INSTITUTION OF GAS ENGINEERS AND MANAGERS IGEM/TSP/24/215

Founded 1863
Royal Charter 1929

IGEM/GM/8 Part 1 Edition 3
Communication XXXX

Meter installations of flow exceeding 6 m^3 per hour

Part 1: Design

DRAFT FOR COMMENT

1 This draft Standard IGEM/GM/8 Part 1 Edition 3 has been prepared by a Panel under the chair, David Harper.

2 This Draft for comment is presented to Industry for comments which are required by 29th November 2024, and in accordance with the attached Reply Form.

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

It should be noted that this draft Standard contains intellectual property belonging to IGEM. Unauthorised copying or use by any unauthorised person or party is not permitted.

Peter Hurst

IGEM

IGEM House

26-28 High Street

Kegworth

Derbyshire, DE74 2DA

Tel: 01509 678150

Email: peter@igem.org.uk

Attached is the Draft for Comment of IGEM/GM/8 Edition 3 – "Meter installations of flow exceeding 6 m3 per hour" and the associated comment form.

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

Organisations to which this Draft has been circulated:

Organisation	Representative
AMO	ERIC FOWLER
BPEC	MALLY BUTTERS
BRITISH GAS	BRETT JOHNSON
CADENT	HILARY BUXTON
CMAP	JOHN HEYBURN
DNO COLLAB FORUM	HILARY BUXTON
EI	MARK SCANLON
ENA	JAMES EARL
EUA	STEVE SUTTON
EUSKILLS	RICHARD HARPER
GSR	JONATHAN PALMER
GISG	BOB MURRY
HHIC	STEVEN SUTTON
HSENI	SEAN KEOGH
*Large Business Forum	TREVOR SMALLPEICE
LLOYDS REGISTER	LES THOMAS
RETAIL ENERGY CODE (REC)	ERIC FOWLER
NGN	IAIN FOSTER
OFGEM	VIC TUFFEN
SGN	DOMINIC CUMMINGS
WALES & WEST	GRANT ROGERS
YPN	HARRIET GUIRY.

Institution of Gas Engineers & Managers

IGEM/GM/8 Part 1 Edition 3
Communication XXXX

Meter installations of flow exceeding 6 m³ per hour

Part 1: Design

DRAFT FOR COMMENT

Founded 1863
Royal Charter 1929
Patron: His Majesty the King

STANDARDS

IGEM Institution of Gas Engineers & Managers

IGEM/GM/8 Part 1 Edition 3
Communication XXXX

Meter installations of flow exceeding 6 m^3 per hour

Part 1: Design

DRAFT FOR COMMENT

Price Code: C7S

IGEM House
26-28 High Street
Kegworth
Derbyshire, DE74 2DA
Tel: 01509 678150
Email: technical@igem.org.uk

ASSIDUE EXQUIRENDO SERVIRE

ISBN 978 1 905903 XX X
Published by the Institution of Gas Engineers and Managers

Previous Publications:
Communication 1706 (2005) – 1st Edition
Communication 1795 (2016) – 2nd Edition

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

CONTENTS

APPENDIX

FIGURE

TABLE

SECTION 1 : INTRODUCTION

1.1 This Standard supersedes IGEM/GM/8 Part 1 Edition 2, Communication 1795, which is obsolete.

1.2 This Standard has been drafted by an Institution of Gas Engineers and Managers (IGEM) Panel, appointed by IGEM's Gas Measurement Committee, subsequently approved by that Committee and has been approved by IGEM's Technical Co-ordinating Committee on behalf of the Council of IGEM.

1.3 IGEM/GM/8 is published in 5 parts:

- Part 1 covering design
- Part 2 covering locations, housings and compounds
- Part 3 covering installation and commissioning
- Part 4 covering operation and maintenance
- Part 5 covering notices and labels.

1.4 This Standard covers the design of gas supply meter installations (see Sub-Section 2.1) of capacity greater than 6 $m^3 h^{-1}$ and maximum operating pressure (upstream) (MOP_u) not exceeding 38 bar.

With the exception of the few installations of MOP_u exceeding 38 bar, the majority of industrial and commercial meter installations can be designed by following IGEM/GM/6 (for MOP_u not exceeding 75 mbar only) and/or IGEM/GM/8.

It is the intention that IGEM/GM/6 be used for the largest proportion of installations that can be covered by "standard designs" for MOP_u not exceeding 75 mbar.

For 75 mbar < MOP_u ≤ 38 bar or where an installation is not a "standard design" as specified in IGEM/GM/6, IGEM/GM/8 applies (see also Note 4 to Sub-Section 2.1).

For a turbine meter installation of MOP_u not exceeding 75 mbar, there are no recognised standard designs i.e., IGEM/GM/6 does not apply. It is recommended that IGEM/GM/8 be used for all such installations.

For any meter installation of MOP_u exceeding 38 bar, IGEM/GM/4 applies.

1.5 This Standard applies to new, onshore, gas supply meter installations only. It is not retrospective. However, where work needs to be undertaken on a meter installation, it is recommended that such an installation be brought into line with this Standard. In particular, any unregulated by-pass needs to be removed or a regulator installed in the by-pass.

When re-engineering or replacing legacy meter installations, consideration is to be given to bringing them in line with the standard arrangements within IGEM/G/1. Unless all involved parties are in agreement to continue the legacy arrangement, it is expected that if reasonably practicable such existing systems will be modified to meet the recommended approach.

Irrespective of whether an emergency control valve (ECV) is fitted to the inlet of the meter installation, it is recommended that modification work be undertaken in line with this Standard.

Ownership and responsibility for new installations covered by this Standard has been liberalised from gas transporters (GTs) to Meter Asset Providers (MAPs) who are the title owner of the assets, and Meter Asset Managers (MAMs), responsible for management. The regulation authority, the Office of Gas and Electricity Markets (Ofgem) require that asset managers and installers are separately accredited for the work they carry out. Accredited MAMs have operational and management responsibly while Accredited Meter Installers (AMI) carry out meter work, installation, modification, repair, maintenance and removal activities, both work to the Retail Energy Code Consolidated Metering Code of Practice (REC CoMCoP):

Licence conditions make gas suppliers responsible for coordinating the provision of metering services and have placed responsibilities on GTs to underpin the overall safety of the gas supply system from the distribution main to the inlet to the consumer's appliances.

Note: Under these arrangements, a REC MAM does not have to be an AMI, but has an obligation to use an AMI to carry out work on a meter installation or have the work inspected by an AMI within 20 days of the work.

Notwithstanding Sub-Section 1.11 and Section 2, total compliance with IGEM/GM/8 is necessary for installations and modules where the meter installation has to comply with the CoMCoP.

1.6 This Standard does not detail the management processes required for compliance with the Pressure Systems Safety Regulations (PSSR); such guidance is provided by IGEM/GL/5. It is intended that work carried out in accordance with this Standard and IGEM/GL/5 will conform to the requirements of PSSR.

1.7 Terms such as "maximum operating pressure" (MOP), "maximum incidental pressure" (MIP) and "operating pressure" (OP) are used to reflect gas pressure terminology used in European standards. These terms are used in all relevant IGEM standards and, possibly, in other standards. Other terms have been introduced to assist in recognition of design information to be transferred between interested parties.

Note: Appendix 11 shows an explanation of the terms used by setting out the definitions of the terms, explaining the suffixes, the relationship between the terms, and their significance. It is strongly recommended that Appendix 11 be read immediately.

1.8 This Standard makes use of the terms "must", "shall" and "should" when prescribing particular requirements. Notwithstanding Sub-Section 1.11:

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

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

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

- have done everything to ensure, so far as it is reasonably practicable, that "responsible engineers" have the skills, training, experience and personal qualities necessary for the proper exercise of professional judgement

- have systems and procedures in place to ensure that the exercise of professional judgement by "responsible engineers" is subject to appropriate monitoring and review
- not require "responsible engineers" to undertake tasks which would necessitate the exercise of professional judgement that is not within their competence. There should be written procedures defining the extent to which "responsible engineers" can exercise their professional judgement. When "responsible engineers" are asked to undertake tasks which deviate from this, they are to refer the matter for higher review.

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

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

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

1.12 Requests for interpretation of this Standard in relation to matters within their scope, but not precisely covered by the current text, need to be addressed in writing to:

- Technical Services, The Institution of Gas Engineers and Managers, IGEM House, High Street, Kegworth, Derbyshire DE74 2DA, or
- emailed to technical@igem.org.uk,

and will be submitted to the relevant Committee for consideration and advice, but in the context that the final responsibility is that of the engineer concerned. If any advice is given by or on behalf of IGEM, this does not relieve the responsible engineer of any of their obligations.

1.13 This Standard was published in xxxxxx 20xx.

SECTION 2 : SCOPE

2.1 This Standard applies to all new, onshore, Natural Gas (NG) supply meter installations (hereafter referred to as "installations") (and defined in IGEM/G/1) of flow rate (capacity) exceeding 6 $m^3 h^{-1}$ and MOP upstream (MOP_u) not exceeding 38 bar.

Installations with the following types of meter are covered:

- diaphragm
- rotary displacement (RD)
- turbine
- ultrasonic (USM)
- thermal mass.

Note 1: *For installations of capacity not exceeding 6 $m^3 h^{-1}$, intended to carry NG, BS 6400-1 or BS 6400-2 apply, as appropriate for MOP_u. For non-domestic premises, there are additional legal requirements that may have to be met, e.g., DSEAR.*

The requirements of this document may be applied to installations of capacity not exceeding 6 $m^3 h^{-1}$ and MOP_u exceeding 2 bar.

Note 2: *For installations of MOP_u exceeding 38 bar, IGE/GM/4 applies and IGEM/TD/13 may be used for the regulation of pressure, however, where the metering pressure is not exceeding 38 bar, this Standard applies. Where IGEM/TD/13 is used, the control and fault pressure ranges have to be acceptable to the consumer; it may be necessary to apply tolerances required by IGEM/GM/8 to IGEM/TD/13 control philosophy.*

Note 3: *Primarily, IGEM/GM/8 has been produced for primary meters and other meters used for billing purposes. However, its principles may be applied for other meters, for example appliance check meters or departmental charging meters, when certain procedures may not apply.*

Note 4: *IGEM/GM/6 provides requirements for "standard designs" of meter installations of MOP_u not exceeding 75 mbar. For other, "non-standard designs" of meter installations of MOP_u not exceeding 75 mbar, IGEM/GM/8 applies. See also the note within Sub-Section 1.4.*

Note 5: *For turbine meters and USMs, in addition to IGEM/GM/8, some of the principles of IGEM/GM/4 may apply and further useful information is also included.*

Note 6: *IGEM/GM/8 does not address the Network pipeline (see IGEM/TD/1, IGEM/TD/3, IGEM/TD/4 and IGEM/G/5, as appropriate). IGEM/GM/8 does not address requirements for a pressure regulating installation (PRI) installed in a Network pipeline that is not part of the meter installation, when IGEM/TD/13 applies.*

2.2 This Standard is primarily written to cover installations that are wholly downstream of the outlet of the ECV as recommended in IGEM/G/1 "Standard Arrangements", in which case the installation is not part of the Network. The owner or user of the installation would not, therefore, be a conveyor of gas on the Network and would not be subject to the general duties of the Gas Safety (Management) Regulations (GS(M)R). Similarly, the owner or user of the installation would not be an operator of a pipeline and, therefore, would not be subject to the requirements of the Pipelines Safety Regulations (PSR). However, the installation may be subject to the requirements of PSSR.

The latest edition of IGEM/G/1 permits new meter installations to be installed upstream of the ECV, particularly where the downstream consumer's system has been defined as being a Network under GS(M)R. Also in some situations, where all parties agree, a legacy meter installation as defined in IGEM/G/1 may be replaced with a configuration that does not conform to the "standard arrangements" given in IGEM/G/1.

IGEM/GM/8 may be applied when installing such new or replacement meter installations that do not have an ECV located on their inlet, but have a valve within the meter installation, or the consumer's system nominated as the ECV. In such installations, the section of the installation upstream of the ECV is defined as being "Network Pipework" and will be subject to the requirements of GS(M)R which will have to be complied with in addition to IGEM/GM/8.

Note 1: The responsibilities for the different sections of the system need to be clearly understood, in particular the upstream Network (GT) responsibility will stop at the inlet to the meter installation as defined in IGEM/GM/1.

Note 2: Any part of the meter installation which is subject to the requirements of GS(M)R will have to be operated by an organisation holding a "Public Gas Transporters" licence (or that physically convey gas through pipes but are exempt from the need to hold a PGT licence) and will have to be operated under a suitable safety case, which will need to be agreed with the HSE.

2.3 This Standard applies to installations intended to carry NG (a 2nd family gas as defined by BS EN 437).

Note: The Gas Safety (Installation and Use) Regulations (GS(I&U)R) define "gas" to include 1st, 2nd and 3rd family gases as well as other gases. The principles of IGEM/GM/8 may be used for gases other than NG but suitable adjustments to parameters and procedures will need to be considered by a competent person.

2.4 This Part 1 of IGEM/GM/8 deals with the design of relevant installations.

2.5 All pressures are gauge pressures unless otherwise stated.

2.6 Italicised text is informative and does not represent formal requirements.

2.7 Appendices are informative and do not represent formal requirements unless specifically referenced in the main sections via the prescriptive terms "must", "shall" or "should".

SECTION 3 : LEGAL AND ALLIED CONSIDERATIONS

3.1 GENERAL

3.1.1 This Standard is set out against a background of legislation in force in GB at the time of publication. The devolution of power to the Scottish, Welsh and Northern Ireland Assemblies means that there may be variations to the legislation described below for each of them and consideration of their particular requirements must be made. Similar considerations are likely to apply in other countries, where reference to appropriate national legislation is necessary.

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

Note: Appendix 2 is relevant in this respect.

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

3.1.2 Persons who design meter installations must have a knowledge and understanding of the standards and regulations that apply to ensure that the completed plans will produce a safe and satisfactory installation.

Persons who install or maintain meter installations must be competent to do so and compliance with Gas Safety (Installation & Use) Regulations (GS(I&U)R) must be achieved where those Regulations apply (see IGEM/GM/8 Parts 3 and 4, respectively).

At the time of publication, the body with HSE approval to operate and maintain a register of businesses who are "members of a class of persons" is Gas Safe Register. Therefore, all businesses or self-employed gas fitters working on meter installations must be registered with Gas Safe Register where GS(I&U)R apply.

Persons deemed competent to carry out gas work are those who hold a current certificate of competence in the type of activity to be conducted issued by a certification body accredited by the United Kingdom Accreditation Service (UKAS), to issue certificates of competence under the Nationally Accredited Certification Scheme for Individual Gas Fitting Operatives (ACS).

3.1.3 Any meter installation used by a gas supplier for the purpose of billing shall be designed, installed, commissioned and maintained in accordance with the CoMCoP.

3.1.5 Some GTs operate an approval scheme under their Safety Case arrangements as a prerequisite for authorising an AMI to set any meter regulator or to break a regulator seal. Therefore, an AMI must seek advice from the relevant GT before carrying out such procedures.

3.2 BUILDING REGULATIONS

3.2.1 England and Wales (As Amended)

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

The Approved Documents that apply to gas work are:

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

3.2.2 Building Standards (Scotland) Regulations and Amendments

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

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

3.3 CONFINED SPACES REGULATIONS

These Regulations apply to a whole range of confined spaces. The supplier or designer of an enclosure and equipment within it is required to perform a risk assessment of the enclosure with respect to safe access and egress and to give clear instructions to operators on access/egress as well as to what actions to take in the event of a gas alarm occurring. Employers and the self employed are required to prevent entry into confined spaces unless avoidance is not reasonably practicable and unless there is a system of work which renders the work safe. They are also required to have specific emergency arrangements in place.

3.4 CONSTRUCTION (DESIGN AND MANAGEMENT) REGULATIONS (CDM)

These Regulations impose duties on designers, clients (and their agents), developers, principal designer and principal contractors.

Further information is given in L153, which sets out the principles duty holders are required to use in their approach to identifying the measures they need to take to control the risks to health and safety in a particular project.

The general principles of prevention are to:

- avoid risks where possible
- evaluate those risks that cannot be avoided, and
- put in place proportionate measures that control them at source.

Construction includes the alterations, repair, re-decoration, maintenance, de-commissioning or demolition of a structure. It also covers installation, commissioning, maintenance or removal of gas services.

3.5 CONTROL OF ASBESTOS REGULATIONS

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

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

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

3.5.4 Further information is available in HSG227. Other HSE documents associated with these Regulations are L143 and INDG 223.

3.6 CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH REGULATIONS (COSHH)

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

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

3.7 DANGEROUS SUBSTANCES AND EXPLOSIVE ATMOSPHERES REGULATIONS (DSEAR)

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

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

- L138
- INDG 370.

3.8 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.

3.9 GAS (CALCULATION OF THERMAL ENERGY) REGULATIONS

3.9.1 These Regulations provide for the calculation of thermal energy of gas conveyed by GTs to premises, or to pipelines operated by other GTs, on the basis of the calorific values and volumes of gas conveyed. The calorific values of the gas may be either determined by, or declared by, the GT in accordance with the regulations. The metered gas volumes may be adjusted for the temperature, pressure and compressibility factor of the gas.

3.9.2 Information on converting the actual volume measured into the volume at standard conditions, the methods of determining daily calorific values, and the calculation of thermal energy, is given in Appendix 12.

3.9.3 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 HSE and gives useful information on the Regulations. Further advice is contained in HSR25.

3.10 GAS (METERS) REGULATIONS

3.10.1 Legislation

3.10.1.1 In GB, The Gas Act 1986, as amended, requires that certain gas meters (within the scope of IGEM/GM/8) used for measuring the quantity of gas supplied be stamped.

3.10.1.2 The Gas Act 1986, as amended, defines that a meter exceeding a capacity of 1600 cubic metres per hour (cm^3 h^{-1}), at standard conditions, need not be stamped.

3.10.1.3 There are three different regulations covering the approval of gas meters in Great Britain which sit under the Gas Act 1986, as amended. These are:

a) New meters approved prior to the 30 October 2006

   i. The Gas (Meters) Regulations 1983, SI 1983/684, as amended
   ii. The Measuring Instruments (EEC Requirements) Regulations, as amended, SI 1988/296 – for meters applicable to European requirements.

b) New meters approved post 30th October 2006

   i. The Measuring Instruments (Gas Meters) Regulations 2006, SI 2006/2647.

3.10.1.4 The requirements in the Measuring Instruments (Gas Meters) Regulations is subtly different from that of the Gas Act as these regulations have effectively amended the Act, in that the 1600 m^3 h^{-1} limit is applied to the quantity of gas supplied (when measured at standard conditions) to the consumer and is not related to the meter's design capabilities.

3.10.2 Measuring Instruments Directive (MID) meter designs

Under the Measuring Instruments (Gas Meters) Regulations all new meter designs (and any subsequent production of that type) are required to undertake a conformity assessment by a notified body, designated by an EU Member state, to ensure that they meet the essential requirements of MID. All meters conforming to MID have to bear the "CE" markings and the "M" marking followed by the year of manufacture (for example a meter manufactured in 2013 would have the following MID marking M13) and a four-digit code representing the Notified Body that undertook the conformity assessment. The manufacturer will be issued with a certificate from the assessing notified body proving that the meter design meets the requirements of the conformity assessment. A copy of this may be provided by the manufacturer on request.

Where a gas meter is placed on the market and put into use in accordance with the Measuring Instruments (Gas Meters) Regulations, and bears the appropriate markings, it is then deemed to be stamped and therefore compliant with The Gas Act.

3.10.3 **Pre-MID meter designs**

New meter designs cannot now be submitted for type approval under pre-MID arrangements. However, MID does allow manufacturers to continue to stamp meters already approved under the pre-MID regulations without having to have them reassessed under the Measuring Instruments (Gas Meters) Regulations. This is permitted until 30th October 2016 whereupon all meters placed on the market will be required to conform to MID.

3.10.4 **Meters already in service**

A gas meter, once put into use, is permitted to stay in-service until its performance no longer meets the requirements of the regulations applicable to that meter when it first went into service (MID or pre-MID). There are no specific requirements for the in-service limits for meters under the Gas (Meters) Regulations; however the National Measurement and Regulation Office would expect such meters to meet their initial requirement. The Measuring Instruments (Gas Meters) Regulations do include specific limits.

Only meters that meet the in-service limits are deemed stamped and therefore comply with the Gas Act 1986, as amended.

3.10.5 **Disputed meters**

The Gas (Meters) Regulations deal with the re-examination of disputed meters whereas the Measuring Instruments (Gas Meters) Regulations amend those regulations to reflect the different in-service accuracy requirements of MID meters.

Requirements for those meters stamped under previous arrangements are maintained and are not modified by the MID accuracy requirements.

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

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

3.11.2 GS(I&U)R define the type of work that requires persons carrying out such work, or their employers, to be an “approved class of person”, i.e., Gas Safe registered.

3.11.3 GS(I&U)R requires all those undertaking gas work to be competent. L56 provides guidance as those allowed to undertaking gas work and the training that needs to be provided. The requirements for training in gas work are set out in IGEM/IG/1.

3.11.4 The installer is required to check the safety of any meter installation they install or work on and take appropriate action where they find faults. Where the premises are let or hired out, the landlord or hirer has special responsibilities to ensure that any installer they use for the gas fitting, service or maintenance or safety is a member of an approved class of persons (see clause 3.4.2) and is competent to carry out such work. If any serious fault is found, the installer is required to inform both the landlord/hirer, as well as the user, so that such faults can be rectified before further use.

3.12 GAS SAFETY (MANAGEMENT) REGULATIONS (GS(M)R)

3.12.1 GS(M)R place specific duties on GTs, or their emergency service providers (ESPs), for dealing with gas escapes from pipes on their network. Their primary duty is to make the situation safe. They are responsible not only for dealing with escapes from their own pipes, but also for dealing with escapes from gas fittings supplied with gas from pipes on their network. In GS(M)R, the term "gas escapes" includes escapes or emissions of carbon monoxide (CO) from gas fittings.

3.12.2 The ESP has specific duties to:

- provide a continuously staffed and free telephone service to enable persons to report gas escapes and
- pass such reports on to the person who has the responsibility for dealing with the escape.

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

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

3.12.4 Responsibility for investigating Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) reportable incidents (see Sub-Section 3.9) as a result of an escape of Carbon Monoxide (CO) from incomplete combustion of gas from a gas fitting, is placed on gas suppliers. HSE is required to be notified before such investigations commence.

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

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

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

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

In addition to specific duties under GS(I&U)R (see Sub-Section 3.4) MHSWR impose a duty on employers and the self-employed to make assessments of risks to the health and safety of employees, and non-employees affected by their work. They also require effective planning and review of protective measures.

3.15 PRESSURE EQUIPMENT (SAFETY) REGULATIONS (PE(S)R)

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

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

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

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

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

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

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

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

3.16 PRESSURE SYSTEMS SAFETY REGULATIONS (PSSR)

3.16.1 These Regulations 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).

3.16.2 PSSR apply to relevant fluids, for the purpose of this Standard, capturing installations containing NG at a pressure greater than 0.5 barg. Where captured, there are specific duties on the User of the pressure system (as defined in PSSR).

There are exceptions to some Regulations if the system does not contain a pressure vessel of greater than 250 bar litres. Filters, heat exchangers or silencers may be designed and built to pressure vessel standards and have a pressure multiplied by volume product greater than 250 bar litres. In such cases, there are no exemptions to the Regulations and additional duties apply. Refer to Figure 1

When the pressure in the pipework is reduced below 0.5 barg, and the User can show clear evidence that the system does not contain, and is not liable to contain, a relevant fluid under foreseeable operating conditions, then that part of the system is no longer covered by the Regulations. This may be the case after the isolation valve downstream of a pressure reducing valve which takes the pressure to below 0.5 barg.

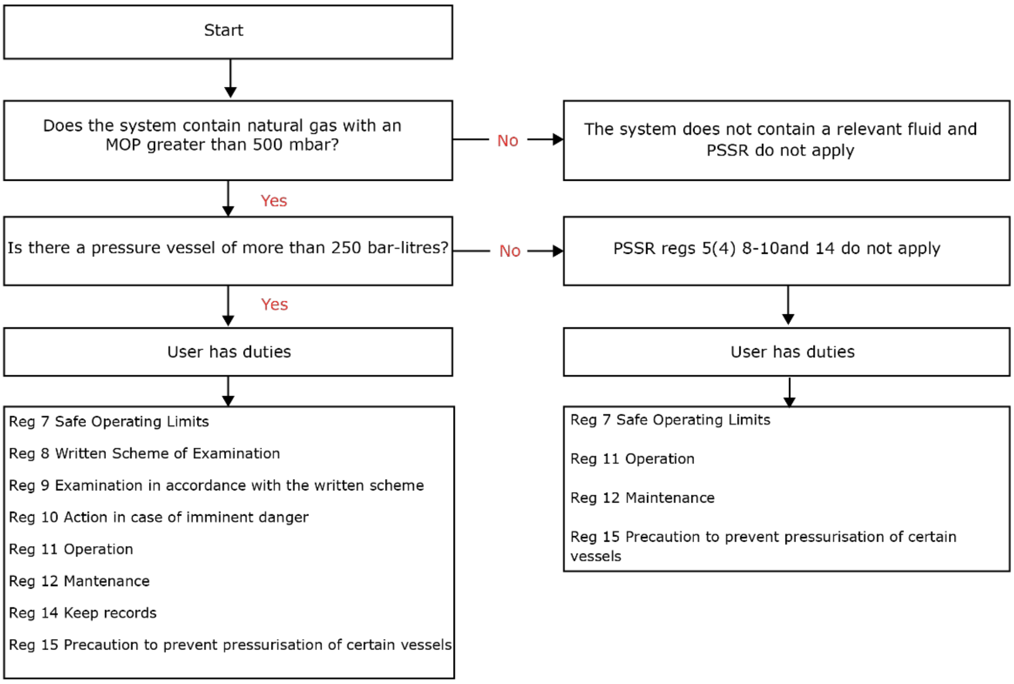


FIGURE 1 - APPLICATION OF PSSR RELATED TO THIS STANDARD DOWNSTREAM OF THE ECV

3.16.3 More information is available in L122 and some information is presented in INDG 261 and INDG 178.

3.17 PROVISION AND USE OF WORK EQUIPMENT REGULATIONS (PUWER)

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

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

3.17.3 More information on the Regulations can be found in L22. Free leaflets include INDG 291 and INDG 229.

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

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

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

- death, major injury, lost consciousness, or been taken to hospital for treatment to an injury arising out of the distribution, filling, import or supply of NG or Liquid Petroleum Gas (LPG) are to be reported by the conveyor for NG and the filler, importer or supplier for LPG

- dangerous gas fittings (as defined in RIDDOR) are required to be reported by a "member of a class of persons". Gas Safe registered engineers are to provide details of any gas appliances or fittings that they consider to be dangerous, to such an extent that people could die, lose consciousness or require hospital treatment. The danger could be due to the design, construction, installation, modification or servicing of that appliance or fitting, which could cause:
  - an accidental leakage of gas
  - incomplete combustion of gas or
  - inadequate removal of products of the combustion of gas.

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

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

  Complete the appropriate online report form listed below.
  - report of an injury
  - report of a dangerous occurrence
  - report of an injury offshore
  - report of a dangerous occurrence offshore
  - report of a case of disease
  - report of flammable gas incident
  - report of a dangerous gas fitting.

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

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

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

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

SECTION 4 : DESIGN OBJECTIVES AND PRINCIPLES

4.1 DESIGN OBJECTIVES

The primary objectives shall be to ensure, as far as possible:

- that pressure is managed, to deliver a suitable pressure to consumers' appliances
- continuous accurate measurement, including the reduction of both random and systematic metering errors where this can be justified economically

  Note: The overall accuracy of a meter installation will depend upon the type of meter installed, the method of any volume conversion being used and the configuration of the installation.
- reliability of operation, including the required level of security of the gas supply
- safety of persons and plant.

4.2 DESIGN PRINCIPLES (see also Appendix 11)

4.2.1 General

4.2.1.1 At the outset, the designer shall consider the requirement to conform with PSSR and, where relevant, should adopt a design management system such as IGEM/GL/5.

4.2.1.2 Any meter and its pressure regulating installation (PRI)/regulator should be designed not in isolation, but as a single unit. Both should be sized for the same load and consideration shall be given to the effect that each may have on the other.

4.2.1.3 The selected meter should be capable of matching the characteristics of the load with the required degree of accuracy. Consideration shall also be given to those future demand changes that can reasonably be foreseen.

An estimate concerning any anticipated growth of load over the following 12 months should be made and included in the overall calculations for meter selection. However, for larger loads, for example exceeding 160 $m^3 h^{-1}$, such allowance should not extend beyond 12 months unless there is certainty of the growth.

Note 1: Oversizing a meter for the initial load in anticipation of a significant later increase in load can adversely affect the meter accuracy until such additional load is taken.

Note 2: Where there is an anticipated additional future load beyond 12 months, it may be prudent to design the installation such that additional capacity can be accommodated at a later date without the need to renew the complete installation.

4.2.1.4 The PRI/regulator should, normally, be located upstream of the meter.

Note: In some cases, it may be economically sound and technically acceptable to locate the PRI/regulator downstream of the meter and, in other cases, to provide an unregulated supply (see clauses 7.6.7 and 7.6.8).

4.2.1.5 The standard of filtration provided shall give adequate protection for the PRI/regulator, the meter and any associated equipment.

4.2.2 Accuracy

4.2.2.1 The meter shall be selected to ensure that its error on the actual volume of gas used per annum does not fall outside:

- ± 3% for $Q_{imax} \leq 160\ m^3\ h^{-1}$
- ± 2% for $Q_{imax} > 160\ m^3\ h^{-1}$.

Note: This error will be affected by both the accuracy of the meter and the range of flows over which the meter will be within the manufacturer's specification.

4.2.2.2 Any volume conversion system shall comply with IGEM/GM/5, with particular respect to the accuracy of the converted volume.

Note: IGEM/GM/5 specifies an error on conversion of no greater than 1%.

4.2.2.3 Pipework and components within the installation shall be selected and designed so as to ensure the meter reading will not be influenced by greater than 0.3% of the actual reading.

4.2.2.4 The meter accuracy can be affected by certain types of loads. The effect of load on the meter accuracy should be limited to ± 1%.

It is the consumer's responsibility to protect the meter installation from excessive load changes, pulsations, etc. As such, the meter installer shall draw the attention of the consumer to any restrictions that need to be imposed on the downstream system in order to achieve this.

4.2.3 Pressure

4.2.3.1 The installation must be designed to maintain a suitable pressure at downstream appliances to ensure their safe operation under all foreseeable conditions.

Note 1: Information concerning the performance of a downstream system will have to be obtained from the consumer, identifying an acceptable range of outlet pressures (or make assumptions in the absence of firm information – see Sub-Section 5.4) and the installation will need to be designed to maintain its outlet pressure within this envelope.

Note 2: GS(M)R state "The gas shall be at a suitable pressure to ensure the safe operation of any appliance which a consumer could reasonably be expected to operate".

Note 3: Where the metering pressure is a nominal 21 mbar, both BS 6891 and IGEM/UP/2 specify a maximum pressure drop of 1 mbar across a gas consumer's pipework.

BS EN 1775 requires gas pipework to be sized such that the pressure at the inlet of all appliances is compatible with their safe and effective operation.

4.2.3.2 The installation shall be capable of withstanding any MIP to which it may be subjected (by either the upstream supply network or the consumer's downstream installation) without jeopardising the integrity of any connected gas fittings (see also IGEM/UP/2, IGEM/UP/3, IGEM/UP/6 and IGEM/UP/9).

Future uprating of the Network shall be taken into account when designing and specifying the meter installation and components. When a design maximum incidental pressure (DMIP) is specified by a GT, it shall be used in the design.

SECTION 5 : EXCHANGE OF INFORMATION

5.1 GENERAL

The effective design, installation, commissioning and operation of a meter installation are dependent upon all parties involved adequately exchanging appropriate information. The designer of any meter installation shall obtain the required information from the GT, Utility Infrastructure Provider (UIP), shipper, supplier and consumer, as necessary.

Note: The exchange of information will, in most cases, be a two-way exercise in order to arrive at a workable solution to which all parties agree.

5.2 INFORMATION CONCERNING THE NETWORK (see also Appendix 10)

5.2.1 In order to provide the required information, the GT will require key identification information to establish the correct supply meter point. The request should include, as a minimum, the following information to allow the GT to identify the pipeline/ECV to which the meter installer is planning to connect:

- meter installer contact details and address
- site contact, name and address, including post code/map reference
- whether the information is for an existing or new pipeline/ECV
- GT reference number, i.e.
  - the meter point reference number (MPRN) for an existing pipeline (where known) or
  - GT connection reference number for a planned but yet-to-be-installed pipeline.

Note 1: In particular, the latter two are important for any site that has more than one primary meter.

Note: 2: Applications to the GTs may be made using application forms to be found at the Energy Networks Association's (ENA's) website https://www.energynetworks.org/industry-hub/resource-library for the relevant document GDN/PM/GT1

5.2.2 Information pertaining to the Network shall be obtained. Such information should include:

- confirmation of a live gas pipeline (for an existing pipeline)
- Network design minimum pressure (= DmP_u)
- Network lowest operating pressure (= LOP_u)
- Network maximum operating pressure (= MOP_u)
- Network maximum incidental pressure (= MIP_u) or Network DMIP (= $DMIP_u$) whichever is provided
- Network design pressure (= DP_u)
- planned, actual or nominated energy value of the pipeline capacity
- size and design of the ECV and its outlet connection detail
- dimensions indicating the approximate position of the ECV
- any constraints that the GT has imposed on the pipeline, meter installation, or use of any meter installation housing.

Note 1: Often, much of the above information is standard across a GT's Network. Appendix 5 provides guidance on Gas Distribution Networks' standard Network operating conditions. The guidance may not apply for another GT.

Note 2: Most GTs will require information requests to be made in accordance with a set procedure. An example GDN/PM/GT1 form is included in Appendix 4.

If any information pertaining to the size, design, outlet connection detail, position of the ECV etc., on an existing pipeline, is not available from the GT, the designer of the meter installation shall establish the detail by other means, for example by visiting the site.

Where a meter installation exchange is planned and the ECV is not upstream of the whole meter installation, the MEM shall contact the GT prior to exchange, to advise the GT of the need to relocate the ECV (see clause 1.5).

Note: Such legacy installations are to be brought in line with the standard arrangements in IGEM/G/1, unless all parties involved agree to the continued use of such an arrangement, and provided the MEM can comply with all relevant legislation.

5.3 METER INSTALLATION DESIGNER CONSTRAINTS IMPOSED ON THE OPERATION OF GAS CONSUMERS' PLANT

5.3.1 In the case of a new gas supply to a premises, the consumer may have no idea of the requirements of his plant and equipment. In such circumstances, and in the absence of any other information being available, the meter installation designer has to assume that the installation will be supplying "standard appliances" (see clause 5.4.1). Where the meter installer has made assumptions about the connected load, size, operation, pressure requirements, lack of special features, etc., these assumptions shall be passed to the consumer in writing (via the contractual chain).

5.3.2 In addition to any assumptions made by the designer, the consumer shall be advised (via the contractual chain) of any restrictions that the designer of the installation has to impose on the operation of the consumer's plant in order to ensure the safe operation of the installation, and to enable it to accurately record the quantity of gas.

5.3.3 Depending on the pressure supplied to the consumer's system, the downstream pipework and equipment may be captured under PSSR. In such cases, the designer shall inform the consumer of this and cooperate with determining Safe Operating Limits (SOL) and formally identifying the demarcation between the meter installation and the installation pipework. Reference can be made to IGEM/G/1 for guidance.

5.3.4 Where relevant to the design of the consumer's system, the meter installation designer shall advise the consumer of the requirements of clause 13.7.3, and draw their attention to the need to comply with IGEM/UP/2 and IGEM/UP/6 as appropriate.

5.4 THE NATURE AND SIZE OF THE LOAD (see also Appendix 10)

5.4.1 Reliable information relating to the nature of the load and the anticipated flow rate (present and anticipated in the future) shall be obtained from the gas supplier or from the consumer (via the contractual chain) as appropriate, and should include:

- the estimated maximum flow rate (which is not necessarily a summation of the total connected load)
- the minimum flow rate anticipated (a realistic assessment and not a zero flow rate)
- the number and type of each unit of plant and, where available, the anticipated load pattern for each
- the best possible estimate concerning the anticipated growth of load over the next 12 months
- where necessary, peak flow likely to occur for a short period, infrequently, possibly in excess of Q_{max}

- establishment of the metering pressure to which the PRI/regulator(s) is/are required to control

  Note: Normally, this will be 21 mbar, unless it has been agreed between the supplier, shipper, GT and consumer to meter at an elevated pressure.

- strength test pressure (STP) (for the downstream system and all connected plant)
- DP_c if higher than MOP_c
- SOL_c
- MIP_c (to which the meter installation could be subjected by the gas consumer's plant and equipment)
- MOP_c (for which the downstream system has been designed to ensure that all connected plant will operate with an inlet pressure not exceeding P_{max})
- OP_c
- LOP_c (for which the downstream system has been designed to ensure that all connected plant will operate with an inlet pressure exceeding P_{min})
- DmP_c (for which the downstream system has been designed to ensure that all connected plant will operate safely and which may have to be obtained from other sources).

Note 1: For an existing downstream system, information on the plant/appliance type is essential as it cannot be assumed that downstream appliances comply with current standards.

Note 2: On an installation with a metering pressure of 21 mbar, the designer has to assume that "standard" appliances will be connected at some stage, unless the consumer specifically advises otherwise. It has been established that standard appliances have the following characteristics (see also Appendix 10):

STP = 50 mbar
P_{max} = 25 mbar
OP = 20 mbar
P_{min} = 17 mbar
P_{ign} = 14 mbar (70% OP).

Note 3: Where the metering pressure is a nominal 21 mbar, both BS 6891 and IGEM/UP/2 specify a maximum pressure drop of 1 mbar across a gas consumer's pipework.

Note 4: On the majority of lower pressure, simple systems, DP_c will not be known and can be assumed to be MOP_c.

5.4.2 Details of any special features of gas plant which may affect the nature of the load, for example fast-fluctuating loads, snap-acting control valves creating rapid on/off load conditions, engines, turbines, gas boosters and compressors, shall be obtained from appropriate sources.

Note 1: Such special features require specialist analysis to determine the significance of possible interactions with the meter installation. Appendices 3 and 7 are typical forms that provide guidance on the information required.

Note 2: The Gas Act allows a GT to insist on the fitting of an anti-fluctuator, to avoid excessive pulsations being present in the Network and, hence, at the meter installation. The fitting and maintenance of such a device is the responsibility of the consumer.

5.4.3 An appropriate record shall be made of the information obtained.

Note: A typical form that may be used for collecting the information is shown in Appendix 3.

5.5 GAS CONSUMER-IMPOSED CONSTRAINTS AND SPECIAL REQUIREMENTS

5.5.1 Any constraints imposed by the consumer, which may affect safety, shall be determined.

Note: Examples include any hazardous area identified by the consumer that may affect the location of the meter installation, or restrict the range of equipment to be installed, or any restrictions on the venting of gas.

5.5.2 Any special requirements for a consumer-stated measurement uncertainty, for example to account for the UK Emissions Trading Scheme (see Appendix 11), shall be taken into account when planning the validation of the performance of the meter installation.

Note: Provision of this information will be the responsibility of the consumer but there may be requests for technical information regarding Maximum Permissible Error from the gas supplier.

5.6 PROVISION OF INFORMATION TO THE MEM/METER ASSET OWNER (see also Appendix 10)

Following design, the MEM/meter asset owner shall be advised by the designer/installer, of the following details of the meter installation:

- maximum capacity of the installation (Q_{imax})
- $DMIP_u$ for which the installation has been designed
- DP_u for which the installation has been designed
- MIP_u (where known)
- MOP_u
- LOP_u
- DmP_u
- STP for different sections of the meter installation
- SOL for different sections of the meter installation
- DP_c (where known by the consumer)
- MOP_c
- LOP_c
- DmP_c
- MIP_c (if applicable)
- SOL_c (if applicable)
- MIP to which the downstream system may be subject (= MIP_{mi})

  Note: For any installation not incorporating a safety device, the consumer needs to be advised that, in the event of a regulator failure, the installation may subject the downstream system to MOP_u which has to be considered by the consumer to equal MIP_{mi}.

- outlet temporary operating pressure (= TOP_{mi})
- outlet peak level operating pressure (peak level OP_{mi})
- meter installation outlet maximum operating pressure (= MOP_{mi})
- metering pressure used for any conversion factor (P_m) (normally the meter inlet pressure)
- outlet lowest operating pressure (= LOP_{mi})
- outlet design minimum pressure (= DmP_{mi})
- set points of all pressure regulators, safety devices and reliefs
- the extent and classification of any hazardous area

  Note: This information will also need to be made available to the consumer.

- any assumptions that have been made concerning the downstream load
- any restrictions that have been imposed on the operation of the downstream plant and equipment
- where a meter by-pass has been installed, the justification for the by-pass and a copy of the GT and gas supplier authorisations.

SECTION 6 : GT AUTHORISATIONS

6.1 METER INSTALLATIONS

6.1.1 Prior to, and to permit, connection of any meter installation to the Network, the responsible person shall submit a warrant in accordance with appropriate GT procedures and obtain written authorisation from the GT to break any seal, set and seal any meter regulator and any associated pressure control and protection device(s). This warrant shall specify the agreed pressure rating and pressure control performance envelope (that will ensure a suitable pressure is available at any appliance under all foreseeable conditions) for the installation and shall represent the installation as it is designed and installed.

Note 1: GTs may grant generic authorisation for meter installations within their Safety Case.

Note 2: The majority of GTs operate an authorisation scheme for unregulated installations (see GDN/PM/GT2 available through the Energy Networks Association (ENA)).

Note 3: Each appraisal (including generic appraisals) will, normally, be given a unique appraisal reference number, together with authorisation, where appropriate, for the meter installer (AMI) to break any regulator seal and set and adjust any meter regulator and any associated pressure protection device (see also Note 4 below).

Note 4: A typical GT appraisal procedure is based on the following principles:

- *the GT will make available, on request, the necessary information relating to any pipeline connected to its network (see Appendix 5 for the Gas Distribution Networks' (GDNs') standard conditions)*
- *any person installing a meter installation being competent for the category of work they are undertaking*
- *while the GT will carry out appraisals for any competent meter installer, the GT will only authorise AMIs to act on their behalf with respect to the breaking of a seal, the initial setting and any subsequent adjustment of a meter regulator or associated pressure protection devices*
- *the GT will require meter installers to give a warranty that any meter installation that they install, which will be connected to the Network, will meet specified criteria, which will ensure that a suitable pressure is available for the safe operation of any appliance supplied through that meter installation.*

Note 5: Prior to giving any authorisation, the GT probably will require the applicant to warrant that any meter installation to be installed under that application will meet the criteria set out in clause 6.1.2 and its Note. The basis of such a warrant would be the completion of an appropriate form.

6.1.2 Any installed meter installation shall meet all of the following criteria:

- the pressure control philosophy meets industry-accepted practice
- the construction of any meter regulator and any associated pressure control or protection device(s) is suitable for all pressures and flow rates to which they may be subjected
- the organisation warranting the performance of the installation is in possession of technical evidence to demonstrate that performance
- the gas is maintained at a suitable pressure to ensure the safe operation of any connected appliance
- any meter regulator will adequately lock up at zero flow and, in conjunction with any protection device, limit the downstream pressure to an acceptable level when gas is supplied at either MOP_u under normal conditions or MIP_u under fault conditions
- the meter and its installation meet the requirements of Schedule 2B of the Gas Act with respect to compliance with its Section 17 (see clause 12.1.2).

Note: Any authorisation by a GT will be subject to the following conditions:

- *the authorisation is only valid for the meter installation described in the letter of authorisation*
- *the organisation undertaking the adjustment is competent to do so*

- *any regulator and any associated pressure control or protection device(s) are set to the values stated in the request and these pressures do not subject the installation pipework and any connected appliance to a pressure greater than that for which they were designed. Such values and any associated conditions are to be clearly labelled on the installation and*
- *the regulator and any pressure control protection device(s) is/are, subsequently, sealed to prevent unauthorised adjustment with a seal marked with the AMI registration number or, for pre-set equipment, the manufacturer's mark.*

6.2 ABNORMAL LOADS

6.2.1 Abnormally large and rapid changes of flow in the Network or installation pipework can be caused by a compressor as defined in IGEM/UP/2 and IGEM/UP/6. Any such change is not permitted to create a pressure fluctuation sufficient to compromise the proper operation of the Network or of other plant/appliances connected to the installation pipework. A GT must be notified of the intention to install a gas compressor and of the following technical details:

- receiver volume
- over and under pressure protection devices on the inlet of a compressor
- performance specification for pulsation damping
- a diagram illustrating any safety device and its logic of operation.

A typical form for submission to a GT is shown in Appendix 7.

6.2.2 A GT will, normally, require analysis to estimate the worst case effect of the compressor load on the Network, paying attention to steady, static and dynamic situations and, in particular, the effect of short term dynamic pressure fluctuations in Networks of MOP not exceeding 0.5 bar. If such an analysis indicates that pressure fluctuations could be excessive, the installation shall comply with any restrictions imposed by the GT, including:

- safeguards to prevent simultaneous start up of compressors that operate in parallel
- the specification of particular start up modes for any compressor
- the specification of a number of low and high pressure safeguards on the inlet to any compressor.

Note: Further guidance is provided in IGEM/UP/6.

6.3 METER BY-PASSES

6.3.1 A meter by-pass shall not be installed without the provision and use of the by-pass being approved by the gas supplier.

6.3.2 Where the GT operates an approval process, a meter by-pass shall not be installed without the approval of the GT.

Note: In most cases, the GT's Network Code requires that the GT approves the provision and use of a meter by-pass (see GDN/PM/GT2 in Appendix 4).

6.3.3 Once approval has been granted, the meter by-pass shall be installed in accordance with this Standard. The meter by-pass valve (MBV) shall be sealed in the closed position in accordance with IGEM/GM/8 Part 3, and be labelled in accordance with IGEM/GM/8 Part 5.

SECTION 7 : DESIGN CONSIDERATIONS

7.1 GENERAL

7.1.1 Reference should be made to Appendix 10 for an explanation of all pressure terms used in this Sub-Section.

7.1.2 Consideration shall be given, at the design stage, to the following:

- the intended location of the meter installation (see IGEM/GM/8 Part 2)
- appropriate means of access (see IGEM/GM/8 Part 2)
- the method of handling and construction on site (see IGEM/GM/8 Part 3)
- maintenance (see IGEM/GM/8 Part 4)
- the requirements under the PSSR (see IGEM/GL/5).

7.1.3 Any meter installation shall include a regulator unless:

- the installation complies with clause 7.6.8 and
- complies with the appropriate GT's policy for unregulated supplies and
- has been authorised by the appropriate GT (see Section 6).

7.1.4 Any meter and associated PRI/regulator should be designed not in isolation but as a single unit. Both should be sized for the same load and consideration shall be given to the effect that each may have on the other.

7.1.5 Any meter installation should be designed to minimize the pressure drop between any regulator impulse point and the inlet of the meter (see clause 16.6.13).

Note: In particular, this is important where fixed factor conversion is being employed, but is less critical when electronic volume conversion is fitted (see clause 9.3.2).

7.1.6 DP and STP of all pipework and equipment upstream of any PRI/regulator (including the regulator) shall be selected such that the pipework and equipment are capable of withstanding MIP_u or, where stated by the GT, $DMIP_u$ (see Figure 2).

DP of the part of the installation upstream of the PRI/ regulator (including the regulator) shall be greater than or equal to DP_u.

7.1.7 DP and STP of all pipework and equipment downstream of the inlet of the PRI/regulator and safety devices shall be selected such that the pipework and equipment are capable of withstanding MIP_{mi} or the highest pressure that could be caused by the downstream equipment (MIP_c) whichever is the greater (see Figure 2).

7.1.8 DP and STP of all pipework and equipment downstream of any PRI/regulator but upstream of the first valve fitted downstream of any regulator (including the valve itself) should be such that the pipework and equipment are capable of withstanding MIP_u or, where specified by the GT, $DMIP_u$. However, an exception is where a meter is incorporated in this section of pipework, when DP and STP shall be selected such that the meter is capable of withstanding DP_u (see Figure 2).

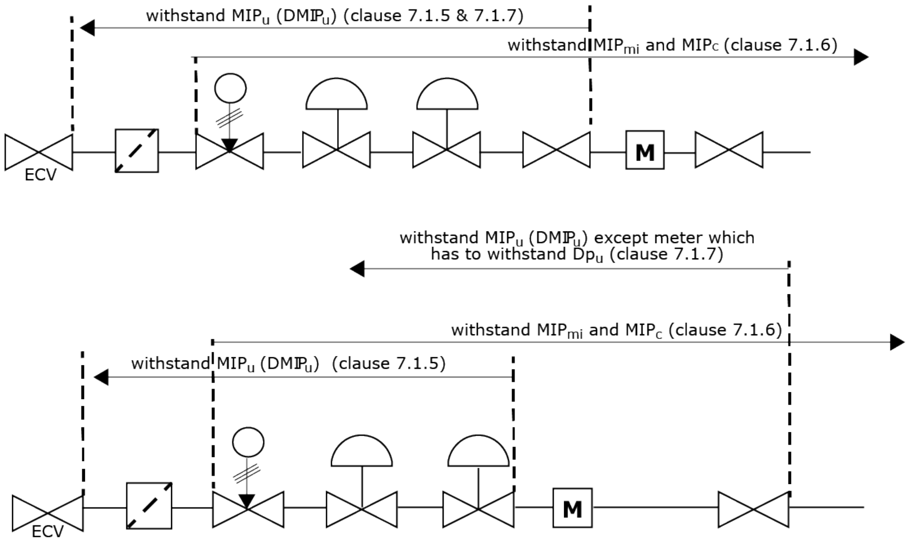


FIGURE 2 - PRESSURE RATING OF EQUIPMENT

7.1.9 The limit of any pressure system shall be determined, and the safe operating limit (SOL) must be established for all gas equipment that forms part of a pressure system as defined by PSSR (see Sub-Section 3.16)

SOLs must be established by the Pressure System User and agreed with the Competent Person as defined in PSSR.

