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भारतीय मानक मसौदा

विधि माप विज्ञान — गैस आयतनमापी
भाग 2 — डायाफ्राम गैस मापक

(IS 14439-*भाग 2 का पहला पुनरीक्षण*)

Draft Indian Standard

Legal Metrology — Gas Volume Meters
Part 2 — Diaphragm Gas Meters

(*First Revision of* IS 14439-Part 2)

ICS 91.140.40

Weights and Measures Sectional Committee, PGD 26	Last date for Comment: As mentioned on the cover letter

FOREWORD

This Indian Standard (Part 2) (First Revision) will be adopted by the Bureau of Indian Standards on the recommendation of the Weights and Measures Sectional Committee and approval of the Production and General Engineering Division Council.

This standard was first published in 1998. This revision has been brought out to align the standard with the latest technological developments and international practices.

The major changes in this revision are as follows:

a) Metrological requirements have been updated as per latest version of OIML R137 Part 1 & 2;
b) New test methods have been incorporated to improve the performance of the meter; and
c) Provision for optional features and additional functional devices have been added.

This standard is published in two parts. Other part in this series is

Part 1 General requirements

In the formulation of this standard, considerable assistance has been taken from the following standards:

a) EN 1359 Gas meters — Diaphragm gas meters
b) EN 16314 Gas meters — Additional Functionalities
c) OIML R137 (Part 1 & 2)

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance

with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*).’ The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

CONTENTS

Page No.

Draft Indian Standard

LEGAL METROLOGY — GAS VOLUME METERS
PART 2 — DIAPHRAGM GAS METERS

(*First Revision*)

1 SCOPE

1.1 This Indian standard specifies the requirements and tests for the construction, performance, safety and production of diaphragm gas volume meters (referred to as meters) of Class 1 and Class 1.5. This applies to meters with co-axial single pipe, or two pipe connections, that are used to measure volumes of fuel gases, which are within the limits of test gases of the 1st, 2nd and 3rd families described in IS 15127. The meters have maximum working pressures not exceeding 0.5 bar and maximum actual flow rates not exceeding 160 m^3/h over an ambient temperature range of -10°C to 55°C and a gas temperature range as either -5°C to 40°C, or as specified by the manufacturer above this, however, within ambient temperature range.

1.2 This standard applies to meters with and without built-in temperature or pressure conversion that are installed in locations with vibration and shocks of low significance. It also applies to meters installed in closed locations (indoor or outdoor with protection as specified by the manufacturer) both with condensing humidity, and with non-condensing humidity. Or, if specified by the manufacturer installed in open locations (outdoor without any covering) both with condensing humidity and with non-condensing humidity and locations with electromagnetic disturbances corresponding to those likely to be found in residential, commercial and light industrial buildings.

1.3 This Standard also specifies the additional functionality requirements and tests for gas meters, which have battery powered devices providing additional functionalities that form part of the gas meter or contained in an Additional Functionality Device (AFD). It also covers the additional requirements when an electronic index is used rather than a mechanical one. This standard only covers meters having gas valves within the meter case.

1.4 This standard does not apply to meters used for gases in the liquefied state, multi-phase, steam and compressed natural gas (CNG) used in CNG dispensers.

1.5 Unless otherwise stated in a particular test, the tests are carried out on meters that include additional functionality devices intended by the manufacturer.

1.6 If no specific requirements are given for test equipment, the instruments used should be traceable to a national or international reference standard and the expanded uncertainty should be better than 1/5 of the maximum value of the parameter to be tested. For differential results the repeatability (2σ) and resolution should be better than 1/5 of the maximum value of the parameter to be tested.

NOTE — Unless otherwise stated, all pressures given in this document are gauge pressure; 1 bar = 10^5 Pa.

2 NORMATIVE REFERENCES

The standards listed in Annex A contain provisions, which through reference in this text, constitute provisions to this standard. At the time of publication, the editions indicated were valid. All standards are

subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed in Annex A.

3 TERMINOLOGY

3.1 Terms and Definitions

For the purposes of this standard, the following terms and definitions shall apply.

3.1.1 *Air* — Air of density as mentioned in **5.6.2.1 (c)**

3.1.2 *Gas Volume Meter* — Instrument designed to measure, memorize and display the quantity of gas volume that has passed it.

3.1.3 *Diaphragm Gas Meter* — Gas volume meter in which the gas volume is measured by means of measuring chambers with deformable walls.

3.1.4 *Actual Flow Rate* — Flow rate at the meter inlet, at the gas pressure and gas temperature conditions prevailing in the gas distribution line in which the meter is fitted.

3.1.5 *Working Pressure* — Difference between the pressure of the gas at the inlet of the meter and the atmospheric pressure.

3.1.6 *Maximum Working Pressure* — Upper limit of the working pressure for which the meter has been designed, as declared by the manufacturer and marked on the meter data plate.

3.1.7 *Pressure Drop* — Difference between the pressures measured at the inlet and outlet connections of the meter whilst the meter is operating.

3.1.8 *External Leak Tightness* — Leak tightness of the gas carrying components of the gas meter with respect to the atmosphere.

3.1.9 *Error of Indication, E* — Value that shows the relationship in percentage terms of the difference between the volume indicated by the meter and the volume that has actually passed through the meter (reference volume corrected to temperature and pressure at the inlet of the meter under test), to the latter volume.

Error of indication, as a percentage, is calculated using the Formula (1):

$$E = \frac{100\ (V_{\mathrm{i}} - V_{\mathrm{c}})}{V_{\mathrm{c}}} \qquad (1)$$

where

V_{i} Indicated volume;
V_{c} Volume which has actually passed through the meter.

3.1.10 *Normal Condition of Use*

Condition referring to the meter operating:

a) At a pressure up to the maximum working pressure (with or without a flow of gas);
b) Within the range of flow rates;
c) Within the ambient and gas temperature range; and
d) With the distributed gas.

3.1.11 *Base Condition* — Fixed condition (temperature 15°C and pressure 1.01325 bar) to which a volume of gas is converted.

3.1.12 *Cyclic Volume* — Volume of gas corresponding to the working cycle of the gas meter. This means that all the moving components, except for the indicating device and the intermediate transmissions, resume for the first time the position they occupied at the beginning of the cycle.

