

**IGEM/GM/5 Edition 3
Communication 1730**

Electronic gas volume conversion systems

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Communication 1730**

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CONTENTS

SECTION		PAGE
1	Introduction	1
2	Scope	4
3	Legal and allied considerations	7
	• 3.1 General	7
	• 3.2 Health and Safety at Work etc. Act (HSWA)	9
	• 3.3 Management of Health and Safety at Work Regulations (MHSWR)	9
	• 3.4 Gas Safety (Installation and Use) Regulations (GS(I&U)R)	9
	• 3.5 Electricity at Work Regulations	9
	• 3.6 Provision and Use of Work Equipment Regulations (PUWER)	10
	• 3.7 Dangerous Substances and Explosive Atmospheres Regulations (DSEAR)	10
	• 3.8 Equipment and Protective Systems intended for use in potentially explosive atmospheres Regulations (EPS)	10
	• 3.9 Batteries and Accumulators (Placing on the Market) Regulations	10
4	Pre-installation tests	11
5	Design and Installation	14
	• 5.1 General	14
	• 5.2 Hazardous areas	14
	• 5.3 Positioning of the components	15
	• 5.3.1 Conversion device	15
	• 5.3.2 Pressure transducer	15
	• 5.3.3 Temperature sensor	15
	• 5.4 Connecting the components	16
	• 5.4.1 Earthing	16
	• 5.4.2 Outputs from conversion devices	16
	• 5.4.3 Gas connections	16
	• 5.4.4 Lightning protection	16
	• 5.5 Security of conversion systems	18
6	Commissioning	19
	• 6.1 General	19
	• 6.2 Test equipment	19
	• 6.3 Physical installation	20
	• 6.4 Pre-commissioning checks	20
	• 6.5 System performance checks	21
	• 6.5.1 General	21
	• 6.5.2 Volume input	21
	• 6.5.3 Temperature	21
	• 6.5.4 Pressure	22
	• 6.5.5 Computation	22
	• 6.6 Post commissioning system performance checks	23

7	Validation of a conversion system	24
• 7.1	Test equipment	24
• 7.2	Physical installation	24
• 7.3	System performance checks	24
• 7.4	Post validation	25
8	Monitoring, inspection and maintenance	26
• 8.1	Monitoring	26
• 8.2	Inspection	26
• 8.3	Maintenance	27
9	Records and reporting	28
• 9.1	General	28
• 9.2	Billing information	29

APPENDICES

1	Glossary, acronyms, abbreviations, units and symbols etc.	30
2	References	34
3	Measurement principles and factors to consider when performing a conversion system cost benefit analysis (CBA)	37
4	Conversion system monitoring (pressure-regulated installations)	57
5	Causes of LF output failures	66
6	Natural Gas composition and properties	67
7	Activity chart	70

FIGURES

1	Typical volume conversion system	6
2	Correct placement of temperature and pressure points for use with volume conversion systems	17
3	Typical three way valve (2 way instrument manifold with test port)	18
4	Conversion factor	38
5	Interpretation of The Gas (Calculation of Thermal Energy) Regulations	42
6	Typical seasonal effect of gas temperature on T_{factor}	43
7	T_{factor} variation	44
8	Altitude effect on meter pressure assuming 66 m is taken as the reference	46
9	Percentage differences of Z relative to Bacton terminal gas (operating conditions)	52
10	Compressibility effects (operating conditions)	52

11	Percentage error of conversion factor vs pressure if a fixed value of 1.0 is used for Z, rather than a calculated value	54
12	Percentage error of conversion factor vs pressure if a fixed value of 1.0 is used for Z, including MPEs	54
13	Compressibility expressed as a percentage error, when using 1.0 as Z_{factor} instead of the value as calculated by The Gas (Calculation of Thermal Energy) Regulations equation	56
14	Temperature conversion acceptance range (typical)	63
15	Standardisation of conversion factors	63
16	Historical Ft trend line with acceptance range	64
17	Ambient temperature with delays	65
18	Compressibility (Z) for "Mean Bacton Gas"	68
19	Compressibility Ratio (Z_b/Z) for "Mean Bacton Gas"	69

TABLES

1	Typical functions provided by conversion devices and flow computers	5
2	Examples of programming parameters	13
3	T_{factor} variation	44
4	Typical regulator performance with volume conversion	45
5	Altitude effects	46
6	Comparison of fixed factors where the gas temperatures are 12.2°C and 2°C, all other parameters being equal	48
7	Comparison of fixed factors where there is variation in metering pressure, all other parameters being equal	49
8	Comparison of three fixed factors where there is variation in metering pressure and all other parameters are equal	50
9	Percentage differences of Z relative to Bacton terminal gas (operating conditions)	51
10	Compressibility of Bacton terminal gas (operating conditions)	53
11	MPEs quoted in BS EN 12405	55
12	Typical Natural Gas Compositions (January 1998)	67
13	Compressibility (Z) for "Mean Bacton Gas"	68
14	Z_{factor} for "Mean Bacton Gas" where $Z_b = 0.997781$	69

SECTION 1 : INTRODUCTION

- 1.1 This Standard supersedes IGE/GM/5 Edition 2, Communication 1669, 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, and has been approved by IGEM's Technical Co-ordinating Committee on behalf of the Council of IGEM.
- 1.3 This Standard encompasses the selection, installation, commissioning, validation, subsequent monitoring and maintenance of gas volume conversion systems, installed with meters of maximum operating pressure (MOP) not exceeding 100 bar. It is important that this Standard is read in conjunction with IGEM/GM/7A and, where necessary, IGEM/GM/7B.
- 1.4 This Standard reflects good practice but does not confer immunity from relevant legal and statutory requirements, particularly those relating to the use of meters for the sale of gas. If the requirements are followed in full for a particular installation, the measurement accuracy of that installation will be both predictable and of a realistic commercial standard.
- 1.5 Why fit a gas volume conversion system?