Where the meter installation incorporates a pressure break, the SOL must be determined for each section of the meter installation within the scope of PSSR.

The SOL should be declared as being equal to the MIP that is used when calculating the STP for a given section of the meter installation. The SOL shall not be declared as a value lower than the MIP that a section of the installation may be subjected to. SOL must not exceed the minimum STP applied to a section of installation.

Note: The change of SOL will normally occur at the pressure break. However, if:

a) the outlet of the meter installation is at 0.5 barg or less and

b) the meter installation is not feeding a 3rd party pressure system,

then the boundary of the Pressure System will be at the outlet of the first valve downstream of the active regulator. The upstream SOL will apply up to the outlet flange of the active regulator, and equipment downstream of the active regulator can be considered to be exempt from PSSR. This can be marked as such on the PSSR drawing and the outlet SOL marked as "N/A".

7.1.10 Where MOP of any part of a meter installation is 0.5 bar or greater, any new component that will operate at such a pressure must comply, where appropriate, with PE(S)R.

7.1.11 All parts of an installation shall be designed to withstand the maximum range of temperature to which the installation may be subjected under test and operating conditions.

7.1.12 For MOP_u exceeding 7 bar, consideration shall be given to conducting a stress analysis of the installation, in which case reference should be made to IGEM/TD/12 which gives detailed guidance and a method of comprehensive analysis.

7.2 PROTECTION OF THE DOWNSTREAM SYSTEM

7.2.1 Reference should be made to Appendix 10 for an explanation of all pressure terms used in this Sub-Section.

7.2.2 The meter installation shall be designed to pass the maximum designed flow rate at DmP_u and to maintain DmP_{mi} at or above DmP_c.

Note: DmP_c has to be sufficient to ensure that P_{ign} is maintained at connected appliances, noting that, where the metering pressure is a nominal 21 mbar, both BS 6891 and IGEM/UP/2 require a maximum pressure drop of 1 mbar across installation pipework. For higher metering pressures, IGEM/UP/2 requires a maximum drop of 10% of the metering pressure.

"Standard" appliances are required to adequately cross light at 70% of their operating pressure, i.e. 70% of 20 = 14 mbar (see Note 2 to clause 5.4.1).

7.2.3 The meter installation shall be designed to ensure that, for inlet pressures in the range of LOP_u to MOP_u and flow rates of 5% Q_{imax} to Q_{imax}, OP at the outlet of the installation is maintained within the pressure range LOP_c to MOP_c.

Note: This is intended to ensure that the pressure at appliances is maintained within the limits P_{min} to P_{max}.

7.2.4 For a meter installation incorporating a monitor regulator, that regulator shall be designed, sized and set so as to ensure that, when the monitor regulator is operating, OP at the outlet of the installation is maintained within the pressure range LOP_c to MOP_c.

Note: This is intended to ensure that the pressure to appliances is maintained within the limits P_{min} to P_{max}.

7.2.5 For a meter installation incorporating a slam-shut valve (SSV), the SSV shall be designed, sized and set to ensure that, under all foreseeable circumstances, MIP_{mi} will not exceed STP of any section of the installation or the downstream system except for any connected appliances that are otherwise protected, i.e. by a downstream pressure regulator.

Note: IGE/UP/1 requires STP to be the greater of 1.1 x MIP and a value that is related to the MOP.

7.3 VELOCITY

7.3.1 Subject to the exceptions given in Note 2 below, gas velocity within a meter installation shall not exceed:

- 20 m s^{-1} upstream of any filter(s) and
- 40 m s^{-1} downstream of any filter(s).

Note 1: Where the inlet pressure to an installation is as low as 25 mbar, the effects of pressure loss across the installation will become prohibitively large before the velocity of 40 m s^{-1} is attained.

Note 2: Where it is essential to the design of an installation, gas velocities within any regulator installation stream may exceed the filtered gas velocity limit, subject to the system design capability, acceptable noise level and good engineering practice.

Note 3: Immediately downstream of a regulator, velocities can be much higher than 40 m s^{-1}. The design of the installation has to take this into account to ensure metering accuracy continues to comply with clause 4.2.2.3.

7.3.2 When high velocities are anticipated, consideration shall be given to the possibility of noise effects and overspeeding of any meter.

Note: Most meters are designed to run at lower gas velocities than those specified.

7.4 NOISE AND VIBRATION

7.4.1 Due account shall be taken of possible noise emission and vibration at all flow and pressure conditions.

Untreated noise or vibration may:

- create an environmental nuisance in the locality of the site
- create a hearing hazard to personnel working on the site
- result in component failure.

Note: In particular, this is relevant for MOP_u exceeding 75 mbar.

7.4.2 Further guidance on the control of noise is given in Appendix 6 which should be referenced if noise may be a problem.

Note: Appendix 6 recommends a survey of ambient noise levels be taken before and after a meter installation becomes operational.

Consideration shall be given to:

- burying pipework
- installing silencing measures on any PRI/regulator or selecting quieter equipment

  Note: In-line silencers are not recommended.
- installing acoustic cladding with due regard to the possibility of accelerated corrosion beneath
- providing an acoustic enclosure
- effects ~~of meters~~ on and of the meters.

Note: Large diaphragm meters and, in particular, RD meters, produce mechanical noise which, although not particularly loud, can prove disturbing in quiet surroundings such as offices.

7.4.3 In addition to assessing noise within the context of noise nuisance and compliance with prescribed limitations, consideration shall be given to noise exposure for operational personnel (in terms of the noise levels likely to be experienced while on site) and to the proximity of noise sources to the area in which operational personnel will be expected to work. Reference shall be made to the Noise at Work Regulations.

7.4.4 Vibration and acoustic fatigue

7.4.4.1 Account shall be taken of the damaging effects of acoustic fatigue caused by high frequency vibration.

Note: Vibration can affect components installed within pipework, particularly the elements within silencers, the pipework itself and small-bore instrument connections. Specific precautions to secure pilots, gauges and small-bore pipework against vibration, or even to alter natural excitation frequency, may be necessary to avoid damage to compression-type fittings.

7.4.4.2 Relief valve and process vent stacks are susceptible to vibration. Steps shall be taken to prevent damage to any stack and associated equipment when in use.

7.5 HEATING

7.5.1 Consideration shall be given to the need for appropriate heating to protect installations and downstream systems against the effects of internal and external ice formation or excessive condensation caused by ambient conditions or by a reduction in pressure which results in a reduction in temperature. Such heating shall not create a fire or explosion hazard.

Where gas pre-heating is to be installed, it shall be in accordance with a suitable standard.

Note: *Normally, heating is only required where a large pressure reduction occurs, typically in excess of 15 bar. In general, a temperature drop of 1°C will occur for every 2 bar pressure reduction.*

7.5.2 In establishing a requirement for the provision of pre-heating, regard should be paid to the:

- ability of the downstream pipe material to retain satisfactory physical characteristics at any reduced temperature of operation
- possibility of frost heave due to frozen ground around buried outlet pipework
- possibility of hydrate or liquid formation which could influence the operation of any PRI/regulator and downstream equipment
- need to prevent icing-up of regulators, auxiliary equipment, etc.

Note 1: *Consideration may be given to the provision of pre-heating to improve the operating condition of equipment by reducing the likelihood of condensation occurring and, hence, reducing corrosion.*

Note 2: *Electrical tape heating, or some other form of low heat input, may be sufficient to meet these requirements.*

7.5.3 Where the effects of low temperature operation could have a detrimental effect on pilot control systems, consideration shall be given to the provision of an independent pilot heating system.

Note 1: *This may be provided by methods such as trace heating, vortex heating, small capacity electric heaters or secondary heat exchanger loops in the main heating system.*

Note 2: *Consideration may be given to the provision of pre-heating to improve the operating condition of equipment by reducing the likelihood of condensation occurring and, hence, reducing corrosion.*

7.5.4 The number of heaters and their capacity should be determined having regard to the probability of failure of a unit occurring simultaneously with a period of extreme demand.

Note: *If this possibility is low, the provision of standby heater capacity to meet the extreme condition may not be necessary.*

7.5.5 Consideration shall be given to the reliability of any heating system in operation, taking into account its dependence on other services.

Note: *It may be necessary to provide standby water and electricity supplies where continuous operation under all fault conditions is essential.*

7.5.6 Where waterbath heaters are utilised, the heater air intake and flue stack shall be sited in a safe area of the PRI, as determined in accordance with IGEM/SR/25 or IGEM/GM/7B. Particular care should be taken with the siting of the heater control system to ensure that any hazardous areas associated with it do not encroach into the vicinity of the heater air intake and flue stack.

7.5.7 Package/modular boiler installations shall be sited in a safe area of the PRI as determined in accordance with IGEM/SR/25 or IGEM/GM/7B and installed to comply with the requirements of BS 6644 and IGEM/UP/10.

Note 1: *For installations where MOP does not exceed 100 mbar, the application of hazardous area classification above Zone 2NE is not, normally, required unless a risk assessment determines otherwise.*

Note 2: *In carrying out a risk assessment, guidance can be obtained from IGEM/UP/16, HSE INDG 163. IGEM/GM/7B also provides information on risk assessment techniques.*

7.5.8 Electrically powered heaters shall be designed to operate in the hazardous area they are installed within as determined in accordance with IGEM/SR/25 or IGEM/GM/7B. A means to prevent operation under no flow conditions shall be installed.

7.5.9 Measures should be taken to protect water-based heating systems from freezing and internal corrosion.

7.5.10 Measures shall be taken to prevent, or to detect, ingress of gas at high pressure into water-based heating systems.

7.5.11 Bursting discs or other automatic means shall be used to prevent over-pressurisation of the water side of package boiler heating systems, such systems shall be interlocked to shut off the boiler system in the event of operation.

7.5.12 Any material used in a meter installation, in particular polymeric and elastomeric types, shall be capable of withstanding the maximum temperature that any pre-heating source can attain.

Note: In order to avoid exceeding the safe operating temperature of such materials in any meter or regulator valve seat, it may be necessary to limit the maximum temperature of the pre-heating source.

7.5.13 Any heater installation should be equipped with a meter for measuring its fuel consumption and a control system which minimises the energy consumed by the pre-heaters.

7.5.14 The fuel gas supply for heating installations should, wherever possible, be taken from the point of lowest pressure within the PRI consistent with the requirements of the heater burner system and, in the case of waterbath heaters, downstream of the waterbath heater.

7.5.15 The supply for any gas fired pre-heater should be upstream of the customer's meter and be registered with a gas supplier. Sub-deduct arrangements shall be avoided.

Note: Where the supply for the gas fired pre-heaters is downstream of the customer's meter any additional metering is to be for energy monitoring purposes only.

7.5.16 The MEM shall be responsible for arranging for the metering of preheat fuel and any commercial arrangements.

7.5.17 The heat input of any heater installation should be calculated to meet the duty. The full calculation shall consider the composition of the gas to be heated and the influence of pressure on the specific heats of its various constituents.

7.5.18 Precautions shall be taken to prevent interchange of the gas with any heating medium.

7.5.19 Consideration shall be given to the effects of thermal stress which may occur in heat exchangers due to the cyclic nature of some heating control systems.

7.5.20 Consideration shall be given to the potential for accelerated corrosion under thermal or acoustic cladding, refer to clause 14.11.1.

7.6 PROVISION AND ARRANGEMENT OF COMPONENTS

7.6.1 General

7.6.1.1 Any meter should be positioned in such a way that the index can be read conveniently, without the use of mirrors, etc.

7.6.1.2 The gas flow through the meter installation should be from left to right, when viewing the index of the meter (see clause 12.1.3).

Note: It may be possible to take advantage of adjustable index positions.

7.6.1.3 Pipework and equipment shall be arranged such as to:

- facilitate easy access to all components for maintenance, particularly meters, regulators, filters and the ECV
- avoid entrapment by considering the position of the doors, equipment and pipework
- avoid over-stressing pipework and plant
- allow for expansion and contraction due to temperature and system loading
- minimise adverse deflections and displacements during normal operation or hydrostatic testing
- provide a minimum cover for buried pipework as given in Table 1
- minimise the number of pipe cross-overs
- provide adequate separation from other pipework to facilitate maintenance. In any event, the minimum separation should be 600 mm.

  Note: Small bore impulse pipework may be installed with less separation.

LOCATION OF PIPE UNDER	**MINIMUM DEPTH OF COVER (m)**			
	MOP ≤ 75 mbar and ∅ ≤ 63 mm	**75 mbar < MOP ≤ 7 bar or ∅ > 63 mm**	**7 < MOP ≤ 16 bar**	**MOP > 16 bar**
Carriageways	0.45	0.75	1.1	1.2
Path footways	0.375	0.6	1.1	1.1
Verges	0.6	0.75	1.1	1.1
Other fields and agricultural land	1.1	1.1	1.1	1.1
Other private ground	0.6	0.6	1.1	1.1
Water courses, rivers and canals*	0.6	1.2	1.2	1.2
Railways**	1.4	1.4	1.4	1.4

**Note 1: Reference to be made to the appropriate environment agency for permission to cross these features.*

***Note 2: Refer to the appropriate authority.*

TABLE 1 - MINIMUM COVER FOR BURIED PIPEWORK

7.6.1.4 There shall not be more than one flexible connection or joint incorporated within any one stream of a meter installation.

Note: Flexible connections and joints are those that are able to move while in service to allow for expansion and contraction.

7.6.1.5 A meter installation inlet valve (MIIV) shall be fitted at the inlet of the meter installation.

Note: The ECV may fulfil this purpose.

7.6.1.6 If Q_{imax} exceeds 16 $m^3\,h^{-1}$, a meter outlet valve (MOV) shall be fitted.

Note: The fitting of a MOV on installations with a lower flow rate will simplify tightness testing and purging operations.

7.6.1.7 On a meter installation having a single stream PRI for MOP_u exceeding 75 mbar, consideration shall be given to the provision of a valve on the inlet and outlet of the PRI along with suitably sized, plugged and sealed valves either side of the PRI.

Similarly, on a meter installation that does not incorporate a meter by-pass, consideration shall be given to the provision of appropriately sized, suitably plugged and sealed, valves (see Appendix 8 Figure 8).

Note 1: These provisions are to enable the downstream pipework to be kept pressurised during maintenance via a temporary by-pass incorporating a regulator and protective device(s).

Generally, for installations of MOP_u not exceeding 7 bar, a 22 mm (¾ in) connection will be adequate.

Note 2: Where the downstream pipework is not extensive, it may be possible to maintain pressure by installing a temporary gas cylinder on a tapping downstream of the installation.

Note 3: These provisions will not permit continuity of supply, for which a suitably sized second stream containing regulators and safety devices have to be fitted (see clause 7.6.4).

7.6.1.8 Any required filter(s) (see Section 8) shall protect the whole meter installation and, hence, shall be installed on the inlet to the installation.

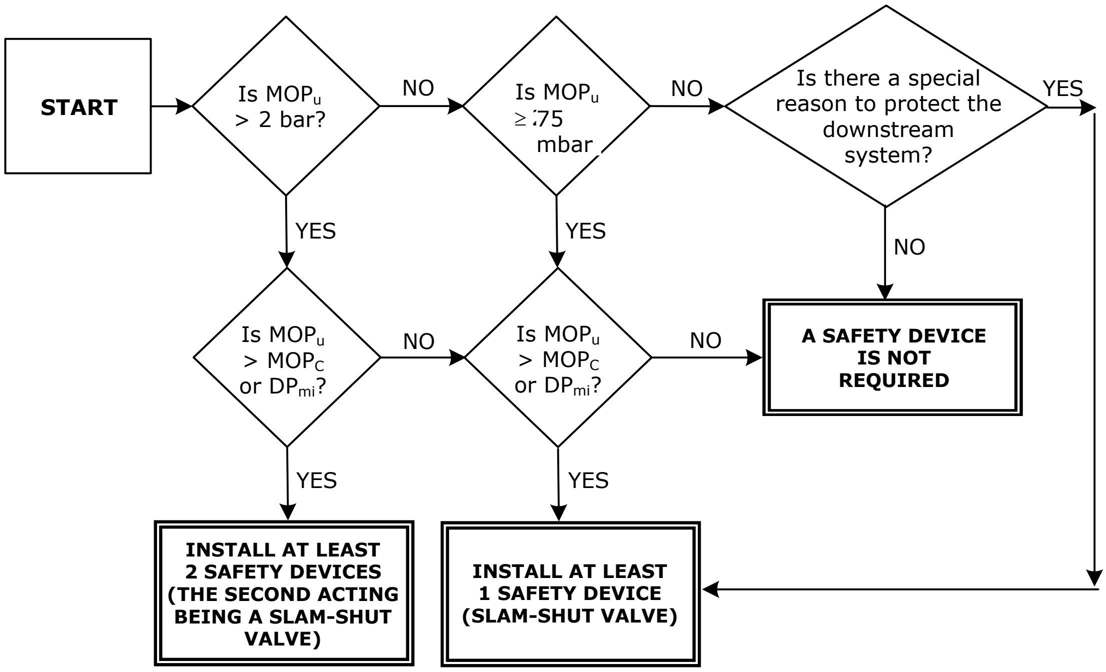
7.6.1.9 For MOP_u not exceeding 75 mbar, arrangements as shown in Appendix 8, Figures 8 to 13 should be used.

Note: Normally, it is not necessary to provide over-pressure protection or creep relief facilities. However, where over-pressure protection is necessary, refer to clause 7.6.2.

7.6.2 Regulators and safety devices protecting the downstream system

Note: Acceptable regulator installation arrangements are shown in Appendix 8, Figures 8 to 25.

7.6.2.1 Where a regulator is required (a regulator will, normally, be required - see clause 7.1.2), it shall protect downstream elements of the meter installation and the downstream system (up to any further regulator) against the effects of over-pressure. The operation and control philosophy of regulator streams shall be established at an early stage in the design process. The minimum degree of safety provided in any one stream shall be in accordance with Figure 3.



Note 1: A typical reason to protect the downstream system when not, normally, required would be when appliances are not "standard" (see Note 2 to clause 5.4.1).

Note 2: For MOP_u exceeding 2 bar slam monitor active is the usual configuration as this has the benefit of providing one level of protection without cutting off the supply of gas to the customer, However, where operation at the higher monitor pressure (TOP_{mi}) is not acceptable for long periods of time or where the risk of venting gas from a failed active breather is unacceptable, a slam slam active configuration may be desirable.

Note 3: For MOP_u exceeding 7 bar, it may be beneficial to install a two stage pressure breakdown with first stage monitor override. In this configuration, both regulators are active, with the 1st regulator fitted with an override pilot monitoring the 2nd stage outlet pressure. The 1st stage regulator takes control if a failure of the 2nd stage regulator is detected by the pressure downstream of the 2nd stage regulator reaching the set point of the monitor pilot.

Note 4: Under the GT1 process for LP networks the GDNs declare an MOP_u of 75 mbars, this is a rounded-up conversion from 30 in water gauge which is equivalent to 74.7 mbars. As such slam shuts are not normally required on LP meter installations.

FIGURE 3 - DECISION ALGORITHM FOR MINIMUM NUMBER OF SAFETY DEVICES

7.6.2.2 Any diaphragm-operated regulator should be installed with the diaphragm in the horizontal plane unless specifically permitted or recommended by the manufacturer (see clause 9.3.1).

Note: Certain diaphragm regulators of nominal bore not exceeding 80 mm can be installed with their diaphragm in the vertical plane, but this will result in impaired performance and, consequently, a reduced capacity.

7.6.2.3 A relief valve shall not be used as a primary safety device.

Note: The use of relief valves is limited to providing protection against regulator let-by and nuisance slam-shut firing.

7.6.2.4 For MOP_u exceeding 7 bar, consideration shall be given to providing a suitably-sized by-pass around the PRIIV, together with a commissioning vent downstream of any regulator and upstream of any regulator/stream outlet isolation valve (ROV/SOIV) to allow the regulator(s) to be commissioned statically.

7.6.3 **Pipework in the vicinity of meters**

7.6.3.1 Normally, a meter and associated pipework should be installed on the outlet side of the PRI/regulator (see also clause 7.6.7).

7.6.3.2 Pipework shall be designed such that the meter orientation will be acceptable to the manufacturer.

7.6.3.3 The pipework should be designed such that significant jetting or swirling does not occur at the inlet to a meter (see also clause 4.2.2.3).

Note 1: Partially open valves and regulators are a common cause of jetting.

Note 2: Jetting and swirling are a cause of meter registration errors.

Note 3: For diaphragm meters, there is no significant loss of accuracy provided correct installation attitude is maintained. For RD meters, significant errors may result at low flows if the impeller/rotor axis alignment is outside the manufacturer's tolerances (pressure loss across the meter will also be increased).

7.6.3.4 Pipework configuration shall incorporate straight lengths of pipe each side of a meter as detailed in Table 2, or as detailed in the manufacturer's installation instructions for fiscal type applications. Further guidance should be sought from the manufacturers on their specific installation requirements for the meter installation to perform in accordance with clause 4.2.2.3.

The straight lengths specified in Table 2 may be reduced by fitting a flow conditioner upstream of the meter (additional to any conditioner within the meter). Where such a flow conditioning device is fitted, it shall be of a type recommended by the meter manufacturer and shall be installed in accordance with their instructions.

Note: Normally, flow conditioning devices have a significant pressure loss and, as such, they may not be suitable for installations of MOP_{mi} not exceeding 75 mbar.

Where the meter is installed in accordance with the manufacturer's instructions, and these are less onerous than the values given in Table 2, such instructions shall be obtained in writing from the manufacturer and retained with the site records.

METER TYPE	$MOP_{mi} \leq 7$ bar		$MOP_{mi} > 7$ bar	
	Pipe upstream	**Pipe downstream**	**Pipe upstream**	**Pipe downstream**
Diaphragm	Not critical	Not critical	Not critical	Not critical
RD	Not critical	Not critical	4D	2D
Turbine	10D	5D	10D	5D
Multipath USM	10D	5D	10D	5D

TABLE 2 - MINIMUM STRAIGHT LENGTH OF PIPE OF SIMILAR NOMINAL BORE

Note: Reductions from the recommended inlet and outlet pipework configuration may produce increasing and significant error levels as OP increases above 7 bar, particularly as the flow rate approaches Q_{max}.

7.6.3.5 Any protrusion into the gas stream, upstream of the meter, for example a thermowell, shall not be installed within the upstream pipe length given in Table 2 or the length advised by the manufacturer (see clause 7.6.3.4).

7.6.3.6 For a turbine meter where a reducer, for example to BS EN 10253/BS 1640, is used to match the pipe size to the meter, a length of straight pipe in excess of 3D shall be installed on the inlet to the meter in addition to the length provided under clause 7.6.3.4. The meter manufacturer's advice should be sought regarding the exact length of additional pipe required.

Note: Where a fabricated reducer of included angle of 15° or less is used, an additional 3D length of pipe is, normally, adequate.

7.6.3.7 Any reducer shall be concentric.

7.6.3.8 The strain placed upon any meter connection shall be minimised and the installation method should allow easy removal and re-fitting of the meter. This shall be achieved by:

- for a diaphragm meter, connecting using a maximum of one flexible connection

  Note: Usually, this is located on the inlet of the regulator.

- for an RD meter, connecting using one flexible connection, located on the inlet or outlet of the meter, positioned so as to protect the meter from any stresses that may be imposed by the upstream or downstream pipework.

  Note: If the flexible connection is on the meter inlet, it can be used to accommodate the open-ended top hat or skirt-type strainer (used for commissioning purposes – see Sub-Section 8.4) at that inlet.

  For MOP_{mi} exceeding 7 bar, the meter may be rigidly piped, but the pipework either side of the meter shall be so designed as to protect the meter from any stresses that may be imposed by the upstream or downstream pipework.

- for a turbine meter, connecting with a maximum of one flexible connection, located either on the inlet or outlet of the meter. Alternatively, the meter should be rigidly piped with the pipework either side of the meter so designed to protect the meter from any stresses that may be imposed by the upstream or downstream pipework.

  If the flexible connection is on the inlet of the meter, it should be located at least 3D upstream of the meter.

- for a USM, installing in accordance with the manufacturer's instructions. Upstream and downstream pipe supports should be designed to prevent movement of connecting pipework in the event of the meter being removed.

Any USM shall be rigidly piped, with pipe supports located on both the inlet and outlet of the meter.

Note: Further guidance on the installation of multipath USMs is given in BS 7965.

Acceptable arrangements are shown in Appendix 8, Figures 21 to 24.

7.6.4 **Multi-stream systems**

Systems incorporating multi streams of regulators or meters may be installed for a variety of commercial and technical reasons, including:

- continuity of supply
- partial continuity of supply for essential loads
- improved pressure control over the required flow range
- achieving the required capacity
- provision of standby and reference metering, see clause 7.6.7.

and these arrangements should be in accordance with Figure 4.

7.6.4.1 Continuity of supply, while not always an essential requirement, may be desirable in some circumstances, for example to enable a customer to take gas during PRI/regulator maintenance or in the event of a fault in the system/meter. Where continuity of supply is important, consideration shall be given to installing a multi-stream PRI/regulator and, possibly, a meter by-pass.

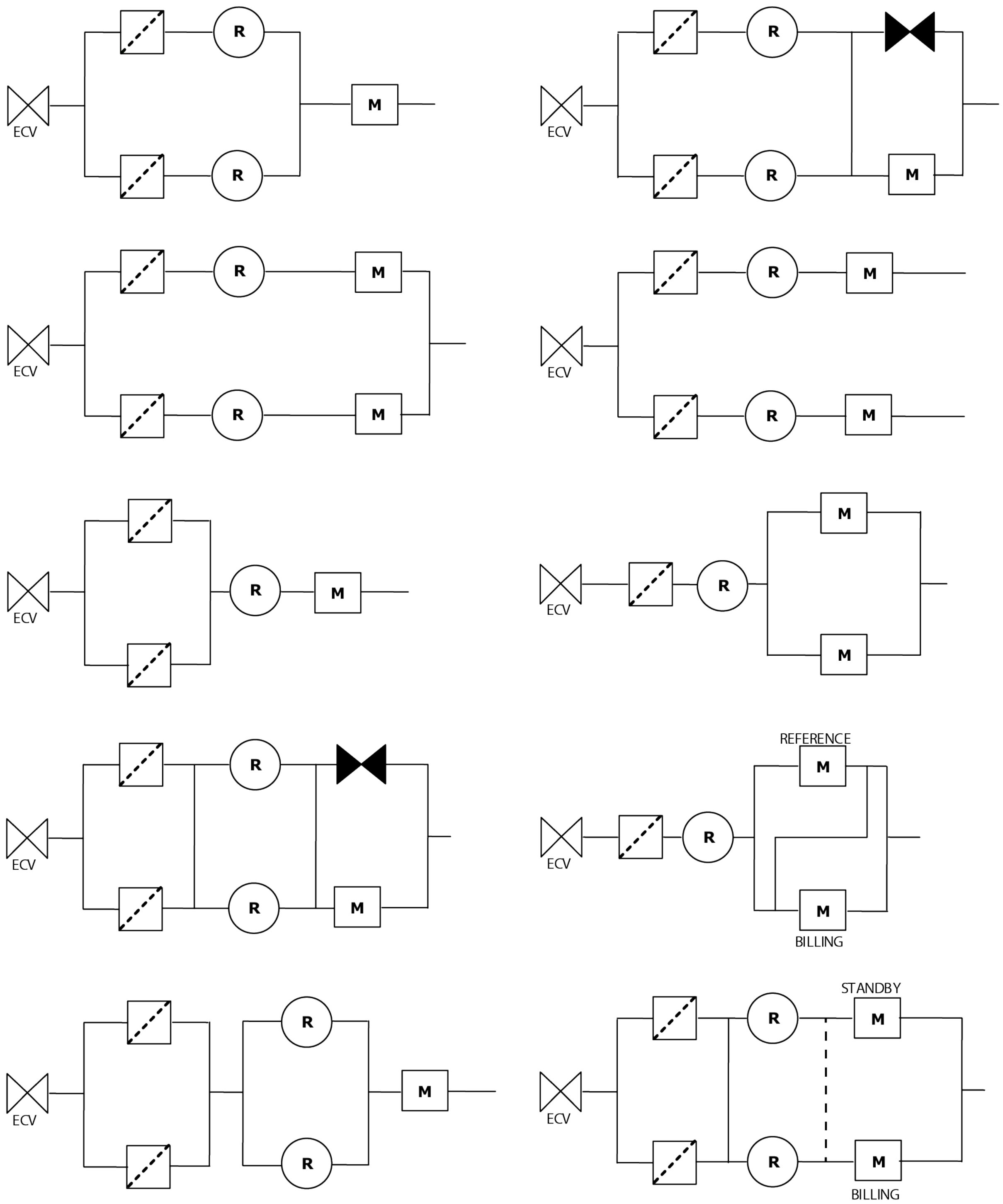
Where two major PRI/regulator streams are installed (other than any small parallel stream to cope with low flow rates) the main stream should have 100% of normal load capacity, with the standby having either 100% capacity or a lower capacity equivalent to the essential load to be maintained to the premises. Alternatively, each stream should be equally sized to supply the essential load, provided that the two streams in parallel can supply the installation design capacity.

7.6.4.2 When two or more PRI/regulator streams are installed and continuity of supply is required, a stream discrimination system should be fitted so that a slam-shut valve in a "healthy" stream is unlikely to be fired by a regulator failure in another stream.

Note: This can be achieved by selecting the set points of the sensing elements in the slam-shut system, so that they are properly sequenced and with sufficient separation to maintain the downstream supply at a safe pressure level and withstand any pressure surge that may occur. In practice, this is only viable on installations where OP_{mi} exceeds 7 bar. On other installations, consideration will need to be given to the inclusion of other features, for example stream discrimination devices, remote warning systems, etc.

7.6.4.3 Any stream discrimination device should be a swinging plate check valve fitted between the regulator outlet and the SOIV, or another system that complies with clause 7.6.4.2.

Note: For OP_{mi} not exceeding 7 bar, stream discrimination has, traditionally, been provided by such check valves. For OP_{mi} exceeding 7 bar, both check valves and pilot-operated systems have been used. The latter are also available for lower pressures.



Note 1: *Other combinations of the above are also acceptable.*

Note 2: *For clarity, stream isolation valves, p and PV points are not shown.*

FIGURE 4 - MULTI-STREAM ARRANGEMENTS

7.6.4.4 Where a swinging plate check valve stream discrimination device is fitted:

- the valve shall be installed in horizontal pipework and have sufficient straight pipe immediately upstream to accommodate the slam-shut impulse points and creep relief
- the valve shall be positioned such that its operation is not affected by downstream equipment, pipework or fittings
- the valve differential pressure should not be so large as to cause nuisance movement of the slam-shut mechanism at flow rates up to 120% Q_{max} (see Sub-Section 10.7)
- a valved tapping shall be provided in the stream pipework between the valve and stream outlet isolation valve:
  - for MOP_{mi} not exceeding 7 bar of minimum diameter 20 mm
  - for MOP_{mi} exceeding 7 bar of minimum diameter 25 mm.

7.6.4.5 Wherever possible, a meter installation that incorporates more than one meter should be designed to avoid common outlet connections from the meters.

Note 1: *This is to avoid problems with over-speeding and interaction between meters. The preferred arrangement is to split the load, i.e., to use separate meters for different parts of the load. The meters may be fed from a single regulator installation or be individually regulated.*

Note 2: *It may be necessary to split the load to ensure that low flow rates are recorded accurately, for example factory catering loads.*

Where two meters, connected to a common PRI/regulator, supply independent systems comprising substantial volumes of downstream pipework, particularly for MOP_u exceeding 75 mbar, consideration shall be given to fitting a positive sealing non-return valve (NRV) on the outlet of each meter stream.

Note: *Where an NRV has not been installed, the downstream pressure in one of the systems may affect the pressure in the other system at times of substantial load change. This is partly due to the response time of the regulator. The equalising of pressure between the two systems can cause a meter to rotate, either forwards or backwards, potentially causing metering errors particularly where a conversion device is installed.*

7.6.4.6 Where it is necessary to use meters in parallel and with a common outlet connection (see Figure 27), each meter should be regulated independently at a slightly different pressure. The difference in regulator set points should not be large enough to cause meter over-speeding.

Where meters of different size are installed, provision shall be made to prevent the smaller meter over-speeding.

Where it is unavoidable to use meters in parallel and with a common inlet and outlet manifold connections, supplied from a common regulator system, for example on very large loads:

- the meters used shall be of the same make and size
- the installation shall be designed such that the pressure loss characteristics of each stream are sensibly identical and, thus, the flow down each measuring stream is the same under all flow conditions.

7.6.4.7 On large loads, it may be desirable to install either a standby meter or a reference meter, in which case the two meters can be installed with common inlet and outlet connections (see Figure 7). In the case of a reference meter, the pipework should include a facility to enable the two meters to be run in series as well as in parallel (see Figure 8) (see clause 7.6.7).

Each meter serial number registered for billing shall have an individual MPRN. Where this is not already present an MPRN will need to be created by the gas supplier/shipper for each meter installed in parallel.

7.6.4.8 On installations with MOP_u not exceeding 75 mbar, where parallel regulator streams are installed for the purpose of providing sufficient flow capacity, each regulator stream shall be equipped with a stream inlet valve.

In all other instances of parallel regulator streams, meter streams or filter streams, there shall be inlet and outlet valves fitted on each stream.

7.6.5 **PRI/regulator by-passes**

7.6.5.1 Any PRI/regulator stream shall not be capable of being by-passed unless a means of pressure control is incorporated, and safety systems are included in the by-pass. Such safety systems shall be at least equivalent to the main stream safety system.

7.6.5.2 For a single stream module, adequate provision should be made to ensure that a positive pressure can be maintained in the downstream system during maintenance (see clause 7.6.1.7).

7.6.5.3 Any temporary by-pass that by-passes the main stream regulator(s) or safety system(s) shall have regulating and safety systems, as appropriate, fitted to protect the downstream system as outlined in clause 7.6.2.

7.6.5.4 Where an auxiliary system by-passes the main stream regulator(s) and the safety system(s), it shall also be fitted with regulating and safety systems to protect the downstream system, as outlined in clause 7.6.2.

7.6.6 **Meter by-passes**

7.6.6.1 A meter by-pass is not preferred and shall only be installed with the approval of all the relevant parties in the contractual chain (see Sub-Section 6.2).

7.6.6.2 Any meter by-pass shall be connected around the meter stream and shall not by-pass the PRI/regulator. On an installation incorporating a twin stream PRI, the meter by-pass and meter stream should be supplied from the PRI outlet header and shall terminate at a header or tee connected to the outlet of the meter stream.

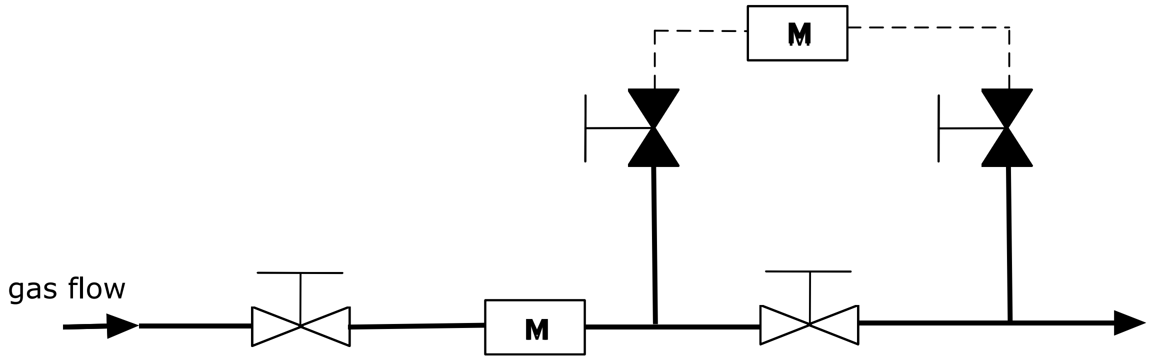
7.6.6.3 An MIV and MOV shall be fitted in each stream to allow meter removal.

7.6.6.4 The meter by-pass shall by-pass the meter and its isolation valves and shall also be fitted with a meter by-pass valve (MBV) (see Sub-Section 13.4).

7.6.6.5 Where it is unacceptable for the consumer to be subject to reduced flow when operating on a by-pass, the meter by-pass should have a pressure loss no greater than the pressure loss in the meter stream.

7.6.7 **Standby and reference metering**

7.6.7.1 Where standby or reference metering is required, an arrangement such as those shown in Figures 5 to 9 should be used.

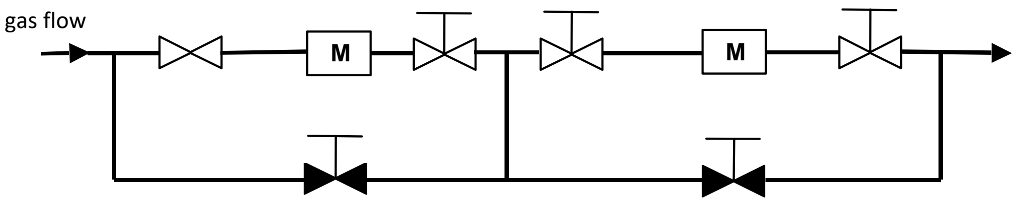


Note: *With this option, valves are installed to enable a check meter or calibration test rig to be temporarily installed in series with the main meter being used for billing. On completion of any tests or calibration, the check meter is removed for use on other installations.*

FIGURE 5 - ARRANGEMENT OF A SINGLE METER. WITH PROVISION FOR A TEMPORARY CHECK METER TO BE INSTALLED IN SERIES

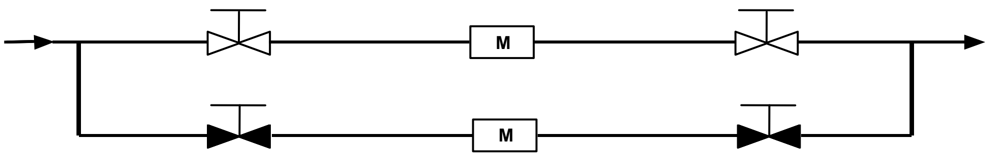
Note: *In this case, a second meter is installed in series. Both meters are on line at all times and readings from each meter can be used to cross check each other's performance and is of value in particular if the meters are of different types for example a turbine meter and a USM. However, this arrangement may mask the effects of any deterioration of the meter through general wear and tear.*

FIGURE 6 - ARRANGEMENT OF TWIN METERS. SERIES CONFIGURATION WITHOUT A BY-PASS



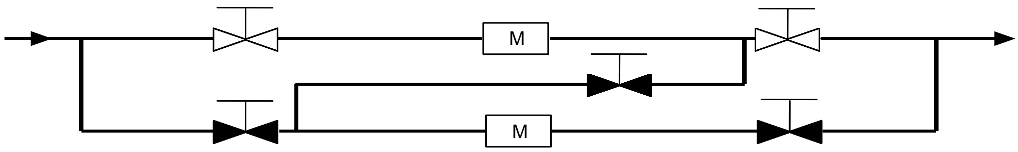
Note: *This configuration is identical to Figure 4 with the addition of by-pass valves around each meter. This combination allows each meter to be removed from service for maintenance or fault finding and also allows for the second or check meter to be isolated and only used during check or calibration procedures. This configuration is, normally, recommended.*

FIGURE 7 - ARRANGEMENT OF TWIN METERS. SERIES CONFIGURATION WITH A BY-PASS



Note: *This arrangement is useful only as a standby arrangement and not as check metering.*

FIGURE 8 - ARRANGEMENT OF TWIN METERS. PARALLEL CONFIGURATION



Note: In this arrangement, meters are installed in parallel, but an internal cross over is provided to enable the meters to be run in series for check and calibration purposes. This combination gives the best flexibility and ease of operation. It is often considered on larger installations where an economic justification can be made against loss of accuracy or meter failure. This is considered to be a preferred configuration and is, normally, recommended.

FIGURE 9-- ARRANGEMENT OF TWIN METERS. SERIES/PARALLEL CONFIGURATION WITH CROSS-OVER

7.6.8 Upstream metering

While the foregoing requirements indicate that the meter is positioned downstream of the regulator(s), under certain circumstances it may be appropriate to install the meter upstream of the PRI/regulator.

In such installations, volume conversion equipment (see IGEM/GM/5) shall be installed and consideration shall be given to the effects that the expected variations in the metering pressure will have on the effective turndown of the meter.

Note: When metering upstream of a PRI/regulator, any variation in supply pressure will have a significant impact on the turndown of the meter selected, as the meter would have to cope with the maximum flow at the minimum pressure, and with the minimum flow at the maximum pressure. For example, a 2 to 1 variation in absolute pressure will result in the usable turn down of the meter being halved.

7.6.9 Unregulated supplies

7.6.9.1 While the foregoing requirements indicate that the installation incorporates a regulator, under certain circumstances it may be appropriate to install an unregulated supply.

7.6.9.2 Unregulated supplies shall only be installed when the installation fulfils the following criteria:

- when the installation is within the scope of the GS(I&U)R, an exemption has been granted by HSE

  Note 1: This has, usually, only been given for a dedicated supply to a CHP installation requiring gas compression.

  Note 2: The scope of the GS(I&U)R does not include certain types of industrial and commercial premises, e.g., factories.
- the upstream conveyor (usually the GT) has given its permission, in writing, for the installation to be connected to its network and that compliance with any requirements specified by the conveyor has been, and will continue to be, achieved, and the requirements of the Gas Act, Schedule 2B have been fulfilled
- an appropriate volume conversion system has been installed (see IGEM/GM/5)
- consideration has been given to the effects that the expected variations in the supply pressure will have on the effective turndown of the meter (see clause 7.6.7)
- consideration has been given to the use of a non-return valve to prevent metering errors arising from reverse flow caused by network pressure variations

- suitable over-pressure protection devices (in accordance with IGEM/UP/6) have been installed and set correctly
- both the GT and the consumer agree to notify the other if any circumstance arises that would invalidate previously approved designs
- when MIP_u not exceeding MOP_c and DP_{mi}
- the installation is fed from a dedicated pipeline
- for OP_u exceeding 2 bar, a dedicated housing/compound for the meter installation is to be provided (see IGEM/GM/8 Part 2).

SECTION 8 : FILTRATION

8.1 GENERAL

8.1.1 Any meter, PRI/regulator and instrumentation system shall be protected adequately against gas-borne dust and liquids that may be present in the upstream system, by incorporating a suitable extraction system on the inlet of the installation.

Note: A diaphragm or USM installation of MOP_u not exceeding 75 mbar does not, normally, require an extraction system.

8.1.2 The extraction system shall be sized for the maximum volumetric flow at minimum system inlet pressure, with an inlet gas velocity not exceeding 20 m s^{-1}.

8.1.3 The extraction system shall be designed to produce an acceptable pressure loss when clean to ensure satisfactory operation of downstream equipment. Unless it is known that a higher pressure loss is acceptable, the pressure loss across a clean extracting system should not exceed those given in Table 3.

MOP	MAXIMUM PRESSURE LOSS
≤ 75 mbar	0.6 mbar
> 75 mbar ≤ 2 bar	20 mbar
> 2 bar ≤ 7 bar	100 mbar
> 7 bar ≤ 38 bar	100 mbar or as manufacturer's instructions.

Note: In certain circumstances, a lower pressure loss than indicated may be essential.

TABLE 3 - MAXIMUM PRESSURE LOSS ACROSS EXTRACTION SYSTEMS

8.1.4 The chosen form of protection shall be installed at the inlet of the meter installation. As a minimum, it shall be a closed end in-line strainer (top/witches' hat for OP_u not exceeding 75 mbar) mounted in the pipe and, for OP_u exceeding 75 mbar where maintenance will need to be undertaken, a box type design where elements can be withdrawn from the housing without breaking the main pipe.

8.1.5 Any in-line type strainer should incorporate some form of external indication of its type, presence and correct installation, such as a handle or label. Other extraction systems should have an identifying plate showing the type and method of operation of release mechanisms.

8.1.6 Any box type filter shall be constructed in accordance with an appropriate standard e.g., GIS/E13, GIS/E13.1.

8.1.6 Where filters are manufactured as a pressure vessel, a recognised construction standard such as, PD 5500, ASME VIII, BS EN 13445-1, GIS/E13.1 or GIS/E13 shall be used.

8.1.7 Any box-type extraction system should have its closure constructed such that it can be opened safely and be fitted with a safety blow down system.

8.1.8 Any extraction system shall have a clear indication of the direction of flow.

8.2 INSTALLATION FILTRATION

8.2.1 Any body of an extraction system of diameter 80 mm (3 in) and larger should incorporate quick-release closures.

8.2.2 Suitable pipework connections shall be provided to enable venting and/or purging and, where necessary, draining of primary cleaning components, prior to changing elements. Extraction systems should be vented using a downstream connection.

Note: This is to ensure that dirt and debris is not dislodged from the filter elements and brought back into the pipework and the filter unit itself.

8.2.3 It shall be ensured, by appropriate configuration or component design, that debris cannot fall into pipework when removing any cleaning element.

8.2.4 Tappings should be provided across any primary cleaning element to enable the differential pressure reading devices to be fitted if required.

Note 1: The tapping may be plugged or comprise a pressure test nipple with sealing screw.

For MOP_u exceeding 75 mbar, any tappings shall be valved.

On a large installation, provision should be made to enable the pressure drop across any filter to be monitored.

Note 2: This can be applied to each individual filter, or across the filter installation as a whole.

Where a differential pressure gauge is provided, it shall incorporate a slave pointer to record the maximum differential pressure reached between inspections.

Note 3: If the meter installation incorporates a telemetry link, a differential pressure transducer may be considered.

Note 4: Remote indication of the differential pressure may be desirable.

8.2.5 For MOP_u not exceeding 7 bar, cleaning element cut offs shall be $\leq 250\ \mu m$ except:

- $\leq 50\ \mu m$ for an RD meter without scraper tips
- $\leq 50\ \mu m$ for any meter installation at 2 bar < $MOP_u \leq 7$ bar.

Note: Notwithstanding these limits, it may be desirable to install a finer mesh/strainer size.

8.2.6 For MOP_u exceeding 7 bar, the following apply:

- any filter/strainer shall be to a suitable recognized standard
- any filter/strainer element should be of a disposable glass fibre type which shall achieve a filtration level of between 2 µm and 50 µm dependent on the sensitivity of the downstream system to contamination

  Note: Elements with mesh or gauze construction are not recommended.
- cyclic pressure conditions shall be considered and specified in the filter/strainer design
- at least two filters/strainers should be incorporated, one active, one on standby
- a pressure-balancing bridle shall be fitted around each filter/strainer inlet valve (FIV). Connections should be of such size to be resistant to mechanical damage
- if the meter installation has a telemetry link, differential pressure monitoring should be installed.

8.3 AUXILIARY LINE FILTRATION

8.3.1 The general principles of Sub-Section 8.1 shall be applied for gas supplies to slam-shut actuators, valve actuators, pilot regulators, other auxiliary systems and instrumentation which shall incorporate a filter/strainer with a cut-off ≤ 50 μm or finer if specified by the manufacturer.

Note: Single, low-capacity, filters are acceptable.

8.3.2 Removal of any filter element shall be possible without disconnection of pipework.

8.4 TEMPORARY FILTERS/STRAINERS FOR COMMISSIONING

8.4.1 Any turbine or RD meter should be fitted with a strainer for commissioning, unless the complete meter installation has been manufactured and assembled under workshop-controlled conditions when it may be deemed unnecessary.

For MOP at the filter/strainer not exceeding 75 mbar, the element shall be an open-ended, in-line, mesh type or skirt-type strainer inserted in horizontal pipework between any meter regulator and the meter. For MOP exceeding 75 mbar, this element shall be a closed end, in-line, mesh type strainer.

Note 1: This strainer is required to protect the meter from any welding slag, pipe scale, rust or other debris existing or occurring in the pipework between the meter and regulator(s), which might otherwise damage the meter.

Note 2: The open-ended strainer is considered to be adequate at low pressures as there is unlikely to be any gas borne dust/debris due to low gas pressure and velocity. They have the added advantage of a relatively low pressure drop, which is important when metering at low pressures. However, at higher pressures, gas-borne dust is more likely and the pressure drop is less critical.

8.4.2 The strainer mesh size shall not be finer than that of the main installation filtration and should not be coarser than 250 μm or 50 μm for RD meters without scraper tips.

8.4.3 Provision shall be made in the design of the pipework to enable removal of the strainer following commissioning of the installation.

8.4.4 For an RD meter, the strainer should be fitted as near as practicable to the inlet of the meter.

8.4.5 For a turbine meter, the strainer should be at least 3D (or other distance as recommended by the meter manufacturer) upstream of the inlet of the meter. Where the meter is installed in accordance with the manufacturer's requirements for fiscal type metering applications, and these allow the strainer to be installed within 3D of the meter, this information shall be obtained in writing from the manufacturer and retained with the site records.

Note: It is likely that installing the strainer any closer than 3D will result in significant metering errors.

8.4.6 Where the main installation filters/separators and regulators are installed separately (with interconnecting pipework) provision should also be made for a temporary strainer to be installed upstream of each PRI/regulator stream, including a suitable means of removal.

SECTION 9 : PRESSURE CONTROL

9.1 GENERAL

9.1.1 For MOP_u not exceeding 75 mbar, any valve within a regulator shall be open at rest.

9.1.2 Any regulator shall conform to BS EN 88, BS EN 334 or IGEM/GM/PRS/33, as appropriate, or shall comply with the general principles of such standards.

9.1.3 Any breather shall be resistant to water ingress and shall enable a pipe to be fitted via a screwed connection to BS EN 10226.

9.1.4 Any pressure-controlling spring supplied as part of a regulator should be colour coded or otherwise identifiable as to its pressure range.

9.2 SIZING A PRI/REGULATOR

9.2.1 The PRI/regulator should be selected so as to provide the necessary performance required by the meter and by the load being supplied through the meter under all foreseeable operating conditions at the inlet to the meter installation.