3.1.13 *Distributed Gas* — all families of gases which these meters used for as in **5.6.2.2(b)**.

3.1.14 *Metering Conditions* — condition of the gas at the point of measurement.

Example:

Temperature and pressure of the measured gas

3.1.15 *Temperature Conversion Device* — Device which converts the volume measured to a corresponding volume at the base gas temperature.

The volume at base gas temperature, V_b in cubic metres (m^3) is given by the equation (2):

$$V_b = \frac{T_b}{T} \times V \qquad (2)$$

where

V Volume at metering conditions, in cubic metres (m^3);
T Gas temperature at metering conditions, in Kelvin (K);
T_b Base gas temperature, in Kelvin (K).

3.1.16 *Pressure - Temperature Conversion Device* — Device which converts the volume measured to a corresponding volume at the base gas pressure and/or temperature.

The volume at base gas pressure and temperature, V_b in cubic metres (m^3) is given by the equation (3):

$$V_b = \frac{T_b}{T} \times \frac{P}{P_b} \times V \qquad (3)$$

where

V Volume at metering conditions, in cubic metres (m^3);
P and T Gas pressure in absolute mbar and temperature in Kelvin (K) at metering conditions respectively;
P_b and T_b Base gas absolute pressure in mbar and temperature, in Kelvin (K) respectively.

3.1.17 *Meter Error Curve* — Plot of average error of indication against actual flow rate.

3.1.18 *Accuracy Class* — Class of measuring instruments or measuring systems that meet stated metrological requirements that are intended to keep measurement errors or instrumental uncertainties within specified limits under specified operating conditions.

For the purpose of this standard, gas meters may be divided in two accuracy Classes 1 and 1.5. A gas meter shall be classified according its accuracy in one of these classes. The value of the MPE is dependent on the applicable accuracy class as listed in Table 3a and Table 3b.

3.1.19 *Maximum Permissible Error (MPE)* — Extreme value of measurement error, with respect to a known reference quantity value, permitted by specifications or regulations for a given measurement, measuring instrument, or measuring system.

3.1.20 *MPE-Initial* — Maximum permissible error for a Class 1 and Class 1.5 diaphragm gas meter before testing in accordance with this standard.

3.1.21 *MPE-Subsequent* — Maximum permissible error for a Class 1 & 1.5 diaphragm gas meter following the completion of specific individual tests within this standard.

3.1.22 *Weighted Mean Error (WME)* — The weighted mean error (WME) within the scope of this standard is as defined in **7.2.2**.

3.1.23 *Ancillary Device* — Device intended to perform a particular function, directly involved in elaborating, transmitting or displaying measurement results.

The main ancillary devices are (for example):

a) Repeating indicating device;
b) Printing device;
c) Memory device; and
d) Communication device.

NOTES
1. An ancillary device is not necessarily subject to metrological control.
2. An ancillary device may be integrated in the gas meter.

3.1.24 *Type Test* — Series of test carried out on one or more number of gas meters of the same type having identical characteristics, selected by manufacturer to prove conformity with all requirements of this standard for relevant class of gas meter. These are intended to prove the general qualities and design of a given type of gas meter.

3.1.25 *Acceptance Test* — Tests carried out on samples taken from a lot for the purpose of acceptance of the lot.

NOTE — However, specific qualities and design of the gas meters in a lot can be conclusively proved by performing relevant type test(s) on a number of samples agreed by the user and the supplier.

3.1.26 *Routine Test* — Tests carried out on each gas meter to check conformity with the requirements of this standard in aspects which are likely to vary during production.

3.1.27 *Meter Case* — Complete body /enclosure of meter which contains all measuring components of meter and may also be strong enough to confine the Natural Gas (fluid) with in it. The body/enclosure shall have suitable and effective seals so that fluid does not leak to atmosphere during normal working /life of meter. It may also contain any display /transmitting devices mechanical index and/or electronic index as integral part.

3.1.28 *Decision Rule* — Rule that describes how expanded measurement uncertainty (*see* **3.1.29**) is accounted for when stating conformity with a specified requirement**.**

3.1.29 *Expanded Measurement Uncertainty* — Non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used.

NOTES

1. The parameter can be, for example, a standard deviation (or a given multiple of it), or a half width of an interval having a stated level of confidence. The expanded uncertainty is generally expressed at approximately 95 percent confidence.
2. Uncertainty of measurement comprises, in general, many components. Some of these components can be evaluated from the statistical distribution of the results of a series of measurements and can be characterized by experimental standard deviations. The other components, which can also be characterized by standard deviations, are evaluated from the assumed probability distributions based on experience or other information.

3.2 Definitions Related to Additional Functionality

For the purposes of this document, the following terms and definitions related to additional functionality shall apply.

3.2.1 *Function* — Process which constantly or at defined intervals, automatically or on demand, performs specific activities such as sampling data, reading a data set, verifying or changing a status, or activating a switch/valve.

3.2.2 *Additional Functionality* — Functions over and above gas volume measurements and registrations, which can be within the meter, attached to the meter, or included within a connected separate device.

NOTE — In general these additional functionalities require some electronic circuits.

3.2.3 *Additional Functionality Device* — A device that carries out the additional functionalities.

3.2.4 *Additional Functionality Device Type 1* (AFD1) — Factory fitted additional functionality device integral within the same meter case.

3.2.5 *Additional Functionality Device Type 2* (AFD2) — Factory or field fitted additional functionality device directly attached to the meter.

3.2.6 *Additional Functionality Device Type 3* (AFD3) — Field fitted additional functionality device connected to the meter.

3.2.7 *Meter* — A device that measures self/auto login data and displays the volume of gas flow through the system.

NOTE — A volume conversion device is a sub-assembly of a meter and therefore in this standard it is part of the meter, if applicable

3.2.8 *Automatic Meter Reading* — Technology for obtaining metering data from an on-site meter by communication from an access point outside the premises.

3.2.9 *Connector* — A mechanical device, or pair of devices, that makes a semi-permanent circuit between the meter and a cable.

3.2.11 *Coordinated Universal Time (UTC)* — A timescale that forms the basis of a coordinated radio dissemination of standard frequencies and time signals. It corresponds exactly in rate with international atomic time, but differs from it by an integral number of seconds.