When considering the installation of a gas volume conversion system, various factors need to be taken into account:

- legal requirements to meet statutory legislation
- contractual obligations
- commercial requirements to comply with the gas transporter's (GT's) Network Code
- if the meter is operating with variable pressure and/or temperature conditions that make the use of fixed or calculated conversion factors impractical, an assessment of benefit from the installation can be measured against the installation costs, such as:
 - reduced exposure to commercial risk
 - reduced uncertainty against fixed conversion factors
 - reduced billing uncertainty by more accurate measurement of gas consumed
- significant deviations at the meter site from average billing conditions.

- 1.6 As part of the commercial assessment for the installation of a gas volume conversion system, it is necessary to understand the effects that temperature, pressure and compressibility can have on overall accuracy of a metering system. More detailed guidance on these issues, together with worked examples, is given in Appendix 3.
- 1.7 It will also be necessary to consider the level of performance required from the conversion system, both at initial commissioning and during service.

All new conversion equipment has to meet the requirements of BS EN 12405 or equivalent. Equipment purchased to BS EN 12405 can then be supported by calibration certificates. BS EN 12405 is harmonised with the Measuring Instruments Directive (MID) which demands a maximum permissible error (MPE) when placing into use, under operating conditions, of $\pm 1\%$ and, at constant laboratory conditions, an accuracy of $\pm 0.5\%$. BS EN 12405 permits a deviation of 0.5% of the MPE at reference conditions during durability testing. Appendix 3 provides guidance on the use of BS EN 12405 in this respect.

- 1.8 MID represents a major change to European legislation on gas meters and volume conversion systems. Many European Community (EC) countries outside the United Kingdom (UK) and the Republic of Ireland regard a volume converter as a metrological device, and it is sealed accordingly. IGEN/GM/5 contains requirements that may require that seal to be broken. If IGEN/GM/5 is being used outside the UK or the Republic of Ireland, local advice has to be taken as to the significance of seals.

While there are legal requirements in the UK for the uncertainty performance of primary meter elements, there are no similar requirements for the conversion system, the combined meter and conversion system, or for in-service tolerance.

As an audit trail, for meters outside Section 17 of the Gas Act, a calibration certificate has to be held as part of the record system.

Following this Standard is likely to ensure that the conversion system remains within the requirements of BS EN 12405.

- 1.9 In the preparation of IGEN/GM/5 Edition 3, account has been taken of the improvements in electronics and transducer technology which is reflected in improved performance and stability of modern measurement systems.

The basic tenet of this Standard is that the measurement accuracy of modern conversion equipment can be as good as, or better than, calibration equipment used in far-from-ideal field conditions.

As a result, IGEN/GM/5 states that on-site re-calibration is not acceptable and that only performance validation checks are acceptable in the field. Where re-calibration is considered necessary, IGEN/GM/5 requires that the conversion system be removed from service and returned to the manufacturer or to an approved calibration facility where controlled calibration and test facilities exist.

- 1.10 This Standard applies to newly-installed gas volume conversion systems. For an existing system, the principles given for validation, maintenance etc. may be used where appropriate. However, activities such as in-situ adjustment may be necessary on older systems.

- 1.11 The de-regulation of the metering market has led to the need for new sets of rules and Standards. This has been addressed by the Ofgem Meter Asset Manager Code of Practice (MAMCoP), developed to cover whole life management of gas meter installations. The OFGAS CoPs 1/a, 1/b and 1/c which cover the installation of the meter only, will continue to apply. Businesses installing meter installations are required to be an Ofgem Approved Meter Installer (OAMI). There has also been a review and harmonisation of industry standards and CoPs to reflect the needs of the changing market.

Note: Under the new arrangements, an Ofgem-approved Meter Asset Manager (MAM) does not have to be an OAMI, but has an obligation to use an OAMI to install a meter.

- 1.12 This Standard makes use of the terms "should", "shall" and "must" when prescribing particular procedures. Notwithstanding Sub-Section 1.15:

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

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

- 1.13 The primary responsibility for compliance with legal duties rests with the employer. The fact that certain employees, for example "responsible engineers", are allowed to exercise their professional judgement does not allow employers to abrogate their primary responsibilities. Employers must:
- have done everything to ensure, so far as it is reasonably practicable, that "responsible engineers" have the skills, training, experience and personal qualities necessary for the proper exercise of professional judgment
 - have systems and procedures in place to ensure that the exercise of professional judgment by "responsible engineers" is subject to appropriate monitoring and review
 - not require "responsible engineers" to undertake tasks which would necessitate the exercise of professional judgment that is not within their competence. There should be written procedures defining the extent to which "responsible engineers" can exercise their professional judgment. When "responsible engineers" are asked to undertake tasks which deviate from this, they should refer the matter for higher review.
- 1.14 It is now widely accepted that the majority of accidents in industry generally are in some measure attributable to human as well as technical factors in the sense that actions by people initiated or contributed to the accidents, or people might have acted in a more appropriate manner to avert them.
- It is therefore necessary to give proper consideration to the management of these human factors and the control of risk. To assist in this, it is recommended that due regard be paid to HS(G)48.
- 1.15 Notwithstanding Sub-Section 1.12, this Standard does not attempt to make the use of any method or specification obligatory against the judgement of the responsible engineer. Where new and better techniques are developed and proved, they should be adopted without waiting for modification to this Standard. Amendments to this Standard will be issued when necessary, and their publication will be announced in the Journal of IGEM and other publications as appropriate.
- 1.16 Requests for interpretation of this Standard in relation to matters within its scope, but not precisely covered by the current text, should be addressed in writing to Technical Services, IGEM, Charnwood Wing, Ashby Road, Loughborough, Leicester, LE11 3GH and will be submitted to the relevant Committee for consideration and advice, but in the context that the final responsibility is that of the engineer concerned. If any advice is given by or on behalf of IGEM, this does not relieve the responsible engineer of any of his or her obligations.

