact that certain employees, for example "responsible engineers", are allowed to exercise their professional judgement does not allow employers to abrogate their primary responsibilities. Employers must:
- have done everything to ensure, so far as is reasonably practicable, that there are no better protective measures that can be taken other than relying on the exercise of professional judgement by "responsible engineers"
 - have done everything to ensure, so far as is reasonably practicable, that "responsible engineers" have the skills, training, experience and personal qualities necessary for the proper exercise of professional judgement
 - have systems and procedures in place to ensure that the exercise of professional judgement by "responsible engineers" is subject to appropriate monitoring and review
 - not require "responsible engineers" to undertake tasks which would necessitate the exercise of professional judgement that is beyond their competence. There should be written procedures defining the extent to which "responsible engineers" can exercise their professional judgement. When "responsible engineers" are asked to undertake tasks which deviate from this, they should refer the matter for higher review.
- 1.9 Notwithstanding Sub-Section 1.7, 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 of this Standard. Amendments to this Standard will be issued when necessary and their publication will be announced in the Journal of Igem and other publications as appropriate.
- 1.10 Requests for interpretation of this Standard in relation to matters within its scope, but not precisely covered by the current text, may be addressed to Technical Services, Igem, Igem House, High Street, Kegworth, Derbyshire, DE74 2DA, and will be submitted to the relevant Committee for consideration and advice, but in the context that the final responsibility is that of the engineer concerned. If any advice is given by or on behalf of Igem, this does not imply acceptance of any liability for the consequences and does not relieve the responsible engineer of any of his or her obligations.
- 1.11 This Standard was published in September 2011.

SECTION 2 : SCOPE

2.1 This Standard covers the design, construction, inspection, testing, operation and maintenance of any PRI installed as below and whose extent is shown in Figure 8 (a), (b) and (c).

2.2 This Standard covers any PRI containing NG that is installed in a Network pipeline, i.e:

- a transmission pipeline (whose design is in accordance with IGE/TD/1) or
- a distribution main (whose design is in accordance with IGE/TD/3) or
- a service (whose design is in accordance with IGE/TD/4).

This Standard covers any PRI containing LPG or mixtures of LPG and air, that is installed in a distribution main whose design is in accordance with IGE/TD/3 or in service pipework whose design is in accordance with IGE/TD/4.

Note 1: For regulating installations downstream of an emergency control valve (ECV) (which defines the end of the Network as in IGE/G/1 (NG) or downstream of a distribution main or service pipework (LPG and LPG/air)), and which are associated with a meter installation, the relevant standards are IGE/GM/4, IGE/GM/6, IGE/GM/8, BS 6400-1, BS 6400-2 (all for NG) and BS 6400-3 (for LPG), as appropriate. There are no recognised, equivalent, Standards to the IGE/GM Standards where LPG or LPG/air is used. The principles of the IGE/GM Standards may be applied. Where it is required to install a PRI downstream of an ECV or downstream of a distribution main or service not associated with a meter installation, the principles of this Standard may be applied. See also Figures 1, 2 and 3.

Note 2: Minimum requirements are contained in appropriate normative Standards (see Figures 1, 2 and 3).

2.3 This Standard covers PRIs of MOP not exceeding:

- for Natural Gas, 100 bar

Note: Higher MOPs may be accommodated, in which case specialist advice needs to be sought in addition to adopting the principles of the Standard.

- for LPG, 16 bar
- for LPG/air, 2 bar.

2.4 This Standard covers PRIs of operating temperature:

- for Natural Gas, between -20°C and 120°C
- for LPG, between -20°C and 50°C
- for LPG/air, between -20°C and 50°C.

2.5 This Standard covers PRIs for gases in the vapour phase. This Standard does not address gases in the liquid phase.

2.6 There is no intention that this Standard be applied retrospectively. However, for inspection, testing, operation and maintenance, IGE/TD/13 Edition 2 can be applied to existing PRIs that were designed and constructed to IGE/TD/13 Edition 1, IGE/TD/9 or IGE/TD/10, but it may be necessary to continue some operations in accordance with those Recommendations.

Note: There are no equivalent obsolete IGE Standards for PRIs operating on LPG or LPG/air.

2.7 This Standard covers PRIs handling odourised or unodourised gases.

2.8 All pressures quoted 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 “must”, “shall” or “should”.

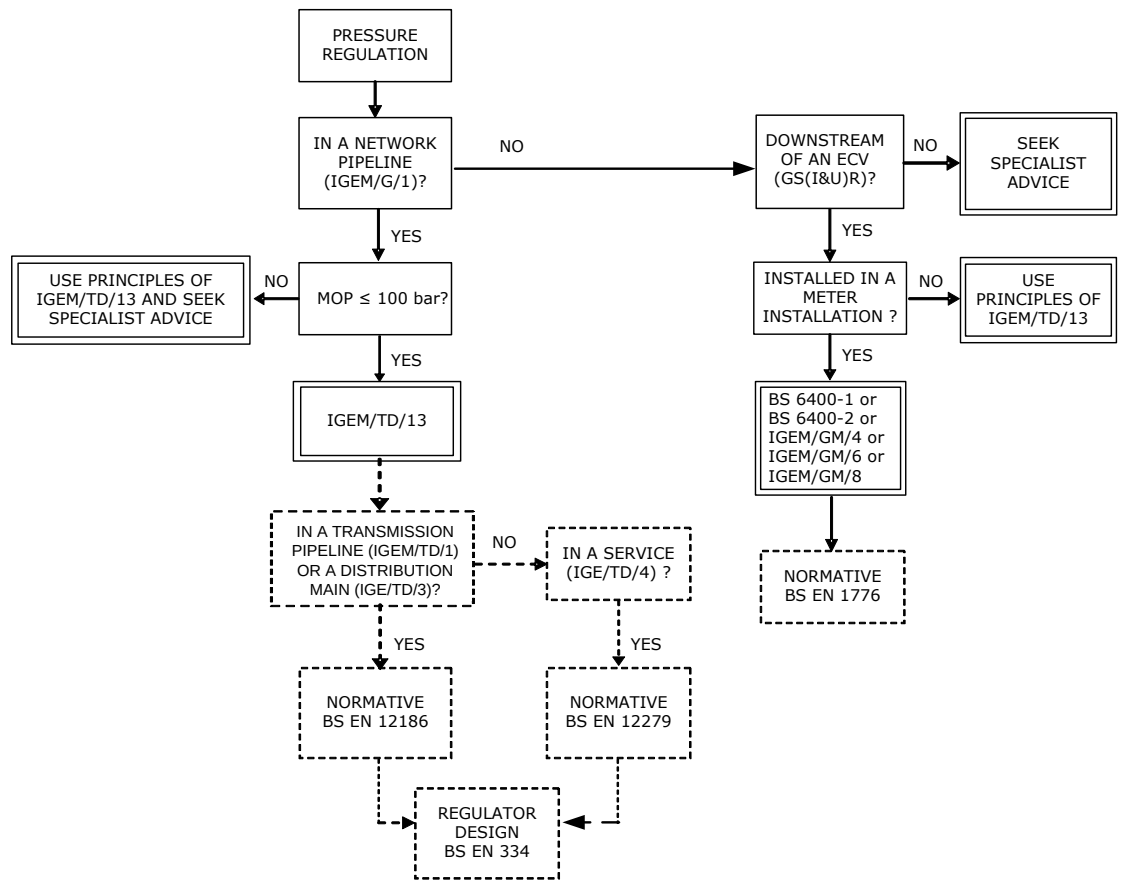


FIGURE 1 - SELECTION OF STANDARDS (NG)

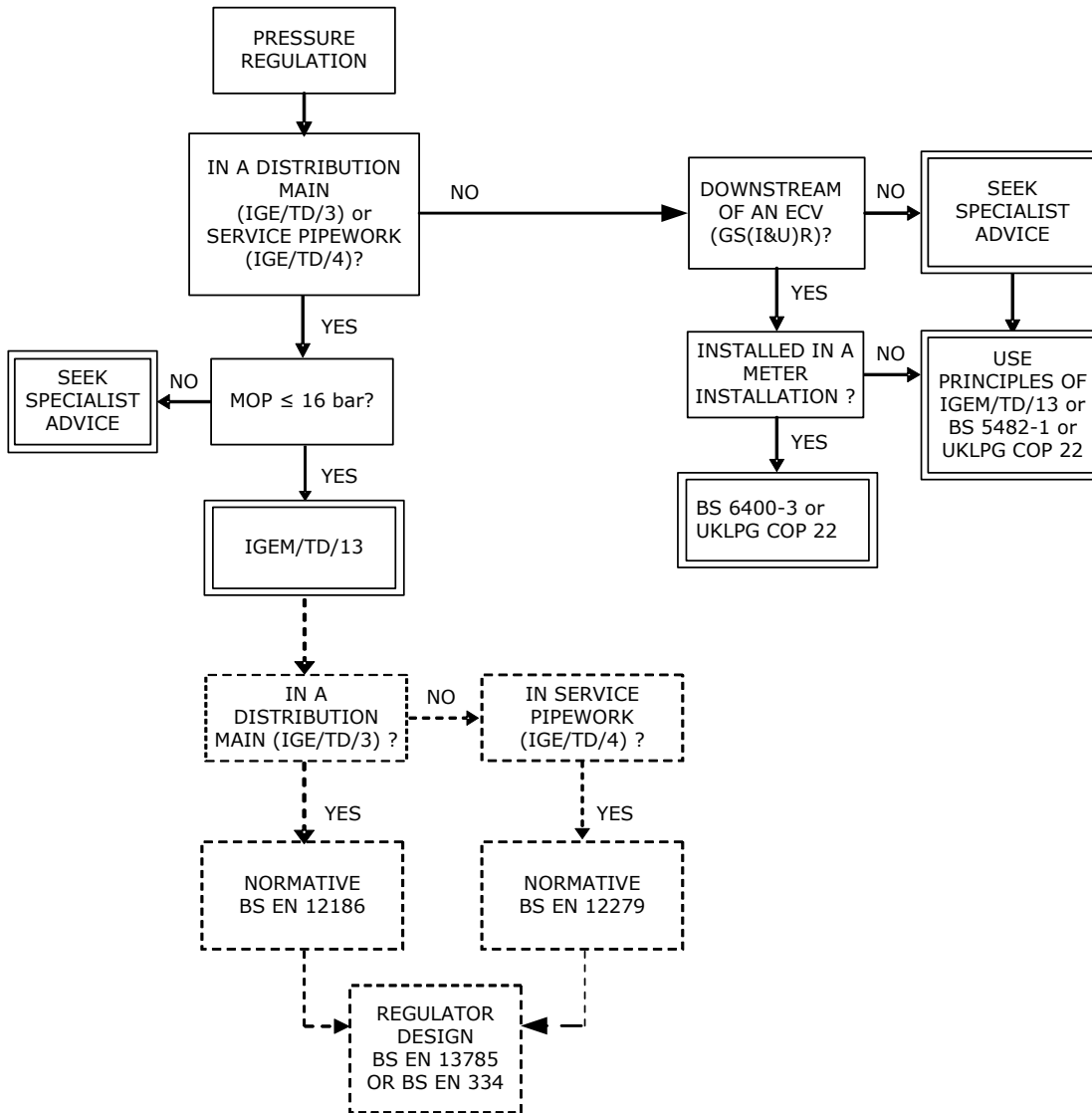


FIGURE 2 - SELECTION OF STANDARDS (LPG)