Any PRI/regulator shall be able to pass the required load with the installation inlet pressure at DmP_u while maintaining the outlet pressure above DmP_c.

When a meter is installed downstream of a regulator, the regulator shall be able to maintain the required meter inlet pressure within the tolerances given in Sub-Section 9.3.

When sizing a regulator, due consideration shall be taken of the pressure loss across filters, inlet valves and pipework which will reduce the inlet pressure to the regulator at high flows.

Note: In particular, this is important when the inlet pressure is as low as DmP_u.

9.2.2 Where significant volumes of gas are expected to flow at less than 2% of the maximum capacity of a regulator, consideration shall be given to the installation of either a smaller parallel stream to cope with those low flow rates or identical stream(s).

Note: Hunting could occur when the regulator operates at a flow of less than 2% of its maximum capacity. This could, in turn, affect the accuracy of any meter and the operation of the consumer's appliances.

9.3 CONTROL OF METER INLET PRESSURE

The following assumes that a meter is installed downstream (not upstream) of a regulator.

9.3.1 The regulator shall be capable of controlling, in a stable manner, the meter inlet pressure over its designed flow range and over the anticipated range of installation inlet pressures.

Note: To achieve the control accuracy specified in clause 9.3.2 over the anticipated range of inlet pressures, a regulator that is balanced against the effects of inlet pressure will normally be required. A two stage regulator may also provide an enhanced level of control.

9.3.2 The meter inlet pressure shall be controlled to within the accuracy limits given in Table 4, unless automatic volume conversion is fitted to the meter (see IGEM/GM/5) in which case the limits given in Table 4 may be relaxed (see Table 5).

9.3.3 Where the annual quantity of energy expected to pass the meter is less than 732 MWh and the metering pressure is greater than 21 mbar, a volume converter shall be installed.

METER INLET PRESSURE	CONTROL ACCURACY
≥ 21 mbar ≤ 100 mbar	± 7.5% (gauge) preferred ± 10.0% (gauge) limit*[2]
> 100 mbar ≤ 38 bar	± 1% (absolute)

Note 1: The flow range is from 5% Q_{imax} to 100% Q_{imax}.

Note 2: When the 10% gauge limit is applied, due regard needs to be paid to ensuring minimum required delivery pressure to downstream appliances.

TABLE 4 - CONTROL ACCURACY OF METER INLET PRESSURE (WITH FIXED FACTOR CONVERSION)

METER INLET PRESSURE	CONTROL ACCURACY (GAUGE)
≥ 21 mbar ≤ 100 mbar	± 7.5% (gauge) preferred ± 10% (gauge) limit*[2]
> 100 mbar ≤ 350 mbar	± 5% (gauge)
> 350 mbar ≤ 38 bar	± 2.5% (gauge)

Note 1: The flow range is from to 5% Q_{imax} to 100% Q_{imax} .

Note 2: When 21 mbar < the regulator set pressure ≤ 75 mbar and when the 10% gauge limit is applied, due regard needs to be paid to ensuring minimum required delivery pressure to downstream appliances.

TABLE 5 - CONTROL ACCURACY OF METER INLET PRESSURE (WITH AUTOMATIC VOLUME CONVERSION)

9.4 REGULATOR LOCK-UP

For normal inlet pressures, i.e. up to MOP_u, as flow is reduced slowly from 5% Q_{imax} to zero, the regulator shall not permit the regulator outlet pressure to rise by more than 5 mbar or 5% of the meter inlet pressure, whichever is the greater, above the value at 5% Q_{imax}.

For installations with a MOP_u not exceeding 75 mbar, for inlet pressures exceeding MOP_u, up to and including $DMIP_u$, an additional 2 mbar increase is permitted.

9.5 REGULATOR RESPONSE TIME

Regulator response time is a measure of the time in which a regulator opens or closes in response to an abrupt change in pressure caused by a change in demand flow rate.

9.5.1 The response time shall be sufficiently short to follow the variations in outlet pressure caused by changing demand flow rate.

The load profile of the supply shall be determined by consultation with the consumer and the regulator performance matched to meet the load characteristics.

Note 1: Installations of MOP_u not exceeding 75 mbar and which are fitted with direct acting regulators are only likely to be problematic when subjected to extreme changes in load.

Note 2: Failure to take into account the load profile on systems of MOP_u exceeding 75 mbar can lead to inadvertent operation of relief valves and slam-shut valves.

Note 3: In some instances where large swings in load change are to be expected, a complete system analysis would need to be carried out by a suitably qualified organisation.

9.6 PRESSURE SET POINTS FOR TWIN STREAM INSTALLATIONS

9.6.1 Where an installation has parallel regulator streams whose purpose is to provide the necessary flow capacity, the set points shall be as close together as practicable (see also clause 9.6.2) and the pressure at the meter shall not vary by more than the control tolerances given in Sub-Section 9.3.

Note: This does not apply to regulator streams that are used only as standby streams.

9.6.2 Where more than one regulator stream may be in operation at any given time, there shall be a differential between the set points, to prevent instability. The minimum differential between the set points of any two regulators shall be:

- for OP_{mi} not exceeding 7 bar; 2.5% OP_{mi}
- for OP_{mi} exceeding 7 bar; 1% OP_{mi}.

Note 1: In addition to twin stream for capacity installations this may also apply where working and standby stream active regulators have had to be set close together due to customer pressure requirements.

Note 2: Instability can occur where two or more parallel streams operate with insufficient differential(s) between their set points.

Note 3: On a system where the nominal meter inlet pressure would be 21 mbar, at lower flow rates when only one regulator operates, the set pressure will have to be in excess of 21 mbar.

Given Sub-Section 9.3 and clause 9.6.1, the necessity to separate the set points and fit additional valves will result in the capacity of a twin-stream regulator installation being less than double the individual regulator capacities, particularly when operating at a low pressure.

9.7 MONITOR REGULATORS

9.7.1 Any monitor regulator shall be upstream of the active regulator.

Note: Monitor regulators are only applicable for MOP_u exceeding 2 bar (see Figure 2).

9.7.2 The speed of response when closing shall be the same or faster than the speed of response of the active regulator when opening.

Note: This could be achieved by using a direct acting regulator as the monitor. The active regulator could be a pilot controlled regulator (for control accuracy).

9.8 ABNORMAL LOADS

9.8.1 Consideration shall be given to the effects of abnormal loads.

Note 1: If sudden changes in flow rate occur, a pressure variation may arise due to the inertia of RD meter impellors, or the inability of a regulator to respond sufficiently quickly. Regulator control may be sufficiently disturbed to cause operational problems. This is, particularly, important for installations operating at elevated pressures or feeding unusual downstream plant, for example power stations and combined heat and power (CHP) plant.

Note 2: Adverse effects may be avoided by the consumer installing slow acting controls on major appliances served by the meter, and/or installing buffer vessels. Where this is not practical, installing a fast response regulator or a meter with low inertia may also assist.

In some cases, a separate meter and regulator stream may be required to supply only the appliance that is fluctuating.

Advice regarding such installations can be obtained from specialists who will be able to model the installation using a dynamic analysis programme.

Note 3: Further information on the design and installation of gas boosters, compressors and engines is provided in IGEM/UP/2, IGEM/UP/6 and IGEM/UP/3, respectively.

9.8.2 For installations subject to abnormal loads, the following should be assessed:

- instantaneous start up
- ramp rate i.e. load changes over time
- decrease in load against time
- load prior to shut down, for example turbine – generator running synchronous idle
- ability of the downstream system to absorb pressure surges.

9.9 SEALING REGULATORS (see also Section 6)

9.9.1 Any regulator (and any associated pressure protection device) shall be capable of being adequately sealed so as to prevent unauthorised adjustment without breaking the seal.

9.9.2 Provision should be made, in the form of an appropriately located hole of minimum diameter 2.5 mm, for fitting an appropriate seal.

Note: The regulator has to be sealed by the manufacturer or by an AMI authorised by the GT (see Section 6).

9.10 AUXILIARY SYSTEMS

9.10.1 Any regulator and its associated control equipment should not be selected in isolation but as a complete system. Each regulator stream shall have its own dedicated system.

9.10.2 Any auxiliary system should be fitted with an inlet and outlet valve. The inlet valve should be followed by a filter, the cut-off of which should be determined by reference to manufacturer's instructions but should not be greater than 50 μm. The filter should be suitably sized having regard to the condition of the supply mains system, particular attention being paid to the possibility of entrainment of liquids.

9.10.3 The section of the auxiliary system normally exposed to inlet pressure shall be designed to withstand MIP_u.

All components included within the auxiliary system, and the parts of the main regulator to which the control signal is applied, shall be designed to withstand MOP_u. Where this is not reasonably practicable, measures should be taken to prevent unsafe pressures occurring in any part of the installation. Where applicable, this may be achieved by the inclusion of a suitably positioned pressure relief valve within the auxiliary system.

9.10.4 Separate sensing lines shall be provided for each outlet pressure control pilot.

9.10.5 All auxiliary pilots and valves that are accessible to the consumer, and whose operation can adversely affect the safety of the installation and/or metering accuracy, shall be capable of being sealed (see Sub-Section 9.9).

9.10.6 On an installation of MOP_u exceeding 7 bar, programmable electronic controls may be used to enhance or replace the pneumatic technology. When utilising such controls, IGEM/SR/15 shall be applied.

9.10.7 Those parts of the regulator stream equipment and systems from which release of NG might arise during normal operation shall be identified and an assessment made of the feasibility of modifying the design to minimise both the likelihood of such release and/or the rate of release.

9.10.8 The breathers and vents of pilots and auxiliaries should be threaded.

Note: This will permit piping to a safe area.

SECTION 10 : SLAM-SHUT VALVE (SSV) SYSTEMS

10.1 Any SSV shall not allow the pressure in the downstream system to exceed MIP_{mi} that shall not exceed STP_{mid} or $STP_{c.}$

10.2 Any SSV shall:

- be fully automatic in operation
- require manual re-setting
- be able to withstand external vibration and shock without tripping
- be reliable, repeatable and secure in operation
- include indication of operation, for example a local visual mechanical indicator or, where telemetry is fitted, a remote indication alarm.

10.3 Any SSV should comply with BS EN 14382.

10.4 Any SSV of MOP exceeding 7 bar shall be either an actuator fitted to the stream inlet isolation valve (SIIV) or be a dedicated SSV, or be incorporated into the monitor regulator mounted upstream of any active regulator.

Note: Mechanical trip-type SSVs are preferred.

10.5 Any SSV of the actuator type which operates at a pressure exceeding 7 bar shall comply with an appropriate standard, for example ISO 14313 (for the valve) and GIS VA1/E or GIS VA2/E, as appropriate (for the actuator).

10.6 The impulse tapping for any SSV shall be positioned at a suitable point, between the regulator and the first isolation valve downstream of the regulator. The design shall be such as to accurately reflect downstream system pressure at all design, and potential fault, flow and pressure conditions.

10.7 There shall be no detrimental movement of the SSV's trip mechanism at flows not exceeding 120% Q_{max} of the installation stream with any combination of inlet and outlet pressure for which the installation is designed.

Note 1: The pipework will have to be correctly sized to ensure that the pressure generated at the slam-shut sense point is not so high as to cause detrimental movement of the SSV's mechanism.

Note 2: SSV sense pressures approaching the SSV's accuracy group limit could cause movement of the SSV mechanism. Such movement needs to be avoided as it can lead to subsequent spurious operation of the SSV. The preferred accuracy group (AG) of SSVs is:

- *OP not exceeding 7 bar; 5%*
- *OP exceeding 7 bar; 1%.*

Note 3: Instantaneous changes in demand can cause momentary high pressures in the regulator stream which could result in tripping of an SSV – an additional override control may be necessary.

10.8 High velocities, for example as caused by a regulator fault, can cause low or negative pressure at the SSV sense point. Consequently, consideration shall be given to ensuring the pressure at the SSV sense point is not so low as to prevent the SSV operating if MIP_{mi} is reached at the regulator pressure sense point.

Note 1: Regulator sense pressure is the pressure at the sensing point of the regulator.

Note 2: Short term high gas velocities can occur when systems have "step" control action. An additional overriding control may be needed if these high velocities would result in an unacceptable pressure at the SSV sense pressure point.

10.9 Any SSV that is accessible to a consumer shall be capable of being sealed so as to prevent unauthorised adjustment in accordance with clause 9.9.2.

SECTION 11 : PRESSURE (CREEP) RELIEF

11.1 Where appropriate, a meter installation shall incorporate creep relief (see clause 7.6.1.9).

Note: Creep relief is included to prevent nuisance operation of a SSV resulting from let-by due to worn or dirty regulator seats or, in some cases, to protect against pressure increase due to solar/thermal gain on downstream pipework.

11.2 Any creep relief shall be sized to limit to the lowest practical level the quantity of gas passing through the vent.

The capacity of any creep relief shall not exceed 1% of the respective stream design capacity or 3 $m^3 h^{-1}$, whichever is the greater.

11.3 Any creep relief intended to operate at a pressure not exceeding 7 bar should be direct-acting.

If a pilot-operated relief is used, a test connection should be provided.

11.4 Where a meter installation includes a stream discrimination system based on a swinging plate check valve, the creep relief shall be located between the valve and the active regulator. The creep relief valve shall, in this instance, be capable of relieving the creep past the active regulator and reverse-flow (creep) across the closed check valve at a pressure differential of MIP less OP, occurring simultaneously.

For systems not employing a check valve, any creep relief shall be located between the active regulator and the SOIV.

11.5 Gas discharged from a creep relief valve shall be vented to a safe place (see Section 17). The location of the creep relief vent termination shall be in accordance with IGEM/GM/8 Part 2. IGEM/GM/7B or IGEM/SR/25 shall be used to determine the hazardous area resulting from the vent.

11.6 An isolation valve shall not be fitted between the relief valve and the PRI/regulator stream it is protecting, except where MOP_u exceeds 7 bar when such a valve may be included, along with suitably positioned tappings to enable a nitrogen test to be carried out on the relief valve. Such a valve should be padlocked in the open position and the key held by the responsible person.

11.7 Any creep relief valve shall be set such that it is capable of preventing nuisance firing of the SSV, but should be set higher than the expected lock-up pressure of the pressure regulator(s).

Care should be taken to avoid nuisance venting at periods of zero flow when the regulator(s) lock-up.

11.8 Any pressure relief that is accessible to the consumer shall be capable of being sealed so as to prevent tampering, in accordance with clause 9.9.2.

11.9 For MOP exceeding 7 bar where demands on the downstream system (combined with the degree of lock-up achieved by the regulator(s)) could lead to unacceptable operation of any creep relief valve, consideration shall be given to increasing the level of isolation.

The increased level of isolation may be a dedicated tight shut-off valve in every regulator stream, in which case consideration shall be given to:

- failure modes of the valve and its control system
- pressure drop across the valve when open
- adequacy of the speed of opening
- the location within the whole meter installation.

When utilizing an electronically controlled valve, the system shall comply with IGEM/SR/15.

SECTION 12 : METERS

12.1 GENERAL

12.1.1 Any meter shall be appropriate to the load being supplied.

Note: Correct matching is required for both the size and characteristics of the load (Figure 30 in Appendix 13 and Table 7 provide guidance).

12.1.2 Any meter of capacity not exceeding 1600 m^3h^{-1} std at 15°C and 1013.25 mbar must be approved by a notified body in accordance with MID (CE marked) or Measuring Instruments Regulations (MIR) (UKCA marked) and must be stamped (labelled) prior to delivery.

Note: Such a meter can only be installed and used if it has been type approved and stamped (that is sealed in accordance with Section 17 of the Gas Act, as amended).

For a meter of capacity exceeding 1600 $m^3 h^{-1}$ std, one of the following options shall apply:

- the meter is approved and stamped accordingly
- a commercial contract exists between the consumer, shipper/supplier, GT and the MEM, which will specify the accuracy requirements for installation, maintenance and validation requirements.

12.1.3 The direction of flow through the meter should be left to right when viewing the index end.

12.1.4 Any meter shall include an index used as prima-facie evidence of gas used and the index must register in cubic metres (m^3).

Note: For any USM, the index may be incorporated as part of a flow computer.

12.1.5 Any meter shall be installed in accordance with clause 7.6.3.

12.1.6 Any meter shall comply with the standards shown in Table 6.

Note: The provision of an "EC" stamp is primarily for the removal of "Barriers to Trade" and enables meters so marked to cross borders in EC countries. Nevertheless, the EC Directive 71/318/EC specifies the accuracy requirements for those types of meter that are used when the measurement is subject to statutory regulations. Meters conforming to the Directive and which are duly approved and examined, and bear the EC mark of approval and initial verification, may be used legally in all EC member states and the UK, although legislation in individual states may also permit the use of meters conforming to alternative standards within that state, such as MIR in the UK

METER TYPE	STANDARD
Diaphragm	BS EN 1359 or BS 4161-3, 5
RD	BS EN 12480 or BS 4161-6
Turbine	BS EN 12261 or BS 4161-6
USM	BS 7965.
Thermal mass	BS EN 17526

TABLE 6 - METER CONSTRUCTION STANDARDS

12.2 PRESSURE RANGE

A meter shall not be used outside its designed and badged pressure range. Table 7 provides guidance on the pressure ranges available.

12.3 FLOW RANGE

12.3.1 The flow being measured by a meter should be, as far as possible, within its flow range (Q_{min} to Q_{max}) as specified by the manufacturer.

For a metering pressure not exceeding 21 mbar, the maximum flow should not exceed Q_{nom} of the meter (see Sub-Section 12.4).

The maximum flow rate must not exceed the meter badged maximum flow.

Table 7 and Appendix 13 should be used to assist in the selection of the meter, and IGEM/GM/4 may be used to assist in the sizing of a meter.

12.3.2 Where relatively small volumes of gas are passed at the lowest flows anticipated, it may be uneconomic to measure accurately over the complete flow range. Consequently, the integrated accuracy should be estimated for a period of one year, to achieve an economic design that complies with clause 4.2.2.1.

Note 1: Invariably, a flow rate lower than Q_{min} will be under-registered and, in extreme cases, will not be registered at all. Therefore, it is necessary to consider the total quantity of gas likely to flow under such conditions during the yearly period to determine a realistic overall metering accuracy for the installation.

Note 2: On installations where the range of flows being measured is such that it is not possible to ensure that the load is, normally, within the usable range of the meter AND where significant volume of gas is passed below meter Q_{min}, the starting flow rate could influence meter selection.

In most cases, the usable range of the meter is best used as the primary method of meter selection, as this gives the best indication of the range over which the meter will accurately measure the passage of gas.

A meter starting flow is not part of its usable range. It depends greatly on factors specific to the individual meter, such as bearing friction, impeller position, tip clearance, oil viscosity, dust contamination, bearing wear, etc. and, as such, is not a good guide for meter selection.

12.3.3 Any meter should not be oversized to accommodate high flow rates that may occur very infrequently. However, consideration shall be given to possible short term over-speed effects. Under such circumstances, overload flow rates shall be limited to 120% Q_{max}.

Note 1: Pressure absorption limitations may result in some over-sizing of the meter being necessary.

Note 2: Over-sizing a meter could reduce significantly the effective turndown of the meter. This may result in a significant under-registration of the gas supplied.

Note 3: An example of the type of situation for which the meter is not to be oversized would be an excessive flow which might occur during commissioning of certain plant such as a gas compressor. In some cases, it may be necessary to restrict the way in which the consumer's plant operates to avoid over-speeding the meter.

FACTOR	DIAPHRAGM	RD	TURBINE
Range of Q_{max}	6 to 160 $m^3 h^{-1}$ 212 to 5650 $ft^3 h^{-1}$.	25 to 2,885 $m^3 h^{-1}$ 800 to 102,000 $ft^3 h^{-1}$.	65 to 25000 $m^3 h^{-1}$ 2275 to 882,875 $ft^3 h^{-1}$.
Typical pressure range	0 to 75 mbar. Others available as special case	0 to 10 bar. Special meters available up to 38 bar.	0 to 38 bar.
Typical rangeability (and accuracy)	Badged: 50:1 (± 2% to ± 3%) Usable: > 150:1 (± 2% to ± 3%) Dynamic: > 1000:1.	Badged: 20:1 to 50:1 (± 1% to ± 2%) Usable: > 50:1 (± 1% to ± 2%) Dynamic: 500:1.	Badged: 10:1 to 30:1 (± 1% to ± 2%) Usable: > 10:1 (± 1% to ± 2%) Dynamic: 75:1.
Effect of gas density	Unaffected in design range within manufacturer's specification.	Insignificant.	Minimum flow is lowered with increased density, increasing the usable and dynamic rangeability.
Effect of gas borne solids	Normally unaffected but coarse filter recommended at higher pressures.	Meter may stop rotating. Filter required.	Blades may be damaged and freedom of rotation may be affected. Coarse filter required.
Effect of gas borne liquids for example water, oil, grease etc	Corrosion possible. Freezing may result in damage. Materials of construction may be affected. Over-registration possible.	Corrosion possible. Oil may be displaced from gears. Freezing may stop the meter. Materials of construction may be affected. Under-registration possible.	Corrosion possible. Freezing may result in damage. Lubricant dilution and rotor imbalance possible. Materials of construction may be affected. Inaccuracy possible.
Pressure variations	Excessive differential pressure variations will cause damage.	Rapid change of differential pressure may cause damage.	Rapid pressure changes may cause damage or registration errors. Particular problems when meters are installed interstage at higher pressures.
Acoustic Noise	Unaffected.	Unaffected.	Unaffected.

Note 1: *Flow range specified is related to actual flow through a meter at the prevailing pressure and temperature. Consequently, metering pressure has to be taken into account when selecting a meter. The flow range also affects the accuracy of the meter and needs to be taken into account.*

Note 2: *When a meter is installed upstream of the pressure regulator, any variation in inlet pressure to the meter will have a significant impact on the turndown of the selected meter. The meter will have to cope with the maximum flow at the minimum pressure and the minimum flow at the maximum pressure. A two to one variation in pressure will result in a halving of the usable turndown of the meter.*

TABLE 7A - FACTORS AFFECTING METER SELECTION, ACCURACY AND PERFORMANCE

FACTOR	THERMAL MASS FLOW	MULTIPATH & CARTRIDGE TYPE ULTRASONIC
Range of Q_{max}	2.5 - 160 $m^3\ h^{-1}$	65 to 85,000 $m^3 \cdot h^{-1}$
	88 - 2,296 $ft^3\ h^{-1}$	28,000 to 3001,900 $ft^3\ h^{-1}$.
Typical pressure range	0 - 500 mbar	0 to 38 bar.
Typical rangeability	150:1	Certified over 40:1 to 160:1 (1%)
(and accuracy)	1.5%	Usable: > 40:1 (1%)
	Dynamic: Not Applicable	Dynamic: Not applicable.
Effect of gas density	Generally unaffected by density; The measurement principle is based on King's Law and takes account of the heat capacity of the gas relative to the density.	Meter accuracy does not deviate over the specified working range of transducers. Certain types of transducer will not operate at low densities dependent upon meter size, line density and gas composition.
Effect of gas borne solids	Normally unaffected; Type Test Approval requires the application (and passing) of a contaminants test.	Normally unaffected, but contamination of the transducers can affect meter performance.
Effect of gas borne liquids for example water, oil, grease etc	Accuracy may be affected by contamination of the heating element. Corrosion possible depending on materials used and material coating system.	Liquids settling in the bottom of the meter, or grease on the internal walls reduce the cross-sectional area and cause the meter to over-read. Freezing may cause a temporary increase in uncertainty.
	Freezing has the potential to present problems	Materials of construction may be affected.
Pressure variations	Normally unaffected	Normally unaffected.
Acoustic Noise	Normally unaffected	Can be affected by acoustic noise. Precautions need to be taken with the location of the meter and its proximity to noise sources such as control valves, pressure regulators and partially open line valves.

Note 1: Flow range specified is related to actual flow through a meter at the prevailing pressure and temperature. Consequently, metering pressure has to be taken into account when selecting a meter. The flow range also affects the accuracy of the meter and needs to be taken into account.

Note 2: When a meter is installed upstream of the pressure regulator, any variation in inlet pressure to the meter will have a significant impact on the turndown of the selected meter. The meter will have to cope with the maximum flow at the minimum pressure and the minimum flow at the maximum pressure. A two to one variation in pressure will result in a halving of the usable turndown of the meter.

TABLE 7B - FACTORS AFFECTING METER SELECTION, ACCURACY AND PERFORMANCE

12.4 PRESSURE LOSS ACROSS A METER

For a meter operating at an inlet pressure of 21 mbar, at the required Q_{imax}, the pressure loss across the meter shall not exceed 1.25 mbar on gas, unless it is known that a higher pressure loss is acceptable and safety and operational requirements are not compromised.

The meter pressure loss is of less significance when the meter is operating in excess of 21 mbar. However, due consideration shall be given to providing a suitable pressure for the downstream connected appliances.

Note 1: The Gas (Meters) Regulations specify a maximum pressure loss allowable across the various sizes of diaphragm meter. The maximum pressure loss allowed in the Regulations varies with the size of the meter (the highest pressure loss allowed is 4 mbar measured on air and 2.4 mbar measured on gas).

Note 2: There is no legal limit to the pressure loss allowed across an ultrasonic, RD or turbine meter. In practice, the pressure loss at maximum flow when passing gas at near atmospheric pressure is unlikely to be more than 10 mbar. For a meter of OP_{mi} not exceeding 75 mbar, this pressure loss may be unacceptable, as it could result in insufficient pressure at the appliance.

Note 3: It may be necessary to operate a meter at less than its "badged" capacity (Q_{max}) in order not to exceed the permitted pressure loss. In such cases, the usable turndown will be reduced, in which case it is vital to establish realistic actual maximum and minimum flows. This is of particular relevance when using ultrasonic, RD or turbine meters for MOP_u not exceeding 75 mbar.

Note 4: As an alternative to using an oversized meter, it may be possible to meter at a higher pressure than normal and to apply appropriate pressure conversion. This solution is preferable to using an oversized meter, but, usually, is not possible for MOP_u not exceeding 75 mbar. When metering at pressures exceeding 21 mbar, appropriate pressure conversion may be achieved either by the installation of a volume conversion device, or the use of a site-specific fixed factor. These may only be applied in accordance with The Gas (Calculation of Thermal Energy) Regulations.

12.5 EFFECTS OF LOAD

12.5.1 Diaphragm meters

In general, diaphragm meters are unlikely to be affected by downstream load changes. However, diaphragm meters should not be installed where they are subject to vibration and continuous pressure pulsations.

Note: Both of these effects can be caused by boosters or compressors and may cause the valve mechanism to "bounce", thus giving rise to substantial under-registration.

12.5.2 RD meters

Where large step load changes are anticipated, or where a booster (or compressor) is installed, or where small burners, for example permanent pilots, are also supplied, an RD meter should be used with caution as they can cause operating problems.

Note 1: In extreme cases, a sudden load increase may cause a temporary low pressure at the meter outlet, resulting in pilot outage or burner system lock-out. A sudden load decrease may cause the meter to over-run, resulting in a temporary over-pressure condition with consequences similar to the low pressure condition.

Note 2: These problems (due to meter inertia) may be minimised (by the consumer) by installing a large reservoir of gas between the meter installation and the appliances or, in some cases, the installation of a suitable NRV at the outlet of the meter installation.

Where possible, the use of an RD meter for such loads should be avoided, using a diaphragm meter or, in some cases, a turbine meter as an alternative. Where use of an alternative meter type is not possible, a dynamic analysis model (see Note 3 to clause 9.5.1) should be performed to determine whether the expected transient pressure changes are within acceptable limits.

Note: RD meters generate small pressure pulses. If the meter is subjected to pressure pulsations of similar frequency (or simple harmonics thereof) to the inherent meter pulsation, the system may resonate. Substantial metering errors may arise if resonance occurs and, if the condition persists, the meter may be damaged.

12.5.3 **Turbine meters**

12.5.3.1 A turbine meter should not be used to measure flows which are rapidly pulsating, nor should one be used where the total metered gas flow is on/off, unless the on-time is greater than 30 minutes. The necessary on-time can be reduced to 2 minutes if a continuous base load flows through the meter equal to at least 10% of the maximum metered flow.

Note 1: This is because the turbine wheel continues to rotate for some time after the flow through the meter has ceased, which can result in substantial errors. With certain turbine meters, the above requirements may be relaxed and shorter on-times would be acceptable, provided the meter manufacturer gives an assurance that metering errors due to non-steady flow will not exceed 1%.

Note 2: Pulsating flows may be caused by cycling loads having on/off control or even by some high/low controls. In addition, reciprocating gas compressors and engines will give rise to flow pulsations which would affect the metering accuracy and, in extreme cases, can reduce operational life or cause damage.

12.5.3.2 Where it is not possible to use an alternative type of meter, steps shall be taken by the consumer to ensure that flow oscillations at the meter are reduced to within the limits specified in IGEM/UP/6. Where flow pulsations are suspected, a dynamic analysis should be performed to verify that the pulsations have been reduced to an acceptable level.

12.5.4 **USMs**

In general, USMs are unlikely to be affected by downstream loads. However, consideration shall be given to the particular "measurement and computational" strategy employed, as certain combinations of strategy and load characteristics may result in metering errors.

As such where pulsating or rapidly changing loads are anticipated, guidance should be sought from the manufacturer.

12.5.5 **Thermal Mass**

In general, Thermal Mass meters are unlikely to be affected by downstream loads. However, consideration shall be given to the particular "measurement and computational" strategy employed, as certain combinations of strategy and load characteristics may result in metering errors.

As such, where pulsating or rapidly changing loads are anticipated, guidance should be sought from the manufacturer.

12.6 **NOISE EFFECTS ON USMs**

12.6.1 Pressure regulators and control valves generate noise in the frequency range that can affect the operation of USMs. Care should be taken when designing systems to ensure that:

- valves are sized and selected to ensure that excess noise is not generated at the higher frequencies

- if noise is generated, the meter skid is designed in such a fashion as to include noise reduction either by the inclusion of silencers or combinations of bends and blind tees.

USMs can use transducers within various frequency ranges (usually in the range up to 300 kHz) and a noise survey may be carried out to determine the suitability of the USM for use at the required location.

On new installations where it is not possible to undertake site surveys, the valve manufacturer should be consulted at the design stage.

12.6.2 During design, meter manufacturers (who can model the system) should be consulted to ensure that a practical working design is produced.

12.6.3 The manufacturer should be consulted when planning to install a USM in the vicinity of a pressure-reducing component, including control valves, reducers, etc.

Note: Some installations, including, for example, pressure reducing control valves which are specifically designed to reduce audible noise, may produce very high levels of ultrasonic noise under certain flow conditions (even when the valve is located downstream of the USM). The ultrasonic noise from these "quiet" control valves can interfere with the operation of a nearby USM.

12.6.4 If acoustic noise is considered to be a potential problem for a USM in service, a means should be provided to monitor its impact on the meter. This is best achieved by monitoring the signal to noise ratio (SNR) (and/or the automatic gain control (AGC) for each transducer or measurement path).

Note: An alarm facility may be needed to advise the operator when the values exceed an acceptable level.

12.6.5 In general, it is good practice to locate control valves, compressors etc. downstream of any USM. If this is not possible, the maximum practical distance between the control valve and the USM should be attained.

12.6.6 Blind tees, baffles and other such fittings, which provide high attenuation, should be fitted between any source of noise and the USM. This precaution should be taken for both downstream and upstream sources of noise. These devices should be fitted at the maximum distance from the USM that the pipework will allow, given that some of them can and will produce distorted velocity profiles which may result in metering errors.

Note: Further advice may be sought from the manufacturer.

12.7 ANCILLARY EQUIPMENT

12.7.1 Any meter shall be supplied with, or be capable of being fitted with, a low frequency (LF) transmitter, as a minimum.

12.7.2 Any LF output should be mounted in such a manner as to enable its installation removal or repair without interfering with the official metrological seals. Suitable steps shall be taken to prevent unauthorised removal or tampering with the LF outputs.

Note 1: The official metrological seals of any badged meter are not allowed to be broken unless in the presence of, and instructed to do so by, a Gas Meter Examiner i.e. a person authorised under the Gas Act to stamp, or authorise the stamping of, a meter or to break a meter seal.

Note 2: Whenever installation or repair of a meter or pulse generator involves the breaking of official metrological seals, it will be necessary for a Gas Meter Examiner to be in attendance throughout to officially break the seals, witness the work and re-seal the meter after the work has been completed to the examiner's satisfaction. If the work can be undertaken without breaking the official metrological seals, a Gas Meter Examiner is not required.

12.7.3 Any need for LF and high frequency (HF) pulse outputs shall be taken into consideration when specifying the meter to be used.

Note: This will depend upon whether the installation is to be fitted with data logging, volume conversion systems, and/or telemetry.

12.7.4 Any attachment to the meter shall not invalidate the Certificate of Approval for that badged meter.

12.7.5 Any electrical connection to a meter shall be made in accordance with IGEM/GM/7A.

12.8 METER CONNECTIONS

12.8.1 Any connection on a meter shall be in accordance with Tables 8 and 9.

12.8.2 For a flanged connection, the bolt holes shall be evenly spaced around the bolt circle and shall be distributed uniformly about, but not on, the centre line between the inlet and outlet connections.

METER TYPE	METER CONNECTION	
	$Q_{max} \leq 40\ m^3\ h^{-1}$	$Q_{max} > 40\ m^3\ h^{-1}$
Diaphragm	Threaded. BS 746	Flanged BS EN 1092 PN16
RD	Threaded. BS EN 10226 or flanged	Flanged
Turbine	Flanged	Flanged
USM	Threaded. BS 746 or flanged	Flanged
Thermal mass	Threaded. BS 746	Flanged BS EN 1092 PN16

Note: Flanges are to comply with relevant Standards as described in Table 13.

TABLE 8 - METER CONNECTIONS

METER Q_{max}	CONNECTIONS (NOMINAL SIZE)		CONNECTION CENTRES		OVERALL HEIGHT	REAR METER CASING TO CENTRE	FRONT EXTREMITY TO CENTRE	WIDTH
	Thread to BS 746	Flange to BS EN 1092	(min)	(max)	(max)	(max)	(max)	(max)
($m^3\ h^{-1}$)	(in)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
16	$1^1/_4$	-	152.4	250	415	160	190	343
25	2	-	250	380	415	160	190	436
40	2	-	280	335	500	180	210	553
65	-	65	335	570	550	200	235	614
100	-	80	430	500	687	275	290	775
160	-	100	430	675	885	290	326	894

Note: The column "connection centres minimum" are the typical historic UK dimensions.

TABLE 9 - RATINGS AND DIMENSIONS OF DIAPHRAGM METERS

SECTION 13 : VALVES (see also Sub-Section 7.6)

13.1 GENERAL

13.1.1 In addition to the following clauses, valves should be selected in accordance with the guidance given in Tables 10 and 11 with respect to application and fitness for purpose.

13.1.2 Any valve shall close by turning the hand wheel or lever/handle in the clockwise direction.

There shall be clear indication of direction of operation to open or close a valve and there shall be clear indication of whether the valve is open or closed.

13.1.3 Any lever-operated valve shall be fitted/designed such that the lever is parallel with the axis of the pipe when the valve is in the open position.

13.1.4 If the spindle of a lever-operated valve is in the horizontal plane, the lever shall move downwards to close.

If the spindle of a lever-operated valve is in the vertical plane, the lever shall move towards the operator i.e. the front of the installation, to close.

13.1.5 Any hand wheel or lever/handle shall be located so that it can be conveniently operated by persons standing at ground level or on a permanent platform.

For any lever or wrench-operated valve, sufficient clearance shall be provided to access the valve.

For MOP exceeding 75 mbar and diameter exceeding 150 mm, multiple-turn hand wheel or gear-driven valves should be used.

Where a fast acting valve is utilized, i.e. lever operated, and for MOP exceeding 7 bar, consideration shall be given to provision of a small bore by-pass around the valves, to enable safe pressurisation of the downstream system.

Note: This is to minimise the possibility of damaging or over-pressurising the downstream equipment or systems.

13.1.6 Where a lever operated valve is used for MOP exceeding 7 bar, it should be of the trunnion mounted ball or plug type which can be opened incrementally to allow gradual pressurisation of the downstream equipment and system. Valves with a potential for out-of-balance forces acting to rotate the closing components, for example butterfly valves, shall not be used.

13.1.7 For MOP not exceeding 75 mbar, the valve should be of a type that minimises pressure drop. In particular, any valve (other than a MBV) intended to operate at a pressure not exceeding 25 mbar should be sized such that, at Q_{imax}, the pressure loss will not exceed 0.3 mbar.

13.1.8 Any valve installed immediately upstream of a meter shall not be of the forced lubrication type.

13.1.9 Where it is necessary to lubricate a valve for continued satisfactory operation, seals or check valves should be provided to minimise the amount of excess lubricant passing into the gas stream.

13.1.10 Non lubricated plug valves shall not be used.

13.1.11 Any valve shall comply with an appropriate standard and one that does not permit let by.

13.1.12 For MOP exceeding 7 bar, any valve (other than an ECV or an additional emergency control valve (AECV)) shall be capable of being secured to prevent its unauthorised operation.

13.1.13 For MOP exceeding 7 bar, any valve operating mechanism shall be designed such that, should any part of it fail, the failure will occur in such a manner that the part may be repaired and/or replaced without taking the valve out of commission, with the valve subject to OP and with the valve in any position from fully open to fully closed.

13.1.14 Limit switches shall be fitted to every remotely-operated valve to indicate valve open and valve closed. The signal should be relayed back to the point of operation.

13.1.15 Reference should be made to the HSG253.

13.2 STREAM AND METER ISOLATION VALVES

13.2.1 For MOP exceeding 75 mbar, any isolation valve shall be designed with a positive seal on both the upstream and downstream faces; for any single ball or gate valve of nominal bore 50 mm or greater, the space between the faces shall be constructed with the facility to install a vent and any valve of nominal bore exceeding 50 mm shall have its vent valved and plugged.

Note: At the higher pressures, care is needed when removing the plug. It may be prudent to use a fitting that will more safely allow de-pressurisation, for example a flanged valve.

13.2.2 Valves with forced lubrication as a means of providing a seal shall have valved and plugged vents or vent valves installed in the installation pipework.

13.2.3 Where two valves are used for isolation, the space between the valves shall be fitted with a valved and plugged vent.

13.3 EMERGENCY AND ADDITIONAL EMERGENCY CONTROL VALVES (ECV AND AECVs)

13.3.1 The valve designated the ECV shall be confirmed. This valve is the termination of the Network and is fitted by the gas conveyor (which is, usually, the GT).

Note 1: Where the Network pipeline is of nominal bore exceeding 50 mm and a pipeline isolation valve is fitted, it is not essential that the first above ground valve (which may be the ECV) is of a fire safe type.

Note 2: Plug and ball valves are, generally, of fire safe design, but guidance is to be sought from the manufacturer.

13.3.2 Where an AECV(s) is/are required to be fitted between the ECV and the termination of the meter installation, this must be in accordance with GS(I&U)R and such valves shall not be by-passed.

Any AECV must be labelled clearly, be readily accessible and be fitted with a means of operation, position indication and indication of the direction of operation to open or close.

Note 1: Closure of the ECV will depressurise the PRI/regulator which may result in the need for the party responsible for the PRI/regulator to be involved in re-commissioning. As such, on installations of MOP_u exceeding 75 mbar, it may be beneficial to designate a valve downstream of the PRI/regulator as an AECV.

Note 2: An ECV is able to isolate gas to all fittings downstream. An AECV will isolate gas to an individual consumer (or item of plant) but not necessarily all fittings in the system.

13.3.3 A butterfly valve shall not be used as an ECV, AECV, or as a stream or meter isolation valve where DP and/or MOP exceeds 75 mbar.

13.4 METER BY-PASS VALVES (MBVs)

Any MBV shall be provided with a purpose made means of actuation, for example a handle or wheel and be capable of being sealed in the closed position.

Note: Acceptable methods of sealing are shown in IGEM/GM/6, IGEM/GM/8 Part 3 and the REC CoMCoP.

13.5 BELOW-GROUND VALVES

13.5.1 A valve shall not be located below ground unless other options are not practical.

13.5.2 Provision should be made for the protection of glands and for remote lubrication, which should include:

- stem extensions for above ground operation
- extended vent and sealant or lubrication points
- isolation valves in the sealant injection lines having a pressure rating in excess of the pressure required to inject the sealant.

13.5.3 Stem extensions and extended spindles shall not be placed in the path of moving equipment and shall not protrude into access ways.

13.5.4 Where a valve is located in a pit:

- any pit cover should be designed to prevent ingress of surface debris into the pit
- pipe entry and exit detail design, through the pit wall(s) and/or base, should be such as to avoid the transmission of the weight of the pit structure into the pipe and should be compatible with the assumption of the pipework design (including any stress analysis) with respect to the degree of restraint of such movement.

13.5.5 Locations should be chosen free of surface water or flooding and high water tables should be avoided.

13.5.6 Any pit cover shall be secured to prevent the cover being dislodged by wind.

13.5.7 Any pit cover shall be sufficiently strong as to withstand any foreseeable loading, for example due to pedestrian traffic. Alternatively, the covered pit shall be surrounded by a substantial fence.

13.6 VALVE ACTUATION

13.6.1 For a large diameter valve (typically exceeding 450 mm), consideration shall be given to the provision of a suitable actuation device.

Note: Such a device would be needed when the force required to operate the valve exceeds that achievable by normal manual operation.

13.6.2 Any valve actuator (and its control system) shall incorporate provision for local and, where applicable, remote operation.

Note: A remotely-operated valve may be required by the GT or the consumer and the approval of those parties will be needed for its installation.

13.6.3 Any gas-powered actuator shall be in accordance with an appropriate standard, for example GIS/VA1. Any electric-powered actuator shall be in accordance with an appropriate standard, for example GIS/VA2.

13.6.4 For a below-ground valve, valve actuation should be brought to a convenient working height above ground.

13.7 PROTECTION OF THE INSTALLATION FROM REVERSE FLOW AND EXCESS PRESSURE

Under the Gas Act and GS(I&U)R, the GT may require a consumer using an engine, a compressor, or air at higher pressure, or any extraneous gas not supplied by the GT, to install, use and maintain a device to prevent the high pressure air or extraneous gas from entering the service (pipe) or any of the GT's pipeline. Such a device is a NRV, complying with IGEM/G/10.

Other devices may be used, when they shall be of a type acceptable to the GT and shall function as an NRV.

Note: For clarity, the term NRV means either an NRV or one of these "other devices".

13.7.1 The NRV shall be sufficiently fast acting as to protect the meter and upstream pipework from pressures in excess of those for which they were designed.

13.7.2 On an installation supplying a gas compressor which may subject the meter installation to a pressure exceeding 7 bar, the NRV should be in the form of a reverse facing SSV, impulsed in such a way as to protect the meter installation from a high pressure from the downstream system.

13.7.3 An NRV should be fitted to each booster/compressor or item of plant or equipment using compressed air or extraneous gas, thus protecting the consumer's pipework installation in addition to protecting the Network.

In certain cases, particularly in large or complex installations, it might be necessary to fit an additional NRV on the outlet of the meter installation.

NRVs installed to prevent compressed air or extraneous gases entering the meter installation and gas supply shall be of a type that provides a good reverse flow shut-off.

Where oxygen is being used, special care should be exercised in the choice of NRV and reference should be made to IGEM/UP/2.

Note 1: Special care is essential wherever oxygen is being used in conjunction with a fuel gas. A spontaneous explosion may occur when oxygen is in contact with oil or grease and it is imperative that any NRV used to provide protection against reverse flow of oxygen is suitable for use with oxygen.

Note 2: In particular, it is important that a suitable NRV is fitted to each item of plant or equipment using oxygen so that these valves can also protect any other NRV installed on the outlet of the meter installation.

13.8 IMPULSE LINE VALVES

Isolation valves for impulse pipework shall be of the plug or ball type, to a recognised standard, requiring 90^{o} operation from fully open to fully closed. Such valves shall be of a tamperproof design, or the means of actuation shall be removed.

For MOP_u exceeding 2 bar, consideration shall be given to all impulse line valves being flanged or of welded construction.

VALVE APPLICATION	VALVE TYPE					
	Lubricated plug	**Ball**	**Wedge gate**	**Parallel slide gate**	**Butterfly**	**Resilient seated gate**
Meter stream	1bj	1j	1	1	1fgh	1ghk
Isolation	1bj	1j	1	1g	1fgh	1ghk
Buried	1egj	1ej	1eg	1eg	2	2
By-pass	1bij	1ij	1i	1gi	1fghi	1ghik
AECV	1bcj	1cj	1c	1cg	2	2

KEY TO CHART	CATEGORY	KEY TO CHART	RESTRICTION
1	Acceptable - see restrictions	a	Do not exceed 50 mm nominal bore
2	Not acceptable	b	Not suitable as the first valve upstream of a SSOV or a meter
		c	Fire resistance of valve to be checked (BS EN 1775 compliant), if required
		e	Steel or iron only
		f	Fully lugged
		g	Dust/debris to be checked
		h	Normally, MOP exceeding 75 mbar, above this pressure it may be appropriate to apply two valves in series with a valve test vent between them (double block and bleed) if gas tight isolation is important for downstream operations.
		i	Valve to have the facility to be sealed or locked in the closed position
		j	Mechanical assistance (gearing) required above certain pressure and size
		k	Valve stem to be horizontal.

Note: *The fire resistance tests refer to Annex A Test Procedure B of BS EN 1775. This annex describes Procedures A and B. A pipework component is considered to be resistant to high temperatures when it retains its leak-tightness up to a temperature at which there is no longer any danger of a gas explosion.*

For first, second and third family gases (see BS EN 437) the permissible temperature is 650 °C (this is the self ignition temperature of a natural gas/air mixture). It is accepted that for certain pipework components, such as meters and insulating joints, this leak-tightness relates to the atmosphere (external leak-tightness). For other pipework components, such as means of isolation, leak-tightness also includes leak-tightness at the outlet in relation to the inlet (internal leak-tightness).

A pipework component may be considered to be resistant to high temperatures if it has passed a test following either Procedure A or Procedure B. Procedure A is generally applied for building products, and Procedure B for pipework components.

TABLE 10 - SUITABILITY OF VALVES

VALVE FEATURE	VALVE TYPE					
		Lubricated plug	**Ball**	**Wedge and parallel slide gate**	**Resilient seated gate**	**Butterfly**
Pressure		All MOP.	All MOP.	All MOP.	MOP ≤ 75 mbar.	MOP ≤ 75 mbar.
Servicing		Easy to service. Lubrication is possible with the valve in service using grease sticks or guns. Regular lubrication may be required to avoid sticking and leakage.	Little servicing normally required. Some types require removal for maintenance.	Little servicing required. Gland servicing is often difficult. Debris and corrosion in the body can prevent tight shut-off.	Little servicing required. Gland servicing may be possible depending on the type. Debris and corrosion in the body can prevent gas tight shut-off	Little servicing required. Removal required for maintenance.
Position indication		Yes, by means of an engraved or embossed indicator line on the top of the plug head. Ensure that the lever is fitted such that it is in line with the ports through the plug.	Yes, often by means of an indicator affixed to, or incorporated in, the stem head or ball shank head. When valves are lever operated, the lever also acts as an indicator.	Yes, often by means of an indicator affixed to, or incorporated on, the valve stem.	Yes, often by means of an indicator affixed to, or incorporated on, the valve stem	Yes, for valves with lever actuators and also available on valves with geared actuators.
Overtravel		Yes, but the degree is dependent upon the shape of the ports in the plug and body. Rectangular ports generally afford more overtravel than circular full-bore ports.	Yes, but the degree is dependent upon whether the valve has full bore or reduced bore ports.	No, for wedge gate valves. Yes, for some parallel slide gate valves although monitoring the overtravel is difficult.	No overtravel protection.	No, for lugged type valves.
Valve seats		Metal to metal sliding.	Usually soft seats, but types with primary or secondary metal to metal seats are available.	Usually metal to metal, although soft seats may be obtained. Sliding action in parallel slide valves and partially sliding action in wedge gate valves.	Soft seating from a resilient coating on the gate assembly and reliance on a smooth clean contact area on the valve body.	The majority of valves have soft body liners or soft edged valve disks. Valves are available with metal to metal seats, either as the primary seal or as a secondary seal to a soft primary seal.
Speed of operation		Fast with 90° movement for those fitted with lever actuation. If geared actuators are fitted, the speed of operation is reduced.	Fast with 90° movement for those fitted with lever actuation. If geared actuators are fitted, the speed of operation is reduced.	Slow.	Slow but may require fewer turns than a slide gate valve.	Fast with 90°movement for those fitted with lever actuation. If geared actuators are fitted, the speed of operation is reduced.
Double seals		Yes.	Yes, and often double secondary seals. Double block and bleed facility available.	Yes, for wedge valves, but may not be for parallel slide valves as only the downstream face is sealed tightly under pressure. Double block and bleed facility available.	Yes.	No.
Strength		Normally adequate.	Normally adequate.	Normally adequate.	Normally adequate	Normally adequate.
Pressure drop		Usually low, but some valves have reduced bore circular or rectangular ports.	Usually low, but some valves have reduced bore.	Low.	Low.	Generally low, but can be significant in some valves due to the disk thickness.
Size range		Available in all sizes, but wrench operation is not normally suitable above 100 mm due to the higher operating torques.	Available in all sizes.	Available in all sizes.	Up to 300 mm.	Available in all sizes. Lever operation to be restricted to 150 mm.

TABLE 11 - VALVE TYPES AND FEATURES

SECTION 14 : MATERIALS AND PIPEWORK

14.1 GENERAL

This Section assumes pipework is above ground. If any section of pipework is buried, its design and construction shall be in accordance with the principles of IGEM/UP/2, as appropriate.

14.2 SELECTION OF MATERIALS

14.2.1 All pipework materials and fittings shall be suitable and safe for the conditions of use and shall comply with relevant specifications, standards and recommendations. Reference should also be made to Table 14.

Note: Equivalent standards to those quoted may be applied.