SECTION 2 : SCOPE

Acronyms and abbreviations

HF	=	high frequency
LF	=	low frequency
MOP	=	maximum operating pressure
OP	=	operating pressure
PTZ	=	pressure, temperature, compressibility
SCADA	=	Supervisory Control and Data Acquisition

Symbols

P_m	=	pressure tapping
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- 2.1 This Standard covers electronic gas volume conversion systems. However, many principles may equally be applied to flow computers and procedures for flow computers are included where considered appropriate.

This Standard is not intended to be used in conjunction with high accuracy meter installations where, for example, flow computers are configured to receive live data of gas composition. Such installations are the subject of other standards, for example IGE/GM/8 and IGE/GM/4 and, as appropriate, national and international standards.

Note: Typical differences in functions of volume conversion devices and flow computers are given in Table 1.

- 2.2 This Standard covers installation (including appropriate pre-installation tests), commissioning, validation, monitoring and maintenance of systems that convert gas volume readings to base conditions by taking into account temperature, pressure and, if appropriate, compressibility of the gas. While conversion devices may be installed with meters of MOP up to 100 bar, in general they are not used at operating pressure (OP) exceeding 7 bar (when a flow computer is used).

Note 1: Normally, the conversion devices referred to in this Standard are battery powered, whereas flow computers are mains powered.

Note 2: A typical volume conversion system is shown in Figure 1.

- 2.3 The conversion devices covered by this Standard usually process low frequency (LF) pulsed signals from a LF transmitter within, or external to, a meter, together with other inputs to provide a digital display of converted volume.

Density correction is outside the capability of such conversion devices.

Note 1: Traditionally, meters have been supplied with pulse generation created by a magnet incorporated in the index mechanism and a magnetically-operated switch (usually, a reed switch). However, some more modern meters use optical sensing or electronic sensors of other forms. While many of these are compatible with the conversion devices available, care has to be taken to ensure that this compatibility is demonstrated and, where appropriate, correct polarity is observed when making electrical connections to these assemblies.

Note 2: IGE/GM/7A provides guidance on all electrical connections to gas meters.

Note 3: In general, flow computers process high frequency (HF) pulsed signals.

Note 4: Further details on flow computers are contained in IGE/GM/4.

- 2.4 The conversion systems covered by this Standard may be designed for installation in either indoor or outdoor environments. Conversion devices of suitable design may be installed in hazardous areas.

Note: In general, flow computers are not installed in hazardous areas.

- 2.5 A conversion device may, or may not, be an integral part of a meter but, in any event, it will provide converted readings in addition to the actual index provided on the meter.

- 2.6 This Standard, although not intended to form a specific site procedure, can, nevertheless, be used as the basis for such a procedure.
- 2.7 Normally, the installation of conversion systems will not involve consideration of IGE/SR/15 but, when installed as part of another control system, for example emergency shut-down of gas supply, IGE/SR/15 may need to be taken into account.
- 2.8 All pressures are gauge pressures unless otherwise stated.
- 2.9 Italicised text is informative and does not represent formal requirements.
- 2.10 Appendices are informative and do not represent formal requirements unless specifically referenced in the main sections via the prescriptive terms "should", "shall" or "must".

FUNCTION	CONVERSION DEVICE	FLOW COMPUTERS
Alarm outputs	✓	✓
Internal battery powered	✓	
External (usually 24 V DC) powered		✓
Communications (TIA 232F, TIA 485F, etc.)	✓	✓
Composition (see Sub-Section 2.1)	✓	✓
Database (logging)	✓	✓
Density input		✓
Display	✓	✓
Dual stream metering		✓
Energy calculation		✓
External power to transducers		✓
Flow input (analogue)		✓
Flow input (differential pressure)		✓
Flow input (digital)		✓
Flow input (pulse)	✓	✓
Front end to SCADA		✓
Local (keypad) input	✓	✓
Mains powered		✓
Meter A + B measurement comparison		✓
Meter correction curves		✓
Optical (BS EN 61107)	✓	
Pressure input (analogue)		✓
Pressure (dual input and cross compare)	Possible	✓
Pressure input (solid state)	✓	✓
Printer output		✓
Proving		✓
PTZ conversion	✓	✓
Pulse output (repeat)	✓	✓
Safe area location with barriers – connections in hazardous areas	Possible	✓
Smart transducers		✓
Solar powered		✓
Status inputs		✓
Suitability for installation in hazardous areas	✓	Rarely
Temperature input (analogue)		✓
Temperature (dual input and cross compare)	Possible	✓
Temperature input (PRT 100 or 1000)	✓	✓
Totalising	✓	✓
User security	✓	✓