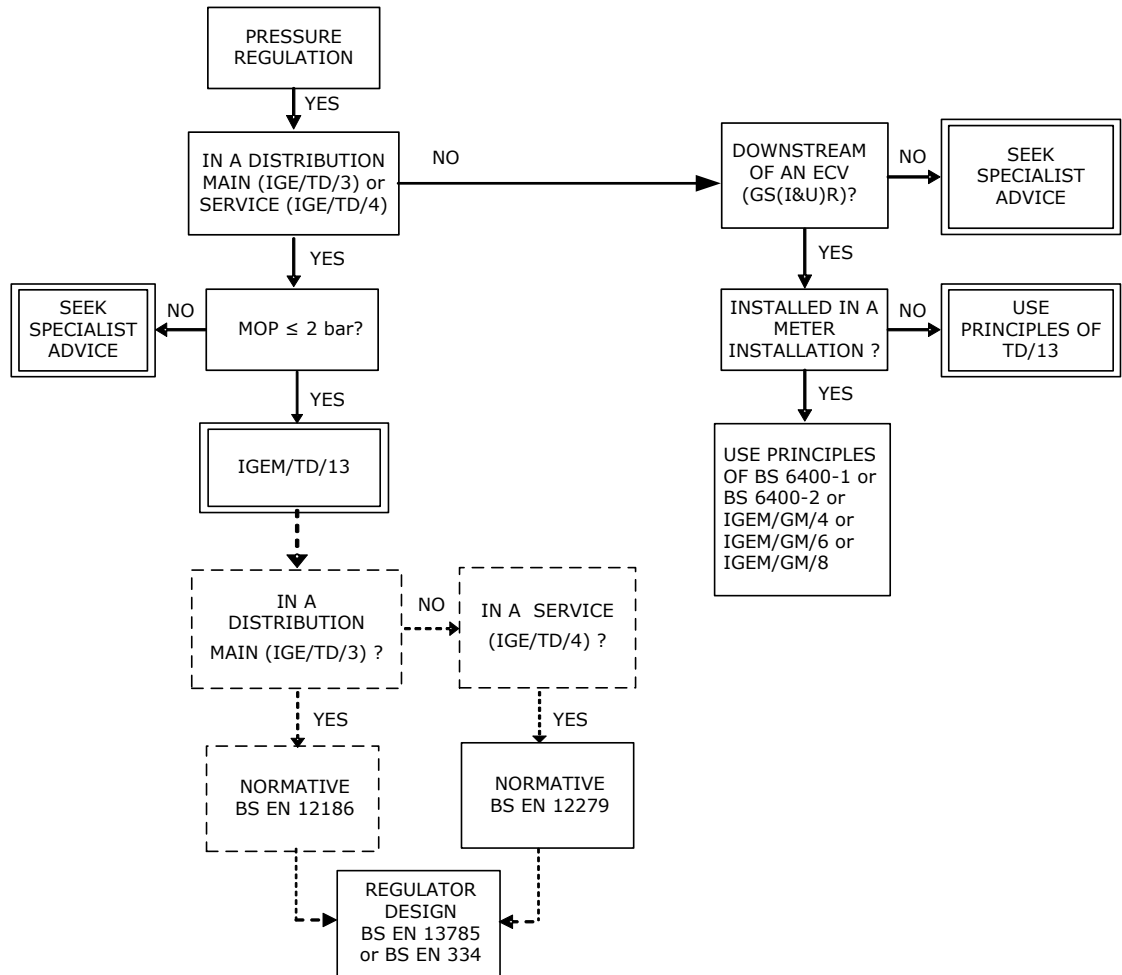


FIGURE 3 - SELECTION OF STANDARDS (LPG/AIR)

SECTION 3 : COMPETENCY AND QUALITY ASSURANCE

3.1 COMPETENCY

Any person engaged in the design, construction, commissioning, inspection, operation, maintenance or alteration of a PRI shall be competent to carry out such work.

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

3.2 QUALITY ASSURANCE

3.2.1 Materials

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

Note: It is recommended that all materials and components be obtained from suppliers operating a quality system in accordance with BS EN ISO 9001, to ensure that products consistently achieve the required levels of quality.

3.2.2 Inspection

Particular emphasis shall be placed on the inspection of materials, welding, coatings and testing. Any workmanship or materials not in accordance with this Standard or the construction specification shall be rejected.

SECTION 4 : LEGAL AND ALLIED CONSIDERATIONS

The matters dealt with in this section refer to legislation and their application to all aspects of PRI design, planning, construction and operation. Reference to specific legislation in GB is made in Appendix 2.

4.1 GENERAL

4.1.1 European Community (EC) Legislation

In countries within the EC, it shall be ascertained, at the planning stage, whether the PRI is likely to be subject to EC legislation.

4.1.2 National and local legislation

Consideration must be given to relevant national and local legislation, which may control, regulate or protect, for the PRI:

- its location
- its specification
- the methods and procedures for its construction
- the various authorisations, consents, or permissions, whether from owners or occupiers of land through which the pipeline is laid or from private/public organisations having a function or interest in its construction
- its environmental impact.

4.1.3 LPG and LPG/Air

LPG supplied through pipes may be subject to the Pipelines Act 1962. UKLPG publishes Codes of Practice and provides guidance on the safe use and handling of LPG across applications, including specifications for pipe materials and fittings.

4.2 GREAT BRITAIN (GB)

The matters in this Sub-Section are set out by reference to legislation in force in GB at the time of publication.

4.2.1 Gas Acts

4.2.1.1 Gas Act 1986

The construction of offtakes and pressure reduction stations is an activity which a GT is entitled to undertake under the Gas Act as amended.

In certain circumstances, Gas Transporters (GTs) have powers to place structures and apparatus near houses, in streets.

4.2.1.2 Gas Act 1995

The Gas Act 1995 updates provisions in the Gas Act 1986, including licensing arrangements for GTs so permitting competition.

4.2.2 Land and planning

4.2.2.1 It is advisable to obtain legal advice when proposing to develop land for above-ground installations.

4.2.2.2 GTs have power to obtain by negotiation the freehold or leasehold interest in land required for above-ground installations.

4.2.2.3 Whether a GT needs planning permission depends on the size of any structure which houses the PRI and/or on whether it is sited on land. The Town and Country Planning (General Permitted Development) Order prescribes the requirement. Any non-GT will always need planning permission. This Order addresses the installation of a PRI underground.

4.2.2.4 Where an above ground PRI, including buildings housing pipelines, and associated apparatus, are to be constructed, planning permission must, generally, be sought.

4.2.3 **Nature conservation**

4.2.3.1 *Forestry Act*

By the Forestry Act, a licence from the Forestry Commissioners is not required for the felling of trees where the felling is immediately required for the purpose of carrying out permitted development but, where a tree preservation order under the Town and Country Planning Act is in force, the consent of the local authority must be obtained.

4.2.3.2 *Wildlife and Countryside Act*

This Act details the protection given to birds, other animals and plants. It states the duties of the County Councils to establish Sites of Special Scientific Interest (SSSIs) to protect flora, fauna, geological or physiographic features and details the procedures to protect these sites.

4.2.3.3 *Countryside Act and the Countryside (Scotland) Act*

These Acts lay a duty on the Government, local authorities and other public bodies to have regard to the desirability of conserving the natural beauty and amenity of the countryside.

4.2.4 **Water**

Under The Water Resources Act, the necessary consents must be obtained from the appropriate authority for the supply and disposal of water for hydrostatic testing, including the time, point and rate at which water may be drawn.

4.2.5 **Pollution**

4.2.5.1 *Environmental Protection Act*

The provisions in Part 111 of this act empower a local authority in England and Wales to control statutory nuisances such as dust, fumes and noise.

4.2.5.2 *Control of Pollution Act*

Part 1 of this act covers the disposal of wastes which are poisonous, noxious or polluting and likely after disposal on land to give rise to an environment hazard. The disposal of waste to which the act applies must be notified to the waste regulation authorities. Regulations have been made exempting from the act the disposal of earth and ordinary construction waste.

Disposal of non-toxic waste water may be subject to special conditions and the advice of the authority responsible should be sought.

Part 111 of this act concerns the control of noise. Local Authorities are empowered to control noise during works of construction.

4.2.5.3 *Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations*

These Regulations cover oil and gas pipeline installations under certain criteria. If covered, development rights are lost and planning permission is needed along with an environmental impact assessment.

4.2.6 **Farm animals**

4.2.6.1 *Animal Health Act*

In 1981, a number of acts were consolidated under this act including, the Disease of Animals Act 1950. Orders made under this act may regulate operations in infected areas and places, and in relevant cases the Department for Environment, Food and Rural Affairs (DEFRA) will advise. Special attention is drawn to the rules to be observed in an 'infected place' contained in Article 7 of the Foot and Mouth Disease (Packing Materials) Order of 1983.

4.2.6.2 *Foot and Mouth Disease (Packing Materials) Order*

Unsterilized hay and straw must not be deposited on agricultural land and all such packing materials brought onto the site should be certified as sterilised by the supplier.

Further details and advice may be obtained from DEFRA.

4.2.7 **The Health and Safety at Work etc. Act (HSWA)**

HSWA sets out general duties which employers have towards employees and members of the public, and employees have to themselves and to each other. It is also the "umbrella" under which safety regulations are made.

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

MHSWR apply to all work activities and require, among other things, that employers assess the risks to the health and safety of their employees and of persons not in their employment but who may be affected by their activities and then to make appropriate arrangements for preventative and protective safety measures.

4.2.9 **Construction (Design and Management) Regulations (CDM)**

CDM place a duty on clients, designers, planners, supervisors and contractors to take health and safety matters into account and manage them effectively from the planning stage of a construction project through to commissioning and beyond.

4.2.10 **Gas Safety (Management) Regulations (GS(M)R)**

GS(M)R deal with the safe management of gas, whether a single system or a network of connected systems. It is unlawful for gas to be conveyed in a system or network without a safety case being prepared by the GT and accepted by the Health and Safety Executive (HSE).

Copyright Institution of Gas Engineers & Managers

4.2.11 **Pressure Systems Safety Regulations (PSSR)**

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

4.2.11.2 Relevant fluids for the purpose of this document would be NG, LPG and LPG/Air 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). Pipelines and their protective devices where the pressure does not exceed 2 bar are exempt from PSSR (see Sch 1 part 1 item 5 of HSL122).

More information is available in HSL122 and in the HSE free leaflets INDG261 and INDG178.