NOTES

1. Coordinated universal time is established by the International Bureau of Weights and Measures (BIPM) and the International Earth Rotation Service (IERS).
2. The UTC scale is adjusted by the insertion or deletion of seconds, so called positive or negative leap seconds, to ensure approximate agreement with UT1.
3. In India, this time is disseminated by National Physical laboratory, New Delhi; which is called Indian Standard Time (IST).

3.2.12 *Index* — Current reading of the total volume passed through the meter.

3.2.13 *Metrological Software* — Software identified during the type testing examination, which is part of the meter and is critical to its metrological characteristics (Annex 1 of OIML R 137).

3.2.14 *Register* — Electronic component which memorises the values of the meter and/or the Additional Functionality Device (AFD).

3.2.15 *Tariff* — Price structure (normally comprising a set of one or more rates of charge) applied to the consumption of a product or service provided to a consumer.

3.2.16 *Event* — Condition requiring action or to log an action.

3.2.17 *Display* — Shows visual information in either numbers or text.

3.2.18 *Gas Meter Designation, G* — G size generally indicates the minimum gas flow rate through the meter in Cubic Meters per Hour (CMH) divided by hundred. For example, G1.6 meter has minimum flow of 0.016 CMH, G65 meter has minimum flow of 0.65 CMH.

3.3 *Symbols* — For the purposes of this document, the following symbols and definitions shall apply.

3.3.1 *MPE* — Maximum permissible error in percentage.

3.3.2 *Volume Flow Rate, Q* — Actual flow of gas passing through the diaphragm gas meter.

3.3.3 *Minimum Flow Rate, Q_{min}* — Lowest flow rate at which the gas meter provides indications that satisfy the requirements regarding MPE.

3.3.4 *Transitional Flow Rate, Q_t* — Flow rate occurring between the maximum and minimum flow rates at which the flow rate range is divided into two zones, the 'upper zone' and the 'lower zone', each zone having a characteristic MPE.

3.3.5 *Maximum Flow Rate, Q_{max}*— Highest flow rate at which the gas meter provides indications that satisfy the requirements regarding MPE.

3.3.6 *Overload Flow Rate, Q_r* — Highest flow rate at which the meter operates for a short period of time without deteriorating.

3.3.7 Q_{start} — Lowest flow rate at which the meter must start and continue to register the passage of gas.

3.3.8 V — Cyclic volume (in case of diaphragm meters).

3.3.9 p_{max} — Maximum working pressure.

3.3.10 t_b — Base gas temperature.

3.3.11 P_b — Base gas pressure.

3.3.12 $t_{b,i}$ — Base gas temperature for meters declared suitable for differential temperature and intermittent operation.

3.3.13 t_m — Ambient temperature.

3.3.14 $t_{m,\ min}$ — Minimum temperature of ambient temperature range.

3.3.15 $t_{m,\ max}$ — Maximum temperature of ambient temperature range.

3.3.16 t_g — Gas temperature.

3.3.17 $t_{g,\ min}$ — Minimum temperature of gas temperature range.

3.3.18 $t_{g,\ max}$ – Maximum temperature of gas temperature range.

3.3.19 t_{sp} — Specified centre temperature for meters with temperature conversion.

3.3.20 T_i — Temperature at meter inlet.

3.3.21 g_n — Nominal gravitational acceleration.

3.3.22 g_l — Local gravitational acceleration.

3.3.23 M_{max} — Maximum permissible torque.

3.3.24 M_i — Torque applied to i^{th} drive shaft.

3.3.25 C_i — Constant for i^{th} drive shaft.

3.4 General Prepayment Metering

3.4.1 *Available Credit Value* — Value of available credit (in monetary or volume units) usable for further consumption that is either stored in the payment meter or calculated by it whenever required.

3.4.2 *Payment Meter* — Gas meter with additional functionality that can be operated and controlled to allow the flow of gas according to agreed payment modes.

> NOTE — It includes the following functional elements: measuring unit; register(s) storage, and control; meter accounting process; user interface including any physical token carrier interface; any virtual token carrier interface; and Shut off valve.

3.4.3 *Payment Metering Installation* — Set of payment metering equipment installed and ready for use at a customer's premises. It includes the connection of the gas supply network to the supply interface, the connection of the customer's installation, and the commissioning of the equipment into an operational state as a payment metering installation.

3.4.4 *Prepayment Mode* — Payment mode in which automatic interruption occurs when available credit is exhausted.

3.4.5 *Gas Supply Interface* — Connection terminal(s) where the gas supply line is connected to a payment meter or to a specified matching socket, where applicable.

3.4.6 *Emergency Credit* — Payment meter accounting function that deals with the dispensing of gas volume after available credit value becomes zero.

3.4.7 *Time-Based Credit* — Payment meter accounting function that deals with the calculation and transacting of a (social) grant of credit that is released on a scheduled time base.

3.4.8 *User Interface* — That part of a payment meter or payment gas metering installation that allows the customer to monitor and operate the installation. It may also facilitate meter reading, inspection, and metering services activities. Where physical token carriers are employed, it includes a token carrier interface.

3.5 Definition of Tokens

3.5.1 *Token*

3.5.1.1 *Equipment related definition* — Information content, including an instruction issued on a token carrier by a vending or management system, that is capable of subsequent transfer to and acceptance by a specific payment meter, or one of a group of meters, with appropriate security.

> NOTE — In a more general sense, the token refers to the instruction and information being transferred, while the token carrier refers to the physical device being used to carry the instruction and information, or to the communications medium in the case of a virtual token carrier.

3.5.1.2 *System related definition* — Subset of data elements, containing an instruction and information that is transferred to the payment meter by means of a token carrier.

3.5.2 *Credit/Value Token* — Token that represents an amount of credit in monetary or energy value or volume for transfer from the vending point to the payment meter.

3.5.3 *Duplicate Token* — Token that contains the same information as a token that has already been issued, and hence may also be a valid token.

> NOTE — This is not same as replacement token. A duplicate token is a reissue of the same token that was previously issued and is identical to it in all aspects; whereas replacement token is a newly generated token in place of a previously generated token and may not be identical to it in all aspects.

3.5.4 *Multiple-Use Token* — Token (such as a test token), that can be used for more than one successful session in a payment meter or possibly with each in a group of meters. These are typically used for meter reading or service purposes on repeated occasions.