✓ = Yes

TABLE 1 - TYPICAL FUNCTIONS PROVIDED BY CONVERSION DEVICES AND FLOW COMPUTERS

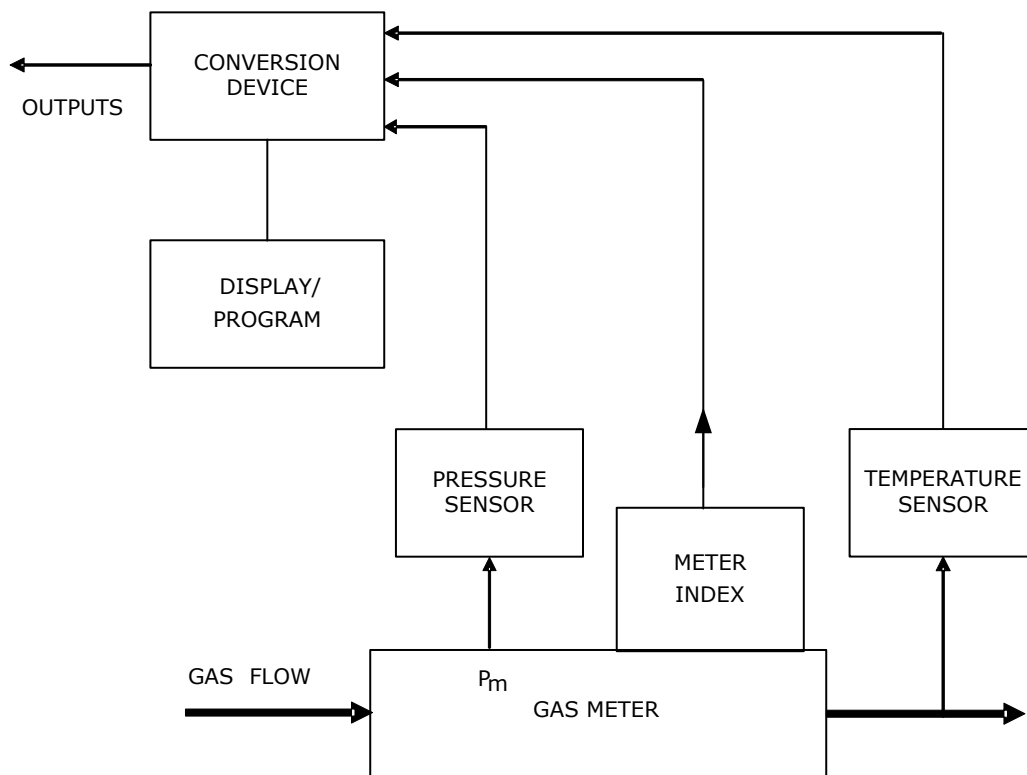


FIGURE 1 - TYPICAL VOLUME CONVERSION SYSTEM

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SECTION 3 : LEGAL AND ALLIED CONSIDERATIONS

Acronyms and abbreviations

ACoP	=	Approved Code of Practice
ACS	=	National Accreditation Scheme
CORGI	=	CORGI
DSEAR	=	Dangerous Substances and Explosive Atmospheres Regulations
EMC	=	Electromagnetic Compatibility Regulations
EPS	=	Equipment and Protective Systems intended for use in potentially explosive atmospheres Regulations
GB	=	Great Britain
GS(I&U)R	=	Gas Safety (Installation and Use) Regulations
HMSO	=	Her Majesty's Stationery Office
HSE	=	Health and Safety Executive
HSWA	=	Health and Safety at Work etc. Act
MAMCoP	=	Meter Asset Manager Code of Practice
MHSWR	=	Management of Health and Safety at Work Regulations
MID	=	Measuring Instruments Directive
Ofgem	=	Office of Gas and Electricity Markets
PUWER	=	Provision and Use of Work Equipment Regulations
UK	=	United Kingdom
UKAS	=	United Kingdom Accreditation Service

Units

$\text{m}^3 \text{h}^{-1}$ = cubic metres per hour

Symbols

$\leq$ = less than or equal to

3.1 GENERAL

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

All relevant legislation must be applied and relevant ACoPs, official Guidance Notes and referenced codes, 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.

Note: Increasingly, GB gas legislation is being adopted in such as Northern Ireland. Although any differences may be few, the relevant equivalent legislation outside GB will need to be consulted for use outside GB.

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 and Use) Regulations (GS(I&U)R) (see Sub-Section 3.4) must be achieved where those Regulations apply.

Note: Further information on competency is given in IGEM/GM/7A.

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 CORGI. Therefore, all businesses or self-employed gas operatives working on meter installations must be registered with CORGI 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 National Accreditation Scheme (ACS) for individual gas fitting operatives.

Persons who work on volume conversion systems should attain the level of competency as required by IGEN/GM/7A.

3.1.3 Any meter installation shall be designed, installed, commissioned and maintained in accordance with the Ofgem MAMCoP.

3.1.4 Any meter of capacity $\leq 1600 \text{ m}^3 \text{ h}^{-1}$ used to render a charge must be approved and stamped, as required by the Gas Act.

Any meter seal applied by, or under the supervision of, a Meter Examiner shall not be interfered with or removed, for example to facilitate the installation of any additional equipment, except in the presence of a Meter Examiner and with the agreement of the meter owner and other contractually interested parties.

Note 1: A Meter Examiner will have to witness and approve the work being carried out before resealing the meter upon completion of the work.

Note 2: MID and associated UK legislation has requirements that differ, in that the manufacturer or a notified body may "seal" the meter. Such seals require the same treatment as Meter Examiner seals.

3.1.5 Any electrical circuit shall meet the requirements laid down for the defined hazardous area. Reference should be made to IGEN/GM/7B which provides a method of assessing the presence of a hazardous area.

As a minimum, and even for non-hazardous areas, any electrical circuit connected to a gas meter shall be suitable for use in at least a Zone 2 hazardous area.

3.1.6 Equipment shall comply with the Electromagnetic Compatibility Regulations (EMC) for both emissions and immunity.

3.1.7 In order to minimise the possibility of generating spurious signals, equipment used should be tested to BS EN 61000-4-6 for emissions and to BS EN 61000-6-3 for immunity.

3.1.8 So that the meter owner/gas supplier and other contractually-interested parties can be assured of the acceptability of any electrical system to be connected, manufacturers and/or suppliers of such equipment shall support their claims of suitability. This may take the form of a certificate and/or evaluation report from a recognised authority (which could include the manufacturer). Such a certificate and/or report shall relate to the electrical system to be connected and indicate its suitability to provide safe operation and meet the requirements of this Standard.

Certification should form part of an explosion protection document that conforms with the ATEX Directive.

3.1.9 Prior written authorisation from the owner of a meter and any equipment already connected to the meter shall be obtained before connecting any electrical/electronic equipment or system to the meter or equipment (see IGEN/GM/7A).

Note 1: In addition, any other interested party (such as the shipper or meter reading organisation) in any contractual chain may need to be notified in writing.