14.2.2 The selection of materials and method of jointing shall take into account the maximum range of pressures and temperatures to which the installation may be subjected and should also take into account any stresses that may be imposed. Reference should be made to IGEM/TD/12 which gives detailed guidance and a method of comprehensive analysis.

14.2.3 Pipework (other than that for auxiliary, impulse and relief vent systems when reference should be made to Sub-Section 14.10 and 11.6) shall be of steel.

Note: Grey and ductile iron pipe and pipe fittings are not considered suitable for meter installations.

Non-metallic pipe and pipe fittings shall not be used on meter installations except for:

- purpose-designed insulation joints
- vent pipework for non-walk in housings where the relief capacity does not exceed 2.25 $m^3 h^{-1}$, MIP_{mi} does not exceed 75 mbar and the vent pipe does not protrude more than 75 mm from the box wall.

14.2.4 Press-fit systems shall not be used on meter installations.

Note: The pipe wall thicknesses do not meet the requirements to withstand handling during construction and loads in service.

14.2.5 Materials and components within the meter installation shall be selected to suit MIP_u, MIP_c or MIP_{mi}, as appropriate (see clauses 7.1.5 to 7.1.7).

14.2.6 The minimum wall thickness of pipe shall be equal to or greater than the design thickness determined from:

$t = PDX(20fs)^{-1}$ where:

t	=	design wall thickness of pipe (mm) (nominal less under tolerance)
P	=	design pressure at the relevant design temperature (bar)
D	=	outside diameter of the pipe (mm)
X	=	Maximum Incidental Pressure (MIP) divided by MOP as an over pressure factor
f	=	maximum design factor (0.3)
s	=	specified minimum yield stress (SMYS) ($N\ mm^{-2}$).

and subject to the minimums in the following table:

NOMINAL DIAMETER OF PIPE (mm)	**MINIMUM WALL THICKNESS (mm)**
50	3.9
80	4.7
100	4.7
150	4.7
200	6.3
250	6.3
300	6.3
400	6.3
450	6.3
500	7.9
600	7.9
750	9.5
900	9.5
1050	11.9
1200	12.5

Note: At lower pressures, these minimum wall thicknesses are still necessary to withstand handling during construction and while in service.

TABLE 12 - MINIMUM WALL THICKNESS OF STEEL PIPE

14.2.7 Elastomeric and polymeric components, including seals and gaskets, if regularly subject to a gas environment, shall be fabricated from materials that are suitable for use on NG and complying with a suitable standard. They shall not be affected adversely by any of the constituents or additives, for example methanol and glycol. O-rings and other types of proprietary seals shall conform to class A2 of BS EN 549 and shall be ozone-resistant.

FITTING TYPE	MATERIAL*1	LIMITATIONS	APPROPRIATE STANDARDS	NOTES
Bends, branches, reducers, tees	Copper	ø ≤ 22 mm, p ≤ 2 bar	BS EN 1254-2	Restricted use
Bends, tees, reducers, plugs etc.	Malleable iron and steel	ø ≤ 50 mm/ screwed p ≤ 7 bar	BS 143 & 1256, BS EN 10241 and 10242	Commonly used in screwed form for small PRIs
Screwed and Socket Weld Fittings	Steel	p ≤ 7 bar	BS 3799 ASME B1.16.11 GIS/F7	
Compression fittings	Brass Carbon steel Stainless steel	ø ≤ 40 mm	BS 7993 DIN 2353 or GIS/F9	See clause 14.10.
Forged or extruded bends, tees, reducers, caps etc	Steel	None	BS EN 10253 BS 1640 for ø > 600 mm MSS SP 75 for ø ≥ 600 and ø ≤ 900 mm	Preferred type, especially for MOP > 7 bar
Weldolet branches	Steel	d/D ≤ 0.5 p ≤ 7 bar d/D ≤ 0.3 p > 7 bar	ASME B16.11 BS EN 10253	Normally available up to 200 mm ø Note 5
Threadolet branches	Steel	ø ≤ 50 mm screwed p ≤ 7 bar ø ≤ 25 mm screwed p > 7 bar	ASME B~~31.1~~ 6.11	
Weldoflange branches	Steel	ø ≤ 50 mm	BS EN 10222	Note 7
Sweepolet branches	Steel	d/D ≤ 0.75 p ≤ 7 bar d/D ≤ 0.6 p > 7 bar	BS EN 10253 or ASME B16 11	Also called "easy sweep" or curved branch. Note 5
Full encirclement branches	Steel		PD 5500 or ASME equivalent BS EN 13445	Wrapper plate to completely encircle the pipe
Other fabricated branches (stub junctions)	Steel	p ≤ 7 bar		Note *2 and 3
Mitre bends	Steel	p ≤ 7 bar		Note *4
Cast bends	Steel	None		
Fabricated tapers	Steel	None	BS EN 13445 PD 5500	
Cast tapers	Steel	p ≤ 7 bar		
Forged components	Steel	None	BS EN 10222 – 1 to 5 or ASME equivalent	Forgings which form the whole or part of a component
Flanges	Steel- according to relevant flange standards	p ≤ 16 bar > PN16 ø ≤ 600 mm ø > 600 mm p ≤ 7 bar 15 mm ø ≤ 450 mm	BS EN 1092 BS 1560 ISO 7005 ANSI B16.5 ISO 15590-3 BS 3293 GIS/F/7	To the relevant pressure rating. Preferred for > 7 Bar

Note 1: *Steel used to manufacture fittings requires at least equivalent wall thickness and physical and chemical properties to those of the pipe.*

Note 2: *Branches made from line pipe for use in modular constructions etc. where external loadings at the tee are not significant.*

Note 3: *Branches made from pipe that is thicker than the respective line pipe where a significant external load may be applied to the tee.*

Note 4: *Mitre bends are acceptable providing that the angle of each mitre does not exceed 11.25^{o} and the minimum axial distance between welds is half the pipe diameter.*

Note 5: *Where d/D (ratio of nominal external diameters of pipe) exceeds 0.5, it is recommended that the proposed location in the line pipe be examined for defects, especially laminations.*

Note 6: *Flanges of alternative material, for example SG iron or aluminium, are permitted where they form an integral part of the equipment fitted as part of the installation, for example a regulator body, provided they are dimensionally compatible.*

Note 7: Small diameter "set-on" flanged branches, subject to fatigue or vibration under operational conditions, have to be one-piece "weldoflange" forgings.

TABLE 13 - LIMITATIONS ON THE SELECTION AND USE OF PERMANENTLY INSTALLED FITTINGS

14.3 METHODS OF JOINTING

14.3.1 The method of jointing steel pipes shall be as given in Table 14.

MOP	NOMINAL BORE	JOINTING METHOD
> 7 bar ≤ 38 bar > 7 bar ≤ 38 bar	≤ 25 mm > 25 mm	Screw or weld Weld
> 2 bar ≤ 7 bar > 2 bar ≤ 7 bar	≤ 50 mm > 50 mm	Screw or weld Weld
> 75 mbar ≤ 2 bar > 75 mbar ≤ 2 bar	≤ 50 mm > 50 mm	Screw or weld Weld
≤ 75 mbar ≤ 75 mbar	≤ 50 mm > 50 mm*	Screw or weld Weld

**Note: On an existing installation of MOP not exceeding 75 mbar, it is permissible to use screwed connections to valves, filters and regulators of nominal diameter not exceeding 80 mm.*

TABLE 14 - JOINTING OF STEEL PIPE

14.3.2 Welded joints shall be used in preference to flanges and screwed joints where reasonably practicable, to eliminate potential leaks.

14.3.3 For MOP_u exceeding 2 bar, screwed pipe and fittings should not be used for main inlet pipework upstream of the SIIV on multi stream installations, nor upstream of the MIIV (where this is not the first above ground valve) on single stream installations.

14.4 SCREWED PIPEWORK

14.4.1 Pipe shall be:

- for MOP not exceeding 2 bar, to BS EN 10255 Grade 235GT M or H wall thickness, API 5L-Gr B
- for 2 bar < MOP ≤ 38 bar, to API 5L-Gr B

14.4.2 Fittings shall conform to BS 143 and BS 1256, BS EN 10241, BS EN 10242, BS 3799, or IGEM/GM/PRS/1, as appropriate for the application and MOP.

Note: Proprietary fittings are available. Where considered of equivalent quality, they will need to comply with an equivalent standard.

14.4.3 Threads shall conform to BS 746, BS EN 10806 or BS EN 10226, as appropriate.

BS 746 threads shall be limited to 75 mbar, 2" NB and shall only be used for connections to:

- ECV, if it has a compatible thread
- LP Regulator
- diaphragm, thermal mass or ultrasonic meters Q_{max} ≤ 40 $m^3 h^{-1}$.

BS EN 10806 threads should only be used for the connection of the screwed outlet connection on the ECV and to the regulator or SSV assembly (where they are supplied with this thread).

Note 1: Other threads are permitted for auxiliary pilots to the body of pressure controls and instrumentation equipment.

Note 2: BS 746 is the specification for the threads on "gas meter unions and adaptors", which are typically used on diaphragm meter connections, the outlet of small angle pattern regulators, smaller sizes of semi-rigid connections, and valves.

14.4.4 It should be ensured that connecting male and female threads are compatible.

For MOP not exceeding 7 bar, threads should be specified as either taper male/parallel female, or taper male/taper female. Taper male/parallel female threads are non preferred.

For MOP exceeding 7 bar, threads shall be specified as taper male/taper female.
14.4.5 Parallel/parallel threads shall not be used (except for the limited use for instruments. Long screw fittings shall not be used).

14.4.6 Where the joints are sealed in a thread a suitable jointing material shall be applied to the threads only. Joints shall not be turned back for alignment purposes, but dismantled and remade.

14.4.7 Jointing compounds shall conform to BS EN 751, BS 5292 or BS 6956-5.

Polytetrafluoroethylene (PTFE) thread sealant tape shall conform to BS EN 751-3.

Note: The scope of BS EN 751-3 covers threads on pipework up to 50 mm nominal bore. The tape manufacturer can provide details of appropriate wrapping technologies for pipe diameters exceeding 50 mm.

14.4.8 Jointing paste shall not be used as the sealant on screwed meter connections of RD meters.

14.5 WELDED PIPEWORK

IGEM/UP/2 provides further advice on welding of pipework.

14.5.1 Pipe shall conform to, as appropriate:

- API 5L
- BS EN 10216 or BS EN 10217
- BS EN 10208 withdrawn
- ISO 3183-2 supplement to API 5L
- ASTM A 106
- BS EN 10255.

14.5.2 Fittings shall conform to the Standards, etc. listed in Table 13.

14.5.3 Prior to welding, the welding procedure specification should be agreed and welding procedure tests and welder qualification tests, using BS EN 1011-1 and BS EN 1011-2, shall be completed satisfactorily (see Table 15).

CONSTRUCTION STANDARD/CODE	WELDING PROCEDURE APPROVAL	WELDER APPROVAL
BS 2633	BS EN ISO 15614	BS EN ISO 9606
BS 4677	BS EN ISO 15614	BS EN ISO 9606
ANSI/ASME B31.1	ASME IX ~~B&PV Section 1~~	ASME IX
ANSI/ASME B31.3	ASME IX ~~B&PV Section 1~~	ASME IX
BS 2971	BS EN ISO 15614	BS EN ISO 9606
BS 4515-1	BS 4515-1	BS 4515-1

TABLE 15 - WELDING STANDARDS

14.5.4 For MOP exceeding 7 bar, welding should be carried out to an appropriate standard such as BS 4515 (for pipe welding) and BS 2633 (Class I) (for steel pipework). Where components of different material specifications are to be jointed, the welding procedure should comply with that specified for the material with higher yield.

14.5.5 For MOP not exceeding 7 bar, welding and inspection should be carried out to the standards specified in BS 2971 (Class II). The inspection category shall be agreed with the purchaser.

14.5.6 In certain circumstances, for example where the pipe wall is exceptionally thick, heat treatment of site fabrications may be necessary. Reference should be made to an appropriate standard such as PD 5500 (for welded pressure vessels) and the treatment should be to appropriate standards such as the procedures laid down in BS 4515 (for welding pipelines) or BS 2633 (Class I) (for steel pipework), where appropriate.

14.5.7 Following pipework fabrication, all welding slag shall be removed and internal wall surfaces cleaned.

14.5.8 For welded connections to impulse and instrumentation pipework, the edge of the socket weld shall not be closer than 15 mm from any part of any other weld which should be increased to 50 mm for MOP exceeding 7 bar. All other welds shall not be closer to each other than 150 mm or one pipe diameter, whichever is the lesser.

14.6 FLANGED JOINTS

14.6.1 Flanges shall conform to:

- BS EN 1092 Table PN16 for MOP not exceeding 16 bar
- BS 1560 Class 300 for MOP exceeding 7 bar.

except where other flanges are necessary to match existing equipment connections, for example flanges to BS 1560-3 Sections 3.1 and 3.2, and BS 10 Table D or E, may be used in these circumstances, as appropriate.

14.6.2 Flanged joints shall be made incorporating the appropriate gasket. Jointing paste or compounds shall not be used.

14.7 GASKETS

14.7.1 Compressed asbestos fibre gaskets shall not be used.

14.7.2 For meter installations located in multi occupancy buildings reference shall be made to IGEM/G/5.

14.7.2 Gaskets for BS EN 1092 flanges shall be in accordance with BS EN 1514.

14.7.3 Gaskets for use with flat face flanges shall conform to the dimensions given in BS 10, BS 1560 (or ASME B16.5) or BS EN 1514, as applicable, and to the materials in BS 6956 or BS 7531.

14.7.4 Gaskets for use with raised face flanges shall conform to the dimensions given in BS 1560 or BS EN 1514 as applicable, and to the materials in BS 6956 or BS 7531 grade X or Y and should be 1.5 mm thick.

14.7.5 Joint rings for ring type joint (RTJ) flange assemblies and spiral wound gaskets raised face (RF) flange connections shall be in accordance with a suitable standard such as BS 3381, API 6A (RTJ), ASME B16.20 or BS EN 12560.

14.8 BOLTS AND STUDS

14.8.1 Bolts and nuts shall comply with BS EN 1515, BS 3692 (precision metric threads), BS 4190 (Black bolts) or BS 4882, as appropriate (see Table 16).

Note 1: DIN 933 and BS EN ISO 4017 are equivalent to BS 3692 and BS 4190 for bolts and are also acceptable.

Note 2: DIN 934 and BS EN ISO 4032 are equivalent to BS 3692 and BS 4190 for Nuts and are also acceptable.

14.8.2 The correct length of bolt, with two 3 mm thick washers shall be used for each application.

Note: The assembled length of the bolt/stud to be such that at least one thread is visible beyond the nut, or where the body of a component is threaded as recommended by the manufacturer.

14.8.3 Stud bolts shall be selected in accordance with BS EN 1515-1 and comply with a suitable standard such as BS 4882, stud material, ASTM A320 L7 or ASTM A193 B7.

14.8.4 Nuts and washers for stud bolts shall be selected in accordance with BS EN 1515-1 and comply with a suitable standard such as BS 4882, material ASTM A194 2H and with washers at least 3 mm thick. Two washers per stud bolt shall be used and shall be chamfered 30°.

14.8.5 For MOP not exceeding 7 bar, studs should not be used, as they may cause difficulties in dismantling and removing components from the meter installation for maintenance.

14.8.6 For MOP exceeding 7 bar, flanged joints shall be assembled using suitable stud bolts, nuts and washers in accordance with a suitable standard (see clause 14.8.3). Bolts shall not be used on such installations.

BOLT OR STUD BOLT	NUT
BS 4882 Grade B7	BS 4882 Grade 2H
BS EN 1515	BS 1515
BS EN ISO 898-1 Grade 8.8	BS EN ISO 898-2 Grade 8
ASTM A320 Grade L7	ASTM A194 Grade 7
ASTM A193 Grade B7	ASTM A194 Grade 2H

TABLE 16 – BOLT AND NUT COMPATIBILITY

14.9 **FLEXIBLE CONNECTIONS AND JOINTS**

Further guidance is provided in IGEM/UP/2.

14.9.1 Flexible connections and joints shall only be used at pressures and temperatures approved by the manufacturer.

Note 1: Flexible connections may take the form of either flange adapters, couplings (flexible joints) or flexible metallic tubes.

Note 2: Generally, flexible joints and couplings are limited to pressures not exceeding 2 bar. However, they are available for substantially higher pressures.

14.9.2 Flexible connections and joints shall not be used to correct misaligned pipework, components, etc.

14.9.3 Flexible connections and joints shall not be located where they could be damaged, subjected to the effects of extreme temperatures, or where access is difficult. They shall be protected against physical damage, the effects of extreme temperatures, and be located in an accessible position.

14.9.4 Where flange adaptors and couplings are used:

- the pipework should be restrained to prevent separation of the pipes for example by tie rods. However, for a single isolated flexible joint in firmly supported pipework, where all other joints are rigid, or where the flange adaptor incorporates a proprietary locking mechanism, this would not be necessary
- lateral restraint should also be provided to counter any angular movement due to internal pressure
- they shall be capable of being dismantled and shall incorporate elastomeric seals to BS 7874, and be suitable for use with NG.

Note 1: Flange adaptors and couplings (flexible joints) are intended to be used on plain ended pipe. Although they provide a gas seal, most do not prevent the pipe from being pulled out. However, some manufacturers have developed special locking flange adaptors that incorporate a restraining device.

Note 2: Flange adaptors allow up to 3º angular movement and 5 mm longitudinal expansion or contraction. Couplings allow up to 6º angular movement and 10 mm longitudinal expansion or contraction. Where ties are used, the angular deflection may be restricted.

14.9.5 Where non-braided flexible metallic tubes are used:

- MOP should not exceed 75 mbar

  Note: For MOP exceeding 75 mbar, hoses need to be certified for MIP to which they may be subjected and the maintenance regime has to include periodic checks that degradation has not occurred.

- for installations that may have copper outlet pipework, typically up to 25 $m^3 h^{-1}$, they should be protected against damage from flux such as using yellow plastic heat shrinkable tubing in accordance with clause 8.6 of IGEM/GM/PRS/6, Edition 1
- they should comply with BS 6501-1 or BS EN ISO 10380 and be as specified in IGEM/GM/PRS/6
- they shall be made from convoluted stainless steel to BS EN 10088-2
- they shall have screwed, integral union, or flanged end fittings to suit the particular application
- they shall be installed strictly in accordance with the manufacturer’s recommendations
- they shall be strength tested to 2 bar

- the tube length should be the minimum practicable and should have an overall length not greater than 350 mm for RD and turbine meter installations, or 600 mm for diaphragm meter installations. Longer connection distances should be bridged by a combination of solid pipework and the flexible tube
- pipework on either side of the flexible tube shall be supported separately so that the flexible tube is not supporting the weight of any of the pipework
- they shall not pass through walls or other rigid structures.

Note: Great care needs to be exercised where other types of metallic tubes are used and guidance from the manufacturer has to be rigorously followed.

14.10 MATERIALS FOR AUXILIARY IMPULSE AND INSTRUMENTATION PIPEWORK

14.10.1 Safety-critical impulse pipework shall be:

- screwed steel (see Sub-Section 14.4) or
- welded steel (see Sub-Section 14.5) or
- stainless steel to ASTM A269 316L having couplings to BS 7993, DIN 2353 or GIS/F9 (see Table 13).

The preferred diameters are 10 mm, 12 mm, 15 mm and 22 mm.

14.10.2 Non-safety-critical impulse and instrumentation pipework of MOP not exceeding 7 bar should be, as a minimum:

- screwed steel (see Sub-Section 14.4) or
- welded steel (see Sub-Section 14.5) or
- stainless steel to ASTM A269 316L having couplings to BS 7993, DIN 2353 or GIS/F9 (see Table 13)
- for MOP not exceeding 2 bar, copper to BS EN 1057 having couplings to BS EN 1254-1, 4 and 5, or BS 2051.

The preferred diameters are 6 mm, 10 mm, 12 mm, 15 mm and 22 mm.

14.10.3 Pipework to permanently installed pressure recorders, data loggers and gas volume conversion systems shall be run in small bore metallic tube, preferably of stainless steel.

14.11 CORROSION PROTECTION FOR PIPEWORK AND FITTINGS

14.11.1 The exterior of pipework and fittings shall be protected adequately against corrosion.

Note: In normal indoor atmospheres, the application of suitable paints may provide the necessary degree of protection. In corrosive or damp atmospheres, protection may be afforded by bituminous paint or wrapping.

14.11.2 Cleaning and painting shall not be carried out until satisfactory testing has been completed.

14.11.3 Steel pipework and fittings shall be protected adequately against internal corrosion which may occur prior to delivery to site and during storage and handling.

Note 1: Grease films, primer paint coatings or plastic end caps could satisfy this procedure.

14.11.4 The installation should be prepared and coated/painted in accordance with an appropriate standard.

14.11.5 The installation shall be finished to:

- for MOP not exceeding 75 mbar, BS 4800, colour 08 C35 (yellow ochre)
- for MOP exceeding 75 mbar, BS 4800, colour 10 E53 (primrose yellow)
- alternatively, the pipework may be painted any other colour and the pipework banded to BS 1710 (see IGEM/GM/8 Part 5).

14.11.6 Stainless steel pipework and fittings shall not be painted.

14.11.7 All breathers shall be clear following painting of the installation, for example on regulators and slam-shut valves.

SECTION 15 : SUPPORTS AND FRAMEWORK

15.1 GENERAL

15.1.1 The meter installation shall be supported adequately during construction, testing, operation and maintenance.

15.1.2 For a pre-assembled module where equipment requires support, the module shall be fitted with a support frame.

15.1.3 For MOP exceeding 7 bar, further guidance should be sought from IGEM/TD/12.

15.1.4 The meter and its associated gas fittings shall not be in contact with any wall or floor and shall be protected, either by design (for example by the fitting of feet that are not part of the meter casing), installation or position from contact with any cement and/or cement composition and any floor that might be wetted.

Note: This can be achieved by raising the meter above the floor by using a purpose designed shelf/plinth or using a meter with insulated feet.

15.2 PIPE SUPPORTS

15.2.1 The meter installation supports shall be fit for the purpose intended and provide stability during and after assembly.

15.2.2 The location of the supports should contain bending stresses within acceptable limits. Care should be taken in the location of supports to ensure that stresses other than bending stresses remain within acceptable limits.

Note: The prime requirement of supports is to retain the installation in a level plane at a designated height.

15.2.3 Any support system shall allow for easy removal of all major components, leaving the rest of the installation mounted securely without the need for support from external pipework, or any other additional means, and should not subsequently allow misalignment or movement of the pipework.

15.2.4 Supports shall be designed in accordance with BS 3974-1 with due consideration given to avoiding corrosion at the interface between the pipe and its supports.

15.2.5 The design of the pipework supports shall take into account all foreseeable forces, for example:

- the weight of the pipe(s)
- the weight of any components supported by the pipe(s)
- any foreseeable wind and snow loadings
- any mechanical or noise-excited vibration
- the length of the support, i.e., the height from the base or reach from a wall. The greater the length, the stronger the support will need to be.
- the weight of additional water if a hydrostatic test is to be carried out.

15.2.6 Supports shall not be welded to the pipework, flanges or components.

15.2.7 Supports intended to anchor the installation, rather than merely supporting it, apart from needing sufficient strength to withstand anticipated loads, shall also be capable of withstanding a reversal of half this load.

15.2.8 Supports not intended to anchor the pipe shall not inhibit thermal expansion of the pipe.

15.2.9 Any meter shall be supported adequately. Line-mounted meters may be pipe supported but flexible meter connections shall not be relied upon to provide such support.

15.2.10 Where necessary, insulation should be provided in the supports to meet the requirements of cathodic protection of the pipework.

15.2.11 Where necessary for maintenance, pipe supports shall be designed to be removable.

15.2.12 Care should be taken to adequately support sensing, impulse and auxiliary pipework (due to its small diameter and vulnerability).

15.2.13 Where fitted, care should be taken to adequately support any small bore pipework (due to its small diameter and vulnerability).

15.2.14 Support spacing shall be as given in Table 17.

NOMINAL BORE FOR STEEL AND IRON (OUTSIDE DIAMETER FOR COPPER AND STAINLESS STEEL) (mm)	MAXIMUM SPACING (m) (see Notes 1 and 2)		
	Screwed steel and iron	**Welded steel**	**Copper and stainless steel**
6-10	NA	NA	0.5
12	NA	NA	1.0
15 (15)		2.5	1.2
20 (22)		2.5	1.8
25 (28)		3.0	1.8
32 (35)		3.0	2.5
40 (42)		3.5	2.5
50		4.0	
65		4.5	
80		5.5	
100		6.0	
150		7.0	
200		8.5	
250		9.0	

Note 1: The specified spacings are for self weight conditions only. Where hydrostatic testing is to be carried out or other additional loadings are anticipated, spacing and supports are to be designed from first principles (see also BS 3974-1).

Note 2: Spacings for vertical pipework supports may be increased by 25% of the values quoted, subject to the guidance provided in Sub-Section 15.2.

TABLE 17 - MAXIMUM DISTANCE BETWEEN PIPE SUPPORTS FOR HORIZONTAL AND VERTICAL PIPES

15.3 INSTALLATION SUPPORT FRAMES

Where the installation pipework and components are supported by a frame (skid unit), the following apply:

- the base frame of the installation shall be in a form that will be stable when placed on the forks of a suitable standard forklift truck
- the support frame shall have a rectangular base with at least two longitudinal members of sufficient strength to enable the installation to be supported on two rollers. The base shall also be provided with suitable bolt holes for securing the framework to the floor
- the support framework shall be such that the installation can be safely and easily transported, and be a stable stand-alone unit.

15.4 LIFTING

15.4.1 Where the installation pipework and components are supported by a skid unit that may require subsequent lifting at any time in the future, the following apply:

- if the meter installation has been designed to allow for lifting by suitably positioned slings, lifting eyes need not be provided, but clear instructions shall be marked permanently on the installation frame
- if the installation weighs 150 kg or more, the installation frame should be provided with integral slots or transverse channels to allow the installation to be lifted and positioned by means of a suitable standard forklift truck. The installation shall also be fitted with suitably positioned lifting eyes
- if the lifting eyes are above the centre of gravity, two may be sufficient. Otherwise, four lifting eyes shall be provided
- if only two lifting eyes are provided, they shall be positioned such that the centre of gravity is either directly below, or below and in front of the lifting eyes

- the lifting points shall be located so as not to place any undue strain on the meter or other components of the installation
- the installation shall be arranged such that if tilted by 25^{o} from the vertical, the centre of gravity will remain within the area bounded by the base.

15.4.2 Tapped holes and eye bolts shall not be used for lifting purposes.

15.4.3 Where lugs are of welded construction, the welds shall be non-destructively tested and the certificates included in the installation documentation.

15.4.4 The eye of the lifting lugs shall be painted red, as shall any lifting points.

SECTION 16 : ANCILLARY CONNECTIONS

16.1 GENERAL

16.1.1 For MOP_u not exceeding 7 bar, any ancillary connection shall be a minimum diameter of ½ in (15 mm). For MOP_u exceeding 7 bar, any ancillary connection shall be a minimum diameter of 1 in (28 mm).

16.1.2 For MOP exceeding 7 bar, any impulse line valve connection taken from pipework that cannot be isolated, for example in a header, should be at least 25 mm flanged or socket welded.

16.1.3 Plugs should be provided with a 2.5 mm hole to allow an appropriate seal to be fitted.

16.2 PRESSURE TEST POINTS

16.2.1 Pressure test points shall be provided to enable:

- a gas tightness test to be undertaken in accordance with IGEM/UP/1B, IGE/UP/1A, IGEM/UP/1C or IGE/UP/1, as appropriate
- pressure losses across various components to be measured
- regulators and safety devices to be set correctly
- the meter pressure to be determined.

Pressure test points shall be positioned as shown in Figures 10 to 26.

16.2.2 Where a test point is not provided on a component, pressure test points, of minimum diameter ½ in, shall be provided on the adjacent pipework.

16.2.3 For MOP not exceeding 75 mbar, pressure test points shall be bushed and plugged with a 1/8 in plug or 1/8 in pressure test nipple.

For MOP exceeding 75 mbar, pressure test points shall be fitted with full bore valves to the same diameter as the tapping and suitably plugged.

16.3 PURGE AND VENT POINTS (refer to Appendix 8)

16.3.1 Purge and vent points shall be provided to enable the pipework, and individual or groups of components to be purged or vented. Purge and vent points shall be positioned as shown in Figures 10 to 26.

16.3.2 Connections for purge and vent points shall be suitably sized and positioned to facilitate purging or venting in accordance with IGE/UP/1, IGE/UP/1A and IGEM/UP/1B, as appropriate, and shall be suitably capped or plugged.

Note 1: On installations of MOP not exceeding 7 bar, it is not, normally, necessary for such points to be larger than ¾ in.

Note 2: When the metering stream is de-pressurised, it is possible to cause severe damage to the meter by exceeding the maximum allowable gas velocity, particularly when metering at pressures exceeding 2 bar.

Guidance on the sizing of purge and vent points for meter runs of MOP exceeding 2 bar is given in Appendix 9.

16.3.3 For MOP exceeding 75 mbar, purge and vent points shall be fitted with valves of the full bore type.

16.3.4 For MOP not exceeding 75 mbar, consideration shall be given to the fitting of appropriately sited valve(s), within the meter installation, to facilitate its purging and venting.

Note: In some cases, the location of the installation, particularly if installed within a consumer's premises, may make it unacceptable to vent the installation down without piping the gas away from the area.

16.4 CONNECTIONS FOR VOLUME CONVERTERS AND OTHER GAUGES, etc.

16.4.1 For a badged meter capacity (Q_{max}) equal to or exceeding 65 $m^3 h^{-1}$, a suitable pressure tapping shall be provided to enable a volume conversion device to be installed.

16.4.2 Where a volume conversion device is to be installed, the pressure connection for volume conversion purposes shall be made to:

- diaphragm meter - a pressure tapping on the inlet side of the meter
- RD meter - a pressure tapping on the inlet of the meter or the P_m (formerly P_r) point on the body of the meter (this will always be on the inlet side of the meter)
- turbine meter to the specially provided P_m point on the body of the meter. If no P_m point is provided to a pressure tapping immediately upstream of the meter
- USM - to the specially provided P_m point on the body of the meter (in the case of a reduced bore meter the tapping shall be in the reduced bore section). For full bore meters the connection point shall either be on the meter body or on the adjacent pipework downstream of the meter
- thermal mass meter – a suitable pressure test point shall be provided on the inlet side of the meter. If volume conversion is required, the manufacturer shall be consulted.

16.4.3 Any impulse pipe for a converter, gauge, pressure recorder, etc. shall have a nominal bore of at least 4 mm.

16.4.4 If a pressure recorder, volume conversion system, or gauge is permanently installed, the pressure connection pipe shall incorporate an isolation valve. For volume conversion systems, the following should apply:

- pressure connection pipe shall be installed immediately upstream of the meter or the P_m point on the meter if fitted
- valve shall be of a type that can be sealed in the open position
- valve may be part of an instrumentation manifold block fitted with a test or calibration valve, often known as a two way manifold. IGEM/GM/5 provides further guidance.

16.5 TEMPERATURE POINTS (THERMOWELLS)

16.5.1 For MOP:

- not exceeding 75 mbar a single ¾ inch tapping should be provided within three pipe diameters of the meter outlet
- exceeding 75 mbar and not exceeding 7 bar two suitable ¾ inch tappings should be provided within three pipe diameters of the meter outlet
- exceeding 7 bar, two suitable sized tappings of minimum diameter 1 inch shall be provided within three pipe diameters of the meter outlet.

Note: For multi path ultrasonic meters care is to be taken not to install the thermowell too close to the meter outlet as it can cause interference. BS EN ISO 17089-1 specifies that the thermowell needs to be at least 2 D from the meter outlet flange.

16.5.2 Unused tappings shall be plugged.

16.5.3 A thermowell shall be installed whenever temperature-converting or recording equipment is to be used which requires the insertion of a temperature probe.

16.5.4 Where a thermowell is required, it shall be fitted into a suitable tapping welded to the pipework as specified in clause 16.5.1. Consideration shall be given to the installation of a second thermowell in order to facilitate validation of the volume converter temperature probe.

16.5.5 Thermowells shall be:

- suitable for MIP
- designed in accordance with BS 2765
- for MOP not exceeding 7 bar may be of lightweight corrosion resistant stainless steel fabrication or non-welded construction and, preferably, forged and manufactured in stainless steel to BS 1503-316 S40 or S41
- for MOP exceeding 7 bar of non-welded construction and, preferably, forged and manufactured in stainless steel to BS 1503-316 S40 or S41
- designed to minimise stress concentration at the root of the stem caused by resonance

  Note: Resonant conditions may occur due to a combination of gas velocity, the design features of the individual thermowell and their configuration in multiple arrays.
- positioned in straight pipe away from branches, bends, tees or any other source of turbulence. Multiple thermowell installation, i.e. sense and test, in the same section of pipe should not be fitted in a straight line, but be staggered radially
- protected against the ingress of water
- filled with oil or conductive paste to improve thermal conductivity, prevent corrosion and exclude water.

16.5.6 Any thermowell should protrude into the pipework by approximately one third of the nominal bore. Where one third of the nominal bore exceeds 100 mm, the insertion depth can be reduced, but shall not be less than 75 mm. Where two or more thermowells are installed, they shall be positioned such that the thermowells will be radially staggered, each being offset from vertical by 30° to 45°, and should be at least one pipe diameter apart.

Note 1: Two thermowells are required to enable calibration of equipment. They are radially staggered to minimise the effects of turbulence caused by the first on the second.

Note 2: Where oil filling is not possible, thermal paste may be used in lieu of oil.

Note 3: On large bore pipes, for example 300 mm, where resonant vibrations of the thermowell stem are known to be a problem, the design of the thermowell may restrict the depth of immersion. In this case, little accuracy will be lost provided the thermowells protrude by at least 75 mm into the bore of the pipe.

Note 4: Resonant conditions may occur due to a combination of gas velocity, the design features of the individual thermowell and their configuration.

16.6 IMPULSE POINTS AND PIPEWORK

16.6.1 All small bore instrumentation, control and auxiliary pipework shall be designed, installed, and tested to a standard compatible with the main installation pipework. Guidance on the design of instrumentation pipework is provided in BS 6739, the requirements of which shall be applied to installations of MOP_u exceeding 7 bar.

16.6.2 Impulse pipework shall not:

- cause a hazard in an otherwise safe zone
- inadvertently earth any cathodic protection (CP) system

- cause a diversion of electric current which may be travelling through the main pipework
- be manifolded to run as a common impulse line
- impede access for maintenance of the components of the installation.

16.6.3 Impulse pipework should be:

- as short as possible and contain the minimum number of joints practicable
- taken from pipework within the confines of the housing/enclosure
- of uniform bore
- designed so that transmission of mechanical vibration is minimised.

16.6.4 Impulse lines, other than those for safety devices, should be capable of being isolated by means of a suitable full bore valve, located as close as possible to the point of connection (see Sub-Section 13.8 and clause 16.6.15).

16.6.5 Impulse lines shall be connected to the pipework on or above the centre line of the pipe.

16.6.6 Impulse lines should be installed so as to fall from the impulsed equipment toward the pipeline connection, with a slope greater than 1 in 20. If this fall is not practicable, they should rise initially from the pipe connection before falling to the impulsed equipment. The slope shall be increased to 1 in 12 if any liquid with a viscosity greater than that of water is likely to be present in the sensing lines.

16.6.7 Catchpots and drain points shall be used at any low points if there is a possibility of liquid condensate occurring in the sensing lines.

16.6.8 Impulse lines shall have a nominal bore of not less than:

- 15 mm for wet gas or
- 7.5 mm for dry, clean gas (but see clauses 16.6.9 and 16.6.10) and should not include any restriction other than those required for control purposes.

16.6.9 Impulse lines should not, in general, exceed 15 m in length. Lines exceeding 1 m long shall have a nominal bore not less than 7.5 mm.

16.6.10 For power gas supplies, impulse lines should be sized such that they can meet the maximum demands of the control system.

16.6.11 Impulse pipework shall be of adequate strength, protected against corrosion, properly supported, and positioned to reduce the risk of mechanical damage.

16.6.12 Impulse pipework design shall allow for commissioning, testing and purging without breaking compression fittings.

16.6.13 Where a regulator is impulsed externally, the connection should normally be made between the regulator and the meter inlet (or meter inlet valve (MIV) where fitted), at a point where the flow is reasonably free from turbulence and velocity-change effects. The point of connection shall be on or above the horizontal centre line of the pipe.

Note 1: The regulator is intended to control the pressure supplied to the meter and it is, therefore, necessary for the impulse connection to be on the inlet side of the meter. In addition, an impulse connection on the outlet side of the meter could give rise to unsafe conditions, for example:

- *a seized RD or diaphragm meter would lead to possible over pressurisation of the meter.*
- *the inertia of RD meters may lead to regulator instability during start up or load changes.*

If it is necessary to impulse downstream of the meter, the above problems may be overcome by the installation of a second, overriding, impulse line taken upstream of the meter inlet valve.

Note 2: Where a regulator is impulsed external to the SOIV, it may be beneficial to also impulse upstream of the SOIV for commissioning purposes.

16.6.14 The impulse tapping for any SSV shall be dedicated for the use of that SSV.

16.6.15 Any SSV impulse line shall not incorporate a valve.

16.6.16 Where a NRV stream discrimination system is fitted, the SSV impulse point shall be taken from a point on the outlet pipework, upstream of the NRV.

The impulse tapping shall be positioned at a suitable position on the outlet pipework to accurately reflect downstream pressures to the SSV at all design and potential fault flow and pressure conditions.

16.7 INSTRUMENTS

16.7.1 Instruments shall be:

- installed in such a way that their removal and replacement can be undertaken without damage to impulse pipework, for example distortion, and electrical connections
- non-venting where available. Where instrumentation generates a hazardous atmosphere, for example by venting gas, consideration shall be given to its location.

SECTION 17 : VENT PIPEWORK FOR BREATHERS, VENT LINES AND CREEP RELIEF VENT STACKS

17.1 GENERAL

Any pressure relief valve shall be fitted with a vent pipe.

17.1.1 Vent pipes shall terminate in a safe area, should terminate at least 3 m above ground level and any adjacent walkway/platform, and preferably terminate at least 1 m above roof level. If it is impractical to terminate above roof level, care shall be taken to vent into a safe area. Consideration shall be given to the topography of the surrounding area, for example, for the effects of downwash.

Note: A safe area in which to terminate a vent is in the open air, remote from potential ignition sources and where there is no risk of vented gases entering buildings or other plant through windows, air intakes, etc. IGEM/SR/25 and IGEM/GM/7B provide guidance on hazardous area classification but, where an installation is not within the scope of IGEM/GM/7B, IGEM/SR/25 applies.

Vent pipes should terminate vertically upwards or vertically downwards, where practicable.

17.1.2 Vent pipes shall not pass through electrical intake rooms, transformer rooms, lift shafts, refrigerator chambers, neither shall they be installed in any other position which may be prejudicial to their safety.

17.1.3 Vent pipes shall be of permanent construction, should be as straight and as short as possible and shall be designed to prevent undue back-pressure upon the relief valve. Where applicable pipework for non-metallic relief vents shall be designed for pressure containing purposes and be resistant to kinking.

17.1.4 Vents need not be fitted with flame arrestors unless the pipe length exceeds 20 m or a significantly increased vent pipe size has been used. When flame arresters (to BS 7244) are fitted, they should, preferably be of the in-line type and be protected by a vent terminal. The design should ensure that the flow capacity of the vent is not significantly reduced.

Note: When selecting a flame arrestor, consideration has to be given to its pressure resistance.

17.1.5 Care shall be taken in the design of vent terminals to minimise the risk of blockage by foreign matter and the ingress of water. Where terminal caps or flaps are used they shall be light in weight, firmly attached to the pipe, self-closing, of non-sparking construction or material and such that they will operate even after long periods of in-operation.

Note: Guidance on vent design is contained in IGE/SR/23.

17.1.6 The vent system shall have adequate support and anchorage to minimise induced stresses that are caused by the venting process.

Note: Further information on pipework supports is available in Sub-Section 15.2 and IGEM/UP/2.

17.1.7 For any vent or relief system for a PRI of MOP exceeding 7 bar, vent pipework should be tested to the same pressure as the main PRI pipework.

17.2 BREATHERS

17.2.1 One or more of the following provisions should be made to prevent gas passing through a breather under fault conditions so causing a flammable mixture in enclosed spaces:

- fit breathers with vent lines to outside the enclosed spaces
- include restrictions in breather connections, provided the operational performance is not impaired
- provide extra ventilation in the space.

17.2.2 If a vent is fitted to a breather serving diaphragms in regulators or safety devices, it should be of sufficient capacity to permit gas to escape freely. The functioning of an associated pressure regulator and/or safety device should not be affected adversely by pressure build-up in the line.

17.2.3 Vent pipework from breathers shall not incorporate a valve.

17.3 VENT LINES

17.3.1 Vent lines working at the same pressure may be combined but gas flow through one or more should not affect the operation of any equipment.

17.3.2 Dedicated vent and de-pressurising lines should not be combined with breather lines in a manifold.

17.3.3 If a manifold is used for a type of vent line, this should not impair the proper functioning of the connected units.

17.4 RELIEF VENT STACKS

Where the installation incorporates either a pressure relief regulator or regulator with integral relief, the relief outlet shall be fitted with a vent pipe sized to cope with the maximum designed relief flow (see Sub-Section 17.1).

Note 1: Further guidance on relief vent stacks is given in IGE/SR/23.

Note 2: Vent stacks may require protection from lightning strikes (see Sub-Section 18.4).

SECTION 18 : ELECTRICAL EQUIPMENT, LIGHTNING, EARTHING AND LIGHTING

18.1 GENERAL

18.1.1 Any electrical equipment associated with a meter installation shall be designed, constructed and installed in accordance with statutory requirements and an appropriate standard such as BS 7671. Compliance with The Electricity at Work Regulations must be achieved.

18.1.2 For external power supplies, any fuse should be of the high-rupturing-capacity type (mica-filled) to minimise any external heat transfer.

18.1.3 Any cable should be installed on a cable tray or in a duct.

18.1.4 All annuluses/duct work communicating between a meter house and electrical components mounted outside of the meter house shall be sealed against the ingress of gas at the end within the meter house. In addition, such communication shall incorporate a "break" at a suitable position outside of the meter house.

Note 1: These measures are to ensure that gas cannot travel into instrument boxes.

Note 2: A minority of cables can carry an "empty" (and, therefore, hollow) sleeve that can act as a gas "pipe". The use of such cables is to be avoided.

18.1.5 A hazardous area assessment shall be undertaken in accordance with IGEM/GM/7B or IGEM/SR/25, as appropriate.

Note: BS EN 60079 defines hazardous areas by making reference to three sets of conditions which are recognised and defined. These may be summarised as follows:

Zone 0: An area in which an explosive gas/air mixture is continuously present, or present for long periods.

Zone 1: An area in which an explosive gas/air mixture is likely to occur in normal operation.

Zone 2: An area in which an explosive gas/air mixture is not likely to occur in normal operation, and if it occurs it will exist only for a short time.

By implication an area not classified as Zone 0, Zone 1 or Zone 2 is deemed to be non-hazardous or a safe area. The conditions envisaged in Zone 0 would not, normally, be encountered in meter installations.

Reference should be made to Sub-Section 3.7 with respect to DSEAR.

18.1.6 A zoning diagram as illustrated in IGEM/GM/7B or IGEM/SR/25 should be produced and maintained as a permanent record to enable the correct selection and siting of electrical equipment (and other potential ignition sources) to be undertaken for both initial installation and future modifications.

Note: To avoid proliferation of types of electrical equipment in small installations, it may be desirable to install Zone 1 equipment in both Zone 1 and Zone 2 areas.

18.1.7 Any electrical device, instrumentation and associated circuits, mounted in or on a meter installation shall be suitably certified for use in any hazardous area in which they are installed as a minimum, and shall be constructed and installed in accordance with BS EN 60079.

18.1.8 Where required, installation pipework shall have equipotential bonding fitted by the consumer's electrical engineer or contractor downstream of the meter installation, in accordance with BS 7671.

18.1.9 The bonding, where required shall be within 600 mm of the outlet of the meter installation or as near as is possible to the building entry.

18.1.10 If electrical continuity of pipework is required, separate bonding straps shall be fitted across any flexible coupling unless they incorporate integral continuity devices.

18.1.11 Where insulating joints are deliberately incorporated anywhere in the installation, for example PME insulators or cathodic protection insulators, cross bonding shall not produce a bond around any such joint.

18.2 VOLUME CONVERSION EQUIPMENT, DATA LOGGERS AND OTHER ELECTRONIC INSTRUMENTATION

18.2.1 Any volume conversion equipment shall be selected and installed in accordance with IGEM/GM/5 and IGEM/GM/7A.

18.2.2 Any other instrumentation, dataloggers, and any other electrical connections to the gas meter shall be installed in accordance with IGEM/GM/7A.

Note: Irrespective of its physical location any electrical equipment installed by the gas consumer which is not considered part of the meter installation as defined in IGEM/G/1, but that is connected to the gas meter (or equipment connected to the gas meter) by electrical means, i.e. wiring, is to comply with the requirements of IGEM/GM/7A.

18.2.3 All electronic metering equipment, for example chart recorders, electronic volume conversion devices, data loggers, associated transducers and telemetry equipment, shall be capable of being sealed to prevent unauthorised adjustment.

18.2.4 Electronic metering equipment, if supplied in weatherproof enclosures, may be fitted in the open air adjacent to the meter with provision made to screen pressure transducers and electronic equipment from direct sunlight. However, whenever convenient, electrical equipment should be located indoors.

18.3 ELECTRICAL ISOLATION

18.3.1 Electrical isolation should be as specified in BS EN 60079 and BS 7671.

18.3.2 Means of isolation should be provided to disconnect incoming power supplies from certain sections of plant, as required for maintenance for normal and emergency purposes.

18.3.3 The position and duty of any isolating switch should be clearly identifiable on site.

18.3.4 Any circuit isolator supplying apparatus located in a hazardous area should disconnect the neutral as well as the phases (double pole isolation).

18.3.5 Automatic or remotely controlled equipment should be provided with immediately-adjacent stay-put-stop buttons or equivalent safeguards, including arrangements for padlocking in order to prevent accidental starting during maintenance or inspection. Either an isolator should interrupt all control and monitoring circuits, main phase and neutral connections, or suitable provision should be made for multiple isolations.

18.4 LIGHTNING

18.4.1 Consideration shall be given to the possible need to protect exposed installations against lightning, by suitably positioned lightning conductors.

18.4.2 Lightning protection may require the use of earthing. Such earthing shall be of sound construction and outside any hazardous area and shall conform to BS EN 62305 and/or BS 7430.

18.4.3 Lightning conductors shall not be bonded to service pipework on the inlet side of any insulating joint.

18.5 EARTHING

18.5.1 The whole of the electrical installation must be earthed adequately and effectively and in accordance with appropriate standards.

Note: In the UK, the supply authority has no mandatory obligation to supply the user with an earthing terminal (with the exception of protective multiple earth (PME) systems).

18.5.2 Any metallic part of the installation, including any stairway and its supports, should be earthed.

18.5.3 The following should be taken into account when designing earthing arrangements:

- where the supply is taken directly from the local distribution system by means of an underground cable, the electricity supply authority will usually permit connection of the user's earthing conductor to the sheath of that cable
- where the supply is taken directly from the local distribution system by means of an overhead line, it may be necessary for the user to provide an earth
- where the supply is taken from a local transformer, the user's earth connection usually will be made at the same electrode as that to which the transformer secondary neutral is connected.

18.5.4 Care should be taken to avoid interactions between the electrical earthing, instrumentation earthing and CP systems.

18.5.5 The design and siting of electrical earthing electrodes should be given specialist attention. Such electrodes should be manufactured from stainless steel, austenitic steel or other CP-compatible materials.

Note: Copper or any other incompatible electrodes are not suitable as the buried steel pipework may corrode preferentially with respect to the electrode.

Coke or other carbonaceous materials should not be used as part of the electrode system.

18.5.6 Sites supplied from PME or combined neutral and earth (CNE) systems present certain problems on which specialist advice should be sought.

Note: In particular, this is important where intrinsically safe circuits are employed and the impedance of earth return paths from safety barriers are to be kept below 1 ohm.

18.5.7 Reference should be made to IGEM/GM/7A for further advice on earthing.

18.6 LIGHTING

18.6.1 Where necessary, adequate lighting shall be made available to ensure safe access, work and movement.

18.6.2 Continuous illumination may be unnecessary in many plant areas, but consideration shall be given to the installation of permanent fixed lighting points, with separate switching at positions where light is frequently required to carry out routine maintenance.

Note: In many cases, the need for flameproof lighting can be avoided by the provision of floodlighting equipment sited outside the hazardous area or mounted at a sufficient height to eliminate the possibility of the flammable mixture approaching the fittings.

18.7 ADJACENT ELECTRICAL SERVICES AND EQUIPMENT

18.7.1 Meter installations shall not be installed in rooms specifically intended for electricity meters or switchgear.

18.7.2 All parts of any meter installation should be located as far as is practicable from any adjacent electricity meters or associated switchgear, the position of the meter installation shall not result in uncertified electrical equipment being located within the hazardous zone generated by the meter installation.

Note 1: For LP installations with ventilation in accordance with IGEM/GM/8 Part 2 the hazardous area zone will be 150 mm Zone 2, see IGEM/GM/7B.

Note 2: This is not intended to preclude the use of suitably-protected and certified electrical instrumentation in connection with the meter.

18.7.3 Any compressor, booster or premix machine shall not be installed in a meter house unless there is no practicable alternative.

18.7.4 Any adjacent electrical equipment shall be suitable for use in any hazardous area in which they are installed, and should be suitable for Zone 2 as a minimum i.e., irrespective of whether the meter house overall is designated as a safe area.