3.5.5 *No-Value Token* — Token that does not result in a financial advantage or disadvantage to the consumer, which may contain meter configuration data, or instructions to perform certain tests, or to display certain values on the user interface, or to retrieve certain data from the meter and return it on a token carrier.

3.5.6 *Replacement Token* — A token that replaces a previously issued token in value. Physical token carrier may require a blank token carrier to be configured for the customer's meters.

> NOTE — A replacement token is a newly generated token in place of a previously generated token and may not be identical to it in all aspects, whereas a duplicate token is a reissue of the same token that was previously issued and is identical to it in all aspects.

3.5.7 *Single Use Token* — Token (such as a credit token), that can only be used for one successful session in a payment meter.

3.5.8 *Valid Token* — In relation to a specific payment meter (or group of payment meters), a token that is capable of being processed successfully by the meter(s).

3.6 Definition of Token Carriers

3.6.1 *Equipment Related Definition* — Devices or media used to transport and present token information to payment meters, such as printed paper or data communication networks. The token carrier may also carry ancillary control or monitoring information to or from the payment meter, depending upon system type and requirements.

3.6.2 *System Related Definition* — Medium that is used in the physical layer of the POS (Point of Sale) to token Carrier Interface, onto which the token is modulated or encoded, and which server to carry the token from the point where it is generated to the remote payment meter, where it is received.

3.6.3 *Bank Token Carrier* — Physical token carrier that has not been processed at the vending point or elsewhere and hence contains no specific data.

3.6.4 *Disposable Token Carrier* — Token carrier that is not capable of further use once it has been accepted or used.

3.6.5 *Numeric Token Carrier* — Token transfer method where the token information can be represented in a secure manner by a visible and human readable sequence of numeric digits (typically 20 digits printed on a receipt).

NOTE — They may be entered into a payment meter via a keypad interface for evaluation and action.

3.6.6 *One-Way Token Carrier* — Physical or virtual token carrier which is used for the transfer of credit and possibly tariff and configuration data in a single direction from the vending point or the management system to the payment meter.

3.6.7 *Physical Token Carrier* — Token carrier that requires a human to transport it at least part of the way between the point where the token is loaded onto the token carrier and the point where it is retrieved from the token carrier by the payment meter.

NOTE — Examples of physical token carriers are: printed numbers or printed bar codes.

3.6.8 *Reusable or Rechargeable Token Carrier* — Reusable or rechargeable token carrier is physical token carrier that can be used for multiple sessions for transportation of tokens.

3.6.9 *Two-Way Token* — Physical or virtual token carrier which is used for the transfer of credit and / or tariff and configuration data from the vending point or management system to the payment meter and response data from the payment meter back to the vending point or management system for further processing, where response data may possibly return on a subsequent vending transaction.

NOTE — Response data may contain consumption information, tamper information, accountancy information and token status with or without time and date stamp.

3.6.10 *Virtual Token Carrier* — Token carrier that does not require a human to transport it between the point where the token is loaded onto the token carrier and the point where it is retrieved from the token carrier by the payment meter.

NOTE — Examples of virtual token carriers include modems on PLC, PSTN, GSM, GPRS, radio, LAN, WAN, direct local communication etc.

3.7 Definitions of Interfaces/Functions Relating to Tokens and Token Carriers

3.7.1 *Physical Token Carrier Interface* — Complete interface protocol stack that includes any token carrier acceptor or keypad for a physical token carrier, the physical layer protocol and application layer protocol, plus any intermediate protocol layer.

3.7.2 *Token Acceptance* — Recognition of the successful completion of the processing of any token that was presented to the payment meters.

NOTE — Typically, this might involve the addition of token credit to the meter's accounting register, cancellation of the token information from the token carrier so as to prevent subsequent acceptance by any meter, and a visible indication to the user on the user interface. Similarly, this may also be applicable to any tariff or configuration data included on the token carrier.

3.7.3 *Token Cancellation*

a) The process of erasing or invalidating information contained in a valid token upon its acceptance by a payment meter to prevent its reuse.

b) Process of erasing or invalidating information contained in a token after it has been created, but before it is presented to a payment meter. This typically happens when the vending operator makes a mistake or if a technical problem occurs during the vending process.

3.7.4 *Token Carrier Charging* — Loading of a token and tariff or configuration data onto a token carrier at a vending point or a management system.

3.7.5 *Token Carrier Interface* — Token carrier interface permits the manual or automatic entry of tokens into a payment meter.

NOTES
1. For example, it may be a keypad for numeric token, or a physical token carrier acceptor, or a communications connection to a local or remote machine for a virtual token carrier interface.
2. The token carrier interface may also be used to pass additional information to or form the payment meter such as for the purposes of payment system management.

3.7.6 *Token Credit* — Value of credit or energy to be transferred from the vending point to the payment meter in the form of a token on a token carrier.

3.7.7 *Token Rejection* — This occurs when a token has been presented to but has not been accepted by a payment meter, and has not been erased or invalidated. In the case of a valid token not being accepted, the token may be presented and accepted at a later time when conditions allow.

3.7.8 *Token Replacement* — Token that replaces a previously issued token in value. Physical token carriers may require a blank token carrier to be configured for the customer's meter.

NOTE — A replacement token is a newly generated token in place of a previously generated token and may not be identical to it in all aspects; whereas a duplicate token is a reissue of the same token that was previously issued and is identical to it in all aspects.

3.7.9 *Virtual Token Carrier Interface* — Complete interface protocol stack that includes the physical layer protocol and application layer protocol, plus any intermediate protocol layers.

4 GENERAL WORKING CONDITIONS FOR GAS METER

4.1 Field of Application

These requirements apply to the following application of gas volume meters:

a) Domestic; and
b) Commercial.

NOTE — In this standard, gas volume meters are referred to as "gas meters".

4.2 Construction

4.2.1 *General* — Gas meters shall be designed and manufactured in such a way that they do not exceed maximum permissible errors under normal working conditions of temperature as specified in **5**, and over the ranges of temperature and pressure of the measured gas (metering conditions) as claimed by the manufacturer.

4.2.2 *Materials* — A gas meter shall be made of such materials and be so constructed to withstand the physical, chemical and thermal conditions to which it is likely to be subjected, and to correctly fulfil its intended purposes throughout its life.