Note 2: Similar authorisation/notification will be required before making any connection to the outputs from any conversion device, flow computer or automatic meter reading installation and before any modifications are made to the installation.

3.1.10 The owner of any electrical equipment installed on, or connected to, a gas meter shall be responsible for the safe and efficient operation of the equipment.

- 3.1.11 Before commencing work on a meter installation, the authority(ies) responsible for the site/installation should be notified and given details of the activities to be undertaken. Enquiries should also be made regarding any particular safety or operational requirements that may be in force on the site.

On completion of the work, the authority(ies) responsible should be notified. The site should be left in a tidy condition and any keys should be returned as appropriate.

- 3.1.12 The connection of any electrical circuit or device shall not unduly impede access to any part of a meter installation, nor render it difficult to read a meter index or any statutory label.

Note: The Gas Act requires that the meter owner be allowed access to the meter at all times to ensure the safety and integrity of the installation.

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

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

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

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.

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

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

- 3.4.2 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. CORGI registered.

- 3.4.3 The installer must 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 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 must inform both the landlord/hirer, as well as the user, so that such faults can be rectified before further use.

3.5 **ELECTRICITY AT WORK REGULATIONS**

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

They are concerned with the prevention of danger from electric shock, electric burn, electrical explosion or arcing, or from fire or explosion initiated by electrical energy.

They impose duties on every employer, employee and self-employed person and require that persons engaged in electrical work be competent or be supervised by competent persons.

Note: A "Memorandum of Guidance on the Electricity at Work Regulations, 1989" is available from Her Majesty's Stationary Office (HMSO) and gives useful information on the Regulations. Further advice is contained in HS(R)25.

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

3.6.1 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.

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

3.6.3 More information on the Regulations can be found in HS(L)22. Free leaflets include INDG 291 and INDG 229.

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:

- HS(L)138
- HS(L)137
- HS(L)136
- HS(L)135
- HS(L)134
- INDG 370.

3.8 **EQUIPMENT AND PROTECTIVE SYSTEMS INTENDED FOR USE IN POTENTIALLY EXPLOSIVE ATMOSPHERES REGULATIONS (EPS)**

These Regulations apply for any equipment to be installed in a potentially explosive atmosphere.

3.9 **BATTERIES AND ACCUMULATORS (PLACING ON THE MARKET) REGULATIONS**

These Regulations apply for any equipment that is battery powered.

SECTION 4 : PRE-INSTALLATION TESTS

Acronyms and abbreviations

HF	=	high frequency
LF	=	low frequency
MAM	=	meter asset manager
MPRN	=	meter point reference number
OP	=	operating pressure
RD	=	relative density
SG	=	specific gravity
UK	=	United Kingdom

Units

bar abs	=	bar absolute
Hz	=	hertz
mbar	=	millibar
ms	=	milliseconds
°C	=	degrees Celsius
°K	=	degrees Kelvin

Symbols

CO ₂	=	carbon dioxide
N ₂	=	nitrogen
P _b	=	base pressure
T _b	=	base temperature
V _m	=	operating (unconverted) volume
V _b	=	base (converted) volume
Z	=	operating compressibility
Z _b	=	base compressibility
Z _{factor}	=	compressibility factor Z/Z _b

- 4.1 Pre-installation testing is optional but, if undertaken, should be carried out in a safe area i.e. not in a hazardous area, and just before installing the system on site. Its purpose is to ensure that all component parts of a conversion system are compatible and that they function correctly under simulated conditions.

Such testing may be necessary if, for example, the system has not been pre-programmed. If the testing is carried out after programming, any changes to the programme should be recorded.

Note 1: Normally, all new and refurbished conversion systems will have been calibrated fully in ideal conditions at the manufacturer's/refurbisher's premises and there is no requirement to undertake further pre-installation calibration at the consumer's premises.

Note 2: Prior to dispatch to site, the conversion system needs to be removed carefully from its packing. All the component parts, i.e. temperature sensor, pressure transducer etc., need to be checked for compatibility, conformity with the manufacturer's stated data, the programmed parameters, purchaser's instructions and for any signs of physical damage.

- 4.2 The following procedure should be used for a pre-installation test:

- assemble the conversion system, including the power source
- check the pre-programmed data and add as required
- within the pre-programmed data, set the value of Z_{factor} to 1.0 if OP is less than or equal to 500 mbar

Note: Attention is drawn to calculating the site-specific fixed factor for the installation as required by the Gas (Calculation of Thermal Energy) Regulations. Under these regulations, the compressibility factor is unity when calculating the site-specific fixed factor for OP ≤ 2 bar.

See Appendix 3 for further information.

- connect an LF transmitter simulator in place of the meter connection, capable of operating in the range 0.1 Hz to 10 Hz and of accurately producing a pre-determined number of contact closures

Note 1: Normally, the manufacturer's instructions give information on the type, frequency input and specified cable lengths for the particular converter.

Note 2: Flow computers may have HF inputs.

Note 3: See also Note 1 to Sub-Section 2.3.

- check that all the display functions are operating and, if applicable, that the manufacturer's prescribed start-up sequence can be carried out

- use the LF transmitter simulator to check that a series of contact closures results in the displays incrementing accordingly
- using a suitable absolute pressure test instrument, supply and maintain a test pressure that approximates to OP

Note: This pressure may be applied either using the internal pump on the test instrument or an external non-combustible gas source.

- with the test pressure applied, check the operation of the conversion system to confirm that the response of the pressure transducer is acceptable
- with the temperature sensor stabilised at ambient temperature, check the operation of the conversion system to ensure that the measurement of temperature is acceptable. Make a further check that the conversion system responds to a change in temperature.

On completion of the pre-installation tests, the conversion system displays may be returned to zero indication. Any alarm should be re-set and the power source disconnected.

The conversion system should be replaced in the original packing (if it is not to be installed immediately) ensuring that all the component parts remain together.