SECTION 19 : PROTECTION AGAINST CORROSION

19.1 GENERAL

19.1.1 As soon as possible following construction, cathodic protection (CP) shall be applied to all buried steel pipework and components, designed and installed in accordance with appropriate standards such as BS EN 13636.

19.1.2 The structure to be protected shall be coated with a good electrical insulating material that has strongly adherent properties that match the design life of the structure to minimise the CP current and maximise efficiency of the application.

19.2 TECHNICAL CONSIDERATIONS

19.2.1 In particular, attention shall be paid to the following:

- the surveillance of ground conditions to determine the resistivity and whether carbonaceous material or stray currents are present
- the provision of permanent monitoring facilities
- possible secondary effects such as coating disbondment or electrical interference with adjacent buried structures
- the need to insulate the installation CP system from adjacent pipelines, pipework and structures by means of insulating flanges or couplings

Note 1: Flange insulation kits are not recommended for use below ground.

Note 2: Where an installation is connected directly to PE pipework, an insulation joint is not required.

- Insulating flanges and couplings shall comply with the requirements of an appropriate standard such as BS EN1594 or BS EN 12007-3.
- Insulating flanges and couplings in hazardous areas shall be protected by explosion-proof spark gaps.
- avoidance of inadvertent earthing of the CP system through such items as pipe supports, instrument connections, electrically operated valve actuators, concrete reinforcement remaining after construction etc.
- the minimising of any shielding effects from concrete pit walls and other structures by careful positioning of anodes or groundbeds
- the need to maintain polarised potentials (with respect to Cu/CuSO4) in the range - 950 mV to -1250 mV for all new installations

Note: For existing installations, –850 mV may be acceptable subject to continued satisfactory performance.

- positioning groundbeds and anodes to avoid electrical interaction causing damage to other metallic equipment
- the need to include pipework interconnections, including sensing pipework and auxiliary fittings in the design of CP
- avoidance of unintended bridging of insulating joints
- in areas of high incidence of lightning or electrical faults, insulation joints may need protection by fitting polarisation cells or surge diverters.

19.2.2 CP cable connections shall be made with either welded or pin-brazed fittings which should be re-coated to avoid accelerated corrosion.

19.2.3 A close interval potential survey of the buried pipework within the instillation shall be considered and, if undertaken, be as soon as possible after complete commissioning of the CP system, in order to fully validate and provide a fingerprint of the system.

19.3 TYPES OF SYSTEMS

19.3.1 Sacrificial anode systems

Sacrificial anode systems are associated with:

- smaller installations or installations without an electrical power supply
- installations having discreet or isolated sections of pipework
- installations where the high current characteristic of an impressed current scheme may otherwise cause damage to neighbouring plant.

The quantity of anodes to be used will be dependent upon the total current requirement for the installation, the size and type of anode material and the ground resistivity.

19.3.2 Impressed current systems

Impressed current systems are associated with larger sites where current demand or ground resistivities preclude the use of sacrificial anodes.

Impressed current systems require a Direct Current (DC) power source, usually in the range of 10 – 50 V and 1 – 10 A. Normally, this is provided from an Alternating Current (AC) powered transformer rectifier or from solar power/battery installations where lower power consumption is required.

For AC powered installations, reference should be made to BS 7671.

19.4 METHODS OF PROTECTION AGAINST EXTERNAL CORROSION, OTHER THAN CP

19.4.1 General design considerations

19.4.1.1 Suitable protection against external corrosion shall be provided, unless the material is, in itself, resistant to corrosion (e.g., the appropriate grade of stainless steel (see clause 14.5.1 and Table 13))

19.4.1.2 Any coating or material shall be specified in accordance with the design requirements of the installation and its environment.

19.4.1.3 Where different coatings are used, joints between the coating systems shall be made by overlapping one coating with another.

19.4.1.4 Where an installation is to be built in an area of contaminated ground or in harsh environmental conditions, consideration shall be given to the use of specialised, high-performance, coatings.

19.4.1.5 Safety-related issues shall be considered, e.g. particular surface preparation requirements and the storage, handling, and application of all materials and equipment.

19.4.1.6 Where applicable, consideration shall be given to the wind-water line, which is potentially more susceptible to corrosion.

19.4.2 **Surface preparation for coating**

Pipework and other structures shall be prepared for coating in accordance with an appropriate standard such as BS 5493, BS 7079, BS EN ISO 12944, etc.

Note: Any coating material will be provided with the manufacturer's instructions for surface preparation and application to ensure the design performance of the coating is achieved. Most high-performance coatings require a blast-cleaned surface with a specific profile range achieved after preliminary degreasing. Other, less onerous, preparations may specify manual cleaning methods as suitable for some coating systems.

Surface preparation is a key stage in achieving coating performance. Inspection shall be implemented during the initial phase of the work to ensure compliance with the appropriate standards.

19.4.3 **Coating of above-ground pipework and components**

A suitable coating system shall be used. These include:

- solvent-based epoxy systems
- water-borne acrylic systems.

Different colours should be used for multi-layer coating systems where available.

Where thermal or acoustic cladding is installed, care shall be taken to ensure that coating is undertaken prior to cladding and consideration should be given to the need for future inspection and maintenance.

Note: Specialised, high-performance, coatings may be utilised where removal of cladding for inspection cannot easily be achieved.

Special coating measures shall be undertaken to protect the bearing surfaces of pipe supports as these are often the source of corrosion on pipework.

Where a moving metal-to-metal contact is inherent in the design, e.g. on a valve spindle, pipe support jack, vessel door, etc., a semi-firm wax-oil coating shall be considered.

Gaps in flanged joints are difficult to coat and maintain. Consideration shall be given to filling such a gap with an inert or anti-corrosive material and fitting purpose-made flange protectors.

19.4.4 **Coating of below-ground pipework**

The coating system shall provide an enduring electrical insulation from its environment. The coating shall adhere strongly to the metal surface and resist cathodic disbondment at holidays.

Note: The complex shape of some components may require the use of different materials and application methods to maintain a uniformly high standard of coating throughout the installation.

A suitable coating system shall be used. These include:

- epoxy resin powder
- multi-component liquid
- polyethylene cladding and,

For field applied coatings:

- two-pack epoxy systems
- multi-component urethanes
- brush-applied mastics

- cold-applied laminate tapes.

Where pipework extends above ground, coatings specified for below-ground applications shall not be used. The first 500 mm of pipework emerging from the ground shall be given additional protection, for example with a multi-component liquid, to provide a satisfactory transition between the pipeline coating and the paint system. For pipes other than vertical, this measurement should be to the nearest surface of the pipe to above- and below-ground level (see Figure 28).

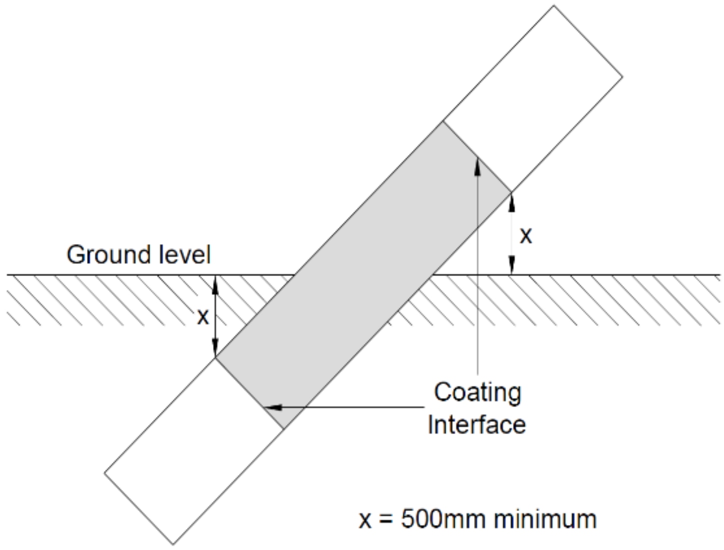


FIGURE 10: EXTENT OF COATING FOR PARTIALLY EXPOSED PIPE

19.4.5 **Backfilling**

19.4.5.1 During backfilling, care shall be taken to avoid damage to the finished coating.

19.4.5.2 Where excavated material contains carbonaceous or other matter that may damage the coating, it shall be substituted by suitable material of an appropriate particle size.

19.4.5.3 The material shall be placed and compacted to ensure that there are no voids and that the pipework is supported adequately.

19.4.5.4 Where backfill contains ballast or rocks, consideration shall be given to appropriate methods of preventing damage. Consideration shall be given to sheathing the pipework and components with a perforated plastic sheet.

Note 1: Further advice on backfilling is provided in IGEM/TD/1 and IGEM/TD/3.

Note 2: If considered necessary, a post-construction coating survey (see IGEM/G/4) may be carried out to determine if coating damage has been sustained during backfilling.

19.4.6 **Inspection**

An inspection regime shall be put in place to control:

- surface cleanliness
- surface profile
- temperature
- relative humidity
- adhesion

- holiday detection
- wet and dry film thickness
- other tests recommended by the manufacturer
- backfilling.

Where the coating application is proved to be outside the required specification, it shall be removed and repaired.

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

A1.1 GLOSSARY

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

Sub-deduct arrangement As described within the Uniform Network Code; Transportation principal document; Section G Supply Points Sub-Section 1.8.

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

A1.2 ACRONYMS AND ABBREVIATIONS

AC	accuracy class
AC	alternating current
ACoP	Approved Code of Practice
ACS	Nationally Accredited Certification Scheme for Individual Gas Fitting Operatives
AECV	additional emergency control valve
AG	accuracy group
AGC	automatic gain control
AMI	approved meter installer
ASME	American Society of Mechanical Engineers
CE	European Community product mark
CEF	Carbon equivalent factor
CDM	Construction (Design and Management) Regulations
CHP	combined heat and power
CNE	combined neutral and earth
CO	carbon monoxide
CoMCoP	Consolidated Metering Code of Practice
CoP	Code of Practice
CR	creep relief
COSHH	Control of Substances Hazardous to Health Regulations
CP	cathodic protection
$Cu/CuSO_4$	copper/copper sulphate
CV	calorific value
D	diameter
DC	direct current
DMIP	design maximum incidental pressure
DmP	design minimum pressure
DP	design pressure
DSEAR	Dangerous Substances and Explosive Atmospheres Regulations
ECV	emergency control valve
EEMUA	Engineering Equipment and Materials Users' Association
ESP	emergency service provider
F	force
FIV	filter/strainer inlet valve
FOV	filter/strainer outlet valve
GB	Great Britain
GDN	Gas Distribution Network
GIS	Gas Industry Standard
GS(I&U)R	Gas Safety (Installation and Use) Regulations
GS(M)R	Gas Safety (Management) Regulations)
GT	gas transporter
HF	high frequency
HP	high pressure

HSE	Health and Safety Executive
HSWA	Health and Safety at Work, etc. Act
IGE	Institution of Gas Engineers
IGEM	Institution of Gas Engineers and Managers
IP	intermediate pressure
K	meter velocity factor
ISO	International Standards Organisation
L	length
LF	low frequency
LP	low pressure
LOP	lowest operating pressure
LPG	Liquefied Petroleum Gas
LU	Lock up
M	meter
MAP	meter asset provider
MAM	meter asset manager
MBV	meter by-pass valve
MHSWR	Management of Health and Safety at Work Regulations
MID	Measuring Instruments Directive
MIIV	meter installation inlet valve
MIOV	meter installation outlet valve
MIP	maximum incidental pressure
MIR	Measuring Instruments Regulations
MIV	meter inlet valve
MOP	maximum operating pressure
MOV	meter outlet valve
MP	medium pressure
MPRN	meter point reference number
NB	nominal bore
NE	neutral earth
NG	Natural Gas
NMRO	Nation Measurement and Regulation Office
NRV	non-return valve
OFGEM	Office of Gas and Electrical Markets
OP	operating pressure
OS	Ordnance Survey
P	pressure
p	purge
Pa	per annum
PE(S)R	Pressure Equipment (Safety) Regulations
PID	Pressure Instruments Directive
PLOP	peak level operating pressure
PME	protective multiple earth
PRI	pressure regulating installation
PRIIV	PRI inlet valve
PRIOV	PRI outlet valve
PSR	Pipelines Safety Regulations
PSSR	Pressure Systems Safety Regulations
PUWER	Provision and Use of Work Equipment Regulations
PTFE	polytetrafluoroethylene
PV	purge valve
Q	flow rate
QS	quotation system
RD	rotary displacement
REC	Retail Energy Code company
RF	raised face
RGMI	registered gas meter installer
RIDDOR	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations
RIV	regulator inlet valve

RTJ	ring type joint
ROV	regulator outlet valve
SIIV	stream inlet isolation valve
SMYS	specified minimum yield stress
SNR	signal to noise ratio
SOIV	stream outlet isolation value
SOL	safe operating limit
SP	set point
SPEV	service pipe energy valve
SSV	slam-shut valve
STP	strength test pressure
TOP	temporary operating pressure
UIP	Utility Infrastructure Provider
UK	United Kingdom
UKAS	United Kingdom Accreditation Service
UKCA	United Kingdom conformity assessment
USM	ultrasonic meter.

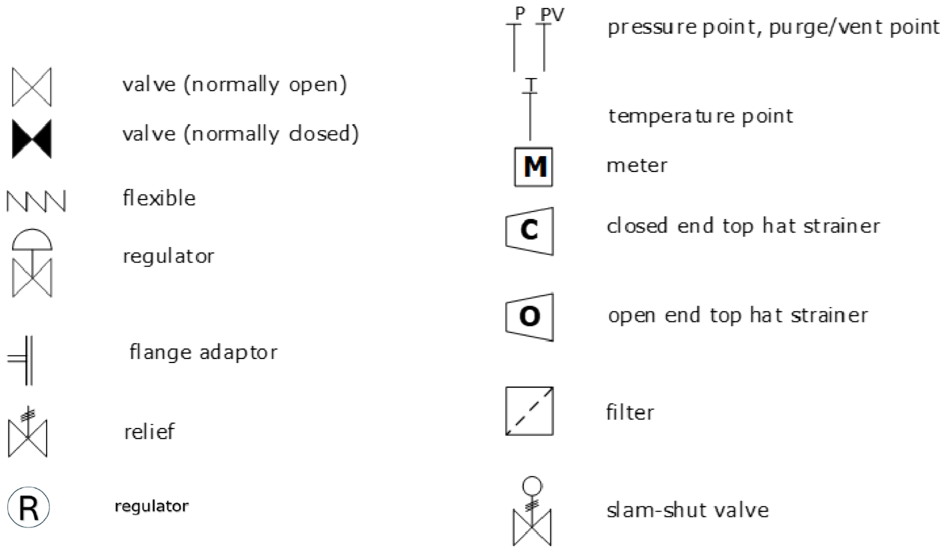
A1.3 SUBSCRIPTS

b	base conditions
c	refers to the consumer's system downstream of the meter installation, e.g., MIP_c is the MIP that the consumer's system may put back onto the meter installation and DmP_c is the minimum pressure at which the consumer's system can operate while maintaining adequate pressure at appliances.
imax	installation maximum
ign	ignition
m	metering (as in P_m)
max	maximum (component)
mid	part of meter installation downstream of the pressure break
min	minimum
miu	part of meter installation upstream of the pressure break
nom	nominal
r	reference
mi	refers to the downstream side of the meter installation, and is a function of the design of the meter installation, e.g. MIP_{mi} is the MIP to which the consumer's system will be subjected by the meter installation i.e. resulting from the operation of a slam-shut valve, and DmP_{mi} is the minimum pressure that the meter installation will provide under extreme conditions i.e. operating with the supply pressure at DmP_u and maximum load.
u	refers to the upstream Network, e.g., MIP_u is the MIP that the Network may apply to the meter installation as a result
u	of a fault on the upstream district pressure regulating station and DmP_u is the minimum pressure that may occur at the end of any service (pipe) at the time of system design flow rate under extreme gas supply and maintenance conditions.

A1.4 UNITS AND SYMBOLS

$cm^3\ h^{-1}$	cubic centimetre per hour
dm^3	cubic decimetre
dB	decibel (frequency scales A and C)
$dm^3\ h^{-1}$	cubic decimetre per hour
$ft^3\ h^{-1}$	cubic feet per hour
in	inch
Hz	hertz
kHz	kilohertz
kg	kilogram

kg m^{-3}	kilogram per cubic metre
lbs in^{-2}	pound per square inch
m	metre
m^3	cubic metre
mbar	millibar
bar	bar
mm	millimetre
$m^3\ h^{-1}$	cubic metre per hour
m s^{-1}	metre per second
MJ	megajoule
W	Watt
mV	millivolt
V	Volt
MWh	megawatt hour
°	degree angular
°C	degree centigrade
μm	micrometre
%	ratio of nominal external diameters
Φ	diameter
>	greater than
≤	less than or equal to
±	plus and minus



SYMBOLS KEY CHART

APPENDIX 2 : REFERENCES

This Standard is set out against a background of legislation in force in GB at the time of publication. Similar considerations are likely to apply in other countries and reference to the appropriate national legislation will be necessary. The following list is not exhaustive.

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

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

A2.1 LEGISLATION

This sub-appendix lists legislation referred to in this Standard as well as legislation not referenced but which may be applicable.

- Building Regulations for England and Wales 2016, as amended
- Building Standards (Scotland) Regulations (Amendment) 2001 and Amendments 2002, as amended
- Building Regulations (Amendment) Act (Northern Ireland) 2009
- Confined Spaces Regulations 1997
- Construction (Head Protection) Regulations 1989
- Construction (Design and Management) Regulations 2015
- Construction (Health, Safety and Welfare) Regulations 1996
- Control of Asbestos Regulations 2012
- Control of Noise at Work Regulations 2005
- Control of Pollution Act 1974, as amended 1989
- Control of Substances Hazardous to Health Regulations 2002, as amended
- Dangerous Substances and Explosive Atmospheres Regulations 2002
- Electricity at Work Regulations 1989, as amended
- Environment Act 1995
- Environment Act 2021
- Environmental Protection Act 1990
- Gas Act 1986 (as amended by the Gas Act 1995 and incorporating stand-alone provisions of the Utilities Act 2000)
- Gas (Calculation of Thermal Energy) Regulations 1996, as amended
- Gas (Meter) Regulations 1983
- Gas Safety (Installation and Use) Regulations 1984; 1994, 1998, as amended
- Gas Safety (Management) Regulations 1996, as amended
- Health and Safety at Work etc. Act 1974, as amended
- Lifting Operations and Lifting Equipment Regulations 1998
- Management of Health and Safety at Work Regulations 1992, as amended
- Manual Handling Operations Regulations 1992
- Measuring Instruments (EEC Requirements)(Gas Volume Meters) Regulations 1979, as amended
- Noise and Statutory Nuisance Act 1993
- Noise at Work Regulations 1989
- Personal Protective Equipment at Work Regulations 1992, as amended
- Pipelines Safety Regulations 1996, as amended
- Pollution Prevention and Control Act 1999

- Pressure Equipment (Amendment) Regulations 2002, as amended
- Pressure Equipment (Safety) Regulations 2016
- Pressure Systems Safety Regulations 2000
- Provision and Use of Work Equipment Regulations 1992; 1998
- Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013
- The Measuring Instruments (Gas Meters) Regulations 2006
- Town and Country Planning Act 1990
- Transport Act 2000; 2008
- Workplace (Health, Safety and Welfare) Regulations 1992.

A2.2 **HSE ACOPs and GUIDANCE**

- EH40 Occupational exposure limits. Guidance
- HSG47 Avoiding danger from underground services. Guidance
- HSG48 Reducing error and influencing behaviour Guidance
- HSG65 Managing for Health and Safety
- HSG227 A comprehensive guide to managing asbestos in premises
- HSG250 Guidance on permit-to-work systems: A guide for the petroleum, chemical and allied industries
- HSG253 Safe isolation of plant
- HSR25 Electricity at Work Regulations
- L22 Safe Use of Work Equipment. ACoP and Guidance
- L27 Managing and working with asbestos. ACoP and guidance.
- L56 Safety in the Installation and Use of Gas Systems and Appliances. ACoP and Guidance
- L73 Reporting of Injuries, Diseases and Dangerous Occurrences Regulations. Guidance
- L80 Gas Safety (Management) Regulations 1996 (as amended). Guidance
- L113 Safe use of lifting equipment. ACoP and Guidance
- L122 Pipelines Safety Regulations. Guidance.
- L138 Dangerous Substances and Explosive Atmospheres Regulations 2002. ACoP and Guidance
- L143 Managing and Working with Asbestos
- L153 Managing health and safety in construction. Construction (Design and Management) Regulations 2015
- HSR25 Electricity at Work Regulations. Guidance
- INDG178 Written Schemes of Examination
- INDG229 Using Work Equipment Safely
- INDG261 Pressure Systems – a brief guide to safety
- INDG291 Providing and using work equipment safely A brief guide to the Provision and Use of Work Equipment Regulations
- INDG362 Noise at work – A brief guide for controlling the risks
- INDG370 Controlling fire and explosion risks in the workplace A brief guide to the Dangerous Substances and Explosive Atmospheres Regulations 2002.

A2.3 INSTITUTION OF GAS ENGINEERS AND MANAGERS

- IGEM/GL/1 Edition 3 — Planning of gas distribution systems operating at pressures not exceeding 7 bar
- IGEM/GL/5 Edition 3 — Procedures for managing new works, modifications and repairs
- IGEM/GL/8 Edition 4 — Reporting and investigation of gas related incidents
- IGEM/GM/4 Edition 3 — Flow metering practice for pressures between 38 and 250 bar
- IGEM/GM/5 Edition 4 — Selection, installation and use of electronic gas meter volume conversion systems
- IGEM/GM/6 Edition 3 — Standard non-domestic meter installations. Flow rate exceeding 6 $m^3 h^{-1}$ and inlet pressure not exceeding 100 mbar
- IGEM/GM/7A Edition 2 — Electrical connections for gas metering equipment
- IGEM/GM/7B Edition 2 — Hazardous area classification for gas metering equipment
- IGEM/GM/8 Part 2 Ed 3 — Non domestic meter installations. Flow rate exceeding 6 $m^3 h^{-1}$ and inlet pressure not exceeding 38 bar. Location and housing
- IGEM/GM/8 Part 3 Ed 3 — Non domestic meter installations. Flow rate exceeding 6 $m^3 h^{-1}$ and inlet pressure not exceeding 38 bar. Installation and commissioning
- IGEM/GM/8 Part 4 Ed 3 — Non domestic meter installations. Flow rate exceeding 6 $m^3 h^{-1}$ and inlet pressure not exceeding 38 bar. Servicing and maintenance
- IGEM/GM/8 Part 5 Ed 3 — Non domestic meter installations. Flow rate exceeding 6 $m^3 h^{-1}$ and inlet pressure not exceeding 38 bar. Notices and labels
- IGEM/GM/PRS/1 — Meter installation fittings
- IGEM/GM/PRS/6 — Meter connectors
- IGEM/GM/PRS/33 — Meter regulators of nominal diameter 32 mm (1¼ inch) and not exceeding 150 mm (6 inch) and for inlet pressures not exceeding 75 mbar
- IGEM/TD/1 Edition 6 — Steel pipelines for high pressure gas transmission
- IGEM/TD/3 Edition 5 — PE and steel pipelines for gas distribution
- IGEM/TD/4 Edition 5 — Gas services
- IGEM/TD/12 Edition 3 — Pipework stress analysis for gas industry plant
- IGEM/TD/13 Edition 3 — Pressure regulating installations for transmission and distribution systems
- IGE/UP/1 Edition 2 — Strength and tightness testing and purging of industrial and commercial gas installations
- IGE/UP/1A Edition 2 — Strength and tightness testing and purging of small, low pressure industrial and commercial Natural Gas installations

- IGEM/UP/1B Edition 3 — Tightness testing and purging of domestic sized Natural Gas installations
- IGEM/UP/2 Edition 3 — Gas installation pipework, boosters and compressors on industrial and commercial premises
- IGEM/UP/3 Edition 3 — Gas fuelled spark ignition and dual fuel engines
- IGEM/UP/6 Edition 3 — Application of positive displacement compressors to Natural Gas fuel systems
- IGEM/UP/9 Edition 3 — Application of Natural Gas and fuel oil systems to gas turbines and supplementary and auxiliary fired burners
- IGEM/UP/10 Edition 4 — Installation of flued appliances in industrial and commercial premises
- IGEM/SR/15 Edition 5 — Programmable equipment in safety related applications
- IGE/SR/23 — Venting of Natural Gas
- IGEM/SR/25 Edition 2 — Hazardous area classification of Natural Gas installations
- IGEM/SR/29 Edition 2 — Dealing with gas escapes
- IGEM/G/1 Edition 2 — Defining the end of the network, a meter installation and installation pipework
- IGEM/G/4 Edition 2 — Definitions for the gas industry
- IGEM/IG/1 Edition 2 — Standards of training in gas work.

A2.4 **BRITISH STANDARDS (abbreviated titles)**

- BS 10 — Flanges and bolting
- BS 21 — Pipe threads for tubes and fittings Withdrawn
- BS 143 & 1256 — Threaded pipe fittings
- BS 746 — Gas meter unions and adaptors
- BS 1503 — Specification for steel forgings for pressure purposes. Carbon manganese, low alloy and stainless steel forgings. Withdrawn
- BS 1552 — Taper plug valves
- BS 1560-3 — Circular flanges
- BS 1640 — Wrought carbon and ferritic alloy steel fittings
- BS 1710 — Identification of pipelines and services
- BS 2051 — Tube and pipe fittings Withdrawn
- BS 2633 — Class I arc welding of ferritic steel pipework
- BS 2765 — Temperature detecting elements and pockets
- BS 2971 — Class II Arc welding of carbon steel pipework
- BS 3293 — Carbon steel flanges (over 24”)
- BS 3605 — Austenitic stainless steel pipes and tubes Withdrawn
- BS 3692 — ISO metric precision hexagon bolts, screws and nuts
- BS 3799 — Steel pipe fittings, screwed and socket-welding
- BS 3974-1 — Pipe supports Withdrawn
- BS 4161 — Gas meters (withdrawn)
- BS 4190 — ISO metric black hexagon bolts, screws and nuts

- BS 4368 Compression couplings
- BS 4515 Welding of steel pipelines
- BS 4518 Toroidal sealing rings
- BS 4800 Paint colours for building purposes
- BS 4818 Metallic coatings
- BS 4882 Bolting for flanges and pressure containing purposes
- BS 5200 Specification for dimensions of hydraulic connectors and adaptors
- BS 5292 Jointing materials and compounds Withdrawn
- BS 5531 Safety in erecting structural frames Withdrawn
- BS 6400-1 Domestic-sized meter installations – low pressure Natural Gas
- BS 6400-2 Domestic-sized meter installations – medium pressure Natural Gas
- BS 6501-1 Metallic hose assemblies
- BS 6644 Specification for the installation and maintenance of gas-fired hot water boilers of rated inputs between 70 kW (net) and 1.8 MW (net)
- BS 6651 Protection of structures against lightning - withdrawn
- BS 6739 Instrumentation in process control systems
- BS 6891 Low pressure gas pipework (domestic premises)
- BS 6956 Jointing compounds
- BS 7244 Specification for flame arresters for general use Withdrawn
- BS 7430 Earthing
- BS 7531 Compressed non-asbestos fibre jointing
- BS 7671 IEE Wiring Regulations
- BS 7874 Microbiological deterioration of elastomeric seals
- BS 7965 Ultrasonic meters
- BS 7993 Twin ferrule connectors and associated tubing for 316 stainless steel systems. Specification and test methods
- BS EN 88 Pressure governors for gas appliances
- BS EN 334 Gas pressure regulators
- BS EN 437 Test gases
- BS EN 549 Rubber materials for seals and diaphragms
- BS EN 751-3 Sealing materials for metallic threaded joints
- BS EN 1011 Welding of metallic materials
- BS EN 1057 Copper and copper alloys. Tube
- BS EN 1092-1 Circular flanges
- BS EN 1254 Copper and copper alloys. Fittings
- BS EN 1359 Diaphragm gas meters
- BS EN 1503 Valves Withdrawn
- BS EN 1514 Flanges and their joints
- BS EN 1515 Flanges and their joints
- BS EN 1775 Gas supply - gas pipework for buildings – maximum operating pressure less than or equal to 5 bar - functional recommendations
- BS EN 10088 Stainless steels

- BS EN 10208 Steel pipes for pipelines Withdrawn
- BS EN 10216 Seamless steel tubes
- BS EN 10217 Welded steel tubes
- BS EN 10222 Steel forgings
- BS EN 10226 Internal and external pipe threads
- BS EN 10241 Steel threaded pipe fittings
- BS EN 10242 Threaded pipe fittings in malleable cast iron
- BS EN 10253 Butt-welding pipe fittings. Non alloy and ferritic alloy steels with specific inspection requirements
- BS EN 10255 Non-alloy steel tubes suitable for welding and threading. Technical delivery conditions
- BS EN 10380 Corrugated metal hose and hose assemblies
- BS EN 10806 Pipework. Fittings for corrugated metal hoses
- BS EN 12261 Turbine gas meters
- BS EN 12405 Gas volume electronic conversion systems
- BS EN 12480 Rotary positive displacement gas meters
- BS EN 13445 Unfired Pressure Vessels
- BS EN 14382 Gas safety shut-off devices
- BS EN 60079 Electrical apparatus for explosive gas atmospheres
- BS EN 61672 Electroacoustics – sound level meters
- BS EN 62305 Protection against lightning
- BS EN ISO 10806 Fittings for corrugated metal hoses
- PD 5500 Unfired fusion welded pressure vessels.

A2.5 **RETAIL ENERGY CODE COMPANY**

- CoMCoP Consolidated metering Code of Practice for meter equipment ~~asset~~ managers and meter installers.

A2.6 **MISCELLANEOUS (abbreviated titles)**

- API 5L Linepipe
- ANSI VIII Pressure vessels
- ANSI B 31.11 Pipeline branches
- ANSI B 16.5 Steel flanges (> 24”)
- ANSI B 16.9 Wrought butt welding fittings
- ASME B31.1 Power piping
- ASME B16.9 Factory-made wrought butt welding fittings
- ASTM A 106 Seamless carbon steel pipe
- GIS F/9 Metric and Imperial Stainless Steel Single and Twin Ferrule Compression Fittings for Tubes
- GIS VA 1/E Actuator
- GIS VA 2/E Actuator
- GDN/PM/GT/1 Management Procedure for requesting gas service pipe pressure and capacity information from Gas Transporters

- GDN/PM/GT2 Management Procedure for requesting a Gas Transporter to: Authorise the setting and sealing of regulators and associated safety devices, authorise the installation of a meter by-pass, Approve a meter housing design
- ISO 3183-2 Steel pipe for pipelines
- ISO 5168 Calculation of uncertainty of measurement
- ISO 7005 Steel flanges (≤ 24")
- ISO 14313 Pipeline transportation systems – pipeline valves
- MSS SP 75 High test wrought butt welding fittings.

APPENDIX 3 : INFORMATION ON LOAD

LOAD INFORMATION REQUIRED AT METER INSTALLATION DESIGN STAGE (INFORMATION TO BE SUPPLIED BY THE GAS SUPPLIER OR CONSUMER)

To obtain a quotation for a meter module/installation, the completed form must be returned to the meter installer.
NOTE: Where information is unavailable, the installer may have to make assumptions during the design stage of the meter installation. These assumptions may impose restrictions on the operation of the consumer's plant and could affect plant operability.

Meter installer contact details:

Company:		Address:	
Engineer:			
Tel No:			
Fax No:		E-mail:	

Gas supplier contact details:

Company:		Contact: Address:	
Contact:			
Tel No:			
Fax No:		E-mail:	

Job/Gas consumer details:

Project Name:			
Company:		Address:	
Contact:			
Tel No:			
Fax No:		E-mail:	

Housing/location requirements/details
NOTE: Housings must have a minimum free ventilation area of 2% floor area.

IGEM/GM/8 Part 2 Housing required? ☐ Yes ☐ No	Finish: ☐ Green ☐ Textured ☐ Brick effect
Please provide details of the proposed location of the housing and installation, indicating proximity to the site boundary, other buildings, plant, etc.	

Preferred outlet pipe orientation:

Outlet orientation:	☐ Vertical down ☐ Vertical up ☐ Horizontal

Plant and downstream system pressure details (safety and performance):

	Non-standard appliances ☐	Standard Appliances ☐
Metering pressure requested:	....................mbar/bar	....................mbar
Strength test pressure STP_c?	....................mbar/bar	..................mbar
Design pressure DP_c?	....................mbar/bar	....................mbar
Maximum operating pressure MOP_c?	....................mbar/bar	....................mbar
Normal operating pressure?	....................mbar/bar	....................mbar
Lowest operating pressure LOP_c?	....................mbar/bar	....................mbar
Design minimum pressure DmP_c?	....................mbar/bar	....................mbar

Load details:

Minimum flow rate $m^3 h^{-1}$:	_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ **NOTE:** Should not be zero.	Maximum flow rate $m^3 h^{-1}$:	
Estimate Q_{max} in 12 months in $m^3 h^{-1}$:		Peak load $m^3 h^{-1}$:	
Is continuity of supply required?	☐ No ☐ Yes If yes, specify reason... .... Other comments sheet attached? : ☐ No ☐ Yes		

Cont.

Details of downstream plant/equipment:	Number, type and size of unit of plant, and where available usage patterns: (including any inter-dependencies). Other comments sheet attached? ☐ No ☐ Yes ----------- sheets

Special features of the load:

Special features present downstream:	
Initial overview of special features where present:	☐ Engine ☐ Turbine ☐ Compressor ☐ Booster ☐ Modulating ☐ Pulsating load Frequency of pulsations ....Hz Amplitude of pulsations ....% ☐ On–Off Frequency on-off loads .... e.g. 20 min on 30 min off ☐ Other possible source of pulsations/step load changes, specify .... and provide details on a separate sheet. ☐ Other possible source of extraneous gases, specify .... and provide details on a separate sheet. Other comments sheet attached? ☐ No ☐ Yes .... sheets.
Maximum incidental pressure (fault pressure) to which the meter installation may be subjected by the consumer's system	....................................mbar/bar

Other requirements/restrictions: e.g. hazardous areas

Other comments sheet attached? ☐ No ☐ Yes --------- sheets

End.

APPENDIX 4 : COLLECTING DESIGN INFORMATION

REQUEST FOR INFORMATION FROM A GT

1. GT CONTACT DETAILS

The requestor completes this section based on information from previous correspondence received from GT relating to this request for information.

For the attention of		GT Network	
Fax No.		Date of Request	
Requestors Reference No.		GT Reference No.	
GT CONFIRMATION			
Name of contact		GT Network	
Phone number		Fax number	
Date request received		Date reply sent	

2. DETAILS OF PERSON/ORGANISATION REQUESTING INFORMATION

The Requestor completes this section identifying their organisation, contact details and the person to be sent the response from GT or to be contacted in the event of a query about the request.

Requestor organisation			
Requestor's address			
Post Code		Fax No.	
Contact Name		Phone No.	

3. SITE DETAILS (where the work is intended to be carried out)

The requestor completes this section providing details of the valid Site address:

Post code to be provided by the requestor where known. Where not known, a valid ordnance survey grid reference number to be provided.

The MPRN or QS Number to be provided by the requestor, unless it is an existing service without a MPRN issued, in which case the GT will generate a number and issue with the pressure and capacity information.

Site name			
Site address			
Post code		O.S. Grid Ref No.	
MPRN		GT QS Number	
Status report from requestor	No gas at ECV ☐ No ECV ☐	Energy required	SPEV = kW

4. INFORMATION REQUIRED

The requestor completes this section identifying the information required.

Pressure information required	☐ **YES** ☐ **NO**	Service pipe status required	Check live/dead ☐ YES ☐ NO
Capacity information	☐ **YES** ☐ **NO**		

Cont.

5. ESSENTIAL NETWORK INFORMATION

GT completes this section.

Service pipe status	☐ Live ☐ Dead ☐ Planned/quoted	MPRN	
Service pipe status planned follow up work		☐ Fix ECV ☐ Open valve ☐ Relay Service pipe	
Service pipe capacity	☐ Nominated ☐ Maximum	Service pipe energy value confirmed or available	$SPEV_{nom/max*}$=.................... kW
		Flow rate	$Q_{nom/max*}$.=.................... std $m^3 h^{-1}$

Pressure tier	Design minimum pressure (DmP)	Lowest operating pressure (LOP)	Maximum operating pressure (MOP)	Design pressure (DP)	Design maximum incidental pressure (DMIP)
LP ☐	19 mbar	25 mbar	75 mbar	75 mbar	200 mbar
MP35 ☐	35 mbar	35 mbar	185 mbar	2.0 bar	2.7 bar
MP65 ☐	65 mbar	75 mbar	250 mbar	2.0 bar	2.7 bar
MP105 ☐	105 mbar	105 mbar	1.1 bar	2.0 bar	2.7 bar
MP180 ☐	180 mbar	180 mbar	1.6 bar	2.0 bar	2.7 bar
MP270 ☐	270 mbar	280 mbar	2.0 bar	2.0 bar	2.7 bar
IP ☐	...........bar	...........bar	...........bar	7.0 bar	9.31 bar
Other ☐	.... mbar/bar*	.... mbar/bar*	.... mbar/bar*	.... mbar/bar*	.... mbar/bar*

6. GT IMPOSED CONSTRAINTS

The GT completes this section. The information provided on the attached sheets to be used in the design and installation process to ensure compatible with other Quotation, Approval or Authorisation procedures.

See attachments for constraints on the:	☐ Service ☐ Meter installation ☐ Meter housing

7. ADDITIONAL NETWORK INFORMATION

The following additional information may be requested. The GT will provide the following information where it has it readily available. The GT will not undertake a site visit specifically to obtain this additional information.
Is the following information requested? ☐ Yes

The following additional information requested is **all/partially/not*** available.

Emergency control valve details	Type of emergency control valve: .... Orientation: **horizontal/vertical*** Size of outlet connection: ....mm Type of outlet connection: **Screwed / flanged*** Detail: ☐ BS EN 10226 ☐ BS 746 ☐ BS 5200 ☐ PN16 ☐ Class 300 ☐ Other:....................please specify
Approximate position of emergency control valve (ECV) outlet face	Height .... cm Distance centreline to rear meter house wall ....cm Distance centreline to meter house wall to left ....cm **Other significant dimensions shown on attached sketch?** ☐ Yes ☐ No

End.

APPENDIX 5 : GT STANDARD OPERATING CONDITIONS

PRESSURE TIER	**PRESSURES AT THE OUTLET OF THE ECV**				
	DESIGN MINIMUM PRESSURE (DmP)	**LOWEST OPERATING PRESSURE (LOP)**	**MAXIMUM OPERATING PRESSURE (MOP)**	**DESIGN PRESSURE (DP)**	**DESIGN MAXIMUM INCIDENTAL PRESSURE (DMIP)**
Low	19 mbar	25 mbar See Note 1	75 mbar	75 mbar	200 mbar
Medium^{35}	35 mbar	35 mbar	185 mbar	2.0 bar	2.7 bar
Medium^{65}	65 mbar	75 mbar	250 mbar	2.0 bar	2.7 bar
Medium^{105}	105 mbar	105 mbar	1.1 bar	2.0 bar	2.7 bar
Medium^{180}	180 mbar	180 mbar	1.6 bar	2.0 bar	2.7 bar
Medium^{270}	270 mbar	280 mbar	2.0 bar	2.0 bar	2.7 bar
Intermediate	See Note 2	See Note 2	See Note 2	7.0 bar	9.31 bar
High	See Note 2	See Note 2	See Note 2	See Note 2	MOP + 10%

Note 1: *Operating pressures of 21.5 mbar may occur, during normal operation, at the outlet of the ECV on parts of low pressure networks. However, experience has shown that low pressure meter installations will provide a satisfactory outlet pressure when designed for an inlet pressure of 25 mbar and a maximum pressure absorption of 4 mbar determined at an inlet design minimum pressure of 19 mbar. Both BS 6400-1 and IGEM/GM/6 use/will use these design criteria and, therefore, 25 mbar is used in this table for consistency with these metering standards.*

Note 2: *On intermediate and high pressure Networks, the applicant has to confirm with the GT the operational pressures at the outlet of the particular service (pipe) ECV.*

APPENDIX 6 : NOISE ASSESSMENT AND CONTROL

A6.1 PROTECTION OF HEARING (edited to match IGEM/TD/13)

A6.1.1 The aim of The Noise at Work Regulations is to reduce the risks of occupational hearing damage to as low as reasonably practicable.

There are, among others, legal duties to:

- protect the hearing of those at work and of others
- carry out a noise assessment if employees are exposed to noise levels exceeding 80 decibels (dB)(A)
- take measures to reduce noise levels to the lowest level reasonably practicable
- use warning signs to indicate where hearing protection must be worn
- inform workers about risks to hearing.

The regulations specify the following exposure limit values and action values:

- lower exposure action values are a daily or weekly exposure of 80 dB(A); and a peak sound pressure of 135 dB(C)
- upper exposure action values are a daily or weekly exposure of 85 dB(A); and a peak sound pressure of 137 dB(C)
- the exposure limit values are a daily or weekly exposure of 87 dB(A); and a peak sound pressure of 140 dB(C).

While attempts are required to be made to reduce noise levels, exposure above the lower exposure action value requires the employer to make hearing protection available on request and exposure above the upper exposure action value requires the employer to provide hearing protection.

Areas above the upper exposure action value, are designated Hearing Protection Zones. Access is required to be controlled to these areas.

No worker is to be exposed to a noise level above the exposure limit value (taking hearing protection into account).

An employer is to provide health surveillance for those regularly exposed above the upper action value or for those occasionally exposed above the upper action value but who are particularly sensitive.

A6.1.2 The HSE publication INDG 362 is designed to give those with responsibilities for reducing noise exposure guidance and advice on legal duties on the introduction of control measures, the selection of ear protection and how to carry out a noise assessment by a competent person.

A6.2 DESIGN PROCEDURE FOR ENVIRONMENTAL NOISE CONTROL

The following represents a general design procedure for environmental noise control.

A6.2.1 Background noise survey

A6.2.1.1 Survey the location of a proposed site initially to confirm its suitability and to confirm existing background noise levels. Since this survey serves as a basis for the design of noise control measures and the validation of any future noise complaints, competent and trained personnel are required to undertake the survey.

A6.2.1.2 Specify a noise survey procedure, to incorporate the following, using a recently-calibrated precision sound level meter conforming to an appropriate standard such as BS EN 61672:

- minimum background levels that, normally, occur between midnight and 0400 hours
- both octave band and "A" weighted sound level data
- the procedure adopted and the data obtained (reported in detail and retained for future reference).

A6.2.2 **Identification of noise sources**

A6.2.2.1 Before effective noise control can be applied, identify probable significant noise sources within the site in terms of generation and radiation. Recognise that noise can be radiated and reflected from points other than its source of generation. The significance of pure tones and infrasound cannot be overstated.

A6.2.2.2 Regulators are the main cause of noise generation at meter installations. They generate significant noise at frequencies in the range of 500 Hz to 8 kHz. The acoustical energy transmitted by the gas itself, and the pipe wall, will radiate from above-ground downstream and upstream piping, even where the piping is brought above the ground after a buried run.

A6.2.2.3 ~~Jet boosters use the energy content of higher pressure gas to entrain gas from lower pressure storage and to compress it to some pressure in between the two values required for distribution. Jet boosters and their associated pipework produce high levels of noise at frequencies in the range of 1 kHz to 8 kHz.~~

A6.2.2.4 In general, relief valves do not require acoustic treatment. However the need for such treatment may need to be assessed in relation to Common Law, Control of Pollution Act, Health and Safety at Work etc. Act Sections 3 (1) and 5 (1) and The Noise at Work Regulations.

A6.2.2.5 Water bath heaters may cause nuisance due to low frequency combustion noise and exhaust stack resonance, together with high frequency air intake noise. In addition, there is often a characteristic low frequency impulse noise when the burner gas ignites.

A6.2.3 **Noise radiation**

A6.2.3.1 Predict the effective radiated sound power (on a decibel scale with a reference level of 10^{-12} W) for each exposed area of piping. Gas-borne regulator noise radiated by exposed pipework is, generally, more significant than the noise radiated by the regulator itself. Significant levels of noise generated by a monitor regulator can be radiated from upstream pipework.

A6.2.3.2 The correct aerodynamic design of piping and components may be expected to reduce locally-generated noise, but will seldom influence the radiation of gas-borne regulator noise which is, normally, dominant.

A6.2.3.3 Water bath heater noise radiates directionally at high frequencies from the air intake(s), and omni-directionally at low frequencies from the stack exit.

A6.2.4 **Sound pressure level prediction**

A6.2.4.1 Identify the nearest noise sensitive location (control point) to the meter installation using the noise survey report (see A6.2.1). The total sound pressure level spectrum produced at that point by contributions from all sources identified in A6.2.2 can then be predicted using suitable guidance, for example, Engineering

Equipment and Materials Users' Association (EEMUA) Publication No. 140. The following information will be necessary:

- the effective radiated sound power spectrum in octave bands for each acoustically significant source
- directional data for each source or group of sources
- the exact location of each of the sources relative to each other and to the noise-sensitive location
- the situation of sources with respect to the ground and any large reflecting or absorbing surfaces
- any environmental or topographical features which could influence the propagation of sound, for example, embankments, hard and soft ground and groups of trees
- acoustical data for any items such as buildings, fixed enclosures, movable covers, line silencers and insulation incorporated in the design.

A6.2.4.2 Some sources may be found to be insignificant when compared with the total level, but care is needed to ensure that they will not assume prominence when more powerful sources have been treated.

A6.2.5 **Prediction of noise reduction**

Compare the predicted sound pressure level spectrum with the required levels for that particular site. Distribute the total attenuation among the sources, beginning with the most significant. Exercise judgement at this stage to establish an acceptable compromise between cost, and extent of treatment. The effect of such treatment on maintenance costs is relevant.

A6.2.6 **Application of noise control methods**

A6.2.6.1 It is unlikely that any one method will provide a complete solution to the noise problem at an individual installation, but it may be possible to obtain a satisfactory result at optimum costs by adopting an appropriate selection of the measures set down in A6.2.6.2.

A6.2.6.2 Noise reduction methods include:

- burying as much of the interconnecting pipework as practicable, with headers buried where possible, and the length of exposed pipework kept to a minimum, particularly that downstream of regulators
- selection of regulators to combine satisfactory overall performance with least noise generation among their characteristics. Primarily, the sound power of a regulator is a function of flow-rate and differential pressure.

  When the flow is unchoked, differences in valve internal geometry influence the sound power spectrum.

  Unchoked valves are quieter than choked valves.

  Considerable noise control benefit may be obtained by the use of more than one stage of pressure reduction if the stages are thereby made subsonic.
- correct use of enclosures, i.e.;
  - locating the complete installation in an underground pit or pits with heavy, lagged, ventilated removable covers which can achieve a reduction in noise level up to 40 dB(A)
  - complete enclosure of the pressure-regulating equipment in a suitable building or kiosk of solid construction. Reverberant noise within enclosures may be reduced by lining them with sound absorbent material. The noise-reducing performance is limited by the need for ventilation, doors and

explosion relief features, and is unlikely to exceed 40 dB(A). This value may fall to 20 dB(A) when constructional compromises are adopted

- enclosure of the installation by use of bund walls, with or without removable covers. Uncovered pits cannot be expected to provide noise reduction in excess of 10 dB(A). They do not have good energy absorbing properties but concentrate the energy elsewhere
- light-weight glass fibre canopies can provide 10-15 dB(A) noise reduction if lined with absorptive material on the inside
- barriers have limited application in the control of valve noise. To be effective, they need to be located very close to the noise source, and to be very large in relation to it. Unless specially designed and located, it is difficult to reduce valve noise, at a distant location, by more than 10-15 dB(A)
- cladding provides a convenient method of reducing radiation from exposed piping. It is difficult to achieve noise reductions in excess of 25 dB(A) using this method with reasonable economy.

A6.2.6.3 Where space allows, or provision has been made in the overall layout of the system, line silencers can be effective, particularly if assisted by the cladding of exposed pipework and components. Overall reductions in sound pressure levels of the order of 20 dB(A) may be obtained from a well designed unit. In all cases, the overall performance will be limited by flanking paths, regeneration and impingement noise from the inlet diffuser. The performance of line absorptive silencers falls as the pipeline pressure increases above 7 bar.

A6.2.6.4 Acoustic treatment of water bath heaters needs to be in accordance with an appropriate standard.

A6.3 PERFORMANCE EVALUATION

When the installation is commissioned, check the acoustic performance. Carry out a noise survey, over a similar period of time on the same basis the pre-design survey referred to in A6.2.2 at appropriate rates of flow and pressure differential, to confirm that an adequate degree of noise reduction has been achieved and that any contract specifications for noise control have been met.

If there are any changes to the operating parameters or physical specifications be carried out, conduct a similar procedure to that outlined above, and include confirmation or otherwise of the background noise conditions.

APPENDIX 7 : DATA FOR ASSESSMENT OF LARGE GAS COMPRESSOR LOADS

The following information is required to assess the possible effect of gas compressor loads on meter installations. In many instances, some of the items included will not be applicable to the system being considered and extra sheets will need to be attached where necessary (refer to IGEM/UP/6).

Much of the information listed may not be known at an early stage in the specification of the system. In these cases, provide as much detail as is available with any items which are assumed, or are based on, similar systems clearly identified.

For more than one type of compressor, use the appropriate number of forms.

Network procedures also require information regarding compressors or boosters, this is part of the GT2 process, consumers using compressors or boosters are classed as non-typical demands and are subject to additional analysis to determine any determinantal effects on the network. Refer to Network documents such as SP/NP/14 published by the Distribution Networks.

Supply details

Installation name/identification

Supply pipe diameter	mm	Supply pressure	MAX bar	MIN bar	NORMAL bar

Any special features of supply, for example any other upstream loads close to the supply?

Is pressure regulated at entry to site? YES / NO

Outline details of regulator system

Load details under standard conditions

Maximum flow rate	$m^3\ h^{-1}$	Minimum normal flow rate	$m^3\ h^{-1}$

Any special features of load, for example minimum load-on/load-off time

Metering system details

Maximum flow rate for metering system	$m^3\ h^{-1}$	Metering pressure	bar

Meter type/size

Any special features of metering systems, for example pressure limits?