4.2.11.3 Inspection is the process that ensures that the installation is suitable for further operation within the design or performance limits specified by the designer or competent person.

4.2.11.4 It shall be determined whether an installation is within the scope of PSSR and, if so, safe operating limits shall be specified and written schemes of examinations must be available prior to commissioning.

4.2.12 **Pipelines Safety Regulations (PSR)**

PSR apply to all pipelines and are designed to ensure that pipelines are designed, constructed, operated, maintained and decommissioned safely. Above-ground installations, including PRIs, are considered to be included in the definition of "pipeline" and are subject to PSR.

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

RIDDOR require employers to notify certain injuries, diseases and dangerous events. Certain gas and pipeline related incidents are reportable.

Further details, advice and guidance on health and safety matters can be obtained from HSE. Initial contact may be made via the local HSE Area Office (details of which are listed in the published guidance to RIDDOR and local telephone directories).

4.2.14 **Dangerous Substances and Explosive Atmospheres Regulations (DSEAR)**

These Regulations incorporate:

- ATEX Directive 94/9/EC (ATEX 95) – Safety of Apparatus
- ATEX Directive 99/92/EC (137A) – Safety of Installation
- Chemical Agents Directive (CAD) 98/24/EC.

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:

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

4.2.15 **Provision and Use of Work Equipment Regulations (PUWER)**

4.2.15.1 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.

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

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

4.2.16 **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 Stationary Office (HMSO) and gives useful information on the Regulations. Further advice is contained in HSR25.

4.2.17 **Control of Substances Hazardous to Health Regulations (COSHH)**

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

4.2.17.2 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.

4.2.18 **Pressure Equipment Directive (PED) and Regulations (PER)**

PED applies to the design of pipework 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 UK by the Pressure Equipment Regulations (PER) and PSSR. Compliance with PED can be demonstrated by the use of a harmonised standard. BS EN 15001 (Parts 1 and 2) have been specifically 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 be affixed by an approved person or body.

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

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

4.2.19.2 GS(I&U)R apply to a range of gases including Manufactured Gas, NG, LPG and LPG/Air.

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

4.2.19.4 GS(I&U)R define the gas supplier for both NG and LPG. HSL56 provides guidance on those definitions, in particular for the more complicated case of LPG supplied from tanks and from cylinders.

4.2.19.5 GS(I&U)R define the type of work that requires persons carrying out such work, or their employers, to be an "approved class of person", for example Gas safe Register.

Note: Guidance on the individual competencies required for persons carrying out gas work at premises not covered by GS(I&U)R is given in HSE COP 20.

4.2.19.6 The gas operative 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 operative they use for the gas fitting, service or maintenance or safety is a member of an approved class of persons (see clause 4.2.19.5) and is competent to carry out such work. If any serious fault is found, the operative must inform both the landlord/hirer, as well as the user, so that such faults can be rectified before further use.

Reference shall also be made to the requirements contained in the Gas Industry Unsafe Situations Procedures (GIUSP).

SECTION 5 : PLANNING, LOCATION, LAYOUT AND SECURITY

5.1 PLANNING

- 5.1.1 Any PRI must be designed, located, constructed, operated and maintained taking into consideration the safety and environmental requirements of applicable legislation.
- 5.1.2 Consideration shall be given to the layout and other uses of the whole PRI station, for example gas storage, the need for security (see Sub-Section 5.4) and any required housing for the PRI.
- 5.1.3 Particular consideration shall be given to the possibility of flooding and, in the case of a below-ground or buried PRI, the likelihood of a rising water table.

5.2 LOCATION

5.2.1 All PRIs

- 5.2.1.1 A risk assessment shall be carried out in which consideration shall be given to the following factors:
- accessibility and security of the site
 - provision of proper means of safe access and egress for construction, maintenance, inspection and dealing with emergencies
 - avoiding areas prone to flooding, subsidence or other naturally occurring hazards
 - below-ground and buried PRIs being located away from any carriageway, for example in the verge or footpath, avoiding traffic hazards and vehicle parking that could make maintenance difficult. A roadway PRI shall not be installed unless there is no alternative and in which case suitable road covers shall be installed and the structure below ground shall be designed to withstand traffic loads
 - vulnerability of sites where traffic accidents, etc. could result in damage to the PRI
 - clearance from overhead power cables and large trees
 - proximity to tall buildings where eddy currents around the building may cause problems with gas dispersal (see IGE/SR/23)
 - where the PRI serves part of a Network or distribution system, its proximity to occupied buildings. Generally, these shall be determined from the building proximity distances given in IGE/TD/1 or IGE/TD/3 or UKLPG CoP 1 Part 1, as appropriate. In any event, the distance shall not be less than 3 m
 - where a PRI is installed in a service or service pipework, its location relative to occupied buildings. Generally, proximity shall be determined in accordance with IGE/TD/4 for pipes
 - where vehicle access is required, a roadway or hard standing should be available
 - consideration shall be given to preventing other parties from impeding access to the site by such acts as the parking of vehicles, the storage of goods and equipment, fly-tipping, etc.
 - avoiding hazardous or potentially hazardous conditions and of any gas venting from regulator relief valves entering property through open windows, airbricks, balanced flues or similar openings in the structure.

Note 1: A hazardous area drawing is required under DSEAR. The extents of the hazardous areas identified in the drawing will influence the location of the PRI in relation to its proximity to properties or potential ignition sources.

Note 2: When selecting a site for a new PRI, or when reviewing the location of an existing PRI near the public highway, the following factors are relevant in a risk assessment:

- distance from the highway and ease of access for construction and maintenance
- speed of traffic
- traffic loading
- overall vulnerability of the PRI
- effect on persons and the environment
- effect on gas supply
- possible future development around the PRI
- ground conditions
- site topography.

The conclusions of the risk assessment may indicate that additional protective measures or re-siting are necessary.

5.2.1.2 Due regard should be taken of the likelihood of the site being flooded, and the effects that any flooding may have on the operation of the unit, and its associated equipment.

In the UK, the information on flooding, and depth of water that could be expected, is available from the local Environment Agency, who can offer advice on this risk.

Where there is no alternative to building on a site at risk of being flooded, mitigation measures shall be considered.

Note: These measures can include raising the breather and vent pipes to a high level, installing electrical equipment on raised platforms within the site, arranging any air inlets to be above expected water levels, etc.

5.2.2 **Small PRIs supplying domestic premises (see Table 2)**

In addition to the requirements of clause 5.2.1, for small PRIs, consideration shall be given to:

- the need to ensure any PRI is installed outside the building in an external surface mounted box or housing, or in the open
- known planned alterations or extensions to buildings which would affect the installation.

5.2.3 **PRIs supplying commercial or industrial premises**

5.2.3.1 *All PRIs*

For a PRI installed in a main building, it shall be sited in accordance with the relevant requirements of clauses 5.2.1 and 5.2.2, and in accordance with the following conditions:

- MOP_u shall not exceed 2 bar
- the only access to the PRI shall be from outside the main building through outward opening doors
- explosion relief should be provided, either within the doors, or by the doors, or on an outside wall (see clause 6.2.10).

Note: Where it is impractical to provide an explosion relief in the walls or doors, it may be sufficient to provide additional ventilation, for example louvred doors and panels, in the outside wall and to the full height and width of the enclosure.

5.2.3.2 Any floor, wall or ceiling separating the PRI from the rest of any building shall be of fire-resistant construction, with a minimum fire rating of 30 minutes, finished with a screed or plaster finish to assist in minimising the leakage of gas through cracks or into any wall cavity. In addition, to prevent gas leakage into the building, particular attention shall be paid to the sealing of ventilation openings, pipes, etc., which cross any cavity.

5.2.3.2 **LPG PRIs**

Any open drain, grille or duct located within 1 m of a PRI or its vent shall be fitted with a water trap or shall be suitably sealed.

5.2.4 **Below-ground LPG PRIs**

Only small LPG PRIs (as defined in Sub-Section 1.5) shall be installed below ground, when the enclosure volume shall not exceed 0.5 m³ and the depth of burial (cover) shall not exceed 0.5 m.

5.3 **PRI STATION LAYOUT**

5.3.1 The area of the PRI station shall be adequate to accommodate the PRI and provide access (see clause 5.2.1.1) for maintenance purposes and/or the location of emergency facilities, for example fire extinguishers.

5.3.2 There should be at least 1 emergency exit unless a risk assessment determines otherwise.

Emergency exit(s) shall be capable of being opened from the inside without the use of a key.

5.3.3 Where the presence of vehicular traffic could cause a hazard, consideration shall be given to the use of safety barriers.

5.3.4 Any hazardous area shall be taken into account when determining the PRI station boundary.

5.3.5 The combustion air intake of any gas heater or other burner equipment shall be located so as to minimise any hazard arising from any source of gas leakage or emission, for example from a filter, relief valve vent, etc.

5.3.6 Consideration shall be given to:

- access for pigging operations and equipment
- access for maintenance activities
- access for fire fighting
- gas detection

Note: Where gas is not odorised, enhanced arrangements may be needed, such as prominent notices and/or additional detection equipment.

- minimising noise (see Appendix 4).

5.3.7 Prominent signs shall be displayed, prohibiting smoking and other ignition sources.

5.4 **SECURITY**

5.4.1 Any PRI station should be secured against entry by unauthorised persons.

5.4.2 If a security fence is used, equipment should be sited at a sufficient distance from the fence to prevent interference from outside and, for electrical equipment this distance shall be at least 2 m. If less, pipework and compound fencing shall be equipotentially bonded.

5.4.3 Consideration shall be given to the provision of a locking device for valves, including auxiliary valves located external to a PRI housing.

5.4.4 Consideration shall be given to installing intruder detection devices.

5.4.5 A permanent notice shall be displayed, clearly showing an emergency telephone number which may be used by the public or others.

5.4.6 Where appropriate, due consideration shall be given to the vulnerability of the site and the need for a higher standard of security, for example by including electric fencing, closed circuit television (CCTV), etc.

SECTION 6 : HOUSINGS

This section applies to any of the following housings for all or part of a PRI in:

- a separate building providing weather protection, and sufficient space for maintenance and general access or
- a cabinet providing weather protection, and facility to remove all or part of the cabinet for the purpose of maintenance and general access or
- a pit, i.e. the PRI is located partly or completely below the nominal ground level or

Note: Such an installation incurs some additional safety considerations but may be deemed appropriate for reasons of appearance, noise reduction, etc. See also clauses 5.2.1 and 5.2.4.

- a buried vessel, designed specifically for the PRI, located partly or completely below the nominal ground level.

Note 1: A PRI may be enclosed in a vessel-type housing designed to be installed as a module between the inlet and outlet pipework. Parts of the housing may contain pressure.

Note 2: A buried vessel incurs some additional safety considerations. See also clauses 5.2.1 and 5.2.4.

A PRI may also be installed in the open air or under a canopy, in which cases the appropriate requirements within this section shall be applied.