4.3

It may be possible to programme the conversion system with a number of parameters by the use of an external computer. This may be done before or after installation. If it is necessary to programme a conversion system in a hazardous area, the programming computer shall have appropriate certification for use in that hazardous area. Otherwise, the computer shall be placed in a safe area and connected to the conversion system via an appropriate protective device (see Section 5).

Note 1: Even when programming a conversion system in a safe area, it may be a requirement of the system's hazardous area certification that any programming computer be connected through a protective device. Refer to the manufacturer's instructions.

Note 2: It may be permissible to temporarily re-classify the area as a safe area, if suitable procedures are followed. It would be usual for such temporary re-classification to revert to the normal classification for the area no later than the operator leaving site.

4.4

Consideration shall be given to the parameters required by the conversion device/flow computer and advice sought from the manufacturer, as necessary. Table 2 provides typical examples of parameters that may be required to program conversion system. The notes refer to additional or differing advice for flow computers.

The data entered should be within the range defined by BS EN 12405, and be representative of site conditions.

PARAMETER	COMMENT
Date and time	
Units of measurement	°C and bar abs.
Compressibility equation	SGERG, AGA 8 etc.
Gas constituents and properties	If relevant and, typically, N ₂ , CO ₂ , RD(SG). ¹
Pressure and temperature ranges for transducers	Confirm transducers and software parameters match correctly.
Base conditions	Temperature (T _b): 15°C (288.15°K). ⁵ Pressure (P _b): 1013.25 mbar abs. ⁵
Gas meter pulse significance	LF value to correspond to the meter data plate. ²
Pulse width and pulse output significance	Approximately 250 ms. Chosen width to allow for a maximum frequency of 1Hz. Converted and unconverted output scaling factors to be notified to appropriate parties in the contractual chain e.g. billing personnel.
Front panel button function	Used to access the following information□: • unconverted volume (V_m) • gas temperature and absolute pressure • conversion factor • converted volume (V_b) • alarm conditions • data affecting metrological results.
Logging functions	e.g. peak flows.
Alarm functions	e.g. low battery, overpressure.
Communications port	e.g. baud rate.
Unconverted display versus meter index	Set the unconverted index reading to be the same as the meter index display.
On-site data information	e.g. date of installation, Meter point reference number (MPRN), MAM and installer's name, etc.

Note 1: For a flow computer, possibly full gas composition.

Note 2: For a flow computer, use HF value.

Note 3: For a flow computer, add meter error curve and correction factor.

Note 4: The table is not an exhaustive list but is provided to give examples of program parameters.

Note 5: These conditions are as used in the UK and may differ in other countries.

TABLE 2 - EXAMPLES OF PROGRAMMING PARAMETERS

SECTION 5 : DESIGN AND INSTALLATION

Acronyms and abbreviations

HF	=	high frequency
IP	=	ingress protection
LF	=	low frequency

Units

m	=	metres
mm	=	millimetres
°	=	angular degrees

Symbols

D	=	pipe internal diameter
P _m	=	pressure tapping

This section sets requirements for the physical installation of a conversion system. Guidance on the installation of metering systems is given in IGE/GM/4, IGE/GM/6 or IGE/GM/8, as appropriate. Reference to those Standards is recommended.

For the purpose of this Standard, a gas meter installation includes:

- a gas meter with an LF transmitter (or HF transmitter for flow computers) and
- a volume conversion system in which the conversion device complies with BS EN 12405.

5.1 GENERAL

5.1.1 The manufacturer's installation instructions shall take precedence over the following general requirements for the design and installation of conversion systems.

5.1.2 Design and installation of volume conversion systems shall be in accordance with this section and the appropriate requirements of IGE/GM/7A.

5.2 HAZARDOUS AREAS

5.2.1 An assessment of both the hazardous area surrounding the gas meter installation and the conversion system location shall be carried out in accordance with IGE/GM/7B.

5.2.2 When considering the location of electrical equipment for conversion systems, the choice should be made taking account of protection methods and zones (see IGE/GM/7A and 7B), manufacturer's instructions and practicality.

Note: Many flow computers are mains-powered and, therefore, are not suitable for physically installing in a hazardous area. However, they may have inputs that are [Exia] or [Exib] hence making them suitable for connection to a gas meter in a hazardous area.

5.2.3 All equipment shall be located in accordance with IGE/GM/7A.

5.2.4 Before fitting a battery in a hazardous area, the manufacturer's instructions should be consulted to determine whether it can be undertaken with the equipment remaining in the hazardous area throughout the process.

Note 1: A risk exists that, where a battery requires replacement, such action may result in an incendive spark. This possibility will need to be taken into consideration before equipment is installed. It may be considered preferable to only use equipment for which battery changes in a hazardous area have been designed and approved. This would avoid the increased maintenance costs involved in moving equipment to a safe area before changing the battery.

Note 2: See also Note 2 to Sub-Section 4.4.

Note 3: For the disposal of batteries, attention is drawn to the Batteries and Accumulators (Placing on the Market) Regulations.

5.3 POSITIONING OF THE COMPONENTS

5.3.1 Conversion device

5.3.1.1 The device should be positioned so that the display is easy to read and there is sufficient access for maintenance, verification, adjustment and battery replacement.

5.3.1.2 Depending on the manufacturer's recommendations and the Ingress Protection (IP) rating, the device may be mounted indoors or outdoors with full or partial environmental protection. If mounted outdoors, protection should be provided from direct sun and from rain and inclement weather during maintenance.

Note: Further information on IP ratings is available in BS EN 60529.

5.3.1.3 Consideration should be given to the position of the device in relation to the pressure transducer and temperature sensor with respect to access to the field connections and the main plant pipework.

5.3.1.4 The device should not be mounted in an area having large variations in ambient conditions, for example near a source of heat or moisture.

5.3.1.5 The device should be so mounted or otherwise protected to guard against accidental damage, vandalism or any significant source of electromagnetic interference.