4.2.3 *Soundness of Cases* — The case of gas meters shall be gas-tight at least up to the maximum working pressure of the gas meters. If meters are to be installed in the open air they shall be impermeable to runoff water.

4.2.4 *Protection Against External Interference* — Gas meter shall be constructed in such a way that any mechanical interference capable of affecting the measuring accuracy causes permanently visible damage to the gas meter or to the verification mark or protection mark.

4.2.5 *Direction of Gas Flow* — On a gas meter where the indicating device registers positively for only one direction of the gas flow, this direction shall be indicated by an arrow. This arrow is not required if the direction of the gas flow is determined by the construction. If a meter is not designed to measure reverse flow, the meter shall either prevent reverse flow, or it shall withstand incidental or accidental reverse flow without deterioration or change in its metrological properties concerning forward flow measurements

4.2.6 *Metrological Properties* — At a flow rate equal to 'Q_{max}' a gas meter shall be able to function continuously for a time fixed by the relevant clauses of this standard without the changes in its metrological properties exceeding the limits fixed by those respective clause requirements.

4.3 Output Devices

4.3.1 *Gas Meters May Be Fitted With*

Integral pulse generators, the outlets of which shall bear an indication of the value of one pulse in the form: '1 Impulse =..... m^3 (or dm^3)' or '1 m^3 =..... Impulse'.

Markings to be done suitably as mentioned in **6.1**.

These devices are regarded as an integral part of the gas meter. They shall be installed in the gas meter at the time of type testing and initial verification.

4.3.2 Gas meters may be fitted with output drive shafts which should be taken to include drive shafts or other facilities for operating detachable additional devices. The torque which the gas meters are required to produce in order to drive the additional devices shall not produce any changes in the gas meter indication greater than the specified values.

4.3.2.1 If there is only one drive shaft, it shall be characterized by an indication of its constant (C) in the form "1 Rev. =..... m^3 (or dm^3)", of the maximum permissible torque in the form "M_{max} =..... N.mm" and of the direction of rotation.

Markings to be done suitably as mentioned in **6.1**.

4.3.2.2 If there are several drive shafts, each shaft shall be characterized by the letter 'M' with subscript in the form "M_1, M_2... M_n", as well as by an indication of its constant in the form "1 rev. = ... m^3 (or dm^3)" and of the direction of rotation.

The following formula shall appear on the gas meter, preferably on the data plate;
$K_1M_1 + K_2M_2 + ...+ k_nM_n \leq A$ N.mm

where

'A' is the numerical value of the maximum permissible torque applied to the drive shaft with the highest constant, where the torque is applied only to this shaft, this shaft shall be characterized by the symbol M_1, and k_i (i = 1,2, ... n) is a numerical value determined as follows:

$$k_i = \frac{C_1}{C_i}$$

M_i (i = 1, 2, ...n) represents the torque applied to the drive shaft characterized by the symbol M_i.
C_i (i = 1, 2, ...n) represents the constant for the drive shaft characterized by the symbol M_i.

Markings to be done suitably as mentioned in **6.1**.

4.3.2.3 When not connected to an attachable additional device, the exposed ends of the drive shafts shall be suitably protected.

4.3.2.4 The connection between the measuring device and the intermediate gearing shall not be broken or altered, if a torque of three times the permissible torque as indicated in **4.3.2.1** and **4.3.2.2** is applied.

5 WORKING CONDITIONS

5.1 Flow Range

The flow rate range shall be one of those given in Table 1. A gas meter may have a lower value for the minimum flow rate, Q_{min}, than that shown in Table 1, but this lower value shall be equal to one of the values shown in the table or to a decimal sub-multiple of these values.

Table 1 Flow Range
(*Clause* 5.1 and 7.6.1)

Gas Meter Designation G	Q_{max} (m^3/h)	Q_{min} (m^3/h)	Q_t (m^3/h)	Q_r (m^3/h)
1.6	2.5	0.016	0.25	3.0
2.5	4	0.025	0.4	4.8
4	6	0.04	0.6	7.2
6	10	0.06	1.0	12.0
10	16	0.1	1.6	19.2

16	25	0.16	2.5	30.0
25	40	0.25	4.0	48.0
40	65	0.4	6.5	78.0
65	100	0.65	10.0	120.0
100	160	1	16.0	192.0

NOTES

1. The values given in Table 1 ensure conformity with the requirements of the minimum ratio Q_{max} to Q_{min} of 150:1
2. The nominal values of maximum flow rates and the corresponding values of the upper limits of the minimum flow rates are given in Table 1.
3. For definitions of various flow rates *see* **3.3.3** to **3.3.6**.

5.2 Maximum Working Pressure

Unless required otherwise for a particular test, all meters shall be capable of meeting the requirements up to the maximum working pressure of the meter, p_{max}, which shall be declared and shall be marked on the index plate of the meter, as mentioned in **6.1**. However, p_{max} shall not be less than 0.5 bar.

5.3 Temperature Range

All meters shall be capable of meeting the requirements for a:

a) Minimum ambient temperature range of -10°C to 55°C ;
b) Minimum gas temperature range as either -5°C to 40°C, or as specified by the manufacturer above this but within ambient temperature range; and
c) Minimum storage temperature range of -20°C to 70°C.

The gas temperature range and the ambient temperature range and shall be marked on the index plate of the meter. Markings to be done suitably as mentioned in **6.1**.

5.4 Climatic Environment

Meters that conform to the requirements of this standard are deemed suitable for installation in closed locations (indoor or "outdoor with protection as specified by the manufacturer") with condensing or non-condensing humidity. If the manufacturer declares that the meter is also suitable for installation in open locations (outdoor without any protection) with condensing or non-condensing humidity, it shall meet the requirements of **7.9.3** of this standard.

5.5 Installation Orientation

The meter shall be designed for installation upright. If meter can be installed in any other orientations it shall be specified by the manufacturer.

5.6 Reference Test Conditions

5.6.1 *Ambient Test Conditions*

The ambient test conditions shall be as mentioned in IS 196.

5.6.2 *Test Conditions for Media Used*

5.6.2.1 *For air*

a) Relative Humidity and temperature for media shall be as per IS 196.
b) Density shall be 1.00 to 1.2 kg/m^3.