6.1 GENERAL

6.1.1 All housings

6.1.1.1 Any vent termination shall be outside the housing except, for NG only, for a housing volume not exceeding 1.5 m³ and MOP ≤ 7 bar, a relief valve vent may be terminated within the housing (see also clause 6.2.8.4).

6.1.1.2 Any metallic structure shall be earthed.

6.1.1.3 Appropriate warning and procedural notices shall be displayed.

6.1.1.4 The materials used in the construction of any housing/compound shall provide:

- low maintenance requirements
- sound insulation, where necessary
- durability
- weather resistance.

6.1.1.5 Where pipes are to enter and leave a housing above floor level, and unless a sleeve has been fitted during construction/manufacture of the housing, the circular holes required should be made, using a suitable tool (for example, a core drill) at the pipe entry and exit points to accommodate both pipe and sleeve. The annular space between the pipe and sleeve and between the sleeve and the housing wall shall be sealed with an appropriate non-setting sealant.

6.1.1.6 Any opening in a housing should be restricted only to those for doors, ventilation, explosion relief, pipework and ancillary services.

6.1.1.7 Any door or ventilation aperture should be located at a safe distance from any window, door or aperture of another building.

6.1.1.8 It shall not be possible to create a path of air movement between a space containing a PRI and another space that contains an ignition source, for example by opening an access door, unless the ignition source is at a safe distance. Otherwise, the planned position of access doors, ventilation apertures, etc. shall be so as to avoid creating such a path.

- 6.1.1.9 If access is required on more than one side of the PRI at least two access points shall be provided, each with an adequate and safe means of escape in an emergency (see Figures 4(c) and 4(d), Sub-Section 6.2.10).

Exit routes to the outside of the housing should be kept free of obstruction at all times.

- 6.1.1.10 The space containing a PRI shall not be connected directly to a sewer, for example by a floor drain, or any other below-ground service duct or chamber.

- 6.1.1.11 Items manufactured from aluminium-based light metals, for example door furniture, protection strips etc. should be used only if the magnesium content does not exceed 6% by weight.

Such items shall be protected against electrolytic action occurring where contact with steel is likely to occur, for example by painting; factory applied coating; non-corrosive material, etc.

- 6.1.1.12 For any glass reinforced plastic (GRP) housing, instrument panel boards or safe area compartments should be pre-fabricated into the housing design.

For other housings, the method of fixing panels and components to interior walls shall be such that the integrity of the housing is not impaired.

- 6.1.1.13 Access to a PRI shall be directly from outside through outward opening doors.

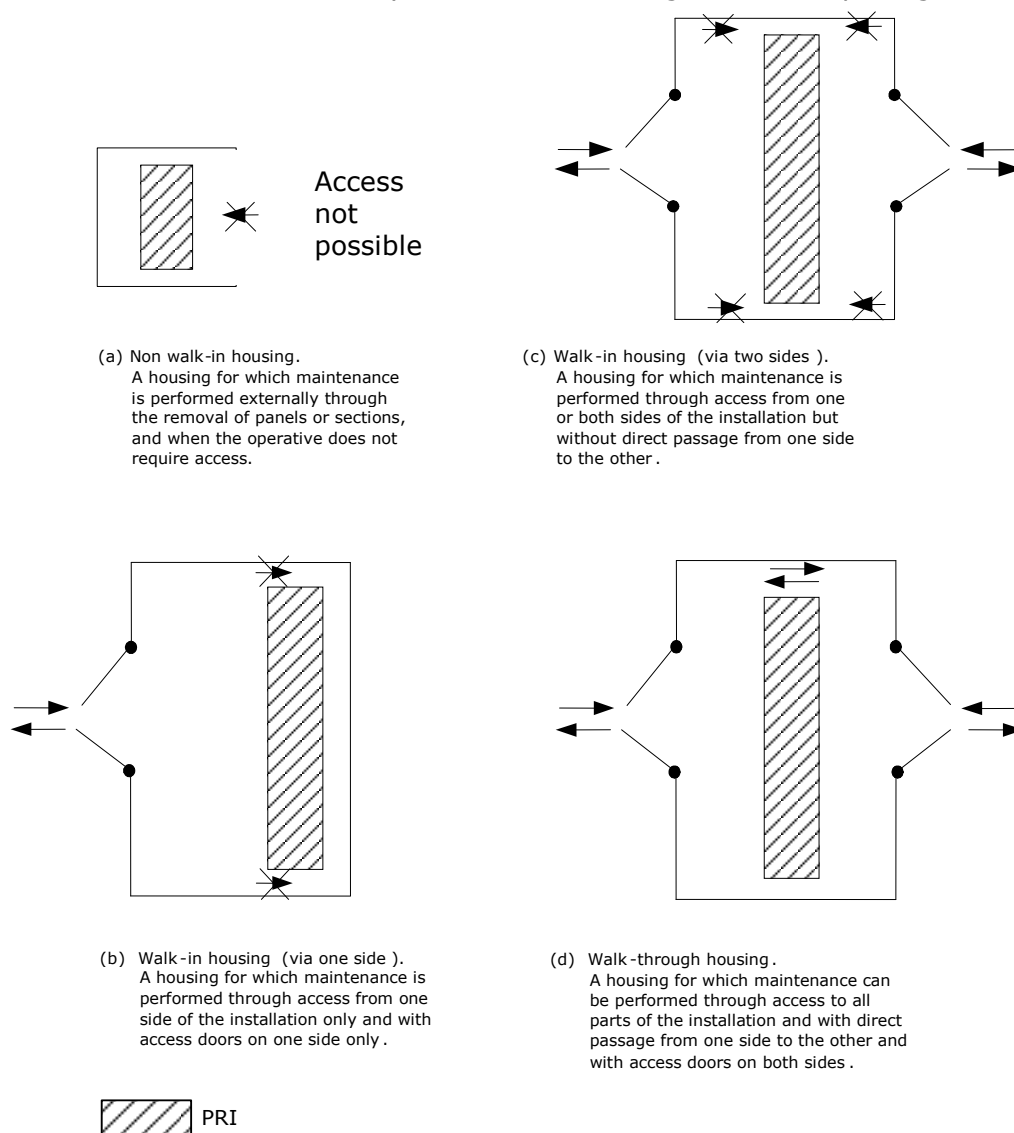


FIGURE 4 - ACCESS CLASSIFICATION

6.1.2 Safety and safe working access

6.1.2.1 Where a design incorporates a hinged access roof, it should be fitted with stays to enable it to be held in the open position. The stays should be fitted in pairs and be capable of supporting the weight of the hinged roof while resisting any wind loading that may be applied to the hinged roof while in the open position.

6.1.2.2 Any "walk-in" or "walk-through" housing (see Figure 4) shall have a minimum internal height of 2.1 m.

6.1.2.3 The following shall be provided, as required:

- sufficient clearances for safe working on equipment, also allowing withdrawal of components

Note: A minimum clearance of 0.5 m is recommended, but significantly more space than this may be required especially where mechanical lifting equipment has to be used within the housing and where large/heavy components may need removing on a trolley. It may be beneficial to make use of a removable roof (even when explosion relief is not required) to facilitate easy access to the installation for the removal of major components.

- where lifting or support equipment is required for safe installation, maintenance or replacement of equipment, as appropriate:
 - a lifting beam or suitable runner at high level, appropriately marked to show its safe working load (SWL), and/or
 - access through the roof for mobile gear and/or provision for removing the housing if pre-fabricated and/or
 - sufficient floor space to enable temporary lifting equipment to be used.

6.1.2.4 Any lift-off housing/cover shall be capable of being easily moved. Where appropriate, lifting eyes shall be fitted.

Note: Advice is contained in the HSE publication "Getting to grips with manual handling - a short guide" (INDG143).

Handles, whether fixed or operational, should be positioned for ease of access and operation and be located so that personnel moving a housing/cover will not be in danger of walking into equipment under the housing/cover.

6.1.2.5 Where lifting eyes are fitted, sufficient plugs shall be provided to allow the permanent sealing of the holes if the eyes are to be removed. The sealing method shall ensure that water ingress is permanently prevented.

6.1.2.6 The design of any lifting eye shall be such that the operation of any explosion relief roof will not be affected if they are not removed.

6.1.3 Documentation for housings and components

6.1.3.1 The following documents shall be produced, as appropriate:

- **planning application, including drawings**
Planning application drawings, whether for a "full planning permission" or approval of a "permitted development" application, are required to show the proposal and should contain sufficient information to demonstrate the general appearance of the housing/compound upon completion. The drawing should contain a location plan, site plan and at least two elevations.
- **site layout drawing**
Site layout drawings may also be required for site construction works. These should show sufficient detail to identify the site location, orientation and boundaries, as well as the exact position of any housing/compound to be located on the site.

- **general arrangement drawing**

General arrangement drawings should provide at least the following information:

- setting out of the housing/compound in plan position
- plans, sections and elevations, as appropriate, showing layout, dimensions and levels of all aspects of the structure
- location of all access doors, holes, chases, pockets, ventilation, fixings and other items
- details of materials to be used, for example brick type, colour and supplier
- details of surface finishes, both internally and externally, including colour
- all other information necessary to permit construction in accordance with design requirements, for example type and location of holding-down fixings.

- **detailed fabrication and construction drawings and specifications**

Detailed fabrication and construction drawings should indicate any specific manufacturing or construction detail that is not indicated on the general arrangement drawing. Copies of these drawings shall be submitted for acceptance by the project manager prior to commencement of any fabrication or construction work.

- **as-built drawings**

As-built drawings should indicate the details of the completed construction and should also identify all changes from the construction issue drawings. Copies of the drawings should be provided by the contractor, or supplier, to the project manager on completion of site works.

- **design calculations**

Calculations for all structural elements and their fixings shall be checked and approved.

6.1.4 **Glass reinforced plastic (GRP) housings**

6.1.4.1 *General*

- 6.1.4.1.1 Pipework shall not enter or exit the housing through the side walls unless the facility has been specifically provided and allows removal of the housing, for example keyhole slots and infill panels. Where a vent pipe is to be fitted, clearly identifiable solid panels, designed specifically for the exit of the pipe, should be provided.

Note: Usually, these are located at high level and at each end of the housing.

- 6.1.4.1.2 The skin should be resin bonded and be of either a single skin or sandwich construction which is cavity-free. Corners, door frames and base frames should be strengthened. Any sandwich structure shall be formed from resin bonded glass fibre inner and outer skins totally encapsulating a suitable core material and meet the criteria and tests in Appendix 8.

- 6.1.4.1.3 Fixing methods that interrupt the continuity of the GRP surface shall be fully sealed to ensure that ingress of moisture does not occur.

- 6.1.4.1.4 Where a framework is used, it shall be of wooden construction or metal, suitably treated to prevent corrosion such that it will attain the required design life. The framework shall have a nominal cross section to adequately support the structure.

- 6.1.4.1.5 All wooden joints shall be glued using appropriate timber adhesives and screwed, and all metal joints suitably welded to attain the required design life.