Installation pipework and layout

Attach a sketch showing the essential features of the installation. Include length/diameter of pipework from meter outlet to compressor inlet.

Describe any special features of the pipework, for example pressure limits

cont/....

Details of any other loads supplied from the meter installation

Is the supply pressure to these loads regulated	YES / NO

Describe any special features of the other loads (for example particular sensitivity to pressure changes)

Compressor system

Number of compressors and their make/model			
Type of machine (reciprocating/screw/other)		Maximum rated flow of machine	$m^3\ h^{-1}$
Is PID available for machine/system (or a typical example)? if YES, attach	YES / NO	Is the supply pressure regulated at the compressor inlet?	YES / NO
If compressor system includes a spill back or by-pass, what is its volume?	m^3	Compressor outlet pressure	bar
Volume of receiver on machine outlet	m^3	Volume of receiver on machine inlet	m^3

For a reciprocating machine

Arrangement, for example 2-cylinder, 2 stage		Layout of first stage, for example single cylinder, double acting	
Bore and stroke of first stage cylinder(s)	m^3	Drive speed of compressor	rpm
Is the level of pulsation damping on machine inlet specified? If so, what is it?	YES / NO	Methods(s) of control, for example step, spillback, inlet throttle, motor speed etc.	

cont/....

For a screw machine

Method(s) of control (for example slide valve, spillback, motor speed, etc)

For any other type of compressor

Operating principle | Method(s) of control

Compressor system supply safeguards

What under/over pressure protection devices are provided on the compressor inlet? (for example low pressure trips, relief valve, etc.)

Sheet completed

The user

Name (individual and/or company)

Address

Tel. No.

Comments of the GT

Name

Date

END

APPENDIX 8 : ACCEPTABLE INSTALLATIONS

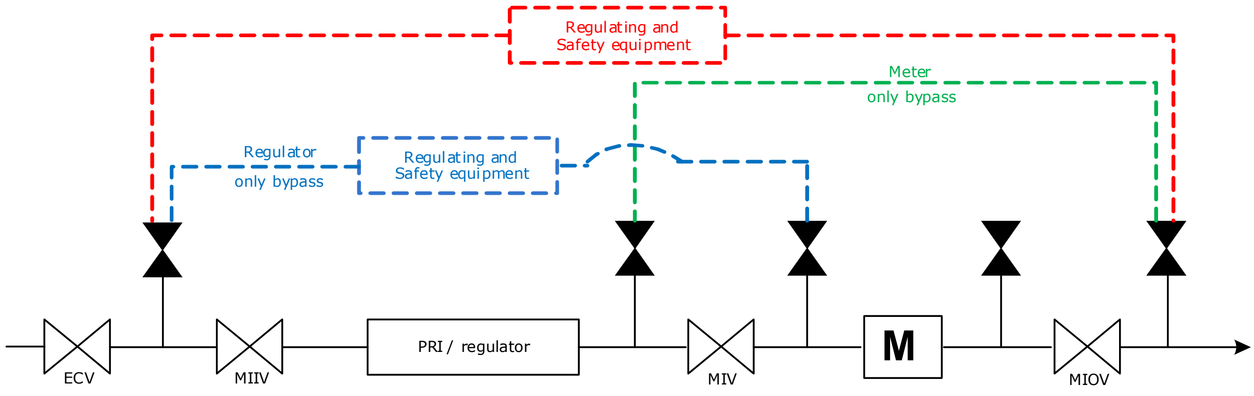
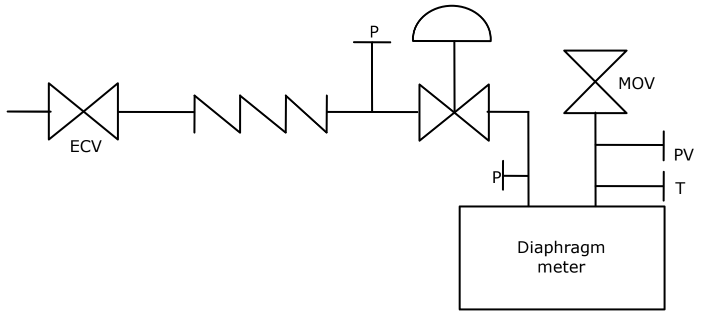
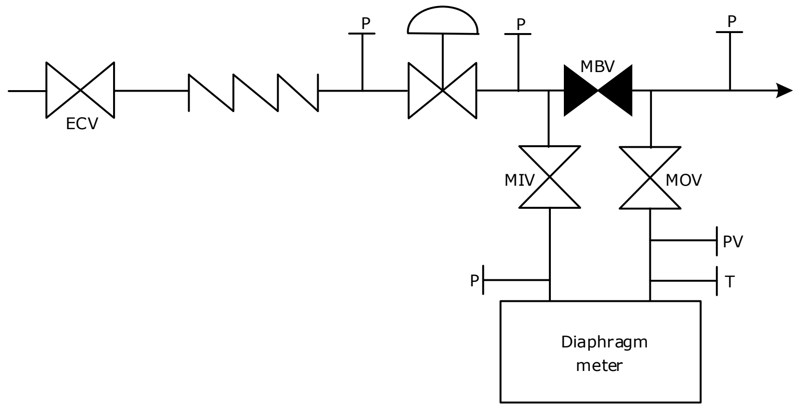


FIGURE 11 - ARRANGEMENTS OF A TEMPORARY BY-PASS



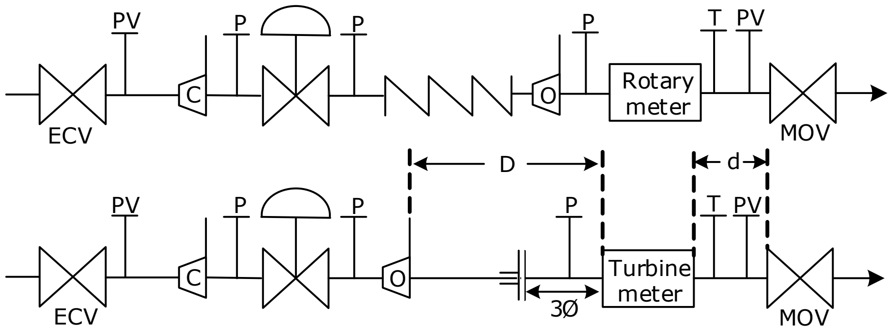
Note 1: *MOV, P and PV points for Q > 16 m^3 h^{-1}.*
Note 2: *T not normally required for Q ≤ 40 m^3 h^{-1}.*
Note 3: *In exceptional circumstances, a filter may be required.*

FIGURE 12 - SINGLE STREAM.
DIAPHRAGM METER INSTALLATION.
MOP_u ≤ 75 mbar



Note 1: *T not normally required for Q ≤ 40 m^3 h^{-1}.*
Note 2: *In exceptional circumstances, a filter may be required.*

FIGURE 13 - SINGLE STREAM.
DIAPHRAGM METER INSTALLATION WITH BY-PASS.
MOP_u ≤ 75 mbar



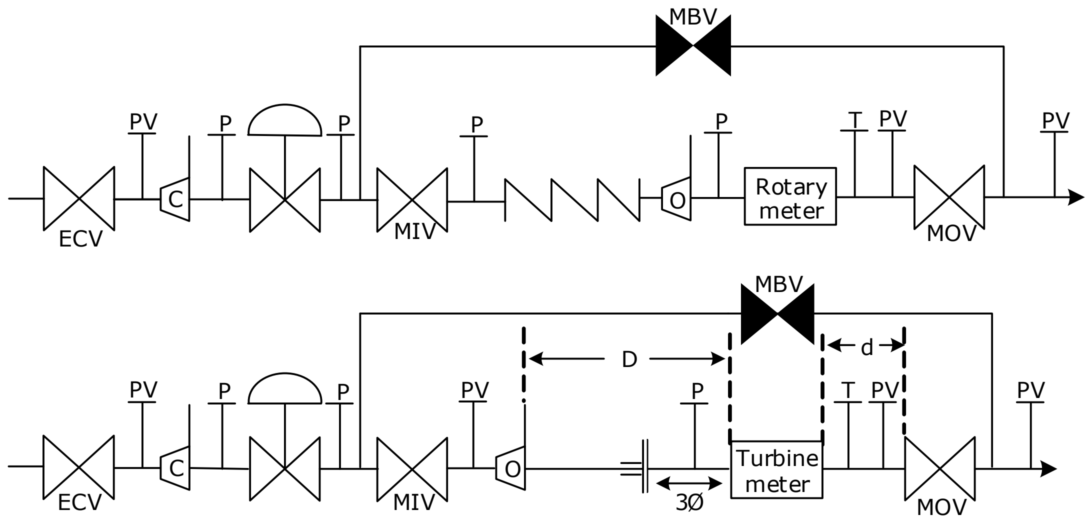
Note 1: *MOV fitted for Q > 16 m³ h⁻¹.*

Note 2: *Where gas is particularly dirty may require a box type filter instead of the closed ended top hat strainer (to ease maintenance).*

Note 3: *D, d show required lengths of turbulent-free pipe.*

Note 4: *Commissioning strainer (o) not required on factory purpose-built modules.*

FIGURE 14 - SINGLE STREAM.
RD/TURBINE METER INSTALLATION.
$MOP_u \leq 75$ mbar

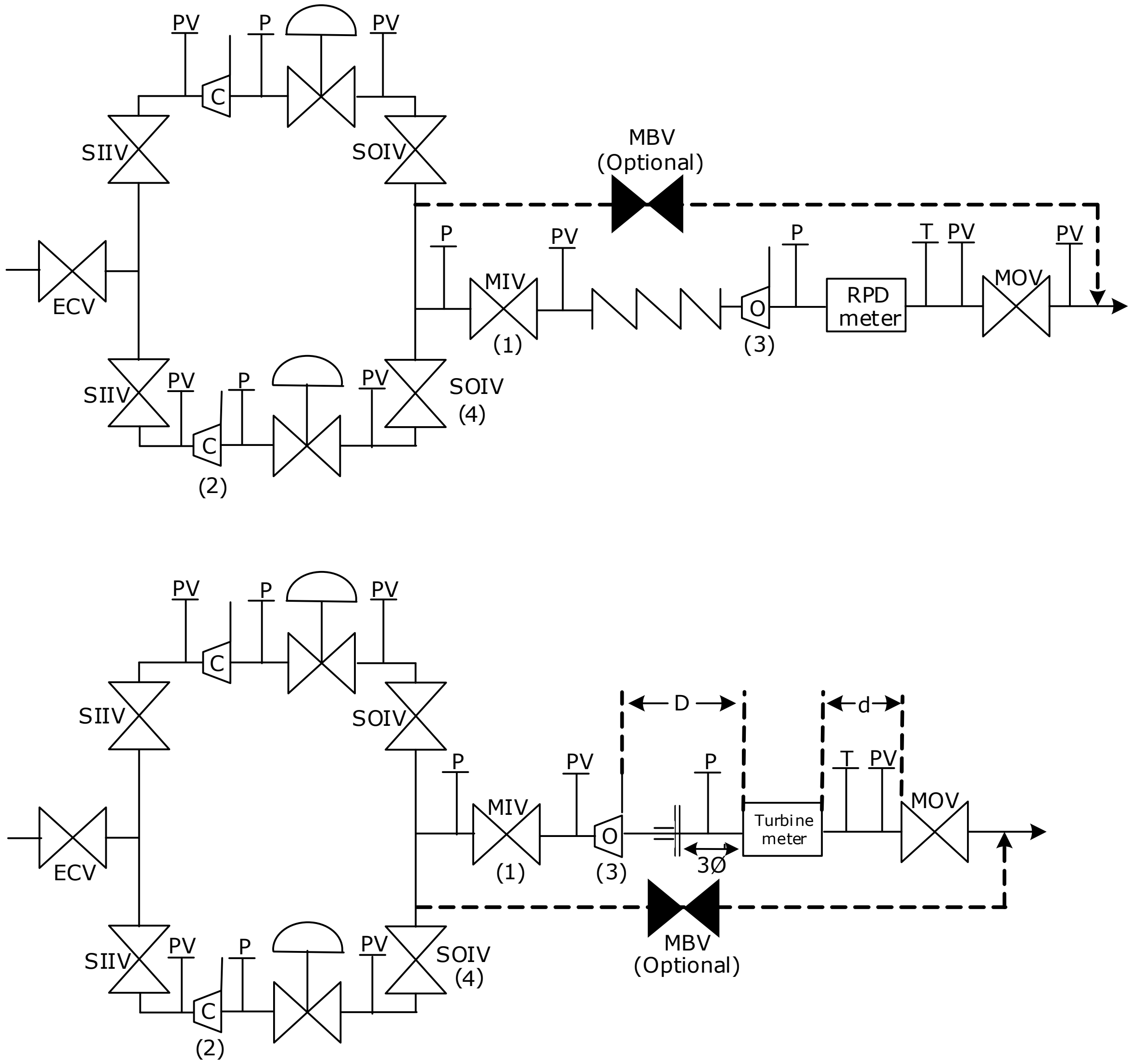


Note 1: *Where gas is particularly dirty may require a box type filter instead of the closed ended top hat strainer (to ease maintenance).*

Note 2: *D, d show required lengths of turbulent-free pipe.*

Note 3: *Commissioning strainer (o) not required on factory purpose-built modules.*

FIGURE 15 - SINGLE STREAM.
RD/TURBINE METER INSTALLATION.
WITH BY-PASS.
$MOP_u \leq 75$ mbar



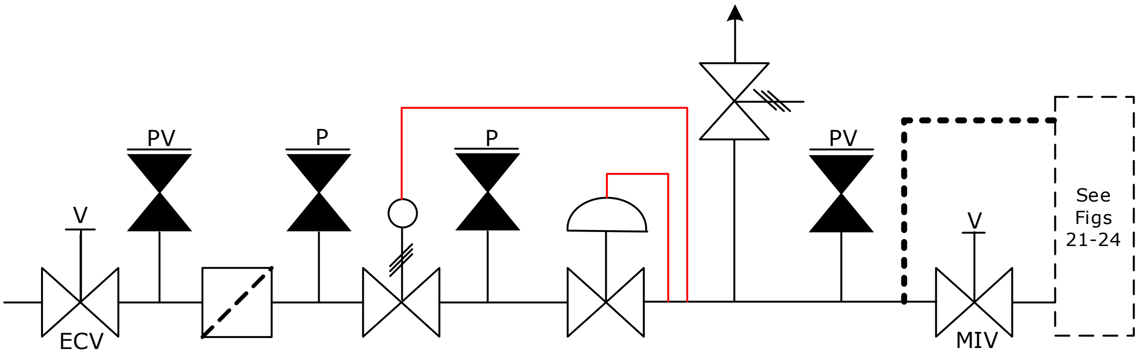
Note 1: If a by-pass is not installed, MIV is not required.

Note 2: Where gas is particularly dirty may require a box type filter instead of the closed ended top hat strainer (to ease maintenance).

Note 3: D, d show required lengths of turbulent-free pipe.

Note 4: Commissioning strainer (o) not required on factory purpose built modules.

**FIGURE 16 - TWIN STREAM.
RD/TURBINE METER INSTALLATION.
$MOP_u \leq 75$ mbar**

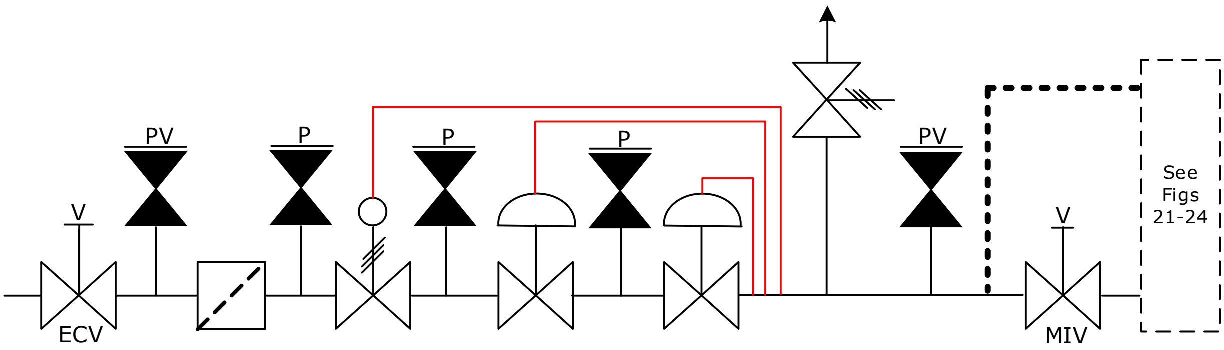


Note 1: *Capacity of the relief valve is ≤ 1% of the stream design capacity or 3 m^3 h^{-1} whichever is the greater.*

Note 2: *GS(I&U)R allow the nomination of an additional valve (AECV) to be used by the consumer to isolate the gas supply.*

Note 3: *Optional by-pass shown by - - - - - (see Sub-Section 6.3).*

**FIGURE 17 - SINGLE STREAM.
SLAM/ACTIVE REGULATOR INSTALLATION.
MOP$_u$ ≤ 2 BAR**

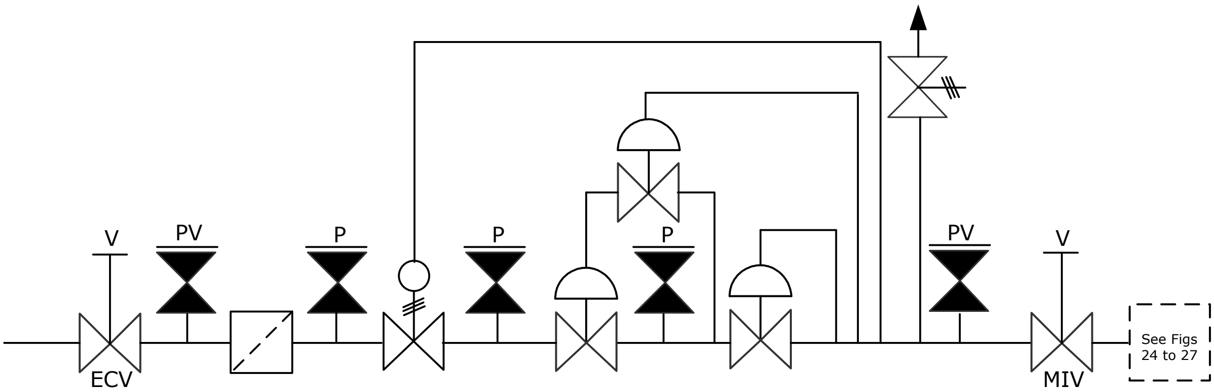


Note 1: *Capacity of the relief valve is ≤ 1% of the stream design capacity or 3 m^3 h^{-1} whichever is the greater.*

Note 2: *GS(I&U)R allow the nomination of an AECV to be used by the consumer to isolate the gas supply.*

Note 3: *Optional by-pass shown by - - - - - (see Sub-Section 6.3).*

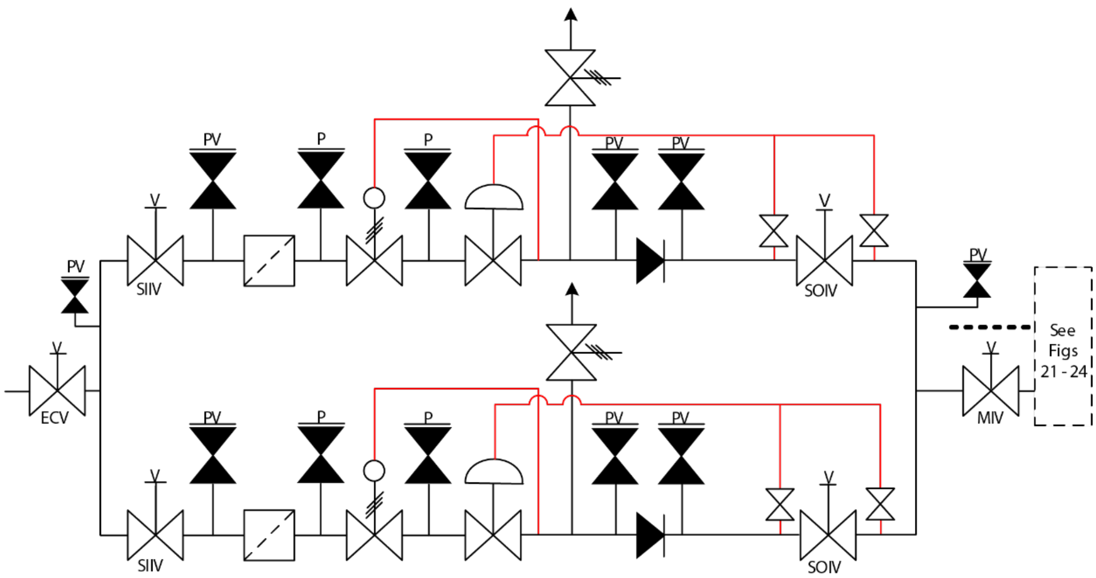
**FIGURE 18 - SINGLE STREAM.
SLAM/MONITOR/ACTIVE REGULATOR INSTALLATION.
MOP$_u$ > 2 bar**



Note 1: Capacity of the relief valve is ≤ 1% of the stream design capacity or 3 m^3 h^{-1} whichever is the greater.

Note 2: GS(I&U)R allow the nomination of an AECV to be used by the consumer to isolate the gas supply.

FIGURE 19 - SINGLE STREAM. SLAM/MONITOR/ACTIVE REGULATOR INSTALLATION. WITH MONITOR OVERRIDE PROVIDING 2 STAGE PRESSURE REDUCTION. MOP_u >2 bar

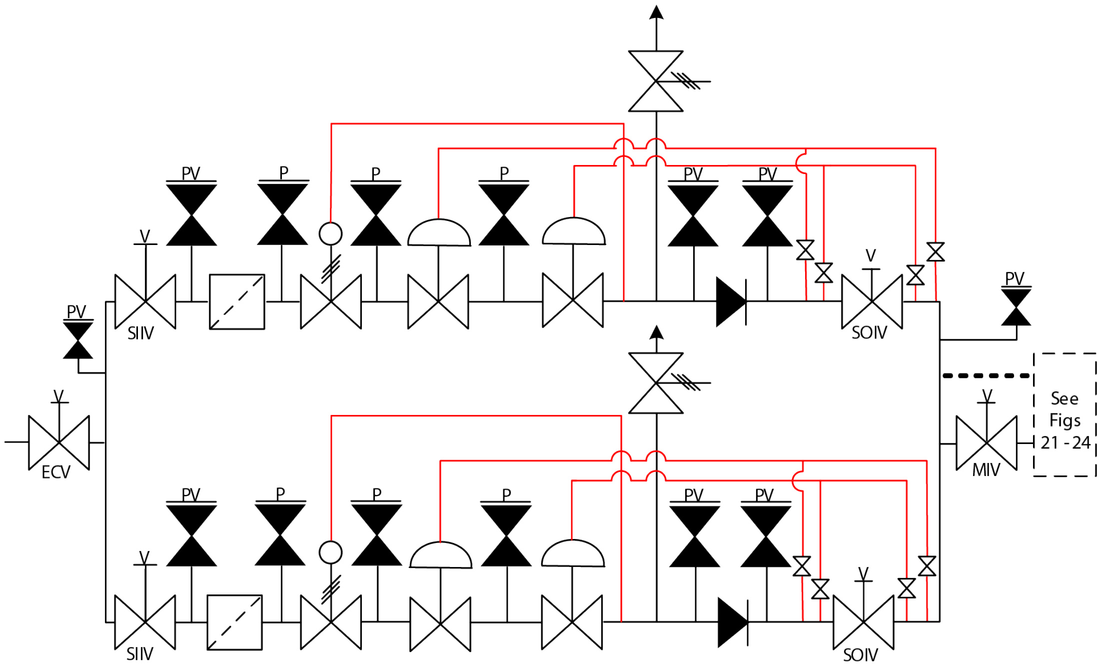


Note 1: Capacity of the relief valve is ≤ 1% of the stream design capacity or 3 m^3 h^{-1} whichever is the greater.

Note 2: GS(I&U)R allow the nomination of an AECV to be used by the consumer to isolate the gas supply.

Note 3: Optional by-pass shown by ----- (see Sub-Section 6.3).

FIGURE 20 - TWIN STREAM SLAM/ACTIVE REGULATOR INSTALLATION. MOP_u ≤ 2 bar

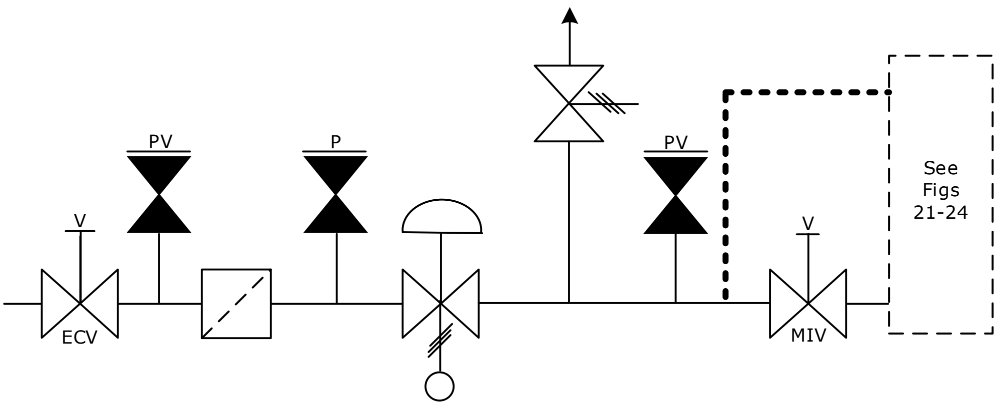


Note 1: *Capacity of the relief valve is ≤ 1% of the stream design capacity or 3 m^3 h^{-1} whichever is the greater.*

Note 2: *GS(I&U)R allow the nomination of an AECV to be used by the consumer to isolate the gas supply.*

Note 3: *Optional by-pass shown by ▬ ▬ ▬ ▬ ▬ (see Sub-Section 6.3).*

FIGURE 21 - TWIN STREAM.
SLAM/MONITOR/ACTIVE REGULATOR INSTALLATION.
MOP$_u$ > 2 bar



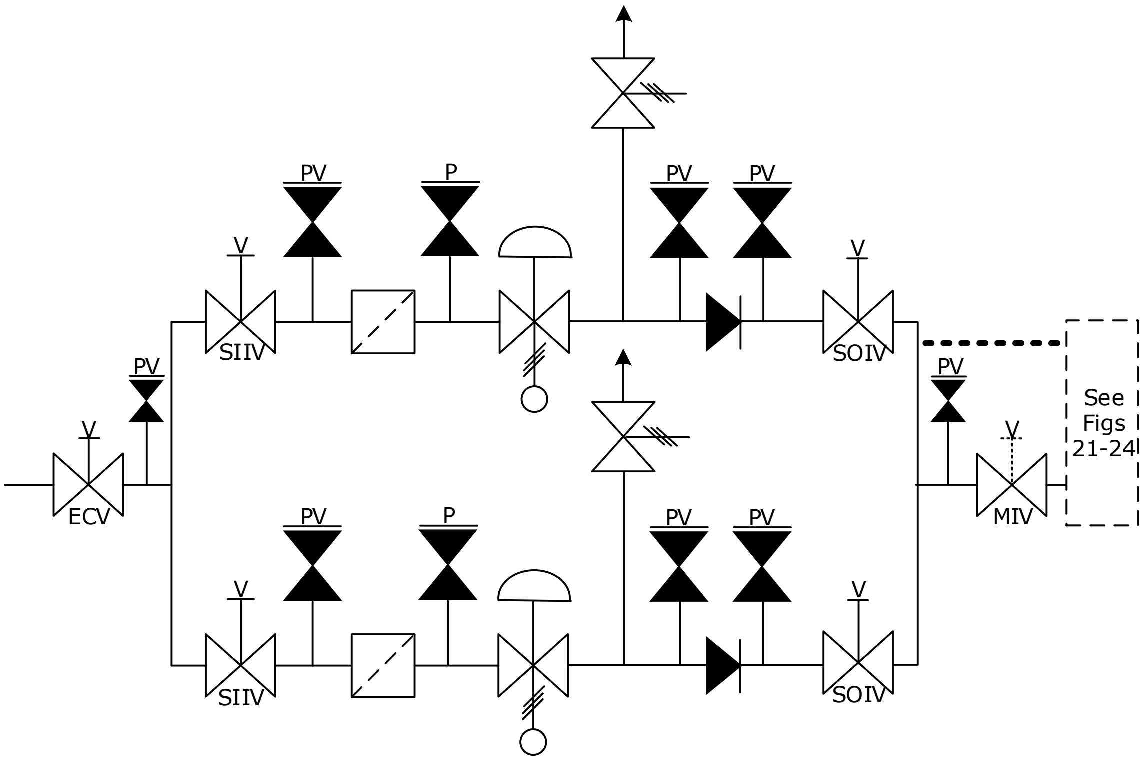
Note 1: *Capacity of the relief valve is ≤ 1% of the stream design capacity or 3 m^3 h^{-1} whichever is the greater.*

Note 2: *GS(I&U)R allow the nomination of an AECV to be used by the consumer to isolate the gas supply.*

Note 3: *Regulator and slam-shut valves may be internally or externally impulse.*

Note 4: *Optional by-pass shown by ▬ ▬ ▬ ▬ ▬ (see Sub-Section 6.3).*

FIGURE 22 - SINGLE STREAM.
REGULATOR WITH INTEGRAL SLAM-SHUT VALVE.
MOP$_u$ ≤ 2 bar

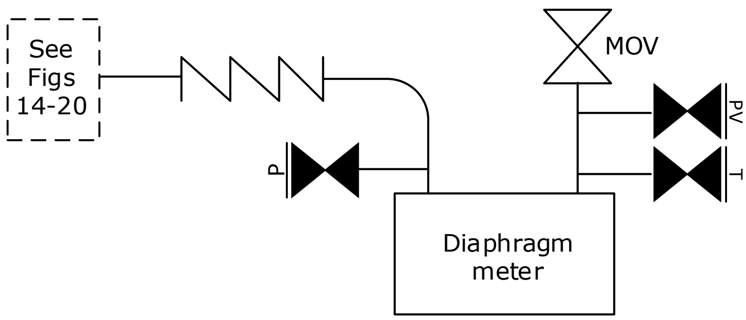


Note 1: *Capacity of the relief valve is ≤ 1% of the stream design capacity or 3 m^3 h^{-1} whichever is the greater.*

Note 2: *GS(I&U)R allow the nomination of an AECV to be used by the consumer to isolate the gas supply.*

Note 3: *Optional by-pass shown by ━ ━ ━ ━ ━ (see Sub-Section 6.3).*

FIGURE 23 - TWIN STREAM.
REGULATOR WITH INTEGRAL SLAM-SHUT VALVE.
MOP_u ≤ 2 BAR



Note 1: *MOV, P V and p points fitted for Q > 16 m^3 h^{-1}.*

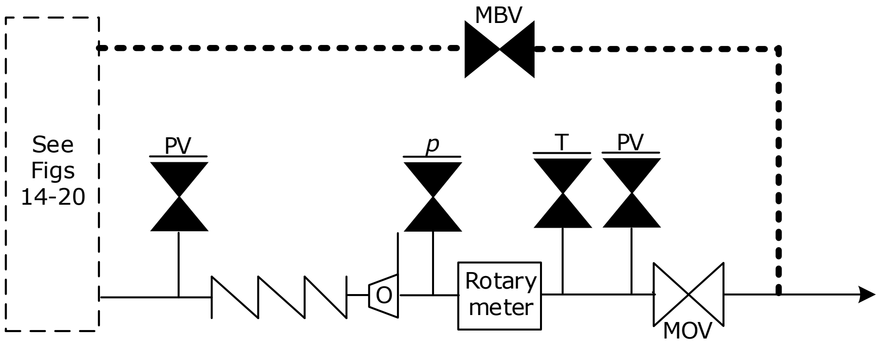
Note 2: *T not normally required for Q ≤ 40 m^3 h^{-1}.*

Note 3: *The flexible connection may be on the inlet of the pressure regulator as long as it is positioned to protect the meter and rated for a suitable pressure.*

Note 4: *P, V and p points fitted with valves if MOP_u > 75 mbar.*

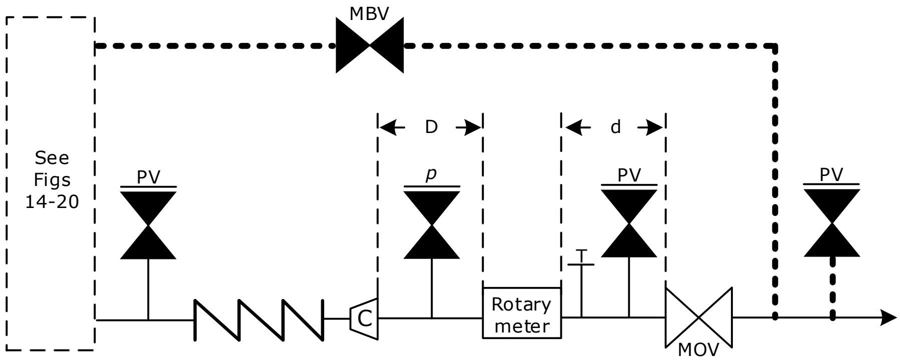
Note 5: *If a by-pass is required see Figure 10.*

FIGURE 24 - DIAPHRAGM METER STREAM



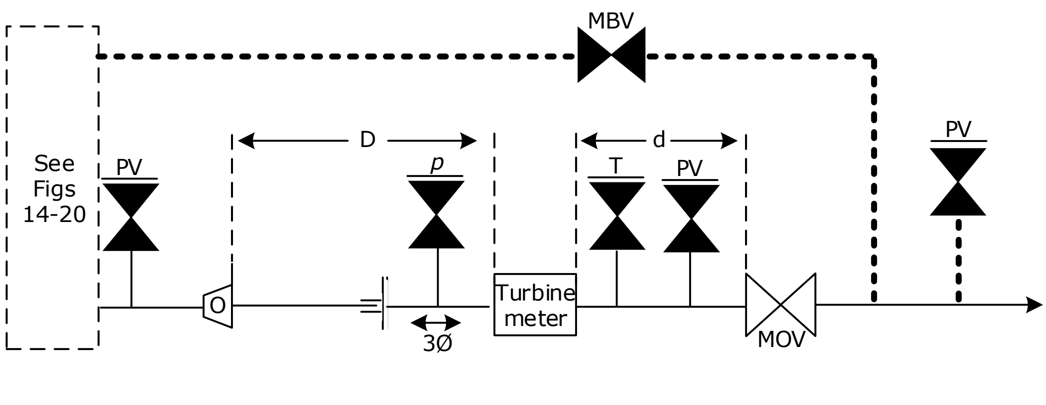
Note 1: *MOV fitted for Q > 16 m³ h⁻¹.*
Note 2: *P, V and p points fitted with valves if MOP_u > 75 mbar.*
Note 3: *The commissioning strainer is a closed end top hat strainer if MOP_{mi} > 75 mbar.*
Note 4: *Optional by-pass shown by - - - - - (see Sub-Section 6.3).*

FIGURE 25- RD METER STREAM.
MOP_{mi} ≤ 7 bar



Note 1: *MOV fitted for Q > 16 m³ h⁻¹.*
Note 2: *D, d show required lengths of turbulent-free pipe.*
Note 3: *P, V and p points fitted with valves if MOP_u > 75 mbar.*
Note 4: *Optional by-pass shown by - - - - - (see Sub-Section 6.3).*

FIGURE 26 - ELEVATED PRESSURE.
RD METER STREAM.
MOP_{mi} > 7 bar



Note 1: *D, d show required lengths of turbulent-free pipe.*
Note 2: *A flange adaptor is permitted within the manufacturer's turbulent free length.*
Note 3: *All P, V and p points are fitted with valves if MOP_u > 75 mbar.*
Note 4: *The commissioning strainer is a closed end top hat strainer if MOP_{mi} > 75 mbar.*
Note 5: *Optional by-pass shown by - - - - - (see Sub-Section 6.3).*

FIGURE 27 - TURBINE METER STREAM WITH FLANGE ADAPTOR

APPENDIX 9 : DETERMINATION OF METER RUN VENT SIZES

When the metering stream is depressurised, it is possible to cause severe damage to the meter by exceeding the maximum allowable gas velocity. Therefore, observe the following relationship between the maximum capacity of the meter and the vent pipe when the metering pressure exceeds 2 bar.

For diaphragm, RD and turbine meters, the relationship is:

$$d \leq 1.45 \left[KQ_{max} \frac{\rho}{P} \right]^{0.5}$$

d	=	nominal bore of vent pipe (mm)
K	=	meter velocity factor
Q_{max}	=	maximum flow rate of meter ($m^3\ h^{-1}$)
ρ	=	gas density ($kg\ m^{-3}$)
P	=	gas pressure (bar abs).

K for diaphragm meters	=	0.2
K for RD meters	=	1.1
K for turbine meters	=	1.5.

Tables 16, 17 and 18 show nominal vent bore “d” (mm) calculated for a range of pressures and flows for diaphragm, rotary and turbine meters.

The tables use the gas composition of Mean Bacton Gas, as defined in Appendix 6 4 of IGEM/GM/5, to calculate the line density.

PRESSURE (bar abs)	FLOW (m^3 h^{-1})						DENSITY kg m^{-3}
	50	250	650	1000	2000	3000	
	Calculated nominal bore "d" of vent pipe (mm)						
3	9	20	33	41	58	71	2.192564
4	9	20	33	41	58	71	2.929873
5	9	20	33	41	58	71	3.670442
6	9	20	33	41	58	71	4.414291
7	9	20	33	41	58	71	5.161441
10	9	20	33	41	58	71	7.422889
20	9	20	33	41	59	72	15.18350
30	9	21	34	42	59	73	23.299889
39	9	21	34	42	60	74	30.921005

Note: *In fact, the tapping has to be limited to a minimum of 15 mm. To achieve the smaller sizes, a restriction would need to be fitted.*

TABLE 18 - NOMINAL VENT BORE VERSUS PRESSURE AND FLOW (RD)

PRESSURE (bar abs)	FLOW (m^3 h^{-1})						DENSITY kg m^{-3}
	250	650	1600	4000	10000	25000	
	Calculated nominal bore "d" of vent pipe (mm)						
3	24	38	60	96	151	240	2.192564
4	24	38	60	96	151	240	2.929873
5	24	38	60	96	152	240	3.670442
6	24	38	60	96	152	240	4.414291
7	24	38	61	96	152	241	5.161441
10	24	39	61	96	153	241	7.422889
20	24	39	62	97	154	244	15.18350
30	24	39	63	98	156	247	23.299889
39	25	40	63	100	158	250	30.921005

TABLE 19 - NOMINAL VENT BORE VERSUS PRESSURE AND FLOW (TURBINE)

APPENDIX 10 : EXPLANATION OF PRESSURE TERMS

A10.1 INTRODUCTION

IGEM/GM/8 uses a number of terms to describe the pressure at different points in the installation, under different conditions. The terms used are based on existing industry and IGEM terminology that have been updated to reflect the terminology being used in Europe.

This informative appendix aims to give the reader an understanding of the various terms used. It does this by setting out the definitions of the terms, explains the use of suffixes in IGEM/GM/8, the relationships between the various terms and their significance. It is not meant as a substitute for compliance with the main requirements.

The main terms used are:

- **SOL – Safe operating limit**
  Is the operating limit (including a margin of safety) beyond which system failure is liable to occur
- **MIP – Maximum incidental pressure**
  This is a term that is used in IGEM/TD/1, IGEM/TD/3, IGEM/TD/13, IGE/UP/1, IGE/UP/1A, IGEM/UP/1B and is defined as:

  "The maximum pressure which a system is permitted to experience under fault conditions limited by safety devices."

  Note: The value is permitted to exceed MOP.

- **DMIP – Design maximum incidental pressure**
  This term is a variation on MIP. It has been introduced to enable the GT to distinguish between MIP that may occur as a result of a Networks current operation and MIP that might be expected in the future should the Network pressures be increased, and is defined as:

  "The maximum pressure which a system is permitted to experience under fault conditions limited by safety devices when the system is operated at the design pressure."

- **DP – Design Pressure**
  This is a term that is used in IGEM/TD/1, IGEM/TD/3, IGEM/TD/13 and is defined as:

  "The pressure on which design calculations are based".

- **MOP – Maximum operating pressure**
  This is a term that is used in IGEM/TD/1, IGEM/TD/3, IGEM/TD/12, IGEM/TD/13, IGE/UP/1 and IGE/UP/1A and is defined as "The maximum pressure at which a system can be operated continuously under normal operating conditions".

- **OP – Operating pressure**
  This is a term that is used in IGEM/TD/13, IGE/UP/1, IGE/UP/1A, IGEM/UP/1B and is defined as:

  "The pressure at which a gas system operates under normal conditions".

- **LOP – Lowest operating pressure**
  This term is defined as:

  "The minimum pressure which a system is designed to experience under normal operating conditions".

- **DmP – Design minimum pressure**
  This term is used in IGEM/GL/1, although the definition from IGEM/GL/1 has been slightly updated and is defined in IGEM/GM/8 as:

  "The minimum pressure that may occur (at a point, e.g., at the end of any service pipe) at the time of system design flowrate under extreme gas supply and maintenance conditions."

- **STP – Strength Test Pressure**
  This term is widely used in IGEM and European standards, and is defined as:

  "The pressure applied to a system during a strength test".

  Note: Whilst the definition is usually the same from standard to standard, the actual value of the strength test pressure, and the way in which it is calculated, are often different.

A10.2 PRESSURES RELATING TO THE UPSTREAM NETWORK

IGEM/GM/8 uses the suffix "u" with the terms defined by A10.1, to represent the pressures that the upstream network impose on the meter installation.

The main terms used to describe the pressure that the meter installation will be subjected to by the upstream Network are:

- **MIP_u**
  The maximum incidental pressure that the network will impose upon the meter installation

  Note 1: Definition of MIP as in A10.1.

  Note 2: The GT is unlikely to advise the meter installer of the actual MIP_u of the upstream network (see $DMIP_u$ below).

- **$DMIP_u$**
  The maximum incidental pressure that the network will impose upon the meter installation should the network pressures be increased at some time in the future

  Note 1: Definition of MIP and DMIP as in clause A10.1.

  Note 2: In most cases the GT will advise the meter installer of DMIP that the meter installation is to be designed to withstand, rather than the current MIP of the Network. $DMIP_u$ (along with DP_u) is used to determine STP for the part of the meter installation upstream of the pressure break (see Figure 27).

  This is in the interests of ensuring safety and producing an economical solution that will not be rendered redundant by a future increase in Network pressures.

- **DP_u**
  The design pressure that the GT advises is to be used by the meter installation designer for the part of the meter installation upstream of the pressure break

  Note 1: Definition of DP as in A10.1.

  Note 2: The GT advises the meter installation designer of the design pressure to which the inlet side of the meter installation is to be designed. This pressure is used along with $DMIP_u$ to calculate STP for the part of the meter installation upstream of the pressure break (see Figure 27).

- **MOP_u**
  The maximum pressure that will occur at the outlet of the ECV under normal operating conditions

  Note 1: Definition of MOP as in A10.1.

  Note 2: The GT advises the meter installer of the maximum operating pressure of the upstream Network. The meter installation has to not only withstand this pressure, but also has to ensure that, for pressures up to and including MOP_u, a suitable pressure will be supplied to the downstream appliances such that they will operate correctly, and the meter installation's metrological performance will be satisfactory.

- **LOP_u**
  The lowest operating pressure that will occur at the outlet of ECV under normal operating conditions

  Note 1: Definition of LOP as in A10.1.

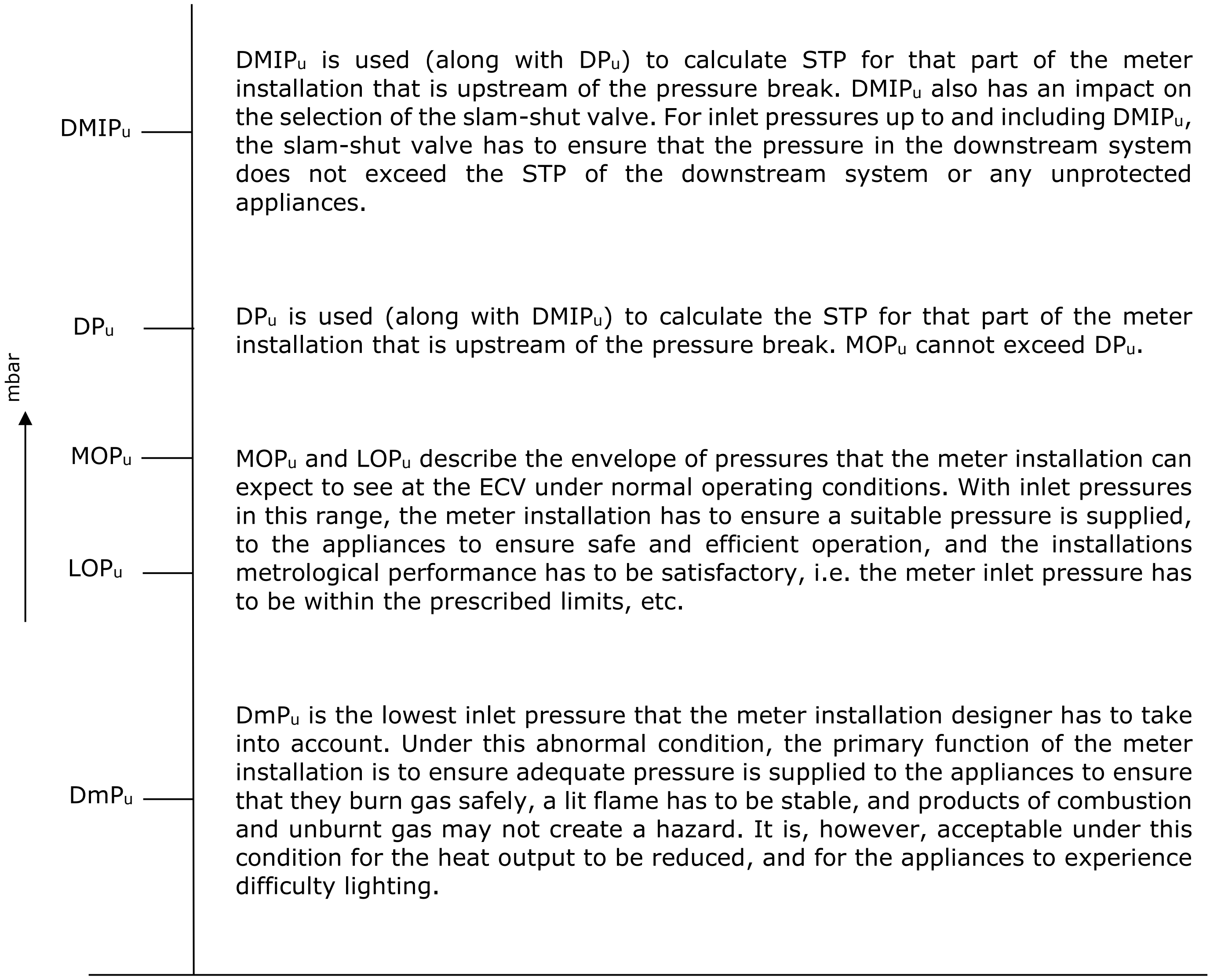
  Note 2: The GT advises the meter installer of the lowest operating pressure of the upstream Network. This pressure, along with the MOP_u forms the envelope of inlet pressures that the meter installation can be expected to see under normal conditions. As such, for inlet pressures from LOP_u to MOP_u (inclusive), the meter installation has to ensure that a suitable pressure will be supplied to the downstream appliances such that they will operate correctly, and the meter installation's metrological performance will be satisfactory.

- **DmP_u**
  The minimum pressure that may occur at the outlet of the ECV, at the time of system design flowrate under extreme gas supply and maintenance conditions

  Note 1: Definition of DmP as in A10.1.

  Note 2: Pressures between LOP_u and DmP_u are not expected to occur under normal conditions. As such under these conditions the primary function of the meter installation is to ensure adequate pressure is supplied to the appliances to ensure that they burn gas safely.

Figure 28 shows the relationship between $DMIP_u$, DP_u, MOP_u, LOP_u, and DmP_u, and their significance to the meter installation design.



DMIP$_u$ is used (along with DP$_u$) to calculate STP for that part of the meter installation that is upstream of the pressure break. DMIP$_u$ also has an impact on the selection of the slam-shut valve. For inlet pressures up to and including DMIP$_u$, the slam-shut valve has to ensure that the pressure in the downstream system does not exceed the STP of the downstream system or any unprotected appliances.

DP$_u$ is used (along with DMIP$_u$) to calculate the STP for that part of the meter installation that is upstream of the pressure break. MOP$_u$ cannot exceed DP$_u$.

MOP$_u$ and LOP$_u$ describe the envelope of pressures that the meter installation can expect to see at the ECV under normal operating conditions. With inlet pressures in this range, the meter installation has to ensure a suitable pressure is supplied, to the appliances to ensure safe and efficient operation, and the installations metrological performance has to be satisfactory, i.e. the meter inlet pressure has to be within the prescribed limits, etc.

DmP$_u$ is the lowest inlet pressure that the meter installation designer has to take into account. Under this abnormal condition, the primary function of the meter installation is to ensure adequate pressure is supplied to the appliances to ensure that they burn gas safely, a lit flame has to be stable, and products of combustion and unburnt gas may not create a hazard. It is, however, acceptable under this condition for the heat output to be reduced, and for the appliances to experience difficulty lighting.

FIGURE 28 - ILLUSTRATION OF RELATIONSHIP BETWEEN DIFFERENT NETWORK PRESSURES

A10.3 PRESSURES RELATING TO THE PERFORMANCE OF THE CONSUMER'S SYSTEM

A10.3.1 The meter installation design process has to take account of the pressures that the consumer's system requires for safe and efficient operation. This includes the safe and efficient operation of appliances, the maximum pressure that the appliances and pipework are capable of withstanding and, in some cases, the maximum reverse pressure that the consumer's system may impose on the meter installation.