5.6.2.2 *For gas*

a) Media temperature shall be as per IS 196.
b) The manufacturer shall specify the range of gases for which the meter is suitable from Table 2.

Table 2 Gas Groups
(*Clause* 5.6.2.2)

First family	Groups	a		
Second family	Groups	H	L	E
Third family	Groups	B/P	P	B

The definitions of the groups of gas families are given below:

Gas Families and Groups	**Gross Wobb Index, Dry gas 15** °C **and 10113.25** mbar MJ/m^3	
	Minimum	**Maximum**
First Family		
— Group a	22.4	24.8
Second Family	39.1	54.7
— Group H	45.7	54.7
— Group L	39.1	44.8
— Group E	40.9	54.7
Third Family	72.9	87.3
— Group B/P	72.9	87.3
— Group P	72.9	76.8
— Group B	81.8	87.3

Meters suitable for:

1) First family of gases ;
2) Second family gases ; and

3) Third family gases.

By agreement with the laboratory, air or any other test gas can be included. The additional gases shall be marked on the meter as defined in **6.1**.

6 MARKING REQUIREMENTS

6.1 All Meters

Each meter shall be marked with at least the following information. The marking can be on external surface of meter or on index or on a separate name plate. The name plate shall be permanently attached to the meter. All markings shall be in a clearly visible position and shall be durable under the normal conditions of the meter.

1) Model Approval mark, and BIS Standard mark (if approved);
2) The identification mark (or trade mark) or name of the manufacturer ;
3) The serial number of the meter ;
4) Year of manufacture ;
5) The maximum and minimum flow rates, Q_{max} and Q_{min} (m^3/h) ;
6) The maximum working pressure, p_{max} (bar) ;
7) The nominal value of the cyclic volume, V (dm^3) ;
8) The number and year of this standard, that is, IS 14439 : XXXX ;
9) Ambient temperature range, if different from t_m = - 10°C to 55°C (*see* **5.3**) ;
10) Gas temperature range, that is, t_g = - 5°C to 40°C (*see* **5.3**) ;
11) Accuracy class of the meter, that is, Class 1.0 or 1.5 ;
12) Any additional marking required by the Annexes of this standard ;
13) Character V or H, as applicable, if the meter can be operated only in the vertical or horizontal position ;
14) For integral/optical pulse generators, the outlets of which shall bear an indication of the value of one pulse in the form: '1 Impulse =..... m^3 (or dm^3)' or '1 m^3 =..... Impulse' ;
15) The maximum permissible torque in the form "M_{max} = ... N.mm" and of the direction of rotation ;
16) If the meter is resistant to high ambient temperatures (*see* **8.6.6**) it shall be marked additionally with T ; and
17) If the meter is declared suitable for use in an open environment (*see* **7.9.3**) it shall be marked additionally with H3.

6.2 Two Pipe Meters

Meters with two-pipe connections shall be clearly and permanently marked either by embossing or engraving with the direction of flow by means of an arrow between the connections.

6.3 Additional Markings for Gas Meters with Additional Functionality Electronic Device, If Any

a) Battery capacity (or operation lifetime) presentation or battery replacement date (not required if early alarm function is available)
b) Software identification of firmware

NOTE — Gas meter with electronic device have option to show above marking with electronic display.

6.4 Durability and Legibility of Marking

6.4.1 *Requirements*

When inspected visually, all labels shall remain securely fixed, in that their edges shall not lift from the backing surfaces, and the markings on the meter, the index and index plate when viewed through the index window and any separate data plate if fitted, shall remain legible after being subjected to the tests given in **8.3.7, 8.4.2.5, 8.5, 9.3.3, 6.4.2** and **6.4.3**.

6.4.2 *Ultraviolet Exposure Test*

When tested in accordance with the ultraviolet exposure test, all labels shall conform to the requirements of **6.4.1**. Expose the window of the indicating device and the name plate to the effects of ultraviolet radiation for 5 periods, each of 8 h duration, using a suspended sun lamp which has been used for a minimum of 50 h and not more than 400 h with a light source which has the same radiation spectrum as a Xenon lamp with a low transmission below 290 nm. The test equipment shall provide an energy of at least 765 W/m^2over the entire surface of the tested items. Ensure the surrounding air is not confined and is free to circulate and regulated at 43 ± 3°C. After each exposure except the last, immerse completely the items in distilled water for 16 h and then clean and dry with cotton wool.

6.4.3 *Indelibility*

All markings on the external surface of the meter, which can be touched when the meter is in normal use, shall conform to the requirements of Annex A of IS/IEC 60730-1.

6.4.4 *Adhesion*

6.4.4.1 *General*

Adhesive metrology labels or seals shall be tamper-evident. Manual removal shall result in damage which prevents re-application. When inspected visually, all labels shall remain securely fixed, such that:

a) The edges shall not lift from the backing surfaces;
b) The label shall not become detached, crazed or blistered; and
c) The markings on the meter, the index and index plate when viewed through the index window and any separate data plate if fitted, shall remain legible after being subjected to the tests given in **8.3.7, 8.4.2.5, 8.4.2.6, 8.5, 9.3.3, 6.4.2** and **6.4.3**.

6.4.4.2 *Requirements*

The peel adhesion, measured as the force required to remove the marking label, shall be greater than 0.4 ± 0.04 N/mm.

6.4.4.3 *Test procedure*

Carry out the following test at 25 ± 4°C. Apply a finished label to the finished meter surface or a sample of the same finished meter material by pressing half the label area to the surface, with the remaining half folded back through 180°. Allow the adhesive to condition for a minimum of 48 h at 25 ± 4°C. Apply a traction of 300 mm/min separation rate to the unattached portion of the label, for example using a dynamometer. Record the force (peel adhesion) at which the label loses adhesion or breaks. Provided that

all the attached area of the label continues to adhere to the surface, it is admissible for the label to break during the test.

7 METROLOGICAL PERFORMANCE AND REQUIREMENTS

7.1 Errors of Indication at Different Orientations

Expanded Uncertainty of Measurement —
When a test is conducted, the expanded uncertainty of measurement of the determination of errors of the measured gas quantity shall meet the following specifications:

1) For type evaluation: less than one-fifth of the applicable MPE ; and
2) For verifications: less than one-third of the applicable MPE.