- 6.1.4.1.6 The framework shall be totally encapsulated within the GRP structure.

Note: Other materials may be considered to be suitable provided that they meet the test criteria in Appendix 8.

- 6.1.4.1.7 Any pre-fabricated housing shall have an identification plate permanently and prominently fixed to the inside of the entrance door or panel, without compromising the housing integrity, giving the following information:

- manufacturer
- date of manufacture
- gross weight of the housing
- roof weight (if removable)
- fixing bolt tightening torque
- ventilation as a % of floor area
- the location of the ventilation.

Note: If the ventilation is in the form of soffit ventilation, this needs to be stated on the plate.

- 6.1.4.1.8 Any lifting eye should be painted red and show the safe working load.

6.1.4.2 *Pre-fabricated safe area compartments*

- 6.1.4.2.1 Compartments shall be internally moulded/attached, projecting into the housing but completely sealed from it.

- 6.1.4.2.2 Access shall be through an external outward-opening door attached to the main housing.

- 6.1.4.2.3 It shall be possible to mount logging and conversion equipment within the compartment such that it is totally isolated from the main housing.

Note: A safe area compartment is not intended to contain instruments that carry fuel gas.

- 6.1.4.2.4 The design of the compartment shall be such that all cables have to be routed into the compartment from outside the main GRP housing, without compromising the integrity of either the compartment or the housing.

Note: This is to ensure there is no relief ingress of gas in the safe area compartment.

- 6.1.4.2.5 All cables and glands shall be matched so as to prevent the ingress of gas or water into the safe area compartment.

- 6.1.4.2.6 The IP ratings of the external door shall be to BS EN 60529, ingress protection (IP) at least IP 65.

- 6.1.4.2.7 The compartment shall not be fitted to the same wall as a relief vent pipe.

6.2 **ABOVE-GROUND HOUSINGS AND BUILDINGS**

6.2.1 **Foundations, bases and floor mounting**

6.2.1.1 *All housings/compounds*

- 6.2.1.1.1 Suitable foundations, generally of the slab (raft) or footing type, shall be provided. They shall be designed to take account of any special features of the site, for example, subsidence, local infill, clay, etc., and shall make adequate provision for pipes to enter and leave the housing.

- 6.2.1.1.2 Foundations, bases and floors shall be designed and constructed to appropriate standards such as BS 8004, BS 8500-1, BS 8500-2, BS 8110-1 and BS 8110-2.

For foundations, the proven nature of the ground and the requirements of the structure to be supported shall be considered.

6.2.1.1.3 The floor should be finished in a material that has non-sparking and anti-static properties, for example certain grades of concrete.

6.2.1.1.4 Floors and duct coverings shall be strong enough to take the required point weight loadings of the installation and any additional loadings imposed during construction and maintenance.

6.2.1.2 *Pre-fabricated housings (including GRP)*

6.2.1.2.1 Sufficient restraining bolts and washers shall be supplied by the housing manufacturer so that, once installed, the housing will meet specified wind loading.

Note Normally, at least size M10 bolts and washers will be required.

6.2.1.2.2 All base fixing points shall be inside the housing, to prevent unauthorised removal once installed.

6.2.1.1.3 The design and location of fixing points shall ensure that accidental stress loading during installation is spread over the body of the housing.

6.2.1.3 *GRP housings*

6.2.1.3.1 The base flange shall be suitably reinforced, and shall be provided with an appropriate number of fixing holes. The fixing holes shall be incorporated into the fabric of the base during construction. The pitch of the fixing points shall not exceed 1000 mm.

6.2.1.3.2 The laminate on the underside of the base flange shall have a thickness of not less than 6 mm and be suitably protected to prevent damage to its weather proofing, in the event of the surface being abraded during installation of the housing.

6.2.1.3.3 Where a housing is designed to fit onto a concrete base, suitable non-setting sealant shall be provided to seal the base to the concrete standing. The sealing kit shall include fitting instructions and detail any safety precautions that may be required.

Note: Lift-off housings may have an alternative method of base fixing, allowing for ease of removal without damaging the housing.

6.2.2 **Doors**

6.2.2.1 Doors shall be designed so that warping is minimised during weathering and minor deviations from square during installation will not cause the door to stick. The design shall ensure that rain water is prevented from entering. Wooden doors shall conform to BS 459 and steel doors to BS 6510.

6.2.2.2 The design of any door and the door access or housing shall be such as to prevent any direct line of sight into the housing when the door is closed.

6.2.2.3 At least three hinges should be provided on doors that are 2 m or greater in height, one each located within 300 mm of top and bottom of the door and the other centrally. Alternatively, a continuous strip-type hinge should be utilized.

Housings with doors that are less than 2 m in height shall have at least two hinges fitted.

The hinge design should ensure that any hinge-securing bolts can only be removed from inside the housing or be totally concealed when the door is in the closed position.

Hinges shall be constructed of corrosion-resistant metal and designed so that differential corrosion is minimised.

- 6.2.2.4 Where an explosion relief is incorporated into the roof or walls of a housing, the doors and locking mechanism shall be strong enough that an explosion would not cause the doors to open.
- 6.2.2.5 Each door for a "walk-in" or "walk-through" housing shall have a minimum nominal width of 800 mm and a minimum height of 2 m.
- 6.2.2.6 Outward opening doors, of sufficient size to afford access to persons and equipment, shall be provided on the outside wall to accommodate installation and maintenance work.
- 6.2.2.7 For a "walk-through" housing, an additional emergency exit shall be provided on the opposite side of the building to the main doors (see Figure 4(d)).

For a "walk-in" housing, at least one set of standard width outward-opening double doors shall be fitted. Two sets of standard width doors are preferred, which should be mounted on opposite ends of the housing for rapid exit in the case of emergency (see Figure 5).

Note: This is to provide an alternative means of escape.

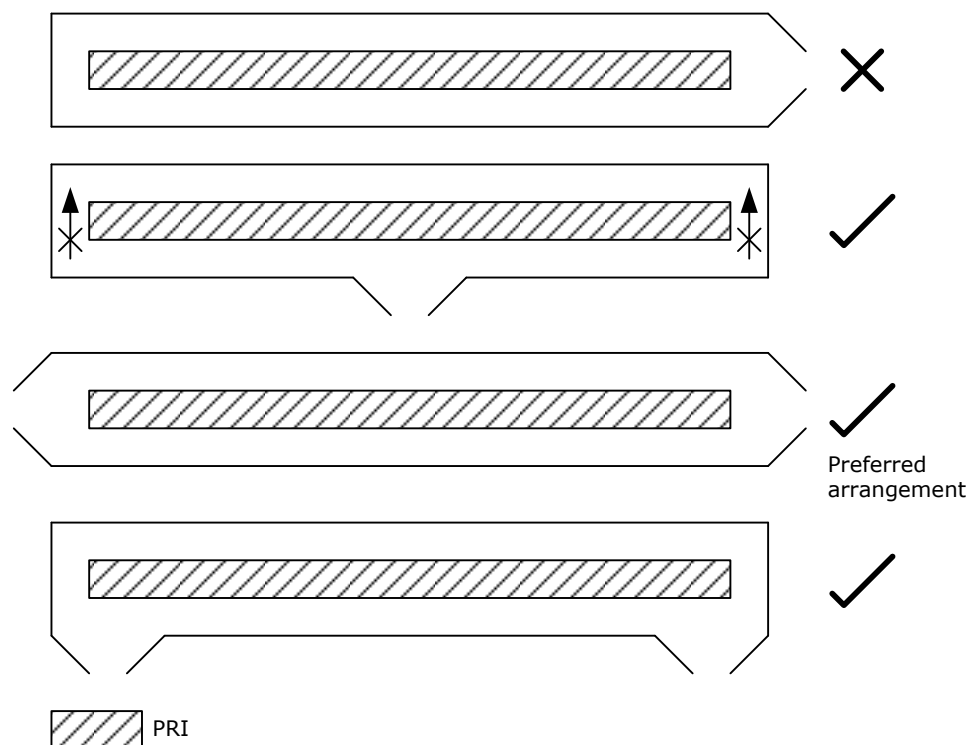


FIGURE 5 - PROVISION OF EXITS IN LONG "WALK-IN" HOUSINGS

- 6.2.2.8 Any means of escape shall be readily operable from inside without the aid of a key.
- 6.2.2.9 Any door shall have unobstructed access to open fully.
- 6.2.2.10 Means shall be provided to fasten any door in the open position.

- 6.2.2.11 For a housing of the cupboard or compartment type, the whole front shall be in the form of a door or an easily removable panel.
- 6.2.2.12 The left hand door of the double doors designated "front" shall be secured internally.
- 6.2.2.13 The right hand door of the double doors designated "front" should be secured by means of a hasp and staple to accept a security lock, or other alternative equivalent means of securing, with a minimum shackle diameter of 12 mm. The hasp should be positioned at the left hand edge of each right hand door when viewed externally and centrally located.
- 6.2.2.14 The double doors designated "rear" on "walk-through" housings shall be secured internally to an equivalent standard as the front doors, and shall only be capable of being opened from the inside and without a key.
- 6.2.2.15 Any double doors designated "rear" on "walk-in" housings (see Figure 4(c)) shall be secured in the same manner as the front doors.
- 6.2.2.16 Any single door of a "walk-in" housing shall be secured externally.
- 6.2.2.17 Any rear door used for escape in an emergency shall not be capable of being padlocked.
- 6.2.2.18 Shooting bolts and locking bars shall locate at the top and bottom of the left hand doors, either behind the door frame against keeper plates or within a suitable, strengthened, sill.
- 6.2.2.19 Where door sills are fitted, they should be a maximum of 10 mm high and shall be of corrosion-resistant material.

6.2.3 Walls

6.2.3.1 *All housings*

- 6.2.3.1.1 Where a new, purpose-built room or building is provided to house an installation, the walls shall be solid without cavity and shall not include openings other than those required for access, ventilation, pipework or other ancillary services.
- 6.2.3.1.2 Where a new housing makes use of existing walls of cavity construction, or an additional room is built onto a housing, which may contain potential sources of ignition, all routes of through wall gas leakage shall be sealed.
- 6.2.3.1.3 For a brick-built building, and where an explosion relief is required, the walls should be a minimum 225 mm thick with the bricks fully interlocking. Piers or returns should be provided on long walls.
- 6.2.3.1.4 The design of any damp proof course should be such as to prevent any tendency for the wall to slide off the damp proof material in the event of an explosion.
- 6.2.3.1.5 Any wall shall be designed as necessary to withstand specified wind loading.

6.2.3.2 *Pre-fabricated housings (including GRP)*

- 6.2.3.2.1 Where a housing is of sectional construction, the walls shall be fully formed. The joints shall be positioned to give maximum strength to the housing, and shall be suitably protected and sealed with non-setting sealant. Walls shall not contain cavities.