Irrespective of whether the consumer has advised the meter installation designer of these parameters, or the meter installation designer has obtained them, IGEM/GM/8 uses the suffix "c" to denote information pertaining to the performance of the gas consumer's system.

The main terms used to describe the performance of the consumer's system are STP_c, MIP_c, MOP_c, LOP_c, and DmP_c. To understand and determine these terms, an understanding of the terms used to describe the performance of appliances is also required.

The main terms used to describe the pressures relating to the performance of the consumer's system are:

- **STP_c**
  The strength test pressure of that part of the consumer's system that is not otherwise protected from the pressures supplied by the meter installation

  Note 1: Definition of STP as in A10.1.

  Note 2: While the definition is usually the same from standard to standard, the actual value of STP, and the way in which it is calculated, are often different. As such, it is important to establish STP for the consumers system and connected appliances. STP of the weakest part of the consumer's system that is exposed to the pressure supplied by the meter installation has to be greater than MIP_{mi} (and MIP_c where applicable). This can either mean that STP of the consumers system is calculated from the value of MIP_{mi} advised by the meter installer or, alternatively, e.g., for an existing system, STP_c can be used to calculate MIP_{mi}.

- **MIP_c**
  The maximum incidental pressure (reverse pressure) that the consumer's system may subject the meter installation to under fault conditions, limited by safety devices (usually back acting slam-shuts, NRVs etc)

  Note 1: Definition of MIP as in A10.1.

  Note 2: In the majority of installations, the term MIP_c is not needed as the only source of pressure is from the meter installation. However, in some cases, e.g. installations incorporating boosters and/or compressors, the gas consumer's system may contain pressures significantly higher than those being supplied by the meter installation, or even the upstream Network. In such installations, the consumer's system has to incorporate safety devices to prevent the consumers system subjecting the meter installation to an excessive pressure.

- **MOP_c**
  The maximum pressure that the consumer's system can be operated at continuously while ensuring safe and efficient operation of all connected appliances

  Note 1: Definition of MOP as in A10.1.

  Note 2: Safe and efficient operation means that the pressure supplied to all appliances has to be maintained below P_{max}. If the consumer's system has any unprotected appliances connected, MOP_c will, normally, be the lowest P_{max} of any such appliance.

- **LOP_c**
  The lowest pressure that the consumer's system can be operated at continuously while ensuring the safe and efficient operation of all connected appliances

  Note 1: Definition of LOP as in A10.1.

  Note 2: Safe and efficient operation means that the pressure supplied to all appliances has to be maintained above P_{min}. When calculating LOP_c due account has to be taken of the pressure drop between the meter installation and the inlet to the appliances.

- **DmP_c**
  The minimum pressure that the consumer's system can be operated at continuously while ensuring safe operation of all connected appliances

  Note 1: Definition of DmP as in A10.1.

  Note 2: Safe operation means that any lit flame has to be stable, and any combustion products or unburnt gas will not create a hazard. The appliances may, however, experience problems with lighting, and the heat output may be reduced, e.g., the pressure supplied to all appliances has to be maintained above P_{ign}. When calculating DmP_c, due account has to be taken of the pressure drop between the meter installation and the appliance.

A10.3.2 Figure 29 shows the relationship between STP_c, MIP_c, MOP_c, LOP_c and DmP_c and their significance to the meter installation design.

A10.3.3 In addition to the terms described above the appliance manufacturers and appliance standards use the following terms to describe the performance of appliances.

- **Limit pressures**
  This term is used in a number of European appliance standards and is defined as:
  "Pressures representative of the extreme variations in the supply conditions of the appliance."

  P_{max} = Maximum pressure

  P_{min} = Minimum pressure.

  Note: The majority of European standards for low pressure appliances specify P_{max} = 25 mbar and P_{min} = 17 mbar. At pressure between P_{min} and P_{max}, the appliance has to operate safely and efficiently.

- **P_n – Normal pressure**
  This term is used in a number of European appliance standards and is defined as:
  "Pressure under which the appliances operate under rated conditions, when supplied with the corresponding reference gas."

  Note: The majority of European standards for low pressure appliances specify this to be 20 mbar.

- **P_{ign} – Ignition pressure**
  This term is not actually defined in European standards. However, the majority of European appliance standards require a cross light test to be undertaken at 70% of P_n. At this pressure, a lit flame has to be stable and any combustion products or unburnt gas may not create a hazard. The appliance may, however, experience problems with lighting, and the heat output may be reduced.

  Note: For the majority of low pressure appliances, this pressure is 14 mbar (see P_n above).

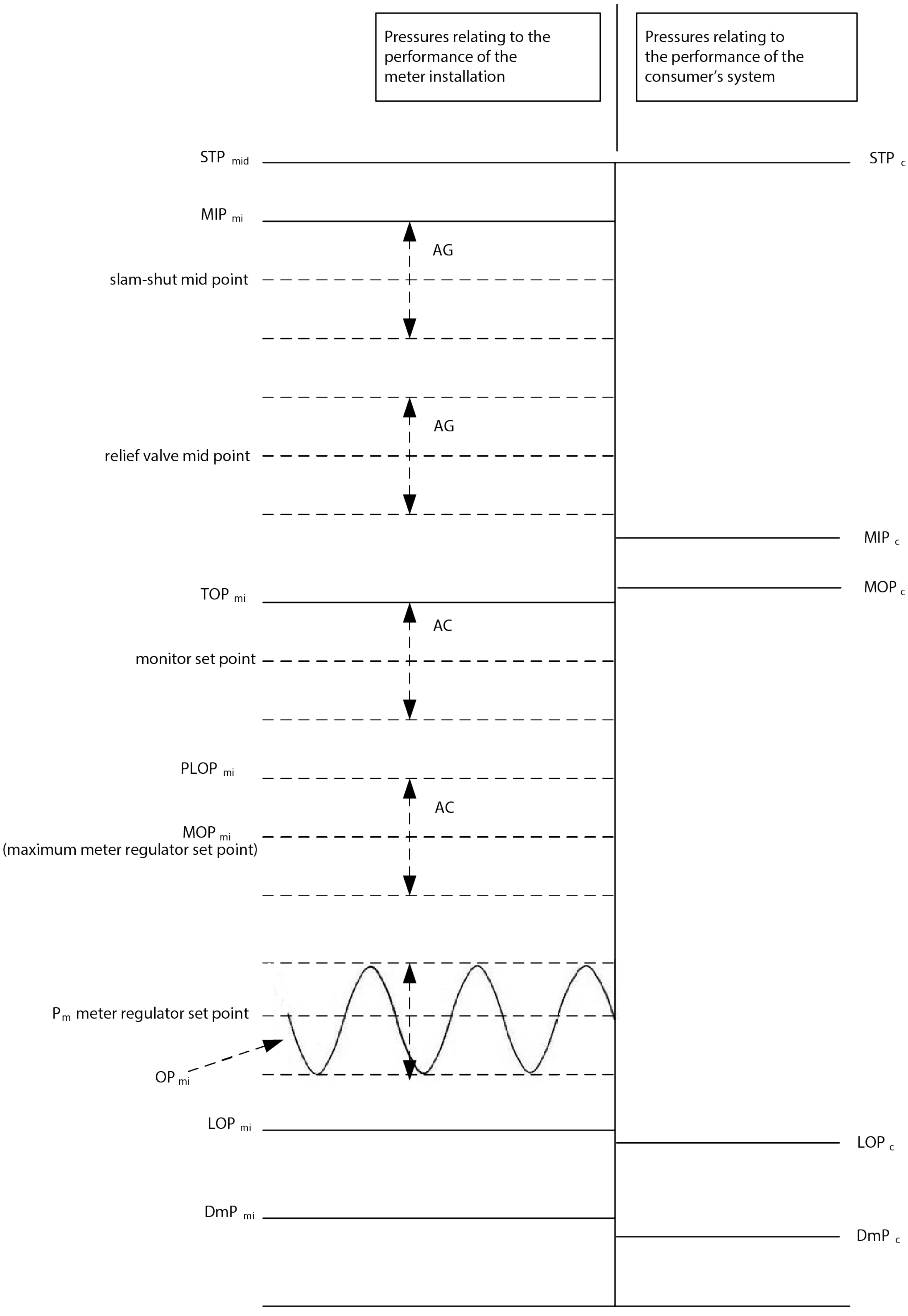


FIGURE 29 - RELATIONSHIP BETWEEN PRESSURES SUPPLIED BY THE METER INSTALLATION AND THE PERFORMANCE OF THE CONSUMER'S SYSTEM

A10.4 PRESSURES RELATING TO THE PERFORMANCE OF THE METER INSTALLATION

The terms in A10.1 are used along with the following additional terms to describe the pressures that the meter installation will provide to the consumer's system under different conditions, i.e., at the outlet of the meter installation:

- **TOP – Temporary operating pressure**
  This term is used in IGEM/TD/13 and is defined as:
  "The maximum pressure at which a system can be operated temporarily under the control of regulating devices during fault conditions".

  Note: This value is permitted to exceed MOP.

- **Peak Level OP – Peak Level operating pressure**
  This term is used in IGEM/TD/13 and is defined as:
  "The upper limit of variations in system pressure permitted under normal conditions".

  Note: This value is permitted to exceed MOP.

  When referring to the above terms in relation to pressures that the meter installation may subject the consumer's system to, IGEM/GM/8 uses the suffix "mi". The main terms used are:

- **MIP_{mi}**
  The maximum incidental pressure that the meter installation may subject the consumer's system to under fault conditions

  Note 1: Definition of MIP as in A10.1.

  Note 2: MIP_{mi} has be $\leq STP_c$. The maximum setting of the slam-shut valve(s) on the meter installation is MIP_{mi} less the tolerance for the accuracy group of the slam-shut valve (see Figure 30).

  For example, if MIP_{mi} = 50 mbar and a 5% accuracy group slam-shut valve is being used, the maximum slam-shut setting = 47.5 mbar, i.e. 50 – 2.5 = 47.5 mbar.

  On a low pressure meter installation that does not incorporate a slam-shut valve, MIP_{mi} is usually taken as being the MOP of the upstream network.

- **TOP_{mi}**
  The maximum pressure that the meter installation will provide to the consumer's system when operating on a monitor regulator. This is a temporary situation, which should only occur following failure of the active meter regulator

  Note 1: Definition of TOP as above.

  Note 2: Although temporary, this condition may exist for some time. As such, it is important that the consumer's appliances continue to operate safely under this condition. TOP_{mi} therefore has to be less than the maximum operating pressure of the consumer's system (MOP_c). The maximum setting of the monitor regulator on the meter installation is TOP_{mi} less the tolerance for the accuracy class of the monitor regulator. For example if TOP_{mi} = 25 mbar and a 10% accuracy class monitor regulator is being used, the maximum monitor setting = 22.5 mbar i.e. 25 – 2.5 = 22.5 mbar (see Figure 28).

- **OP_{mi}**
  Operating pressure at the outlet of the meter installation

  Note: Definition of OP as in A11.1.

- **MOP_{mi}**
  The maximum allowable set point of the meter regulator.

  Note 1: Definition of MOP as in A10.1.

  Note 2: As this is a normal condition, the meter installation has to provide a pressure that will ensure the safe and efficient operation of all connected appliance. As MOP_{mi} is the maximum setting of the meter regulator, the operating pressure will exceed this value in normal conditions (see $PLOP_{mi}$), and in temporary conditions (see TOP_{mi}). As such, the value of MOP_{mi} is dictated not only by MOP_c, but also the accuracy class of the regulator, and the values of TOP_{mi} and $PLOP_{mi}$. Both TOP_{mi} and $PLOP_{mi}$ have to be less than or equal to MOP_c (see A10.3 and Figure 29).

- **LOP_{mi}**
  The lowest operating pressure that will occur at the outlet of the meter installation under normal operating conditions.

  Note 1: Definition of LOP as in A10.1.

  Note 2: As this is a normal condition the meter installation has to provide a pressure that will ensure the safe and efficient operation of all connected appliances, i.e. LOP_{mi} has to be greater than or equal to LOP_c. See A10.1.

- **DmP_{mi}**
  The minimum pressure that the meter installation will provide to the consumer's system, when the upstream network and the meter installation are passing the design flowrate and are under extreme gas supply or maintenance conditions.

  Note 1: Definition of DmP as in A10.1.

  Note 2: Pressures between LOP_{mi} and DmP_{mi} are not expected to occur under normal conditions. As such, under these conditions, the primary function of the meter installation is to ensure adequate pressure is supplied to the appliances to ensure that they burn gas safely. DmP_{mi} has to be greater than or equal to DmP_c. (see A10.3).

Figure 28 shows the relationship between STP_{mid}, MIP_{mi}, TOP_{mi}, $PLOP_{mi}$, MOP_{mi}, OP_{mi}, LOP_{mi} and DmP_{mi} and their relationship with STP_c, MIP_c, MOP_c, LOP_c and DmP_c.

A10.5 STRENGTH TEST PRESSURES

Figure 30 explains the requirements for strength testing.

Depending upon the values of MIP_u, ($DMIP_u$ if quoted by the GT) MIP_{mi}, MIP_c and the equipment being used, the pressure break can be located in one of two places:

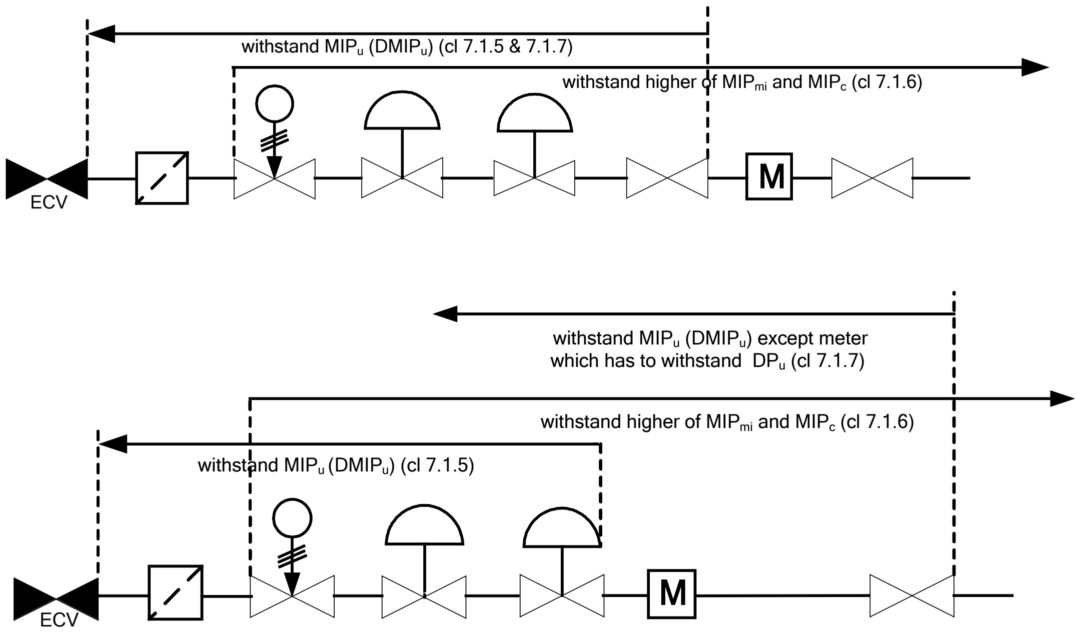
1) MIP_u ($DMIP_u$) > MIP_{mi} and no scope for back pressure from the consumer = pressure break on outlet of first valve downstream of meter regulator.

2) MIP_u ($DMIP_u$) > MIP_{mi} and MIP_c = pressure break on outlet of first valve downstream of meter regulator.

3) MIP_c > MIP_u ($DMIP_u$) and MIP_{mi} = pressure break on inlet to meter regulator/PRI.

The location of the first valve downstream of the meter regulator has an impact on the requirements in that, if the valve is downstream of the meter, it is considered acceptable for the meter to be capable of withstanding DP_u (and MIP_{mi} and MIP_c) but not necessarily MIP_u ($DMIP_u$).

When referring to the strength test pressure and design pressure of the meter installation, IGEM/GM/8 uses the suffix "mi", followed by "u" for upstream of the pressure break or "d" for downstream of the pressure break. e.g. STP_{miu} and STP_{mid}.



Note: Where the GT states a DMIP, use this in place of MIP_u in the above diagrams.

FIGURE 30 - ILLUSTRATION OF STRENGTH REQUIREMENTS

A10.6 EXAMPLES

Example 1

Meter Installation Criteria

- low pressure inlet
- regulator set point 21 mbar
- regulator accuracy 7.5%
- tolerance on setting regulator + 1 mbar - Zero
- lock up is 5 mbar above the pressure at 5% Qmax, as set point less than 100 mbar.

An existing small non-domestic meter installation (Q_{max} = 65 m^3 h^{-1}).
$MOP_u \leq 75$ mbar. The GT has advised that the following pressures are to be taken into account when designing the meter installation:

- $DMIP_u$ - 200 mbar
- DP_u - 75 mbar
- MOP_u - 75 mbar
- LOP_u - 25 mbar
- DmP_u - 19 mbar.

The gas consumer has advised the following pressures apply to the downstream system, and that there are no boosters, compressors, etc:

- STP_c - 82.5 mbar
- MOP_c - 25 mbar
- LOP_c - 18 mbar
- DmP_c - 15 mbar.

There are no special reasons to protect the downstream system (see Figure 2) so the pressure control system will simply consist of a meter regulator. On such installations, MIP_{mi} is taken to be MOP of the upstream network, i.e. $MIP_{mi} = MOP_u = 75$ mbar.

The installation does not include a meter inlet valve. As such, the pressure break will be on the outlet of the meter outlet valve. The only component downstream of the pressure break is an outlet spool.

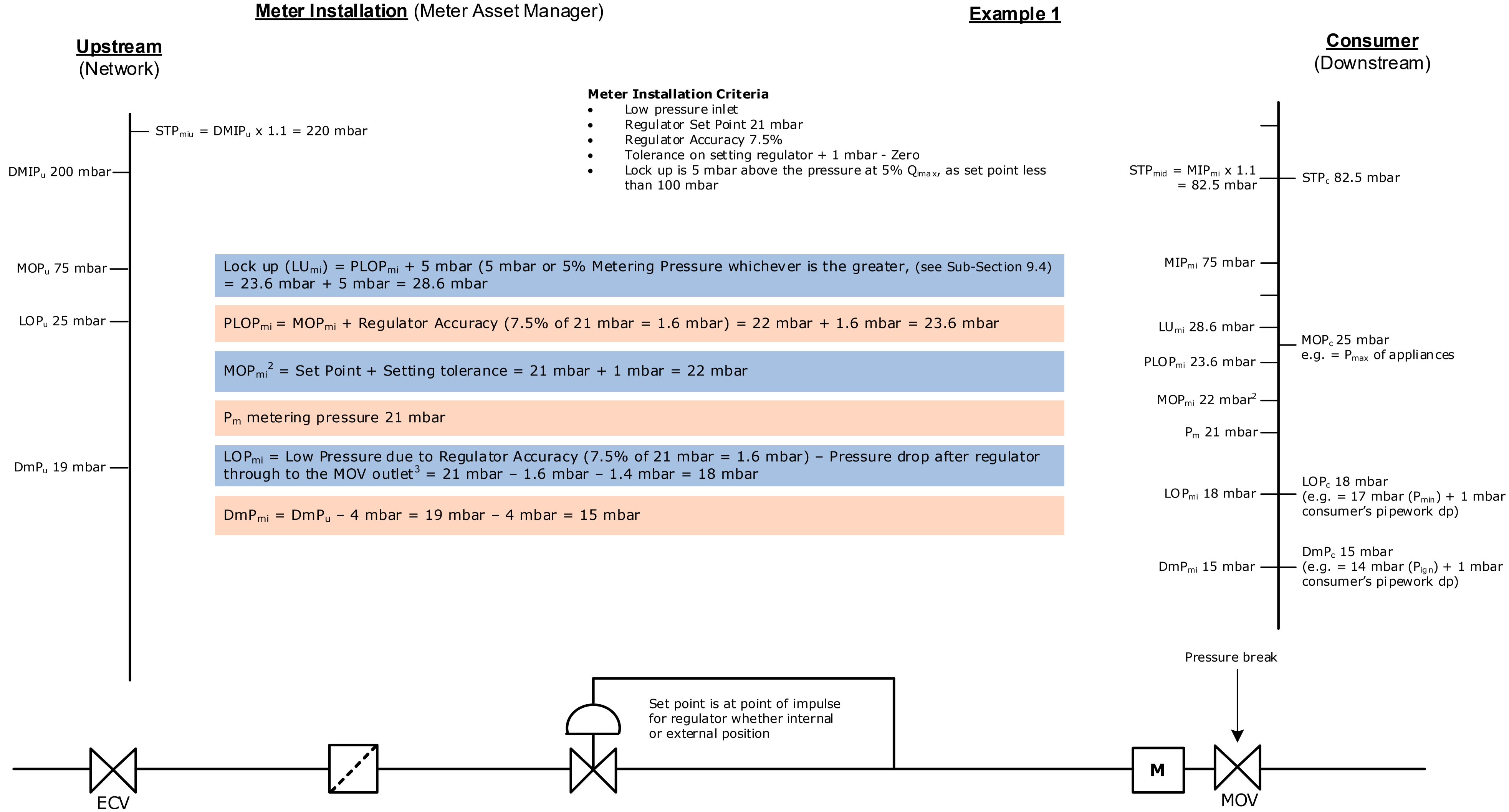
The GT has requested that the design pressure for the part of the installation upstream of the pressure break be 75 mbar. The design pressure for the part of the installation downstream of the pressure break can be any value equal to or exceeding 25 mbar. An excessively high design pressure will result in an excessive STP; as such, in this case, 30 mbar would seem reasonable.

The strength test pressure for that part of the installation that is upstream of the pressure break (the majority of the installation in this case) (STP_{miu}) is 220 mbar (1.1 x $DMIP_u$), with the exception of the meter which has to be capable of withstanding MOP_u. In this case, the designer has decided to strength test the meter at 115 mbar. STP for the spool piece downstream of the pressure break (STP_{mid}) is 82.5 mbar (1.1 x MIP_{mi}).

$PLOP_{mi}$ has to be less than or equal to MOP_c = 25 mbar, the meter regulator is capable of controlling the metering pressure to within ± 7.5%. As such MOP_{mi} = 23.4 mbar i.e. 25-1.6 mbar. but could be declared as any value between 22 mbar and 23.4 mbar. The meter regulator is actually set to give a metering pressure of 21 mbar ± 1.6 mbar.

LOP_{mi} is declared to be 18 mbar (= LOP_c), which means that the pressure loss across the meter and outlet valve has to be less than 1.4 mbar, i.e. 21 mbar – 1.6 mbar – 1.25 mbar – 0.15 mbar = 18 mbar.

DmP_{mi} has to be greater than or equal to 15 mbar (DmP_c), which means, with the installation inlet pressure at 19 mbar, the pressure loss across the whole installation has to be less than 4 mbar.



Note 1: *DP_{miu} is a design pressure upstream of the pressure break which is equal to DP_u which is 75 mbar in this example.*

Note 2: *The above example MOP_{mi} has been calculated using set point + tolerance. Equally valid is to calculate MOP_{mi} from MOP_c – tolerance. If calculated in this way the declared values of $PLOP_{mi}$ and LU_{mi} will have to be recalculated.*

Note 3: *Meter operating at Q_{norm} – Therefore pressure drop across meter 1.25 mbar. Pressure drop across outlet pipework and MOV is 0.15 mbar. Total pressure drop from the outlet of the regulator to the MOV = 1.25 mbar (Meter) + 0.15 mbar (Pipe and valve) = 1.4 mbar.*

Example 2

Meter Installation Criteria

- low pressure inlet
- regulator set point 25 mbar
- regulator accuracy 10%
- tolerance on setting regulator + Half Accuracy - Zero
- lock up is 5 mbar above the pressure at 5% of Q_{imax}, as set point is less than 100 mbar
- for LP networks, and to achieve metering pressures greater than 21 mbar, a LOP_u greater than 25 mbar will be required. This will mean obtaining an ancillary pressure agreement from the GT.

An existing small non-domestic meter installation (Q_{max} = 65 m^3 h^{-1}). $MOP_u \leq 75$ mbar. The GT has advised that the following pressures are to be taken into account when designing the meter installation:

- $DMIP_u$ - 200 mbar
- DP_u - 75 mbar
- MOP_u - 75 mbar
- LOP_u - 25 mbar
- DmP_u - 19 mbar.

The gas consumer has requested a metering pressure of 25 mbar. No other information is provided. As above, the connection is to a Network with $MOP_u \leq 75$ mbar and assuming that there are no boosters, compressors, etc. and that standard appliances are fitted:

- STP_c - 82.5 mbar
- DmP_c - 15 mbar.

For such an installation, a LOP_u greater than 25 mbar would be required, which will mean obtaining an ancillary pressure agreement from the GT. In this case it is assumed the GT has granted an agreement for a LOP_u of 30 mbar, if this wasn't obtained the consumer would have to be advised that the higher metering pressure could not be guaranteed.

Assuming there are no special reasons to protect the downstream system (see Figure 3) so the pressure control system will simply consist of a meter regulator. On such installations, MIP_{mi} is taken to be MOP of the upstream network, i.e. MIP_{mi} = MOP_u = 75 mbar.

The installation does not include a meter inlet valve. As such, the pressure break will be on the outlet of the meter outlet valve. The only component downstream of the pressure break is an outlet spool.

The GT has requested that the design pressure for the part of the installation upstream of the pressure break be 75 mbar. The design pressure for the part of the installation downstream of the pressure break can be any value equal to or exceeding MOP_c. An excessively high design pressure will result in an excessive STP; as such, in this case, 35 mbar would seem reasonable.

The strength test pressure for that part of the installation that is upstream of the pressure break (the majority of the installation in this case) (STP_{miu}) is 220 mbar (1.1 x $DMIP_u$), with the exception of the meter which has to be capable of withstanding MOP_u. In this case, the designer has decided to strength test the meter at 115 mbar. STP for the spool piece downstream of the pressure break (STP_{mid}) is 82.5 mbar (1.1 x MIP_{mi}).

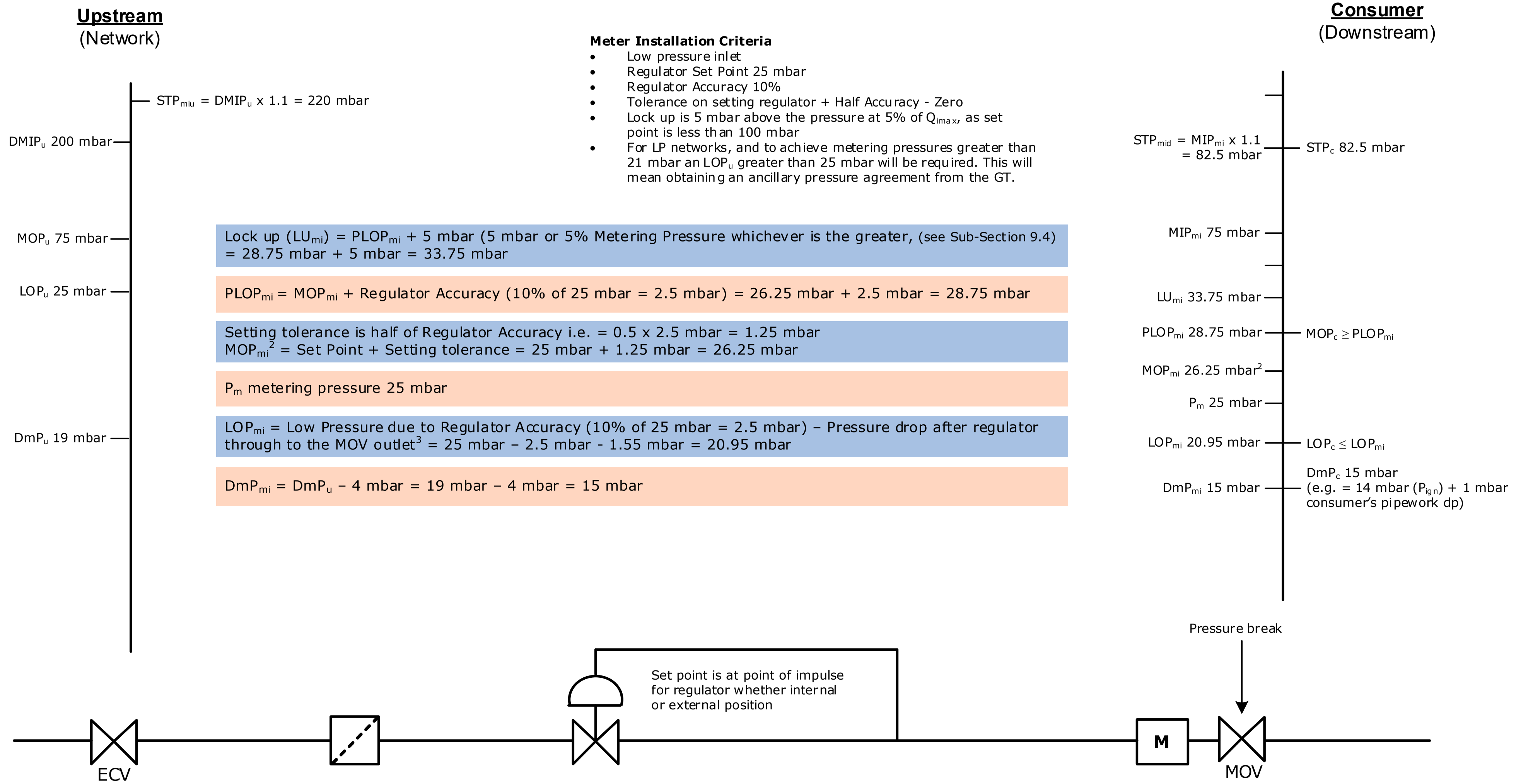
In this case MOP_c is not known, as such $PLOP_{mi}$ has to be calculated from the set point. $PLOP_{mi}$ is therefore 25 mbar + 1.25 mbar tolerance + 2.5 mbar accuracy = 28.75 mbar. The consumer will therefore need to ensure that their system has a MOP_c higher than this value, in this case 30 mbar MOP_c would be reasonable. The regulator lock up will be 5 mbar above the declared value of $PLOP_{mi}$, i.e. 33.75 mbar.

In this example given the lack of information from the consumer, the regulator has been sized to control to within $\pm$ 10%, as such with a set point of 25 mbar MOP_{mi} has been calculated from the set point to be 26.25 mbar (25 mbar +1.25 mbar tolerance).

The consumer has not advised LOP_{mi}, as such it is calculated from the set point to be 20.95 mbar, i.e. 25 mbar – 2.5 mbar accuracy – 1.55 mbar pressure drop across the meter and meter outlet valve (1.25 mbar meter and 0.3 mbar valve). This will need to be confirmed to be acceptable to the consumer.

DmP_{mi} has to be greater than or equal to 15 mbar (DmP_c), which means, with the installation inlet pressure at 19 mbar, the pressure loss across the whole installation has to be less than 4 mbar.

Meter Installation (Meter Asset Manager) **Example 2**



Note 1: *DP_{miu} is a design pressure which is equal to 75 mbar.*
Note 2: *The above example MOP_{mi} has been calculated using set point + tolerance. Equally valid is to calculate MOP_{mi} from MOP_c – tolerance. If calculated in this way the declared values of $PLOP_{mi}$ and LU_{mi} will have to be recalculated.*
Note 3: *Meter operating at Q_{nom} – Therefore pressure drop across meter 1.25 mbar. Pressure drop across outlet pipework and MOV is 0.3 mbar. Total pressure drop from the outlet of the regulator to the MOV = 1.25 mbar (Meter) + 0.3 mbar (Pipe and valve) = 1.55 mbar.*
Note 4: *Where the metering pressure exceeds 21 mbar Annual Quantity less than 732 MWh, a flow conversion device is required (see clause 9.3.3).*

Example 3

Meter Installation Criteria

- medium pressure inlet (MP 105)
- regulator set point 50 mbar (Tolerance on setting regulator + Half Accuracy - Zero)
- regulator accuracy 10%
- relief valve accuracy class 10%
- lock up is at 5% above the upper limit of the accuracy class, as set point is less than 100 mbar
- slam-shut accuracy group 5%.

For a new non-domestic meter installation (Q_{max} = 200 m^3 h^{-1}) on a MP105 Network. The GT has advised that the following pressures are to be taken into account when designing the meter installation:

- $DMIP_u$ - 2,700 mbar
- DP_u - 2,000 mbar
- MOP_u - 1,100 mbar
- LOP_u - 105 mbar
- DmP_u - 105 mbar.

The gas consumer has requested a metering pressure of 50 mbar. No other information is provided. Assuming that there are no boosters, compressors, etc.

With no information regarding the operating limits of the consumer's system and starting from the requested 50 mbar set point.

For a meter inlet pressure of 50 mbar the control accuracy required is +/- 10% (Table 4 or Table 5), the control accuracy is therefore 10% of 50 mbar, i.e. 5 mbar.

Assuming that the regulator is set at the desired value, or within half of the control accuracy above that value, we have a possible upper value of set point of 50 + (0.5 x 5) = 52.5 mbar which is MOP_{mi}.

With 52.5 mbar as the maximum set point the peak operating pressure allowed is 52.5 + control accuracy = 52.5 + 5 = 57.5 mbar this is $PLOP_{mi}$.

The pressure allowed for lock-up is a 5 mbar increase above $PLOP_{mi}$ for metering pressures up to 100 mbar and the lock-up pressure is calculated from $PLOP_{mi}$, that is, 57.5 + 5 = 62.5 mbar.

Continuing to work up the pressure stack, the relief valve setting has to be sufficiently above the lock-up pressure of the active regulator, to avoid nuisance venting at its lowest operating pressure, plus any additional separation determined by the designer.

With a relief valve accuracy class of 10% a trial set point of 12% above Lock-up can be used, 62.5 + (12% of 62.5) = 70 mbar, this set point gives a lowest operating pressure of 70 – (10% of 70) = 63 mbar, this is above the lock-up pressure but sensibly requires more separation, a set point of 72 mbar provides this, 72 – (10% of 72) = 64.8 mbar, 2.3 mbar above the lock-up pressure. Greater separation from a higher relief valve set point may be applied provided the consumer's system can tolerate the higher MIP resulting from it.

The same method is used to select a set point for the slam-shut valve, the lowest operating pressure of the slam-shut valve has to be above the highest operating pressure of the relief valve.

With a slam-shut valve accuracy group of 5% a trial set point of 7% above the upper operating pressure of the relief valve can be used, 79.2 + (7% of 79.2) = 84.7 mbar, this set point gives a lowest operating pressure of 84.7 – (5% of 84.7) = 80.5 mbar, this is above the upper operating pressure of the relief valve but sensibly requires more separation, a set point of 90 mbar provides this, 90 –(5% of 90) = 85.5 mbar, 6.3 mbar above the upper operating pressure of the relief valve. Greater separation from a higher slam-shut set point may be applied provided the consumer's system can tolerate it.

The maximum incidental pressure is equal to the upper operating pressure of the slam-shut valve, this is 90 + (5% of 90) = 94.5 mbar.

Working down from the regulator set point to calculate LOP_{mi}, the lowest meter inlet pressure is the regulator set point minus the accuracy which is 50 – 5 = 45 mbar, further pressure is lost through the meter and the meter outlet pipework, in this case 2 mbar for the meter and 0.5 mbar for the pipe and valve giving a total of 2.5 mbar and leading to a LOP_{mi} of 45 – 2.5 = 42.5 mbar.

As LOP_u and DmP_u are the same, we know that DmP_{mi} will be the same as LOP_{mi}.

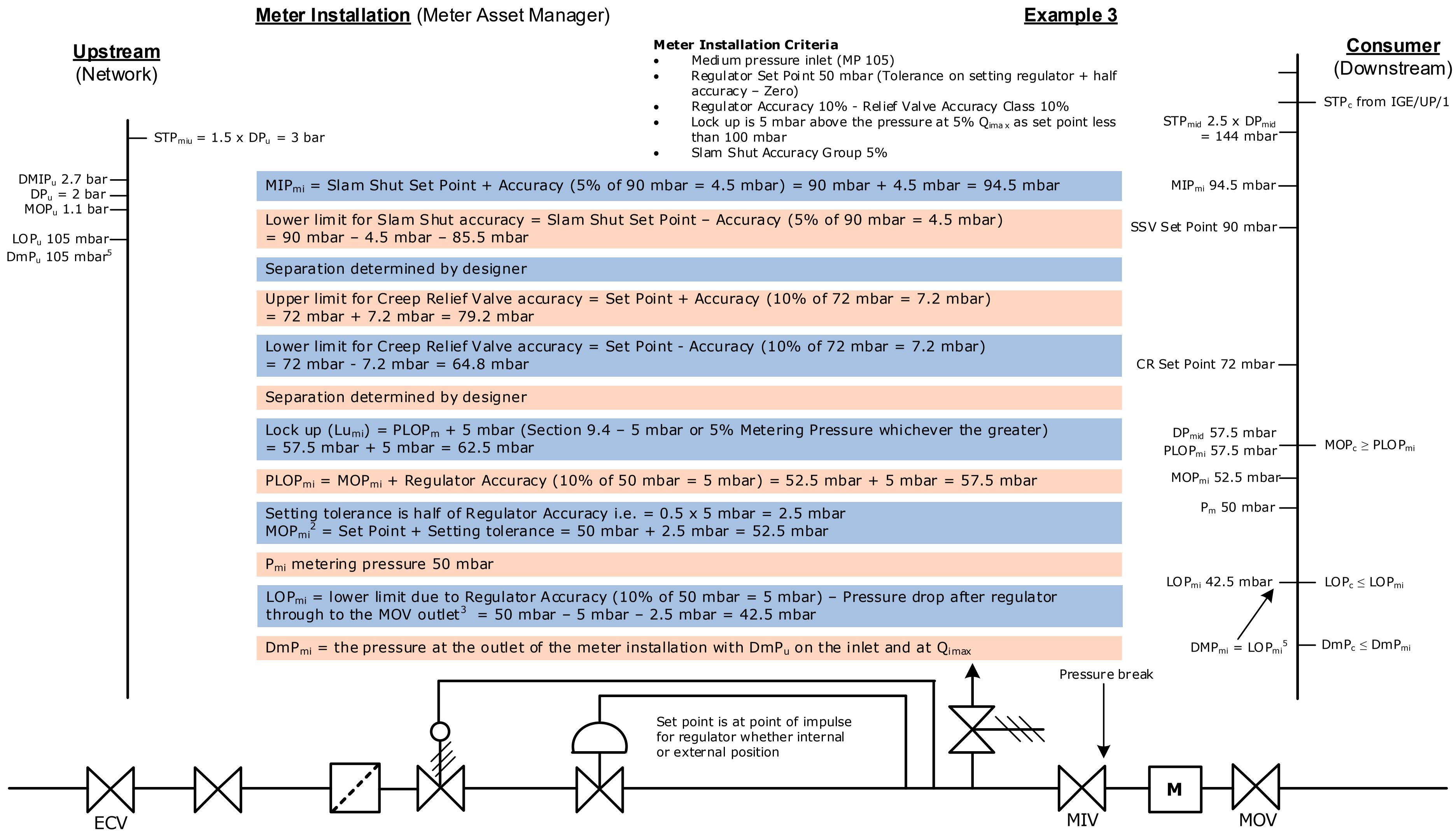
The full range of pressures for the meter installation are therefore as follows:

DmP_{mi}	42.5 mbar
LOP_{mi}	42.5 mbar
Set Point	50.0 mbar
MOP_{mi}	52.5 mbar
$PLOP_{mi}$	57.5 mbar
Lock up	62.5 mbar
Relief Set point	72.0 mbar
Slam-shut set point	90.0 mbar
MIP_{mi}	94.5 mbar

The installation includes a meter inlet valve. As such, the pressure break will be on the outlet of the MIV.

- STP_{miu} - 3,000 mbar, based on DP_u.
- STP_{mid} - 143.7 (144) mbar, based on $PLOP_{mi}$ and IGE/UP/1.

Note: $PLOP_{mi}$ has been used as this has to be the same or less than the consumers MOP.



Note 1: *DP_{miu} is a design pressure which is equal to 2 bar.*

Note 2: *The above example MOP_{mi} has been calculated using set point + tolerance. Equally valid is to calculate MOP_{mi} from MOP_c – tolerance. If calculated in this way the declared values of $PLOP_{mi}$ and LU_{mi} will have to be recalculated.*

Note 3: *Meter operating at a flow rate exceeding Q_{nom} – in this case pressure drop across meter 2 mbar. Pressure drop across outlet pipework and MOV is 0.5 mbar. Total pressure drop = 2.5 mbar.*

Note 4: *Where the metering pressure exceeds 21 mbar Annual Quantity less than 732 MWh, a flow conversion device is required (see clause 9.3.3).*

Note 5: *If LOP_u – DmP_u, then LOP_{mi} – DmP_{mi}.*

Example 4

Meter Installation Criteria

- intermediate pressure network
- regulator set point 200 mbar (Tolerance on setting regulator + Half Accuracy – Zero)
- regulator accuracy 1% Absolute
- relief valve accuracy class 10%
- lock up is 5% above the upper limit of the accuracy class, as the set is point is greater than 100 mbar
- slam-shut accuracy group 5%.

For a new non-domestic meter installation (Q_{max} = 200 m^3 h^{-1}) on an IP Network. The GT has advised that the following pressures are to be taken into account when designing the meter installation:

- $DMIP_u$ - 9,310 mbar
- DP_u - 7,000 mbar
- MOP_u - 7,000 mbar
- LOP_u - 3,500 mbar
- DmP_u - 3,500 mbar.

The gas consumer has requested a metering pressure of 200 mbar. No other information is provided. Assuming that there are no boosters, compressors, etc.

With no information regarding the operating limits of the consumer's system and starting from the requested 200 mbar set point.

For a meter inlet pressure of 200 mbar the control accuracy required is +/- 1% of the absolute pressure setting (Table 4 with no converter), the control accuracy is therefore 1% of 200 + 1013.25 = 12.1 mbar.

Assuming that the regulator is set at the desired value, or within half of the control accuracy above that value, we have a possible upper value of set point of 200 + (0.5 x 12.1) = 206.1 mbar which is MOP_{mi}.

With 206.1 mbar as the maximum set point the peak operating pressure allowed is 206.1 + control accuracy = 206.1 + 12.1 = 218.2 mbar this is $PLOP_{mi}$.

The pressure allowed for lock-up is 5% of the metering pressure, the lock-up pressure is calculated from $PLOP_{mi}$, that is, 218.2 + 10 = 228.2 mbar.

Working down from the active regulator set point to calculate LOP_{mi}, the lowest meter inlet pressure is the regulator set point minus the accuracy which is 200 – 12.1 = 187.9 mbar, further pressure is lost through the meter and the meter outlet pipework. In this case 2 mbar for the meter and 0.5 mbar for the pipe and valve giving a total of 2.5 mbar and leading to a LOP_{mi} of 187.9 – 2.5 = 185.4 mbar.

The monitor regulator can be set in a number of ways, however, provided there is sufficient head room it can be set to be completely clear of the active regulator, that is, remaining fully open throughout the normal pressure range of the active regulator, this principle is used for this example.

To be clear of the active, the monitor will need to be set at least 12.1 mbar (the Accuracy Class allowance) above the lock up of the active, that is 228.2 + 12.1 = 240.3 mbar, this gives no real separation, so a set point of 245 mbar is selected.

With a set point of 245 mbar the control accuracy required is +/- 1% of the absolute pressure setting (Table 4 with no converter), the control accuracy is therefore 1% of 245 + 1013.25 = 12.6 mbar.

Assuming that the regulator is set at the desired value, or within half of the control accuracy above that value, we have a possible upper value of monitor set point of 245 + (0.5 x 12.6) = 251.3 mbar.

With 251.3 mbar as the maximum set point the peak operating pressure allowed is 251.3 + control accuracy = 251.3 + 12.6 = 263.9 mbar this is TOP_{mi}.

The pressure allowed for lock-up is 5% of the monitor set point, the lock-up pressure is calculated from TOP_{mi}, that is, 263.9 + 12.6 = 276.5 mbar. (Where 12.6 is 5% of 245 mbar)

For the monitor regulator the lower operating limit is set point – Control Accuracy = 245 – 12.6 = 232.4 mbar

Continuing to work up the pressure stack, the relief valve setting has to be sufficiently above the lock-up pressure of the monitor regulator, to avoid nuisance venting at its lowest operating pressure, plus any additional separation determined by the designer.

With a relief valve accuracy class of 10% a trial set point of 12% above lock-up can be used, 276.5 + (12% of 276.5) = 309.7 mbar, this set point gives a lowest operating pressure for the relief valve of 309.7 – (10% of 309.7) = 278.7 mbar, this is above the lock-up pressure, a relief valve set point of 310 mbar provides the minimum practical, 310 – (10% of 310) = 279 mbar, 2.5 mbar above the lock-up pressure. Greater separation from a higher relief valve set point may be beneficial and be applied provided the consumer’s system can tolerate the higher MIP resulting from it.

The same method is used to select a set point for the slam-shut valve, the lowest operating pressure of the slam-shut valve has to be above the highest operating pressure of the relief valve.

With a slam-shut valve accuracy group of 5% a trial set point of 7% above the upper operating pressure of the relief valve can be used, 341 + (7% of 341) = 364.9 mbar (say 365 mbar), this set point gives a lowest operating pressure for the slam-shut of 365 – (5% of 365) = 346.8 mbar, this is 5.8 mbar above the upper operating pressure of the relief valve and is acceptable. Greater separation from a higher slam-shut set point may be applied provided the consumer’s system can tolerate it.

The maximum incidental pressure is equal to the upper operating pressure of the slam-shut valve, this is 365 + (5% of 365) = 383.3 mbar.

As LOP_u and DmP_u are the same, we know that DmP_{mi} will be the same as LOP_{mi}.

The full range of pressures for the meter installation are therefore as follows:

DmP_{mi}	185.4 mbar
LOP_{mi}	185.4 mbar
Set Point (Active)	200.0 mbar
MOP_{mi}	206.1 mbar
$PLOP_{mi}$	218.2 mbar
Lock up (Active)	228.2 mbar
Set Point (Monitor)	245.0 mbar
TOP_{mi}	263.9 mbar
Lock up (Monitor)	276.5 mbar
Relief Set point	310.0 mbar
Slam-shut set point	365.0 mbar
MIP_{mi}	383.3 mbar

The installation includes a meter inlet valve. As such, the pressure break will be on the outlet of the MIV.

- STP_{miu} - 10,500 mbar, based on DPu.
- STP_{mid} - 528 mbar, based on TOP_{mi} and IGE/UP/1.

Note: TOP_{mi} has been used as this needs to be equal to or less than the consumers MOP.

Upstream (Network)

HP/IP (see Appendix 5)

For an IP network STP_{miu} = DP_u x 1.5 i.e. 7 x 1.5 = 10.5 bar

Meter Installation (Meter Asset Manager) **Example 4**

MIP_{mi} = Slam Shut Set Point + Accuracy (5% of 365 mbar = 18.3 mbar) = 365 mbar + 18.3 mbar = 383.3 mbar

Lower limit for Slam Shut accuracy = Slam Shut Set Point – Accuracy (5% of 365 mbar = 18.3 mbar) = 365 mbar – 18.3 mbar – 346.7 mbar

Separation determined by designer

Upper limit for Creep Relief Valve accuracy = Set Point + Accuracy (10% of 310 mbar = 31 mbar) = 310 mbar + 31 mbar = 31 mbar

Lower limit for Creep Relief Valve accuracy = Set Point - Accuracy (10% of 310 mbar = 31 mbar) = 310 mbar - 31 mbar = 279 mbar

Separation determined by designer

Lock up (LU) = 263.9 mbar + 12.3 mbar = 276.2 mbar

TOP_{mi} = upper l imit due to Regulator Accuracy = 251.3 mbar +12.6 mbar = 263.9 mbar

Monitor set point + Setting tolerance, (half of Regulator Accuracy i.e. 0.5 x 12.6 = 6.3) = 245 mbar + 6.3 mbar = 251.3 mbar

Monitor set point = 245 mbar

Lower limit due to Regulator Accuracy = set point – Regulator Accuracy (1% abs) of 245 mbar = 12.6 mbar = 245 mbar – 12.6 mbar = 232.4 mbar

Separation determined by designer

Lock up (LU) = $PLOP_{mi}$ + 10 mbar (Section 9.4 – 5 mbar or 5% Metering Pressure whichever the greater) = 218.2 mbar + 10 mbar – 228.2 mbar

$PLOP_{mi}$ = MOP_{mi} + Regulator Accuracy 1% abs, (12.1 mbar) = 206.1 mbar + 12.1 mbar = 218.2 mbar

$MOP_{mi}{}^{2}$ = Set Point + Setting tolerance = 200 mbar + 6.1 mbar = 206.1 mbar (Setting tolerance is half of Regulator Accuracy i.e. = 0.5 x 12.1 mbar = 6.1 mbar)

P_m metering pressure 200 mbar

LOP_{mi} = Lowest pressure due to Regulator Accuracy (1% abs of 200 mbar = 12.1 mbar) – Pressure drop after Regulator through to the MOV outlet[3] = 200 mbar – 12.1 mbar – 2.5 mbar = 185.4 mbar

DmP_{mi} = DmP_c = minimum pressure for safe operation of customer's appliances

DP_{mid} ?? Mbar i.e. a value MOP_c[1]

STP_{mid} = 462 mbar 1.75 x DP_{mid}(TOP_{mi})

MIP_{mi} 33.8 mbar

SSV Set Point 365 mbar

CR Set Point 310 mbar

LU 276.2 mbar

DP_{mid} 264 mbar

TOP_{mi} 263.9 mbar

Monitor Set Point 245 mbar

Lu_{mi} 228.2 mbar

$PLOP_{mi}$ 218.2 mbar

MOP_{mi} 206.1 mbar

P_m 200 mbar

LOP_{mi} 185.4 mbar

DmP_{mi} 185.4 mbar

Consumer (Downstream)

STP_c from IGE/UP/1

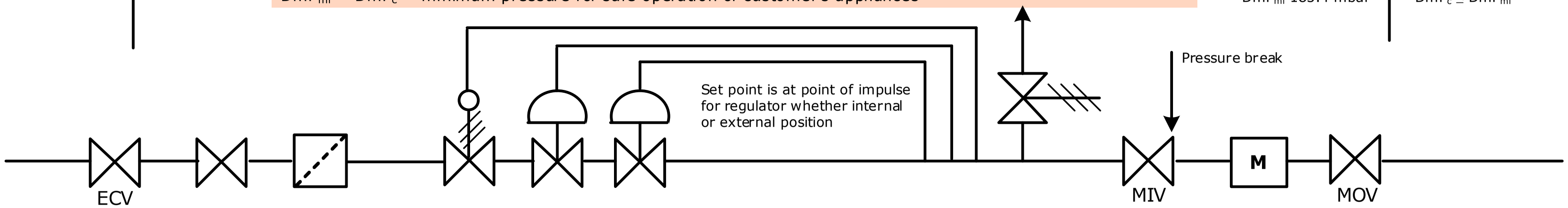
Meter Installation Criteria

- Regulator Set Point 200 mbar (Tolerance on setting regulator + half accuracy – Zero)
- Regulator Accuracy 1% Absolute - Relief Valve Accuracy Class 10%
- Lock up is 5% for set point greater than 100 mbar
- Slam Shut Accuracy Group 5%

$MOP_c \geq PLOP_{mi}$

$LOP_c \leq LOP_{mi}$

$DmP_c \leq DmP_{mi}$



Note 1: DP_{miu} is a design pressure which is equal to 1.1 bar.
Note 2: The above example MOP_{mi} has been calculated using set point + tolerance. Equally valid is to calculate MOP_{mi} from MOP_c – tolerance. If calculated in this way the declared values of $PLOP_{mi}$ and LU_{mi} will have to be recalculated.
Note 3: Meter operating at Q_{nom} – Therefore pressure drop across meter 2 mbar. Pressure drop across outlet pipework and MOV is 0.5 mbar. Total pressure drop from the outlet of the regulator to the MOV = 2 mbar (Meter) + 0.5 mbar (Pipe and valve) = 2.5 mbar.
Note 4: Where the metering pressure exceeds 21 mbar Annual Quantity less than 732 MWh, a flow conversion device is required (see clause 9.3.3).