5.3.2 Pressure transducer

Depending on the design, the pressure transducer may be mounted external to, or be an integral part of, the conversion device.

For an externally-mounted pressure transducer, the cable configuration may be specified by the manufacturer. In addition to those constraints, the pressure transducer should be mounted securely on or near the pressure tapping (P_m) and protected in a similar way to the conversion device.

Note: The variations in ambient temperature of the pressure transducer may be a significant source of error. Any effort to reduce the extremes of ambient temperature fluctuation in the region of the pressure transducer will be beneficial.

5.3.3 **Temperature sensor** (see also IGE/GM/4, IGE/GM/6 or IGE/GM/8, as appropriate)

5.3.3.1 The temperature sensor is external to the electronics, except on conversion systems that are integral to the gas meter. The temperature sensor should be mounted in a thermowell, so that it may be removed for checking without affecting the gas flow. The thermowell should be partly filled with a heat-conducting liquid of freezing point below -20°C .

Note: Normally, the sensor is a platinum resistance thermometer, although other types are in use.

5.3.3.2 The thermowell and associated temperature sensor should be positioned in the gas pipe such that the gas temperature measured is representative of that at the gas meter. The position of the temperature sensor should be as specified in IGE/GM/4, IGE/GM/6 or IGE/GM/8, as appropriate. However, in the absence of such specification, and in general, the position should be as near as practicable to that shown in Figure 2.

Note: A second thermowell may be fitted radially adjacent to, i.e. not in line with, the temperature sensor. This is used with a thermometer to measure the operating gas temperature during validation or maintenance of the conversion system.

- 5.3.3.3 The temperature sensor should be protected in a similar manner to the conversion device (see clause 5.3.1).

5.4 CONNECTING THE COMPONENTS

Electrical connections shall be in accordance with IGE/GM/7A.

5.4.1 Earthing

Earthing shall be provided in accordance with IGE/GM/7A.

5.4.2 Outputs from conversion devices

Most conversion devices have electrical outputs suitable for telemetry etc. The basic outputs are in discrete pulses where a pulse represents a scaled incrementation. Usually, there are two separate outputs, one representing the converted volume and the other unconverted volume.

Some conversion devices may have other outputs available, representing operating pressure, temperature, conversion factor etc. In general, these are in a form suitable for connection to a personal computer, hand held terminal, modem etc. via a TIA 232F or TIA 485A or other suitable communications data link.

For a conversion device certified for use in hazardous areas, care should be taken when using the outputs to prevent any electrical energy being fed back into the device which could compromise the electrical safety. Reference should be made to the manufacturer's instructions and system certificates if applicable.

5.4.3 Gas connections

- 5.4.3.1 Where a P_m tapping is provided, it shall be used for the conversion system pressure connection.

- 5.4.3.2 If a P_m tapping is not available, a pressure tapping should be provided as close to the gas meter as possible but away from any pressure pulsations. It shall be representative of the line pressure and not affected by filters, strainers, bends, etc. and shall be fitted upstream of the meter.

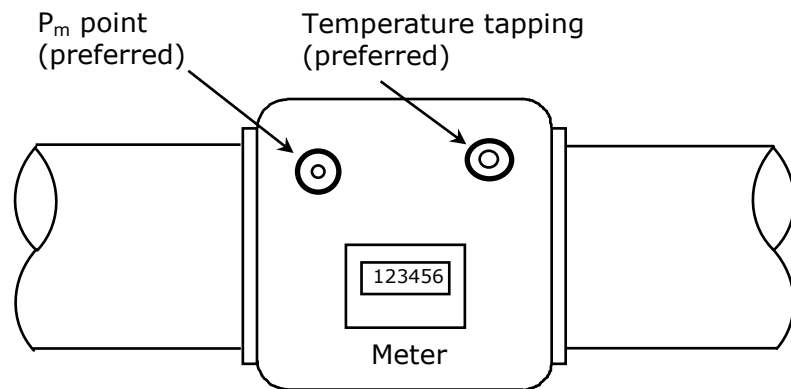
- 5.4.3.3 The impulse pipework between the pressure tapping and the pressure transducer should be designed in accordance with IGE/GM/4, IGE/GM/6 or IGE/GM/8, as appropriate and purged and tested in accordance with IGE/UP/1, 1A or 1B, as appropriate.

Note: It is important to ensure that this is not in any way associated with the regulator impulse pipework and that no liquid can accumulate (as this could affect the accuracy).

- 5.4.3.4 Valves should be fitted between the gas pipe and the pressure transducer to allow isolation and venting of the transducer, to facilitate the removal or checking of the pressure transducer and to provide a test point for measuring the pressure in the gas pipe. A typical arrangement, using a three-way valve (or two-way instrument manifold with test port) is shown in Figure 3.

5.4.4 Lightning protection

Lightning protection shall be provided in accordance with IGE/GM/7A.