- 6.2.3.2.2 Where wall core material is fixed to the frame by means of a lap joint, the depth of the joint shall not be less than two thirds of the thickness of the frame.
- 6.2.3.2.3 Butt joints shall not be used to form corners or openings.
- 6.2.3.2.4 For a GRP housing, clearly defined relief vent panels should be incorporated into housings in both walls and through which relief vent pipes may pass. The panels shall be located centrally in the horizontal plane of the wall, and 100 mm below soffit level.

Note: Normally, panel dimensions of 700 mm long by 100 mm high are sufficient.

The panels shall consist of solid GRP with no core material, but with any decorative finish to match the rest of the housing.

6.2.4 Roofs and lift off panels

- 6.2.4.1 The roof of any purpose-built external housing:
- shall not enclose any unventilated void
 - should be of light-weight construction, or so constructed to minimize damage to installed equipment in the event of a roof fall
 - should provide the same level of security as the rest of the structure, unless other overall site security measures are taken
 - should be of fire resistant material.

- 6.2.4.2 Where the roof is not required to act as an explosion relief, it shall be securely attached to the walls.

Note: It is beneficial that the whole or part of the roof is removable in order to facilitate access to the installation.

- 6.2.4.3 The roof shall be strong enough to be walked upon and be designed to withstand loads imposed by wind, snow, etc.

- 6.2.4.4 The roof shall be waterproof and shall project sufficiently over the walls as to prevent water entering the ventilators.

- 6.2.4.5 The roof shall have a minimum fall (gradient) of 1:60 in order to prevent water holding on the roof. Arrangements shall be made to allow rainwater to be shed away from the door access areas and any safe area compartment.

- 6.2.4.6 Lift off panels and hinged roofs on small moulded housings shall be secured by suitable locking mechanisms.

- 6.2.4.7 Hinged access roofs shall have hold-open stays that resist wind loading.

6.2.5 Finish

- 6.2.5.1 The finish of any housing should allow the removal of graffiti without suffering any damage to coating materials and should be smooth or textured, normally BS 4800 green 14-C-39 or, alternatively, stone, brick or cement rendering or another colour.

- 6.2.5.2 The finish shall resist the effects of ultra violet (UV) light to ensure minimal degradation over its design life.

Note: For a GRP housing, this will involve UV stabilization.

- 6.2.5.3 The internal finish of any GRP or other pre-fabricated housing should be white.

6.2.6 Performance

6.2.6.1 All housings

6.2.6.1.1 Any housing shall withstand wind speeds of up to 50 m s^{-1} .

6.2.6.1.2 Any explosion relief roof fitted shall operate correctly under the load conditions. Compliance should be verified either by design calculations or by an appropriate test method.

6.2.6.1.3 The roof of the housing shall withstand a uniformly distributed load of 1.25 kN m^{-2} . Compliance should be verified either by design calculations or by an appropriate test method.

6.2.6.2 GRP housings

6.2.6.2.1 Housings shall suffer no defects due to temperatures within the ambient temperature range -20°C to $+50^{\circ}\text{C}$.

6.2.6.2.2 The performance test specifications given in Appendix 8 shall be met.

6.2.7 Fire resistance

6.2.7.1 All combustible materials used in the construction of the external surface shall have a fire performance in accordance with clauses 6.2.7.2 and 6.2.7.3.

Note: GRP housings are regarded as combustible and therefore need to be tested in accordance with this section.

6.2.7.2 When tested to BS 476-12, utilising flame 'Source G', $500 \text{ mm} \times 750 \text{ mm}$ there shall be no holes formed in any of the tested specimens when the flame is applied for 3 minutes. The sample shall retain its physical strength which shall be demonstrated by compliance with the impact test specified in Appendix 8. Following the test there shall be no holes formed in the panel.

6.2.7.3 When a large representative section of the housing ($1000 \text{ mm} \times 1000 \text{ mm}$) is tested (in the vertical orientation) to BS 476-12, utilising flame 'Source E' for a period of 20 minutes, the sample shall show:

- no signs of penetration, and
- the extent of damage shall be limited to an area no wider than 550 mm , and
- the flames shall self extinguish within 5 seconds of the 'Source E' being extinguished.

Note 1: A kiosk approximately $1 \text{ m} \times 0.54 \text{ m} \times 0.96 \text{ m}$, may be used as an alternative to a test panel.

Note 2: The flame source is to be positioned such that it is approximately 25 mm from the surface of the test panel, and impinges on the face of the test panel at an angle of 45° at a point approximately 100 mm from the base of the panel.

6.2.8 Ventilation of housings

6.2.8.1 Ventilation shall be provided in a PRI housing.

Note: The purpose of ventilation is to:

- ensure that minor gas leakage does not cause the atmosphere within the housing/building to become unsafe
- allow any escape of gas to be smelled or otherwise detected by passers-by
- reduce condensation.

6.2.8.2 For NG installations, the level of ventilation required in any housing should be determined following reference to IGE/SR/25 with respect to its hazardous area classification. The level of ventilation included should aim to provide the

least onerous hazardous area classification that is reasonably practicable. Zone 0 installations in public areas should be avoided.

For LPG installations, the level of ventilation required in any housing should be determined following reference to EI IP-MCSP-P15 with respect to its hazardous area classification.

As a minimum, the total effective ventilation area (free area) of a housing shall not be less than 2% of the internal floor area of the housing/building or its notional equivalent and should be equally distributed and disposed at high and low levels around at least two walls to outside air.

Note: The notional equivalent floor area is the floor area of an imaginary housing to enclose a PRI which is, in fact, located in a larger open area, for example in the corner of a factory workshop, wall mounted in a shop, in a boiler house etc.

Where only one wall is used, ventilation shall be increased to at least 3% of the internal floor area.

Where a risk assessment indicates that greater ventilation levels are required, this shall be provided.

Note: The hazardous area classification may influence the design and level of the ventilation provided and the required inspection frequency.

The ventilation provided for wall mounted PRIs (see clause 6.2.12) shall not be less than 2% of the floor area for a surface mounted box and be not less than 6% of the floor area for a semi-concealed box. Such ventilation shall be achieved using purpose-designed, non-adjustable louvre type ventilators and/or loose fitting doors/lids.

For a lighter-than-air gas, the low level ventilators should be positioned 150 mm above the floor. The high level openings should be situated as close as possible below, but not more than 10% of the total height below, the roof or ceiling level.

For a heavier-than-air gas, the low level ventilation should be positioned as low as practicable but always at 150 mm or less above the floor. Allowance shall be made for the potential for a vent(s) to be blocked.

- 6.2.8.3 Where a housing has an apex type roof design, the level of ventilation should be achieved by utilising ridge ventilators. Any ceiling shall not create an unventilated void.
- 6.2.8.4 Where a relief valve vent is to terminate within a housing (see clause 6.1.1.1), the minimum ventilation shall be 5 % of the floor area and this shall be distributed across a minimum of 2 walls and be equally spread between high and low level.
- 6.2.8.5 A ventilator shall not be located by or near any air in-take duct, thus minimising the possibility of gas entering any building.
- 6.2.8.6 Any ventilator shall be designed and located to prevent persons tampering with the door restraining fixings.
- 6.2.8.7 Ventilation openings shall not be into a hazardous area, for example a consumer-generated hazardous area or the hazardous area surrounding a vent pipe termination or drain hole.
- 6.2.8.8 Where a duct is used, it shall be in accordance with current Building Regulations but, for gas safety reasons, shall not be fitted with a fire damper. The covers for the duct shall not create an unventilated void.

6.2.8.9 Any ventilator shall be of non-adjustable type (complying with BS 493 Class 1), and should be weatherproof and fire resistant.

6.2.8.10 Any ventilator shall be designed to minimise the risk of ingress of rain and blockage by leaves or snow.

Holes used for the fixing of ventilators shall be fully sealed and designed to ensure that any inner core material will not be exposed to moisture ingress.

6.2.8.11 Any ventilator should be of a circular or square hole, or louvre, design. The openings in the ventilator shall be such that a 9.5 mm diameter sphere cannot pass through.

If the high level ventilator is in the form of a gap(s) between the walls and the roof of the housing, such a gap shall not exceed 9.5 mm.

6.2.8.12 Roof ventilators are more efficient than apertures in the wall but, if installed, they shall provide at least the same effective free area of ventilation as required for high level wall apertures (low level ventilation should be retained).

6.2.8.13 Where a baffle or other design of acoustic ventilation panel is provided within or behind a ventilator, the free area of the aperture as given in clause 6.2.8.2 shall be increased to maintain the required performance of the ventilation system.

6.2.8.14 Ventilation design should take account of the acoustic properties of the building.

6.2.8.15 If a space houses a heating installation, sufficient additional ventilation should be provided to satisfy the appliance combustion requirements.

6.2.9 **Space heating**

6.2.9.1 Where necessary, space heating shall be provided to preserve the fabric of the housing and any electrical, telemetry or other equipment.

6.2.9.2 If a space heating appliance is to be provided in a space in which a flammable atmosphere may be present:

- any combustion chamber shall be isolated from the space
- the surface temperature of any component in direct contact with the space shall not exceed 350°C.

6.2.10 **Explosion relief (see Figure 6)**

6.2.10.1 *General*

6.2.10.1.1 For an inlet pressure exceeding 100 mbar and where the housing is of internal volume 1.5 m³ or greater, an explosion relief shall be provided if an explosion within the housing could present a hazard to:

- the general public
- employees, except where a formal working procedure is in place to prevent ignition of any explosive atmosphere.

The relief shall be designed to ensure the integrity of the housing in the event of an explosion within it.

Where the design of the installation and ventilation of the housing results in a hazardous area classification of Zone 2 NE, an explosion relief roof may be omitted.

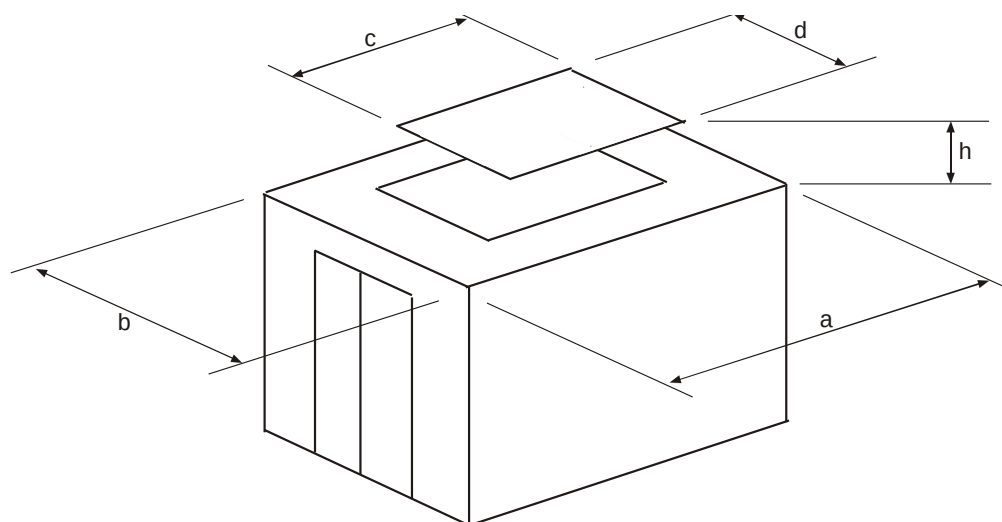
Note: See IGEM/SR/25 and EI IP-MCSP-P15 for further guidance on hazardous area classification.