Example 5

Meter Installation Criteria

- medium pressure (MP 270) network
- regulator set point 50 mbar (Tolerance on setting regulator + Half Accuracy – Zero)
- regulator accuracy 10% -
- relief valve accuracy class 10%
- lock up is 5 mbar above the pressure at 5% of Q_{imax} (Upper limit of the control band), as set point is less than 100 mbar
- slam-shut accuracy group 5%.

A non-domestic meter installation on an MP270 Network. The GT has advised that the following pressures are to be taken into account when designing the meter installation:

- $DMIP_u$ - 2.7 bar
- DP_u - 2.0 bar
- MOP_u - 2.0 bar
- LOP_u - 280 mbar
- DmP_u - 270 mbar.

The gas consumer has requested a metering pressure of 50 mbar, and has requested a twin-stream regulator installation to avoid the need to be off gas at times of maintenance. The consumer has also advised that their system can cope with a minimum pressure of 28 mbar for safe operation.

The GT has requested that the design pressure for the part of the installation upstream of the pressure break be 2.0 bar. The design pressure for the part of the installation downstream of the pressure break can be any value equal to or exceeding MOP_c which is not known, but as $PLOP_{mi}$ has be less than or equal to MOP_c, setting DP_{mid} to be equal to $PLOP_{mi}$ would be reasonable.

Given the requested metering pressure of 50 mbar, the tolerance on setting the lead stream set point will be 2.5 mbar (50 x 10%/2), which gives a maximum possible setting of 52.5 mbar, this can be declared as being MOP_{mi}.

$PLOP_{mi}$ will therefore be 57.5 mbar, i.e. 50 mbar set-point + 2.5 mbar setting tolerance + 5 mbar accuracy band.

The lock up on the lead stream can therefore be calculated to be 62.5 mbar, i.e. 57.5 mbar $PLOP_{mi}$ + 5 mbar (as the set point is less than 100 mbar, see Sub-Section 9.4).

The lead stream will be set higher than the standby stream and as such this will be the declared lock up value for the installation.

The standby stream can be set in a number of ways. If the designer does not want it to operate other than in times of failure of the lead stream or when maintenance is being undertaken, the second stream will have to be set such that its lock up value is lower than the lower limit of variations in pressure produced by the lead stream. i.e. in this example it will need to be set such that the lock up of the standby stream is lower than 45 mbar, (i.e. 50 mbar lead stream set point – 5 mbar accuracy.)

The standby stream set point can then be roughly calculated from this value, i.e. 45 mbar – 5 mbar (lockup) – 4 mbar (approx accuracy) – 2 mbar (approx tolerance) = 34 mbar.

If we use a standby stream set point of 34 mbar the actual setting tolerance allowance is 1.7 mbar, giving 35.7 mbar, and the accuracy allowance will actually be 3.5 mbar which gives an upper limit of variations in pressure for the standby stream of 39.2 mbar. Adding the 5 mbar for the lock up (Sub-Section 9.4) this gives a standby stream lock up pressure of 44.2 mbar which is less than the 45 mbar minimum variation in pressure from the lead stream.

As the standby stream is the lower of the two streams and may operate for prolonged periods, it should be used to calculate the values of LOP_{mi} and DmP_{mi}.

LOP_{mi} can be calculated to be 28.85 mbar, i.e. 34 mbar standby stream set point – 3.4 mbar accuracy tolerance – 1.75 mbar pressure loss from impulse point to meter installation outlet.

DmP_{mi} has to be greater than or equal to the consumer's declared DmP_c of 28 mbar and means the pressure drop across the installation when operating on the standby stream with an installation inlet pressure of 270 mbar will have to be less than or equal to 242 mbar. Given that the outlet pressure with 280 mbar on the installation inlet is only 28.85 mbar, it is likely that the second stream will need to be set higher than 34 mbar if the DmP_{mi} of 28 mbar is to be achieved.

The slam-shut valves and creep relief valves for both streams can be set the same, with their set points calculated off the lead stream's values as that is the higher stream.

Given the lead stream lock-up pressure of 62.5 mbar, and the creep relief valve accuracy class of 10%, a creep relief set point of 72 mbar would be reasonable, as this would give a lower limit of operation for the creep relief of 64.8 mbar, i.e. 72 mbar – 7.2 mbar, which is a couple of mbar above the lock up pressure.

The upper limit of operation of the creep relief would be 79.2 mbar, i.e. 72 mbar + 7.2 mbar, as such given the slam-shut accuracy group of 5% a slam-shut set point of 90 mbar would be reasonable. This would give a lower limit of operation of 85.5 mbar, which is over 6 mbar above the upper limit of operation of the creep relief and should be enough to avoid nuisance firing of the slam-shuts. A slam-shut set point of 90 mbar will give a MIP_{mi} of 94.5 mbar.

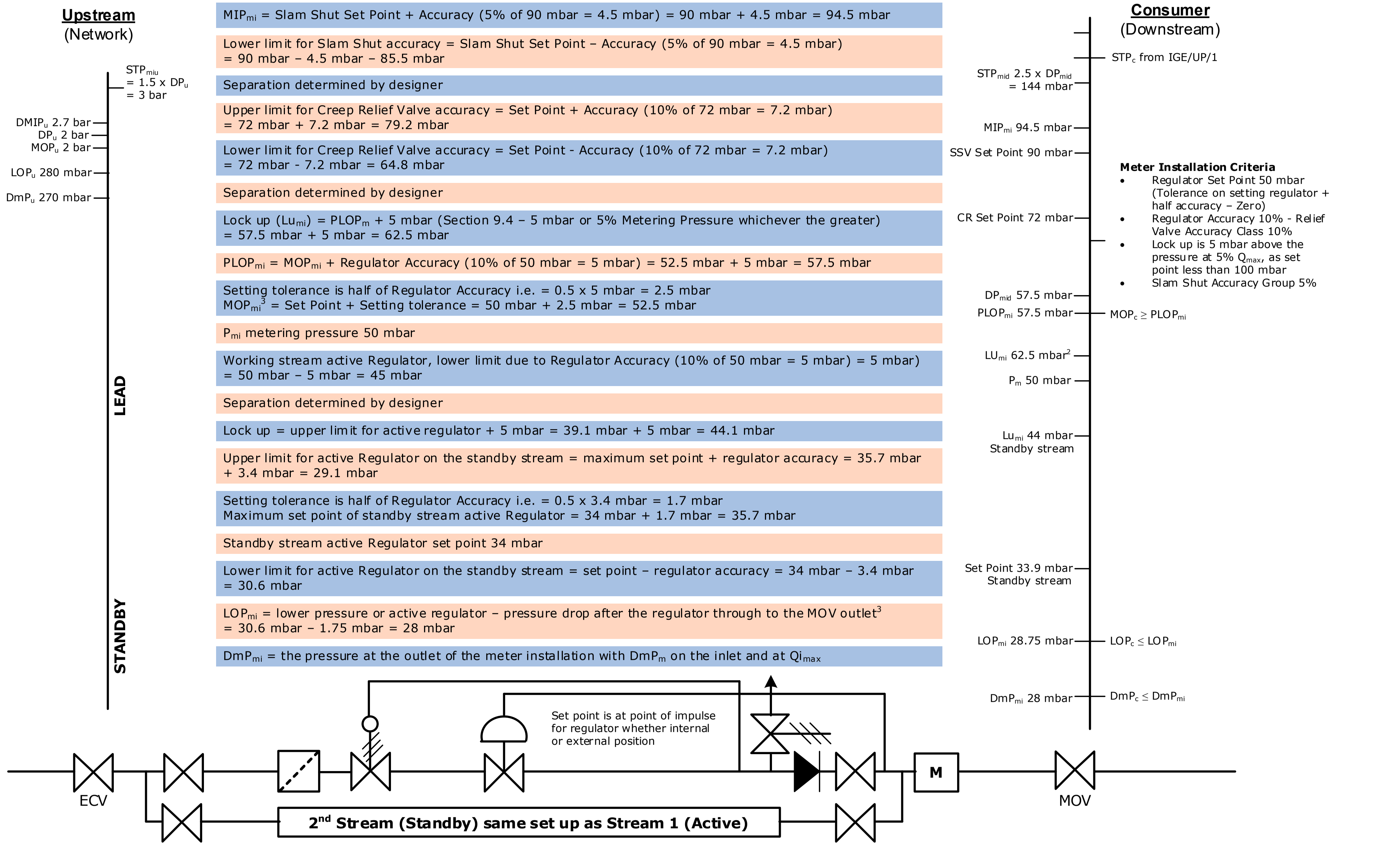
The strength test pressure for that part of the installation that is upstream of the pressure break (STP_{miu}) is 3 bar (1.5 x DP_u). The strength test pressure for the section of the meter installation downstream of the pressure break is 143.75 mbar i.e. (2.5 x $PLOP_{mi}$).

Note: $PLOP_{mi}$ has been used as $PLOP_{mi}$ has to be equal to or less than the consumers MOPc.

The consumer will need to be advised that their system will need to be able to cope with:

- MIP_{mi} - 94.5 mbar
- $PLOP_{mi}$ = DP_{mid} =MOP_c - 57.5 mbar
- Pm - 50 mbar
- LOP_{mi} - 28.75 mbar
- DmP_{mi} - 28 mbar.

Meter Installation (Meter Asset Manager) **Example 5** Figure IV Pressure settings and limits MP Twin Stream 50 mbar set point



Note 1: *DP$_{miu}$ is a design pressure which is equal to 2 bar.*
Note 2: *The above example MOP$_{mi}$ has been calculated using set point + tolerance. Equally valid is to calculate MOP$_{mi}$ from MOP$_c$ – tolerance. If calculated in this way the declared values of PLOP$_{mi}$ and LU$_{mi}$ will have to be recalculated.*
Note 3: *Meter operating at Q$_{nom}$ – Therefore pressure drop across meter 1.25 mbar; across outlet pipework and MOV is 0.5 mbar. Total pressure drop from the outlet of the regulator to the MOV = 1.25 mbar (Meter) + 0.5 mbar (Pipe and valve) = 1.75 mbar.*
Note 4: *Where the metering pressure exceeds 21 mbar Annual Quantity less than 732 MWh, a flow conversion device is required (see clause 9.3.3).*

Example 6

Meter Installation Criteria

- intermediate pressure network
- regulator set point 200 mbar (Tolerance on setting regulator + Half Accuracy – Zero)
- regulator accuracy 1% Absolute –
- relief valve accuracy class 10%
- lock up is 5% of the set pressure above the pressure at 5% Q_{imax}, (Upper limit if control band), as set point is greater than 100 mbar (see Sub-Section 9.4)
- slam-shut accuracy group 5%.

The gas consumer has requested a new meter installation with a metering pressure of 200 mbar, and has requested a twin-stream regulator installation to avoid the need to be off gas at times of maintenance. The installation is to be fed from an IP service.

The GT has requested that the design pressure for the part of the installation upstream of the pressure break be 7.0 bar.

Given the requested metering pressure of 200 mbar, the tolerance on setting the lead stream set point will be calculated from the absolute pressure setting, (1213 mbar x 1%/2) = 6.1 mbar, which gives a maximum possible setting of 206.1 mbar, this can be declared as being MOP_{mi}.

$PLOP_{mi}$ will therefore be 218.2 mbar, i.e. 200 mbar set-point + 6.1 mbar setting tolerance + 12.1 mbar accuracy band (1213 x 1%).

The lock up on the lead stream can therefore be calculated to be 228.2 mbar, i.e. 218.2 mbar $PLOP_{mi}$ + 10 mbar (5% of 200 mbar, as the set point is more than 100 mbar, see Sub-Section 9.4).

As this is an IP installation it is provided with monitor regulators, traditionally these have been set so that they are permanently wide open except in the event of a failure, this is achieved by ensuring that the lower limit of operation of the monitor is higher than the active regulator lock up pressure.

The separation between active lock up and lower limit of operation of the monitor is at the designer's discretion, and the designer may actually choose to have the two overlap. However, in this example a separation of approximately 4 mbar has been chosen, which allowing for the accuracy class of the monitor gives a set point of 245 mbar. Back calculating gives us an actual lower limit of variation in pressure from the monitor regulator of 232.4 mbar, i.e. 245 – 12.6 mbar (1% of 1258 mbar).

The setting tolerance for the monitor regulator will be half of the accuracy allowance, i.e. 6.3 mbar giving a maximum allowed set point of 251.3 mbar.

TOP_{mi} will therefore be 263.9 mbar, i.e. 251.3 + 12.6 mbar (1% of 1264.3 mbar).

The monitor lock-up pressure will be 276.5 mbar, i.e. 263.9 mbar + 12.6 mbar (5% of 251.3 mbar). This is the highest of the four regulator lock up pressures in the installation and as such is the pressure that should be declared as being the installation lock up pressure.

The lead stream will be set higher than the standby stream and as such this will be the declared lock-up value for the installation.

The standby stream can be set in a number of ways. If the consumer's system can't cope with a very wide range of pressures the lead and standby stream active regulators can be made to overlap. The effect of this will be that at times both streams will be feeding. When setting streams like this it is important to ensure sufficient separation to avoid instability, in this example a minimum separation of 5 mbar is specified by IGEM/GM/8, i.e. 2.5% of set point. This gives a maximum possible standby stream set point of 195 mbar.

Allowing for the setting tolerance, which in this case is 6 mbar (1208 mbar x 1%/2) gives a standby stream set point of 189 mbar.

Using a standby stream set point of 189 mbar the actual setting tolerance allowance is 6 mbar, giving 195 mbar, and the accuracy allowance will actually be 12 mbar which gives an upper limit of variations in pressure for the standby stream of 207 mbar. Adding the 9.5 mbar for the lock up (Sub-Section 9.4) this gives a standby stream lock up pressure of 216.5 mbar.

These figures show that for most of the flow range the two streams will actually be operating in tandem, whilst this has the benefit of improved installation outlet pressure it does mean that both regulator streams will wear approximately evenly.

As the standby stream is the lower of the two streams and may operate for prolonged periods, it should be used to calculate the values of LOP_{mi} and DmP_{mi}.

LOP_{mi} can be calculated to be 174.5 mbar, i.e. 189 mbar standby stream set point – 12 mbar accuracy tolerance – 2.5 mbar pressure loss from impulse point to meter installation outlet.

DmP_{mi} has to be calculated based on the performance of the regulators with an inlet pressure of DmP_u.

The monitor, slam-shut valves and creep relief valves for both streams can be set to the same values, with their set points calculated off the lead streams active regulator.

The monitor regulator set point has been calculated (above) to be 245 mbar with a lock up pressure of 276.5 mbar.

Given the lead stream lock up pressure of 276.5 mbar, and the creep relief valve accuracy class of 10%, a creep relief set point of 310 mbar would be reasonable, as this would give a lower limit of operation for the creep relief of 279 mbar, i.e. 310 mbar – 31 mbar, which is a few mbar above the lock up pressure.

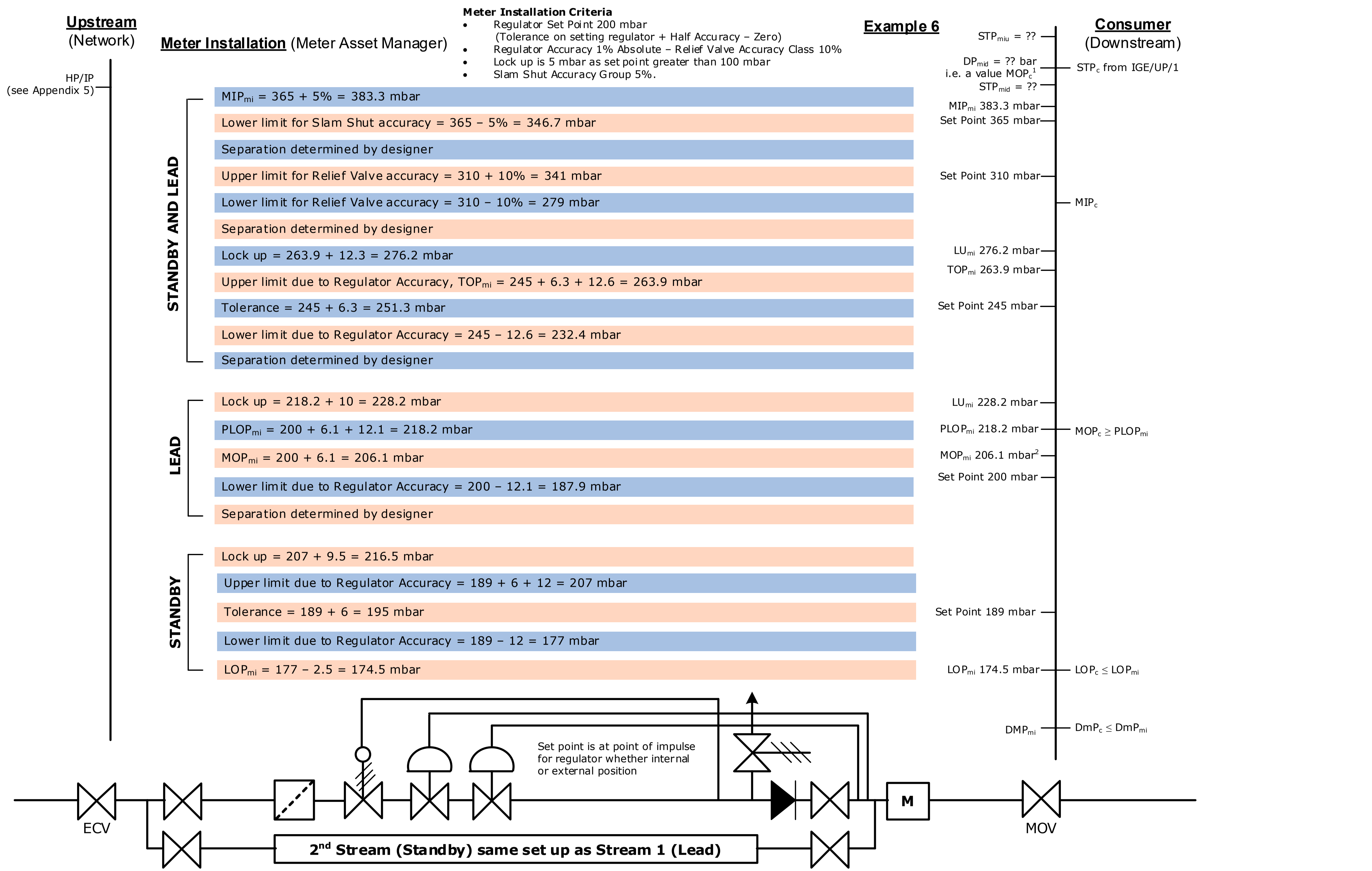
The upper limit of operation of the creep relief would be 341 mbar, i.e. 310 mbar + 31 mbar, as such given the slam-shut accuracy group of 5% a slam-shut set point of 365 mbar would be reasonable. This would give a lower limit of operation of 346.7 mbar, which is 6 mbar above the upper limit of operation of the creep relief and should be enough to avoid nuisance firing of the slam-shuts. A slam-shut set point of 365 mbar will give a MIP_{mi} of 383.3 mbar.

The strength test pressure for that part of the installation that is upstream of the pressure break (STP_{miu}) is 10.5 bar (1.5 x DP_u). The strength test pressure for the section of the meter installation downstream of the pressure break is 528 mbar i.e. (2.0 x TOP_{mi}).

Note: *TOP_{mi} has been used as TOP_{mi} has to be equal to or less than the consumer's MOPc.*

The consumer will need to be advised that their system will need to be able to cope with:

- STP_{miu} - 10.5 bar
- STP_{mid} - 528 mbar
- MIP_{mi} - 383.3 mbar
- $TOP_{mi} = DP_{mid} = MOP_{c}$ - 263.9 mbar
- P_{m} - 200 mbar
- LOP_{mi} - 174.5 mbar
- DmP_{mi} - TBC mbar.



Note 1: DP_{miu} is a design pressure which is equal to 1.1 bar.

Note 2: The above example MOP_{mi} has been calculated using set point + tolerance. Equally valid is to calculate MOP_{mi} from MOP_c – tolerance. If calculated in this way the declared values of $PLOP_{mi}$ and LU_{mi} will have to be recalculated.

Note 3: Meter operating at Q_{max} – Therefore pressure drop across meter 2 mbar. Pressure drop across outlet pipework and MOV is 0.5 mbar. Total pressure drop from the outlet of the regulator to the MOV = 2 mbar (Meter) + 0.5 mbar (Pipe and valve) = 2 mbar.

Note 4: Where the metering pressure exceeds 21 mbar Annual Quantity less than 732 MWh, a flow conversion device is required (see clause 9.3.3).

APPENDIX 11 : METER INSTALLATION ACCURACY AND THE GREENHOUSE GAS EMISSIONS TRADING SCHEME ORDER 2020 SI 2020 NO.1265 CONCERNING THE MONITORING OF CARBON DIOXIDE EMISSIONS

A11.1 GENERAL

A11.1.1 The primary objective of this Appendix is to provide examples quantifying the uncertainty on the reference volumes of gas measured by different metering systems given in this Standard.

An uncertainty analysis has always to be carried out during the design of a new installation.

The purpose of uncertainty analysis is twofold. At the design stage, it identifies weakness in the design of the metering installation and indicates the action necessary to eliminate them. It also permits the estimation of the level of uncertainty likely to be achieved in practice. For existing installations, it serves a similar purpose in identifying possible modifications if the predicted level of uncertainty is too high.

The UK Emissions Trading Scheme (UK ETS) replaced the UK’s participation in the European Union Emissions Trading Scheme (EU ETS) on 1 January 2021.
The UK, Scottish and Welsh Governments and Northern Ireland Department of Agriculture, Environment and Rural Affairs collectively making up the UK ETS Authority established the scheme to increase the climate ambition of the UK’s carbon pricing policy, while protecting the competitiveness of UK businesses. The UK ETS is established through The Greenhouse Gas Emissions Trading Scheme Order 2020.

The UK Government has issued guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to The Greenhouse Gas Emissions Trading Scheme Order 2020. The key requirement of the guidelines for Natural Gas-consuming activities is to report annual emissions of carbon dioxide. This is calculated as the product of the quantity of NG consumed, its carbon equivalent factor (CEF) and an oxidation factor (to allow for slightly less than complete combustion). The guidelines also require reporting of the overall uncertainty of the reported annual emissions, as well as reporting of the calorific value and energy consumed.

A11.1.2 There are specific guidelines for consumers that are not in control of the gas metering arrangement for their operation, these have been simplified from those previously used for the EU ETS that set out various monitoring tiers, which demand increased accuracy of monitoring for higher levels of emissions. Operators that do not own the gas meter used to determine their activity data, may, if that meter is used for billing purposes, use the maximum permissible error in service allowed by UK Legislation or UK rules as their uncertainty value.

For gaseous fuels the tiers are

	TIER 1	TIER 2	TIER 3	TIER 4
Maximum Permissible Uncertainty	± 7.5%	± 5.0%	± 2.5%	± 1.5%

TABLE 20 - MAXIMUM PREMITTED UNCERTAINTY BY TIER FOR GASEOUS FUELS

That is, measurement equipment is approved as suitable for use under one of two UK Regulations, the Measuring Instruments (Gas Meters) Regulations 2006 (SI 2006 No 2647) for newer meters or the Gas (Meters) Regulations 1983 (SI 1983 No 684)

To make use of this simplification operators are required to identify the type of meter used to identify the Maximum Permissible Error in Service (MPES).

The relationship between the MPES and MPE for different meter types is given in Table 19.

MEASUREMENT DEVICE	RELATIONSHIP WITH MPES AND MPE
Class 1 Meter (Inc. Rotary and Turbine)	MPES = MPE
Class 1.5 Meter	MPES = 2 x MPE
Volume Converter	MPES = MPE
Diaphragm Meter/ Other meter (1983 Regulations)	MPES = MPE

TABLE 21 - THE RELATIONSHIP BETWEEN THE MPES AND MPE FOR DIFFERENT METER TYPES

Tables 20 and 21 show the MPES of various meter classes and compares them to the tiers that they would achieve (operators to refer to Article 26 of The Monitoring and Reporting Regulation (MRR) (Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 to identify what tier is needed to apply to major, minor, de-minimis and marginal source streams). It is inevitable that the flow rate will be less than 20% of the maximum flow rate at some point. However, if the meter operates above 20% of the maximum flow rate during normal plant operation, the overall uncertainty is assumed to be within the higher flow.

	ACCURACY CLASS 1.0 (20-100%)	ACCURACY CLASS 1.0 (0-20%)	ACCURACY CLASS 1.5 (20-100%)	ACCURACY CLASS 1.5 (0-20%)
Meter Accuracy/MPE	±1%	±2%	±1.5%	±3%
MPES	±1%	±2%	±3%	±6%
Volume Converter Accuracy	±1%	±1%	±1%	±1%
Uncertainty calculation	$\sqrt{(1^2 + 1^2)}$ = 1.41	$\sqrt{(2^2 + 1^2)}$ = 2.24	$\sqrt{(3^2 + 1^2)}$ = 3.16	$\sqrt{(6^2 + 1^2)}$ = 6.08
Tier threshold	4	3	2	1

TABLE 22 - COMPARISON OF TIER THRESHOLDS WITH VARIOUS NATURAL GAS METER CLASSES (2006 MEASURING INSTRUMENTS (GAS METERS) REGULATIONS

	DIAPHRAGM METER	OTHER METER TYPE (20-100%)	OTHER METER TYPE (0-20%)
Meter Accuracy/MPE	±2%	±1%	±2%
MPES	±2%	±1%	±2%
Volume Converter Accuracy	±1%	±1%	±1%
Uncertainty calculation	$\sqrt{(2^2 + 1^2)}$ = 2.24	$\sqrt{(1^2 + 1^2)}$ = 1.41	$\sqrt{(2^2 + 1^2)}$ = 2.24
Tier threshold	3	3	1

TABLE 23 - SUMMARY OF MPE AND MPES REQUIRED BY THE 1983 GAS METER REGULATIONS FOR VARIOUS NATURAL GAS METER TYPES

Source: European Union Emissions Trading System (EU ETS) Phase III Guidance for installations
How to comply with the EU ETS, including the Small Emitter and Hospital Opt-Out Scheme. March 2017

A11.2 DERIVATION OF UNCERTAINTY EQUATIONS FOR THE REFERENCE VOLUME OF GAS

A11.2.1 General

The uncertainty on the reference volume of gas can only be calculated knowing the method of flow conversion. The reference flow volumes through a given single metering system will, generally, be calculated using either the PTZ method, in some form, for the various tiers of metering pressures or possibly the DENSITY/S.G. method for large volume, high pressure metering systems, i.e. up to 38 bar.

A11.2.2 Calculation of reference volumes

A11.2.2.1 *PTZ method*

For this type of flow conversion method, the volume of gas consumed at reference conditions is given by the equation:

$$V_b = V_m \times \frac{P}{P_b} \times \frac{T_b}{T} \times \frac{Z_b}{Z} \quad \text{......} \quad (1)$$

V_b = volume of gas supplied at reference pressure and temperature
V_m = actual volume of gas measured by the meter at the pressure and temperature conditions within the meter
P = absolute pressure measured at the meter's "P_m" tapping
P_b = absolute reference pressure (1.01325 bar)
T = absolute temperature within the meter
T_b = absolute reference temperature (273.15 + 15 = 288.15°K)
Z_b = gas compressibility factor at reference pressure and temperature
Z = gas compressibility factor at line pressure and temperature.

A11.2.2.2 *Density/SG method*

For this type of flow conversion method, the volume of gas consumed at reference conditions is given by the equation:

$$V_b = \frac{f \times t}{k} \times \frac{\rho}{\rho_{airb}} \times \frac{1}{S.G} \quad \text{.................................} (2)$$

V_b	=	volume of gas supplied at reference conditions of pressure and temperature
f	=	frequency output from meter (e.g. pulses/hour)
t	=	billing period (e.g. hours)
k	=	meter factor at a given flowrate (e.g. pulses/act m^3)
ρ	=	density of flowing gas at the meter's 'P_m' tapping
ρ_{airb}	=	density of dry air (0.03% CO_2) at reference conditions of pressure and temperature
S.G	=	specific gravity of gas.

A11.2.3 **Calculation of uncertainty on reference volume of gas**

A11.2.3.1 *General*

The method of calculating uncertainty follows the principles given in IGEM/GM/4 which is derived from ISO 5168.

Knowing the equations used to calculate the reference volume of gas consumed for the two methods of flow conversion, the uncertainty on the reference volumes of gas can be calculated.

For the two methods, it is assumed all the variables in equations (1) and (2), used to calculate the reference volume, are independent. Using this assumption, the uncertainty on each of the measured variables and estimated parameters can be combined on a "root sum of squares" basis to obtain the overall uncertainty of the reference volume flow.

A11.2.3.2 *Equations for the calculation of uncertainty of reference volume measurement*

Using the above assumptions, the uncertainty equation, for the two methods of conversion, can be formulated; i.e.

(a) **PTZ Method**

$$E_{v_b} = \left(E^2_{v_m} + E^2_{conv} + E^2_{I}\right)^{0.5} \quad \text{.................................} (3)$$

Note: $E_{conv} = \left(E^2_{p} + E^2_{T} + E^2_{zb/z} + E^2_{comp}\right)^{0.5}$

(b) **Density/S.G. Method**

$$E_{v_b} = \left(E^2_{f} + E^2_{k} + E^2_{\rho} + E^2_{SG} + E^2_{comp} + E^2_{I}\right)^{0.5} \quad \text{.................................} (4)$$

- "E" donates the uncertainty on a parameter to a 95% confidence level, to two standard deviations
- e.g. E_{vm} = uncertainty on actual volume of gas (2σ)
  e.g. E_ρ = uncertainty on actual gas density (2σ)
- the uncertainty term (E_{comp}) is introduced to account for any uncertainty in the flow computation process
- the uncertainty term (E_I) is introduced to account for any possible installation effects on the meter accuracy
- it is assumed that the reference pressure and temperature (i.e. P_b and T_b) in equation (1) and the density of dry air at reference conditions (ρ_{airb}) in equation (2), are known without error and hence have zero uncertainty values
- it is assumed all errors are normally distributed and are not bias errors.

A11.3 EXAMPLES OF UNCERTAINTY CALCULATIONS ON REFERENCE GAS VOLUME

Four examples are given below of metering systems, which use various types of meter and conversion processes. These are typical examples given in this Standard which are currently used in the UK.

A11.3.1 Example 1

This metering system comprises:

- diaphragm type meter ($Q_{max} \geq 65$ actm^3/h)
- automatic PTZ conversion
- OP = 21 mbar.

The following table gives representative values of the component uncertainties for the above metering system.

COMPONENT	UNCERTAINTY, E%	COMMENTS/ASSUMPTIONS
Metered volume (V_m)	E_{vm} = ± 3%	This uncertainty is over a flow rate range of approximately 100:1.
Corrected volume (V_{conv})	E_{conv} = ± 1%	This is the total allowed uncertainty of the PTZ conversion system (EN 12405 and IGEM/GM/5)
Installation effects (I)	E_I = ± 0.0%	It is assumed that the accuracy of diaphragm meters are not significantly affected by installation effects.

Substituting the relevant component uncertainties in equation (3) gives the uncertainty on the reference volume of gas.

i.e. $E_{Vb} = (3.0^2 + 1.0^2)^{0.5} = \underline{\underline{\pm 3.16\%}}$ (to a 95% confidence level).

Conclusion

Large industrial diaphragm meters ($Q_{max} \geq 65$ actm^3 h^{-1}) with automatic conversion for pressure, temperature and compressibility will conform to the requirements of Tier 2a in European Directive 2003/87/EC (see Table 20 ~~19~~).

A11.3.2 Example 2

This metering system comprises:

- RD or turbine meter ($Q_{max} \geq 100$ ACT m^3 h^{-1}) which has not been ideally matched to the load but does comply with clause 4.2.2, i.e. max load = 40% Q_{max} for 4 hours and 10% Q_{max} for 20 hours.

The following table gives representative values of the component uncertainties for the above metering system.

COMPONENT	UNCERTAINTY, E%	COMMENTS/ASSUMPTIONS
Metered volume (V_m)	E_{vm} = ± 1.56% (see below)	This assumes the meter is operating at flow rates below the badged Q_{min} of the meter for some time.
Corrected volume (V_{conv})	E_{conv} = ± 1%	This is the total allowed uncertainty of the PTZ conversion system (EN 12405 and IGEM/GM/5).
Installation effects (I)	E_I = ± 0.3%	It assumes that installation conforms to manufacturers' instructions and the installation effects on the metering accuracy are limited to ± 0.3%.

Calculation. 4h at 40% = 40 units x 4h = 160 units at ± 1%
20h at 10% = 10 units x 20h = 200 units at ± 2%
i.e. (160 x 1%) + (200 x 2%) = (1.6 + 4.0) = 5.6 total error

$$\text{Overall error} = \frac{56}{360} \times 100 = 1.56\%$$

Substituting the relevant component uncertainties in equation (3) gives the uncertainty on the reference volume of gas measured.

i.e. $E_{vb} = (1.56^2 + 1.0^2 + 0.3^2)^{0.5} = \underline{\underline{\pm 1.88\%}}$ (to a 95% confidence level)

Conclusion

RD and turbine meters, operating at times below the badged Q_{min} of the meter, with automatic conversion for pressure, temperature and compressibility conform to the requirements Tier 3a in the European Directive 2003/87 (see Table 20 ~~24~~).

A11.3.3 Example 3

This metering system comprises:

- RD or turbine meter ($Q_{max} \geq 100$ actm^3 h^{-1}) which has been well sized and operating within the range of flows for which it is declared to be within ± 1%
- automatic PTZ Conversion.

The following table gives representative values of the component uncertainties for the above metering system.

COMPONENT	UNCERTAINTY, E%	COMMENTS/ASSUMPTIONS
Metered volume (V_m)	E_{vm} = ± 1%	This assumes the meter is operating at flow rates for which it is declared to be within ± 1%.
Corrected volume (V_{conv})	E_{Vconv} = ± 1%	This is the total allowed uncertainty of the PTZ conversion system (EN 12405 and IGEM/GM/5).
Installation effects (I)	E_I = ± 0.3%	It assumes that installation conforms to manufacturers' instructions and the installation effects on the metering accuracy are limited to ± 0.3%.

Substituting the relevant component uncertainties in equation (3) gives the uncertainty on the reference volume of gas measured.

i.e. $E_{Vb} = (1.0^2 + 1.0^2 + 0.3^2)^{0.5} = \underline{\underline{\pm 1.45\%}}$ (to a 95% confidence level)

Conclusion

RD and turbine meters, operating within the range of flows for which they are declared to be within ± 1%, with automatic conversion for pressure, temperature and compressibility, conform to the requirements Tier 4a in the European Directive 2003/87/EC (see Table 20).

A11.3.4 **Example 4**

This metering system comprises:

- turbine meter operating over the range of flows for which it has been calibrated
- automatic density/SG conversion using flow computer
- flow computer undertaking meter error correction.

This type of metering system is, normally, used on large flow systems, operating at high pressure, when the best accuracy is required.

The following table gives representative values of the component uncertainties for the above metering system.

COMPONENT	UNCERTAINTY, E%	COMMENTS/ASSUMPTIONS
Metered frequency output (f)	E_f = ± 0.03%	In general the errors due to frequency measurement or pulse count, over the billing period should be much less than the stated value of uncertainty. It is assumed that the billing period of time has zero uncertainty.
Meter factor (k)	E_k = ± 0.4% over calibrated flow range of the meter	This value assumes that: (i) The meter's error characteristic with flowrate, has been obtained at the nominal working conditions of pressure and temperature at an Internationally recognized flow facility with a traceable uncertainty of ± 0.3% on the measured actual flowrate. (ii) The meter's error characteristic versus flowrate, is accounted for in the flow computational process within the computer. (iii) The repeatability of the turbine meter to measure actual volume flowrate is better than ± 0.03%.
Gas density (ρ)	E_ρ = ± 0.2% over the operating range of gas density	The vibrating element density meter is capable of measurement to an uncertainty of better than ± 0.1% if correctly installed and calibrated and the necessary corrections applied. The major cause of error is due to temperature differences between the gas in the density meter and the primary meter. To achieve the uncertainty quoted this temperature must be less than 0.5°C. Thermal lagging of the density meter and impulse lines may be necessary.
Gas specific gravity (S.G)	E_{SG} = ± 0.15% over range of SG from 0.55 to 0.8	The principle of measuring specific gravity is similar to the vibrating element density meter. The gas Specific Gravity Transducer can therefore achieve an uncertainty of ± 0.15% of reading if installed and calibrated correctly. The sample gas should be conditioned and the pressure reduced before entering the transducer. Calibration can be carried out in-situ using two certified gases of known specific gravity.
Computational process (Comp)	E_{comp} = ± 0.01%	This component of uncertainty is a very conservative estimate.
Installation effects (I)	E_I = ± 0.3%	This assumes that installation conforms to manufacturer's instructions and the effects of the installation on the metering accuracy are limited to ± 0.3%.

Substituting the relevant component uncertainties in equation (4) gives the uncertainty on the reference volume of gas measured.

i.e., $E_{Vb} = (0.03^2 + 0.4^2 + 0.2^2 + 0.15^2 + 0.01^2 + 0.3^2)^{0.5} = \pm 0.56\%$ (to a 95% confidence level).

Conclusion

Turbine meters operating at high pressure with density/SG conversion using a flow computer, will easily conform to the requirements of Tier 4a in the European Directive 2003/87/EC (see Table 20).

APPENDIX 12 : GAS (CALCULATION OF THERMAL ENERGY) REGULATIONS

A12.1 CONVERTING THE ACTUAL VOLUME MEASURED INTO THE VOLUME AT STANDARD CONDITIONS

The regulations provide options for the use of volume converters on the gas meter or for the use of temperature and pressure conversion factors.

In all situations, an appropriate standard volume conversion system can be used that converts the volume of gas determined by a meter into the equivalent volume as if it had been measured at a temperature of 15°C and a pressure of 1013.25 mbar.

Where the annual quantity of energy expected to pass the meter exceeds 73,200 kWh, an appropriate standard temperature conversion system can be used that converts the volume of gas determined by a meter into the equivalent volume as if it had been measured at a temperature of 15°C and separately pressure and compressibility conversion factors have to be applied in accordance with the regulations.

Where no conversion system is used, the regulations allow for the use of a fixed factor of 1.02264 where the annual quantity of energy expected to pass the meter does not exceed 732,000 kWh and, for greater quantities, a factor calculated in accordance with the regulations can be used.

If the metering pressure exceeds 2 bar (gauge), the regulations require that compressibility conversion factor is applied.

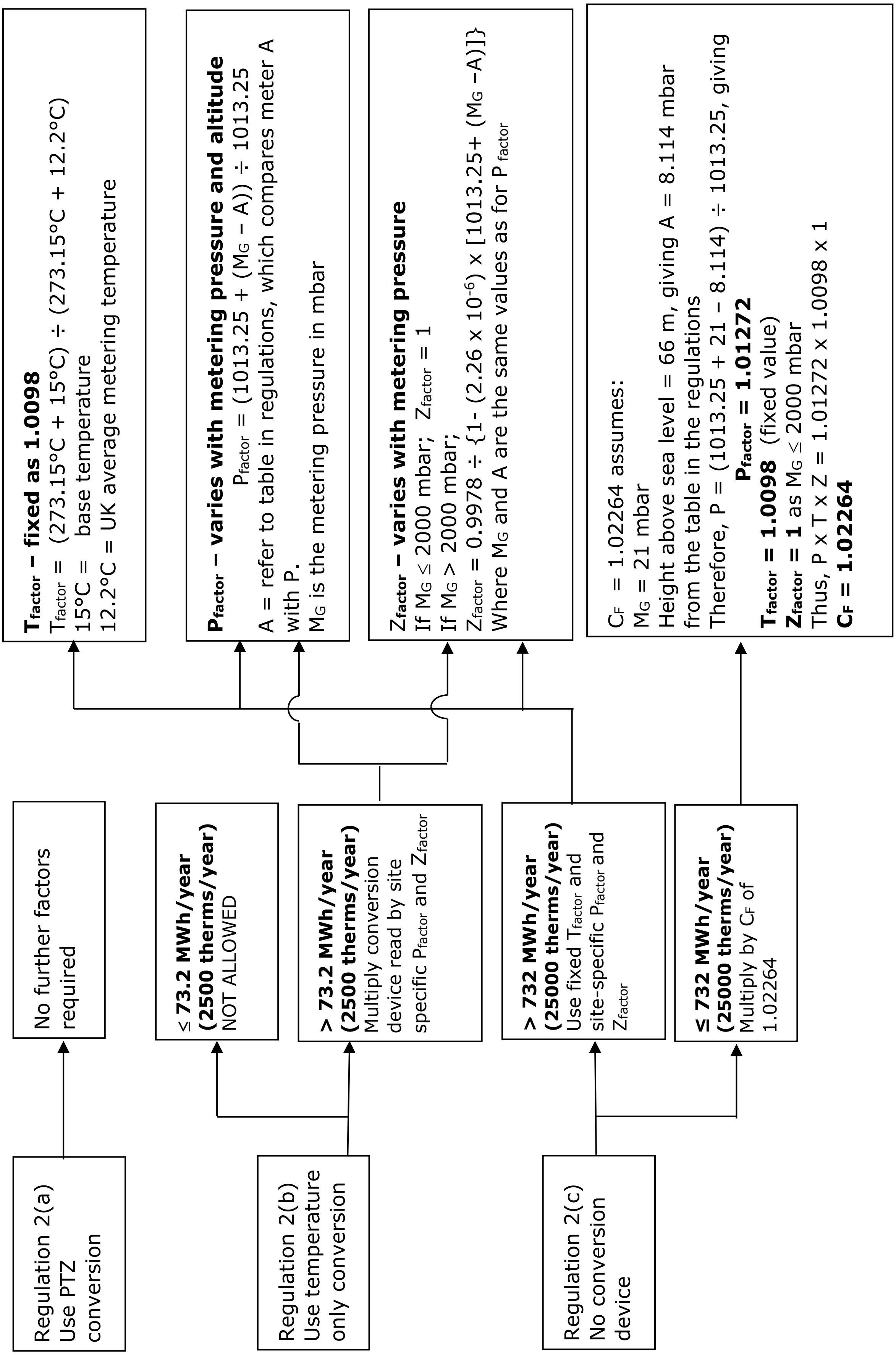
A12.2 METHODS OF DETERMINING DAILY CALORIFIC VALUES

The regulations provide for the GT to determine the calorific value by making measurements at places directed by Ofgem. The GT is required to use the lowest calorific value of those measured for gas flowing into a charging area. Alternatively, where the GT has provided and maintained appropriate flow measurement equipment at inputs to the charging area, the GT may calculate a flow weighted average calorific value which is used subject to it being not greater than 1 MJ above the lowest calorific value measured for gas flowing into the area. If the average is more than 1MJ above the lowest, a capped value of the lowest value plus 1MJ has to be used.

GTs may also declare the calorific value to be used for a charging area, in which case the times and manner of the declaration have to be as directed by Ofgem and the GT has to make tests of the gas conveyed within the charging area in accordance with directions issued by Ofgem.

A12.3 CALCULATION OF THERMAL ENERGY

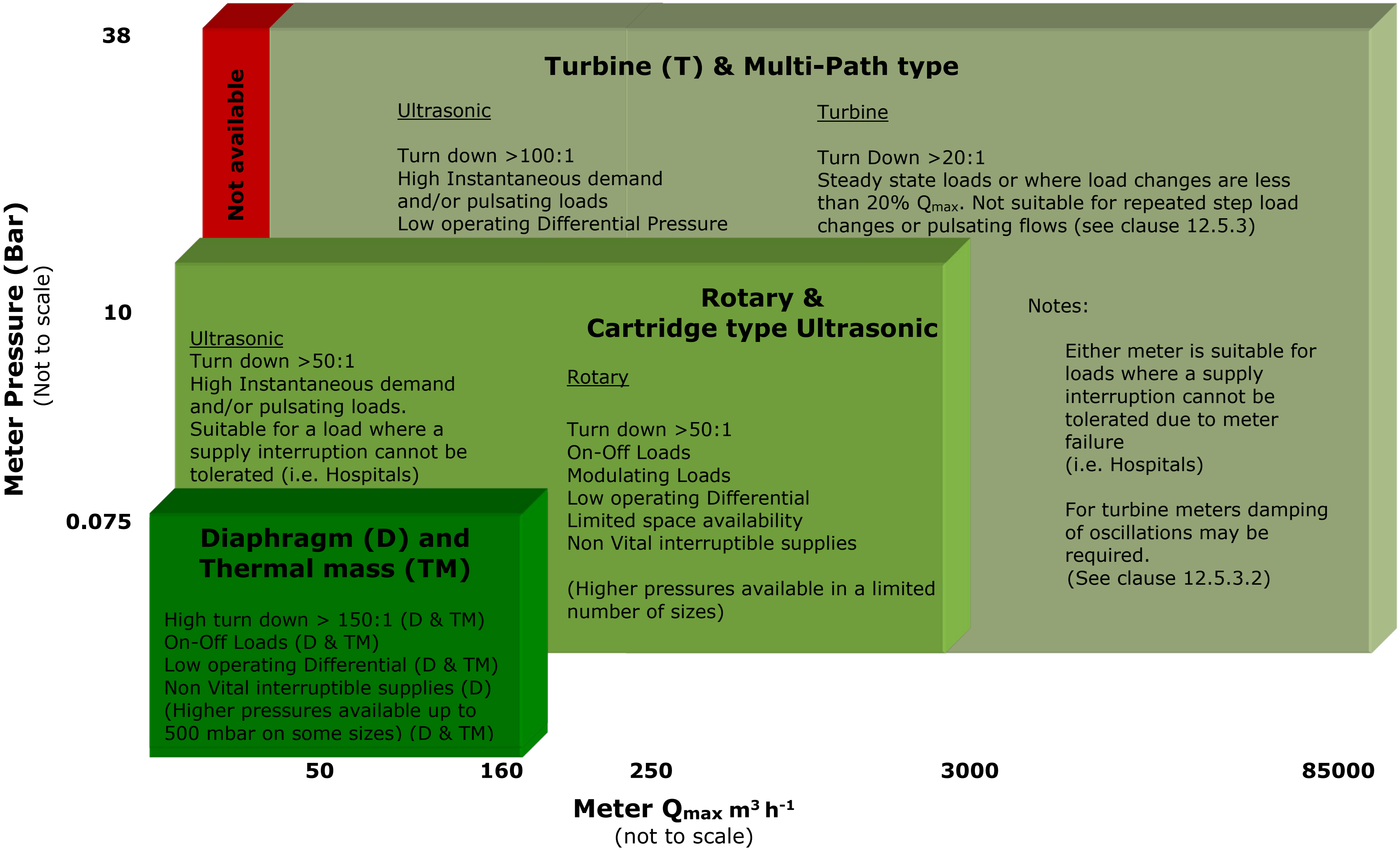
The average calorific value is calculated as a simple average of all the daily calorific values for the interval with the result being truncated at the first decimal place.



Note: The equation shown above is the, confirmed, correct interpretation of that shown in the Gas (Calculation of the Thermal Energy) Regulations, although its appearance is slightly different.

FIGURE 31 - INTERPRETATION OF THE GAS (CALCULATION OF THERMAL ENERGY) REGULATIONS

APPENDIX 13 : SELECTION OF METERS



Note: Where there is an overlap, the darker green denotes the preferred type of meter within the flow.

FIGURE 32 - GENERAL GUIDANCE ON THE SELECTION OF INDUSTRIAL AND COMMERCIAL METERS

BLANK PAGE