However, if the above-mentioned criteria cannot be met, the test results can be approved alternatively by reducing the applied maximum permissible errors with the excess of the uncertainties. In this case the following acceptance criteria shall be used:

1) For type evaluation: $\pm (6/5 \cdot MPE - U)$; and
2) For verifications: $\pm (4/3 \cdot MPE - U)$.

while, $U \leq MPE$

The estimation of the expanded uncertainty *U* is made according to the *Guide to the expression of uncertainty in measurement* (GUM) with a level of confidence of approximately 95 percent.

Example:

> When assuming that during testing for type evaluation of an accuracy class 1 gas meter the test result has an expanded uncertainty *U* of 0.3% ($k = 2$) the test results can be accepted if the error is between $\pm (6/5 \times 1.0 - 0.3)\% = \pm 0.9\%$.

7.1.1 Requirements

When tested by the method given in **7.1.2 a)** the individual errors of indication of the meter shall be within the initial permissible error (MPE-Initial) limits specified in Table 3a and for meters with temperature conversion device Table 3b. If it is intended to use the meter in two directions (forward and reverse flow) then all tests shall be performed in both directions. If meter is designed for more than one orientation, then, metrological tests shall be carried out for every orientation.

Table 3a Maximum Permissible Errors for Normal Meters
(*Clauses* 3.1.18, 7.1.1, 7.6.1, 7.9.1, 7.9.3, 7.10.1, 7.10.2, 8.3.6.3.2.1, 8.3.7.1, 8.3.7.2, 8.3.9.1, 8.5.1, 9.1.1.1, 9.1.1.2, 9.1.2.1, 9.1.2.2, 9.1.3.1, 9.3.1.1, 9.3.2.1, 9.3.3.1, 9.3.3.2, 10.1.2.1, 10.1.3.1, 10.1.4.1, 10.1.5.1, 10.1.6.1, 10.2.5.1, 10.2.6.1, 10.2.7.1, 10.2.8.1, 10.2.9.1, 11.4.1, 11.5.1 and B-2.1.1.1)

Flow rate *Q* (m^3/h)	**Maximum permissible errors**			
	During type evaluation and initial verification		**During subsequent verification and In-service ***	
	Accuracy class		**Accuracy class**	
	1	**1.5**	**1**	**1.5**

$Q_{min} \leq Q < Q_t$	±2 %	±3 %	±4 %	±6 %
$Q_t \leq Q \leq Q_{max}$	±1 %	±1.5 %	±2 %	±3 %

Table 3b Maximum Permissible Errors for Meters with Temperature Conversion Device
(For 30°C span symmetrically distributed around t_{sp} declared by manufacturer)
(*Clauses* 3.1.18, 7.1.1, 7.6.1, 7.9.1, 7.9.3, 7.10.1, 7.10.2, 8.3.6.3.2.1, 8.3.7.1, 8.3.7.2, 8.3.9.1, 8.5.1, 9.1.1.1, 9.1.1.2, 9.1.2.1, 9.1.2.2, 9.1.3.1, 9.3.1.1, 9.3.2.1, 9.3.3.1, 9.3.3.2, 10.1.2.1, 10.1.3.1, 10.1.4.1, 10.1.5.1, 10.1.6.1, 10.2.5.1, 10.2.6.1, 10.2.7.1, 10.2.8.1, 10.2.9.1, 11.4.1, 11.5.1 and B-2.1.1.1)

Flow rate *Q* (m^3/h)	**Maximum permissible errors**			
	During type evaluation and initial verification		**During subsequent verification and In-service ***	
	Accuracy class		**Accuracy class**	
	1	**1.5**	**1**	**1.5**
$Q_{min} \leq Q < Q_t$	±2.5 %	±3.5 %	±4.5 %	±6.5 %
$Q_t \leq Q \leq Q_{max}$	±1.5 %	±2 %	±2.5 %	±3.5 %

Where the error of indication is to be tested beyond the declared gas temperature span of 30°C, the limits mentioned in Table 3b shall be increased by 0.5 percent per every 10°C. After the meter has been subjected to other influences, given in the individual clauses of this standard, the average of the multiple readings of errors of indication of same respective flow rates shall either:

a) Not vary from the average of the multiple readings of initial errors of indication of same respective flow rates by more than that allowed by those clauses ; or
b) Be within the error limits specified within those clauses.

Whichever is applicable, when tested by the methods given in **7.1.2 b), 7.1.2 c)** or **7.1.2 d)**.

7.1.2 *Test Procedure — Errors of Indication*

Thermally stabilize the meter to be tested for a minimum of 4 h at the temperature of the test laboratory and carry out the error of indication test using air at this laboratory temperature.

Immediately before commencing the test, pass a quantity of air equal to at least 50 cyclic volumes of the meter under test, through the meter under test at a flow rate of Q_{max}.

a) Carry out this test six times at each of the flow rates Q_{min}, $3Q_{min}$, $5Q_{min}$, $0.1Q_{max}$, $0.2Q_{max}$, $0.4Q_{max}$, $0.7Q_{max}$ and Q_{max} , ensuring that the flow rates between each individual test are different (that is, it is not permissible to carry out consecutive tests at the same flow rate). Pass a volume of air, the actual volume of which is measured by a traceable standard, through the meter under test and note the volume indicated by the meter index. The minimum volume of air to be passed through the meter under test is specified by the manufacturer and agreed with the accredited test house. Calculate the six errors of indication at each of the flow rates using the equation given in **3.1.9**. Calculate the mean of each of the six errors of indication and record the results as the meter error curve.

b) Pass a volume of air, the actual volume of which is measured by a traceable standard, through the meter under test and note the volume indicated by the meter index. The minimum volume of air to be passed through the meter under test is specified by the manufacturer and agreed with the accredited test house. Carry out this test three times at each of the flow rates Q_{min}, 3 Q_{min}, 5 Q_{min}, 0.1 Q_{max}, 0.2Q_{max}, 0.4Q_{max}, 0.7Q_{max} and Q_{max}; ensure that the flow rates between each individual test are different (that is, it is not permissible to carry out consecutive tests at the same flow rate). Calculate the three errors of indication at each of the flow rates using the equation given in **3.1.9**. Calculate the mean of the three errors of indication and record the results as the meter error curve.