- 6.2.10.1.2 The housing shall be capable of withstanding the maximum internal pressure developed during an explosion and designed such that there would not be any fragmentation sufficient to cause a hazard in the event of an explosion.
- 6.2.10.1.3 The explosion relief shall be designed to limit the internal pressure in the housing, developed during an explosion, to a maximum of 35 mbar.
- 6.2.10.1.4 An explosion relief should not provide easier means of access than a locked door, so maintaining the required degree of security.
- 6.2.10.1.5 An explosion relief shall not be obstructed on the inside or outside of the housing.
- 6.2.10.1.6 Vent stacks/lines shall not pass through an explosion relief.
- 6.2.10.1.7 Any cables and lighting provided within a housing shall not interfere with the action of any explosion relief panel or roof.
- 6.2.10.1.8 Any explosion relief would, normally, be provided by the roof of the housing lifting. However, where circumstances permit the use of an explosion panel within the roof, the discharge area shall not be less than 50% of the area of the roof.
- 6.2.10.1.9 If it is not reasonably practicable to provide a lifting roof explosion relief, consideration shall be given to providing relief by the doors or outside walls of the installation, whichever is the more appropriate to the circumstances. The security of the installation shall not be compromised.
- 6.2.10.2 *Design of a lifting roof explosion relief*

The pressure developed in a housing during an explosion is dependent on the weight per unit area of the explosion relief, the method of retention of the relief and the vent area created when the relief operates.
- 6.2.10.2.1 The restraining fixings of the roof shall be contained within the building and be so designed such that the operation of the explosion relief will not damage any wall of the housing.
- 6.2.10.2.2 The explosion relief shall be designed so as to prevent damage to equipment within the housing when it reseats following operation.

Note: In practice, it is difficult to achieve a satisfactory design of an explosion relief panel which maintains the acceptable level of security. However, explosion relief panels may be a practical solution where levels of security lower than normal are acceptable or on housings within securely-fenced sites.

Copyright © IGHM 2011



$$K_{\text{lift}} = \frac{\text{Cross sectional area of roof}}{\text{Perimeter vent area due to lift}} = \frac{a \times b}{2(d \times h) + 2(c \times h)} = \frac{a \times b}{2h(d + c)}$$

$$K_{\text{roof}} = \frac{\text{Cross sectional area of roof}}{\text{Area of lifting plate}} = \frac{a \times b}{c \times d}$$

Note: For a lifting roof explosion relief, the maximum pressure developed during an explosion will be limited to 35 mbar or less provided that:

- the weight per unit area of the lifting roof does not exceed 50 kg m^{-2} which includes the weight of any parts of the roof restraining/guide mechanism that moves with the roof.

Where acoustic attenuation is required, the weight per unit area of the roof may be increased to 100 kg m^{-2} provided the housing is designed to withstand an internal pressure of 50 mbar (normal brick construction would not be suitable)

- the area of the roof that is lifted is at least 50% of the total roof area i.e. K_{roof} as defined above does not exceed a value of 2.
- the height of lift of the roof is sufficient to create a vent area around the perimeter of the roof equal to at least 30% of the total roof area, i.e. so that K_{lift} as defined above does not exceed a value of 3.3.

In practice, in most cases, the whole roof will lift i.e. $K = 1$, and the height of lift of the roof will be such that the value of K_{lift} will be nearer to unity than the maximum permitted value of 3.3.

The maximum allowable weights per unit area quoted are adequate to withstand most wind loading but are sufficiently low to allow for a snow loading of approximately 30 kg m^{-2} while still retaining the effectiveness of the relief.

FIGURE 6 - HOUSING ROOF AREA/HEIGHT OF LIFT

6.2.10.3 Design of restraints

6.2.10.3.1 The explosion relief restraining mechanism shall allow free opening of the relief within its excursion limits and should ensure that the roof re-seats properly following any explosion.

Note: A suitable design would consist of a slide rod/slide bracket arrangement or sliding concentric tubes in which the restraint/guide mechanism is attached firmly to the four corners of the roof.

For pre-fabricated housings of steel, concrete or a GRP composite laminate construction, this mechanism may be fixed to either the walls of the building or to the floor. However, for brick-built housings, the roof restraint/guide mechanism needs to be fixed to the floor.

- 6.2.10.3.2 The lifting roof shall be held in place by virtue of the force of gravity only. Devices to prevent the free vertical movement of the roof shall be incorporated in the roof restraint/guide mechanism only if due consideration has been given to the effects of release tolerances and delays in operation.

6.2.11 **Electrical**

- 6.2.11.1 Instrumentation and associated electrical equipment associated with a PRI should be:

- housed in a detached building in a safe area, or
- suitable for the hazardous zone in which it is located, or
- housed integrally in a safe area compartment (see clause 6.1.4.2).

- 6.2.11.2 Special care should be taken with underground connections and the sealing of ducts to ensure a gas-free atmosphere within any separate building or room to which connections are made.

6.2.12 **Wall mounted PRIs**

It is permitted to install a small PRI as defined in Sub-Section 1.5 in a surface-mounted or semi-concealed box.

The above requirements apply in general for such boxes, except as amended below.

- 6.2.12.1 The design of the box shall be to a bespoke design that achieves:

- robust, secure construction using durable materials
- sufficient access for replacement and maintenance of installed equipment
- provision for sealing the box at the points where inlet, outlet and vent pipes pass through the box.

- 6.2.12.2 The siting of the box shall be such that:

- the edge of the box/housing is at least 0.18 m from any opening into the property and
- at least 0.33 m away from any electrical equipment and
- when installed, the outlet of the regulator relief vent is at least 1 m from any opening into the property and at least 1.55 m away from any electrical equipment.

- 6.2.12.3 Any rear knockout of the box shall be "intact" and a spigot shall not be fitted.

- 6.2.12.4 Any installed outlet pipework shall not enter the building directly from the back of the box or near the vent termination point.

- 6.2.12.5 There shall be no openings on the back of the box that would permit gas to track into the building.

- 6.2.12.6 A box shall not be built into the outer skin of an external wall.

6.3 **BELOW-GROUND HOUSINGS**

6.3.1 **General**

Any below-ground housing shall comply with the relevant requirements of Sub-Section 6.2 together with the following additional requirements.

Where an LPG PRI is to be located in the turret of a below-ground LPG vessel, the volume of the turret shall not exceed 0.5 m³ and the turret shall not be buried deeper than 0.5 m.

Note: Guidance is provided in UKLPG CoP 1 Part 4.

6.3.2 **Access and egress**

A safe means of access to, and egress from, shall be provided for any pit or vault.

Note: Further guidance can be obtained from the Confined Spaces Regulations and the associated ACoP and guidance, HSL101

6.3.3 **Construction**

The housing shall be designed to withstand foreseeable superimposed loads and forces exerted by ground water.

Any constructional material subject to corrosion shall be protected fully prior to in-ground installation.

The housing shall be watertight as far as is practicable.

6.3.4 **Cover**

6.3.4.1 Any cover shall be designed to withstand foreseeable imposed loads. If a cover is not designed to withstand traffic, it shall be protected from intrusion by vehicles by adequate and permanent barriers. LPG vessels shall not be positioned under any roadway or drive and where necessary, the turret shall be protected from intrusion by vehicles by adequate and permanent barriers.

6.3.4.2 It should be possible to remove the whole or part, as required, of any cover during maintenance work. The cover (or section of cover) should be designed such that no more than two people are required to remove it (one person is preferred), otherwise a mechanical means of removing the cover should be provided.

6.3.4.3 The arrangements for raising and lowering any cover shall be such as to protect the installed equipment from damage due to a handling error.

6.3.4.4 Any handle, whether fixed or removable, should be positioned for ease of access and operation and be located so that personnel moving any cover will not be in danger of walking into pits or equipment under the cover.

Note: Where the design adopts a removable handle, provision may be made in the cover design so that removable handles can be stored inside a lockable compartment attached or adjacent to the cover.

6.3.4.5 Any cover should be durable, fire resistant and weather resistant and should require the minimum of maintenance.

6.3.4.6 The profile of the top of any cover should be such that surface water is directed away from the pit. Where more than one cover is required to cover a pit, provision for surface water collection, and subsequent dispersion, should be incorporated into the design.

- 6.3.4.7 Where the design requires the provision of strengthening or support bars spanning across a pit, they should be removable to allow full access for maintenance of gas equipment.
- 6.3.4.8 Any lift-off pit cover should be secured by means of a hasp and staple to accept a security lock with a staple diameter of 12 mm. Alternatively, a suitable locking mechanism may be incorporated into the design.

6.3.4.9 Locks shall be provided on two opposite sides.

6.3.5 Ventilation

6.3.5.1 It is not necessary to provide ventilation for housings with an internal free volume of 0.5 m³ or less. In such cases, the cover of the housing shall not be airtight but shall prevent the ingress of water. Removable means of reducing the free volume shall not be used.

6.3.5.2 The requirements for minimum levels of ventilation for PRIs carrying a lighter-than-air gas are given in clauses 6.3.5.3 and 6.3.5.4 below. However, the inclusion of electrical equipment, either permanently or temporarily, has implications with respect to hazardous area classification. Where such equipment is to be present, a hazardous area classification shall be carried out in accordance with Sub-Section 10.1.2.

Note 1: The internal free volume of an LPG turret is limited to 0.5 m³ (see clause 6.3.1).

Note 2: The hazardous area classification may influence the design and level of the ventilation provided and the required inspection frequency.

Note 3: UKPLG CoP 1 Part 4 classifies the LPG turret as Zone 1.

Note 4: Further information on the hazardous area classification of LPG installations may be given in EI IP-MCSP-P15.

Where there is no option, an LPG regulator limited relief valve may vent into the turret when the rate of discharge shall not exceed 0.3 m³ per hour and the turret shall be above nominal ground level.

Note: UKPLG CoP 1 Part 4 requires a minimum 3 m distance from a turret to a building, boundary or fixed source of ignition. This distance can be reduced to 1.5 m if a gas dispersion wall is used.

If a decision is taken to provide additional ventilation, the ventilation requirements shall be checked to ensure they attain or exceed the levels given below and be in accordance with the following requirements.

6.3.5.3 The ventilation system should consist of a minimum of 2 ducts starting at both high and low levels in the housing (see Figure 7). The low level duct should terminate at least 3 m above ground level and the high level duct should terminate at least 1 m above the low level duct. The combined free area of the ventilation apertures, as a percentage of the floor area of the housing, shall be as shown in Table 3, where the free area can be less if vent lines are installed on all equipment.