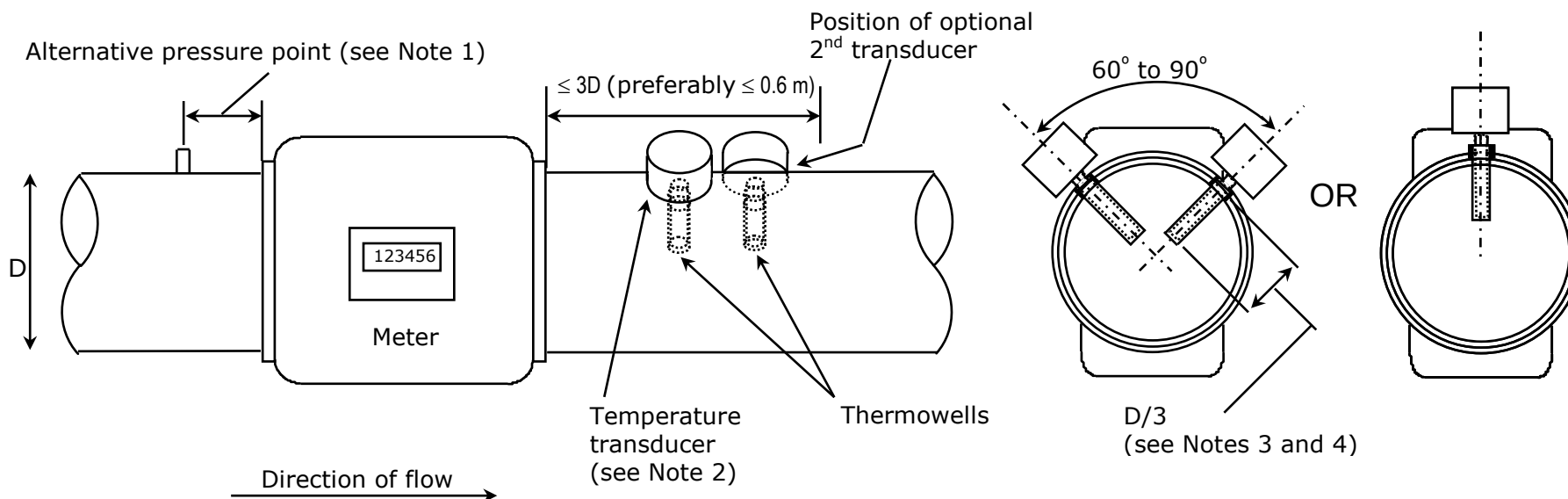
Note 1: If a meter does not have a P_m point, a suitable position is as close as possible to and upstream of the meter, but away from pressure pulsations and in consideration of welding requirements of IGE/GM/8 (see clause 5.4.3).

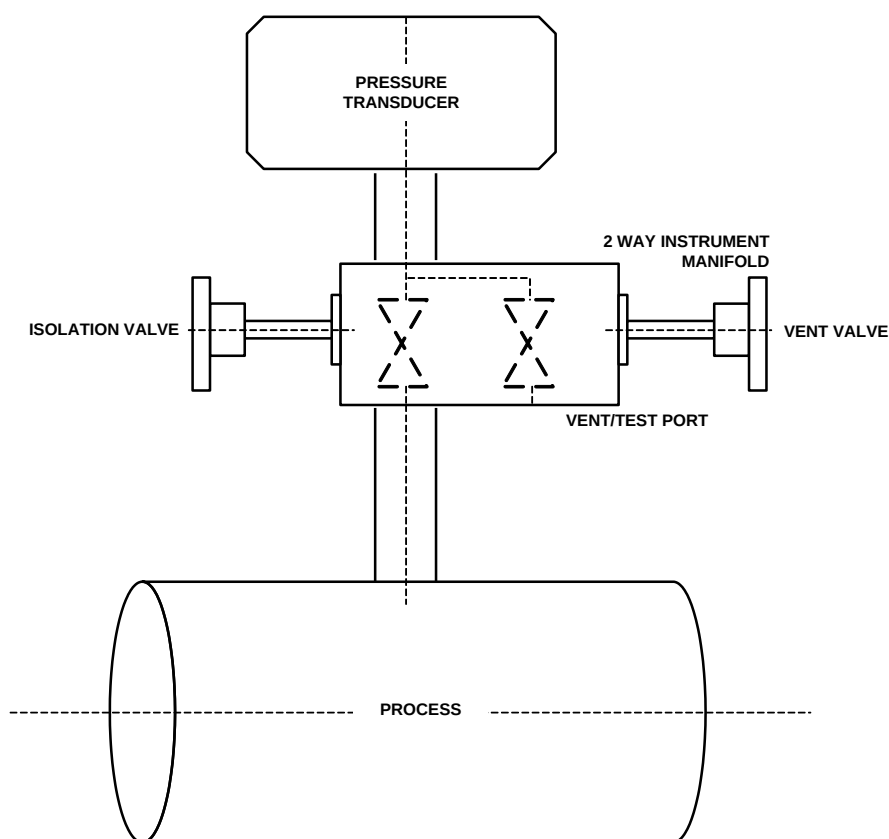
Note 2: On larger diameter pipe, it may not be possible to fit the temperature sensor(s) within 0.6 m of the outlet flange of the meter. However, the limit of $3D$ always applies.

Note 3: Where the thermowell insertion depth exceeds $D/3$ or 100 mm, resonant oscillations of the thermowell are considered a possibility. In such cases, the insertion depth can be reduced, but not to less than 75 mm.

Note 4: Where thermowells are to be installed in pipework, it is preferable to have two thermowells mounted as shown; one for use by the installation's permanent transducer and the second for use by a temporary checking transducer. The use of two permanent temperature transducers is usually restricted to more complex flow computer systems. If there is a good reason to have only one thermowell/transducer, it may be mounted vertically as shown.

FIGURE 2 - CORRECT PLACEMENT OF TEMPERATURE AND PRESSURE POINTS FOR USE WITH VOLUME CONVERSION SYSTEMS





Note: To prevent accidental connection of the pressure transmitter to the vent test point on the manifold, it is recommended that the pressure transducer and test/vent connections are not on the same face of the manifold.

FIGURE 3 - TYPICAL THREE WAY VALVE (2 WAY INSTRUMENT MANIFOLD WITH TEST PORT)

5.5 SECURITY OF CONVERSION SYSTEMS

- 5.5.1 Conversion systems are susceptible to vandalism and unauthorised interference. Unauthorised access to a conversion device/flow computer and their programmable parameters shall be prevented at all times, for example by using a seal.

Note: Access needs to be allowed to data intended to be viewed by the consumer.

- 5.5.2 A seal shall be used to prevent unauthorised access to or tampering with any element of a conversion system, which, if interfered with, could result in inaccurate registration.

Where such interference could affect safety, appropriate security measures shall be taken.

Note: This includes the LF transmitter, pressure and temperature sensors, and valves.