MOP _u ≤ 7 bar		MOP _u > 7 bar	
VENTILATION AS A PERCENTAGE OF FLOOR AREA			
with vent lines	without vent lines	with vent lines	without vent lines
1.5%	2%	2%	3%

Note: Sub-Section 7.8 provides requirements for the installation of vent lines.

TABLE 3 - MINIMUM FREE AREA FOR VENTILATION APERTURES FOR BELOW-GROUND HOUSINGS (> 0.5 m³ volume)

6.3.5.4 The termination of ventilation ducts shall be resistant to obstruction.

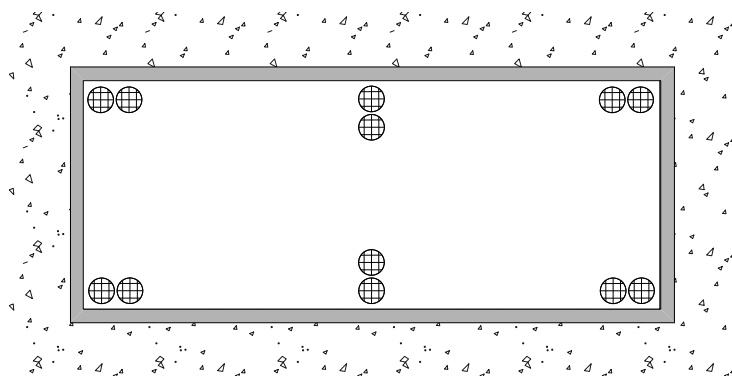


**FIGURE 7(a) - Typical arrangement of vent stacks (plan view).
Total number will depend on pit floor area**

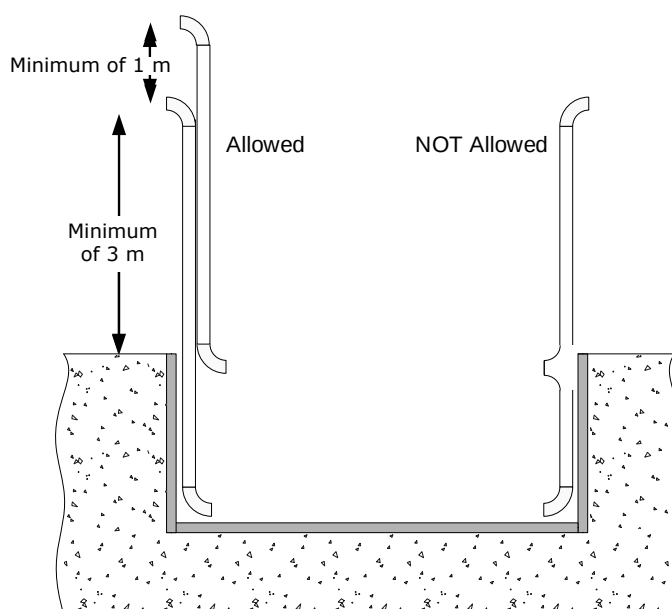


FIGURE 7(b) - Permitted and not permitted combinations of vent ducts

FIGURE 7 - TERMINATION OF VENTILATION DUCTS FROM A PIT

6.3.6 Dimensions

- 6.3.6.1 Any volume that, potentially, could be occupied by an air/gas mixture shall be kept to the minimum possible, consistent with reasonable access by operatives.
- 6.3.6.2 Wherever possible, the depth of a housing shall be such that operatives undertaking maintenance work can have their head and shoulders above the level of the surrounding ground.

6.3.7 Through-wall sealing

Any pipe or conduit passing through a wall of a housing shall be sleeved and the annulus sealed to maintain a gas-tight and watertight seal.

6.3.8 Drainage/pumping/breather lines

- 6.3.8.1 Special consideration shall be given to avoid locations that are subject to flooding, for example in areas with a high water table.

6.3.8.2 A sump shall be constructed in the base of the pit or vault. The sump shall be drained adequately.

6.3.8.3 There shall not be a connection via an open duct or pipe between a housing and a drain or other enclosed space.

6.3.8.4 If adequate drainage cannot be provided, a pumping pit for the removal of water shall be provided and/or breather and vent lines shall be installed on the regulators and be routed to a high level.

6.3.9 **Ground water**

6.3.9.1 Locations shall be chosen free of surface water or flooding. High water tables should be avoided.

6.3.9.2 For a non-roadway installation, consideration shall be given to slightly raising the housing to prevent ingress of water.

6.3.9.3 For a LPG turret, the installation shall be semi-moulded if the turret is 500 mm or more above the nominal ground level.

If required, drainage shall be constructed from the base of the turret to provide adequate drainage. However, if adequate drainage cannot be provided, the PRI shall be installed above ground and in a suitable enclosure.

6.3.10 **Explosion relief**

The requirements for the provision of explosion relief as given in clause 6.2.10 do not have to be applied but shall be considered.

6.4 **VESSEL-TYPE HOUSINGS**

Any vessel-type housing shall comply with the relevant requirements of clause 6.3.5 together with the following additional requirements.

Where a vessel-type housing is classified as a pressure vessel, it shall comply with PD 5500 or BS EN 13445.

6.4.1 **Installation and external loading**

6.4.1.1 The housing shall be installed on a suitably-prepared footing giving a similar amount of support as given to the pipework.

6.4.1.2 The cover for the housing shall comply with the relevant requirements of Sub-Section 6.3.4.

6.4.1.3 If the housing is installed in a roadway or other location where high surface loading may occur, the outer cover shall be supported independently to prevent surface loading being transmitted down to the pipework or housing.

6.4.1.4 The vessel shall have a closure constructed such that it can be operated safely.

6.4.2 **Corrosion protection**

6.2.2.1 Any housing subject to corrosion shall be suitably protected.

6.4.2.2 Consideration shall be given to anti-corrosion coating and to reinforcement by additional protection, for example by wrapping, prior to installing the vessel in the ground.

6.4.3 **Vent stacks**

The vessel shall include a vent stack to contain vent lines and breather lines.

6.4.4 **Ground water**

6.4.4.1 Locations should be chosen free of surface water or flooding. High water tables should be avoided.

6.4.4.2 For a non-roadway PRI, consideration shall be given to slightly raising the housing to prevent ingress of water.

6.4.4.3 For a fully buried housing, the housing shall be watertight as far as is practicable.

Copyright Institution of Gas Engineers & Managers
Provided by IHS Markit under license with IGHM
No reproduction or networking permitted without license from IHS

SECTION 7 : DESIGN OF A PRI

7.1 GENERAL PRINCIPLES

- 7.1.1 The design pressure of the upstream part of any PRI (DP_{upri}) shall be greater than or equal to the maximum operating pressure of the upstream system (MOP_u).

The design pressure of the downstream part of the PRI (DP_{dpri}) shall be greater than or equal to the maximum operating pressure of the downstream system (MOP_d).

- 7.1.2 A PRI shall be designed:

- as part of a system which may comprise other installations and connected pipelines

Note: A system may include compression or other means of inducing flow, monitoring and controlling, as well as communications systems.

- taking into account its complete life-cycle through concept design, detail design, material and equipment procurement, fabrication, installation, testing, commissioning, operation, maintenance, modification and final de-commissioning
- specifying fabrication methods for construction together with any heat treatment, non-destructive testing (NDT), non-destructive examination (NDE) and inspection; the methods and procedures being in accordance with appropriate standards
- so that it does not, at any time, present an unacceptable risk to any person nor adversely affect the environment. Any hazard associated with a PRI shall be identified, risks evaluated and measures taken to reduce risk to as low as reasonably practicable (see IGE/SR/24)
- to allow piping systems, plant and equipment to be isolated safely, inspected, maintained and tested (see HSG253)
- with sufficient safety systems to protect the downstream system(s) in the event of failure of the pressure regulating system (see Sub-Section 8.5)
- with sufficient isolation valves and valved purge and vent points to enable de-pressurisation, testing and maintenance
- so that all plant and equipment is capable of withstanding the most severe conditions of coincident pressure, temperature, chemical action and mechanical loading that may occur during normal operation and reasonably-foreseeable adverse conditions, for example the elevated temperature immediately downstream of a compressor station
- to achieve the required level of reliability, taking into account the requirements for the safe operation of the system, continuity of supply, plant and equipment failure characteristics and redundancy, for example by the inclusion of multiple streams, etc.
- to minimise the effect on the environment of gas venting through the operation of control devices, etc.
- taking into account the guidance in IGE/SR/25 in order to achieve the least onerous hazardous area classification for the installation
- for $MOP \leq 7$ bar, pre-fabricated PRI modules shall conform to GIS/E34.

- 7.1.3 Due account shall be taken of:

- range of flow rate required
- range of design temperature
- range of inlet and outlet pressures related to flow rate

- special characteristics of the load, for example when the PRI is to supply an industrial or commercial consumer
- cleanliness of the gas in respect of both solid particle and liquid entrainment
- odourisation and other treatment

Note: Gas detection equipment may be required for sites with unodorised gas.

- any need for protection against reverse flow
- any need for pre-heating prior to pressure reduction
- any need for metering
- any need for noise control
- any requirements for telemetered information and remote control
- the need for maintenance, especially to;
 - enable safe and easy access to operating components
 - permit safe and simple operation by maintenance staff
 - allow for safe and easy dismantling and reassembly of all or part of the operating components.
- any requirement for periodic inspections.

7.1.4 Where a PRI is constructed in modular form and fabricated off-site, an appropriate lifting facility should be provided by the manufacturer. The total weight shall be marked clearly.

7.1.5 For MOP > 2 bar, all main metallic pipework upstream of any stream inlet isolation valve shall not be of the screwed type, nor contain compression fittings.

7.2 PIPEWORK SIZING

7.2.1 Pipework should be sized such that the gas velocity will not exceed 20 m s^{-1} for unfiltered gas and 40 m s^{-1} for filtered gas in the outlet header of the PRI under conditions of maximum flow and lowest operational pressure.

7.2.2 Installation outlet headers should be designed to have a cross-sectional area of at least 1.5 times the sum of the cross-sectional areas of all working streams to the header, to ensure that impulse points for regulator control systems are representative of the pressure in the downstream network. Pipework between the outlet header and the PRI outlet valve should be at least the same diameter as the header pipework.

7.2.3 Where a PRI serves a network of $\text{MOP} \leq 75 \text{ mbar}$, the pipework between the outlet header and the PRI outlet valve should be designed for a pressure loss of not exceeding 1.25 mbar.

Note: Diameter changes may influence the performance of the system in respect of noise, turbulence and vibration. A change in diameter can be achieved by the use of forged fittings or taper pieces to provide a smooth transition. On the downstream side of a regulator, it is recommended that consideration be given to the use of taper pieces with an included angle not exceeding 15° .

7.3 DESIGN PRESSURE BOUNDARIES

7.3.1 Design pressure (DP) of components and pipework should be compatible with their location in relation to pressure boundaries.

7.3.2 For regulator streams, the design pressure boundary shall be at the outlet connection of the regulator stream outlet isolation valve.