c) Immediately before commencing the test, pass a quantity of air in m^3 equal to at least 1 percent of Q_{max} in m^3/h through the meter under test at a flow rate of Q_{max}. Pass a volume of air, the actual volume of which is measured by a traceable standard, through the meter under test and note the volume indicated by the meter index. The minimum volume of air to be passed through the meter under test is specified by the manufacturer and agreed with the accredited test house. Carry out this test three times at each of the flow rates 0.1Q_{max}, 0.4Q_{max} and Q_{max} ensuring that the flow rates between each individual test are different (that is, it is not permissible to carry out consecutive tests at the same flow rate). Calculate the three errors of indication at each of the flow rates using the equation given in **3.1.9**. Calculate the mean of the three errors of indication and record the results as the meter error curve.

d) Pass a volume of air, the actual volume of which is measured by a traceable standard, through the meter under test and note the volume indicated by the meter index. The minimum volume of air to be passed through the meter under test is specified by the manufacturer and agreed with the accredited test house. Carry out this test three times at each of the flow rates Q_{min}, 0.1Q_{max}, 0.4Q_{max} *and* Q_{max} ensuring that the flow rates between each individual test are different (that is, it is not permissible to carry out consecutive tests at the same flow rate). Calculate the three errors of indication at each of the flow rates using the equation given in **3.1.9**. Calculate the mean of the three errors of indication and record the results as the meter error curve.

e) For additional tests refer annexure B, C, D, E, F, G and H.

7.2 Weighted Mean Error (WME)

7.2.1 *Requirements*

(For 30°C span symmetrically distributed around t_{sp} declared by manufacturer)
The weighted mean error (WME) shall be within the values given in Table 4a and 4b.

Table 4a Maximum Permissible Weighted Mean Error (WME)
(*Clause* 7.2.1)

Flow rate *Q* (m^3/h)	**Maximum permissible errors**	
	During type evaluation and initial verification	
	Accuracy class	
	1	**1.5**
$Q_{min} \leq Q \leq Q_{max}$	± 0.4 %	± 0.6 %

Table 4b Maximum Permissible Weighted Mean Error (WME) for Meters with Temperature Conversion Device

(*Clause* 7.2.1)

Flow rate *Q* (m^3/h)	**Maximum permissible errors**			
	During type evaluation and initial verification		**During subsequent verification and In-service***	
	Accuracy class		**Accuracy class**	
	1	**1.5**	**1**	**1.5**
$Q_{min} \leq Q \leq Q_{max}$	± 0.6 %	± 0.8 %		

7.2.2 *Test Procedure — Weighted Mean Error (WME)*

Using the calculated errors of indication, obtained when carrying out the initial error of indication test in **7.1.2 a)** at flow rates Q_{min}, $3Q_{min}$, $5Q_{min}$, $0.1Q_{max}$, $0.2Q_{max}$, $0.4Q_{max}$, $0.7Q_{max}$ and Q_{max}, and at 20 ± 1°C, calculate the Weighted mean error (WME) according to equation (4) given below:

$$WME = \frac{\sum_{i=1}^{n} k_i E_i}{\sum_{i=1}^{n} k_i} \qquad (4)$$

with,

$$k_i = \frac{Q_i}{Q_{max}} \quad \text{for } Q_i \leq 0.7Q_{max}$$

$$k_i = 1.4 - \frac{Q_i}{Q_{max}} \quad \text{for } 0.7Q_{max} < Q_i \leq Q_{max}$$

where

k_i Weighting factor at the flow rate Q_i ; and
E_i The error at the flow rate Q_i .

Record the result as a pass or fail.

7.3 Repeatability of Error

7.3.1 *Requirements*

The repeatability of error of three consecutive measurements at the specific flow rate shall be less than or equal to as given in following Table 5. Mean errors shall also meet the requirements of **7.1.1**.

Table 5 Maximum Permissible Repeatability Error
(*Clause* 7.3.1)

Flow rate *Q* (m^3/h)	**Maximum permissible errors**	
	During type evaluation and initial verification	
	Accuracy class	
	1	**1.5**
$Q_{min} \leq Q < Q_t$	± 0.6%	± 1%

$Q_t \leq Q \leq Q_{max}$	± 0.3%	± 0.6%

7.3.2 *Test procedure*

Repeatability of error at respective flow rates:

a) Thermally stabilize the meter to be tested for a minimum of 4 h at the temperature of the test laboratory and carry out the error of indication test using air at this laboratory temperature.
b) Immediately before commencing the test, pass a quantity of air in m^3 equal to at least 1 percent of Q_{max} in m^3/h through the meter under test at a flow rate of Q_{max}.
c) Pass a volume of air, the actual volume of which is measured by a traceable standard, through the meter under test and note the volume indicated by the meter index. The minimum volume of air in m^3 to be passed through the meter under test is 1 percent of Q_{max} in m^3/h for flow rates $Q_t \leq Q \leq Q_{max}$ and one-third of 1 percent of Q_{max} in m^3/h for flow rates $Q_{min} \leq Q < Q_t$. (for example, for meter with Q_{max} as $6m^3/h$, minimum volume of air to be passed in m^3 is $0.06m^3$ for flow rates $Q_t \leq Q \leq Q_{max}$ and 0.02 m^3 for flow rates ($Q_{min} \leq Q < Q_t$.)
d) Carry out this test three times consecutively at each of the flow rates Q_{min}, Q_t *and* Q_{max} and the difference between the minimum and maximum measured error, at respective flow rates, is calculated.

NOTE — For gas meters which are intended to be used at high pressures, this test may be performed at the lowest operating pressure.

7.4 Gas — Air Relationship

7.4.1 *Requirements*

When tested in accordance with **7.4.2** the range of mean errors on all test gases combined (including air) shall be within the limits specified in Table 6.

This test is not applicable for mechanical moving meters.

Table 6 Maximum Difference between Errors (All Medias)
(*Clause* 7.4.1)

Flow rate *Q* (m^3/h)	**Maximum range of mean errors**	
	Class 1.0	**Class 1.5**
$Q_{min} \leq Q < Q_t$	2 ⅔ %	4 %
$Q_t \leq Q \leq Q_{max}$	1 ⅓ %	2 %

The difference between the mean error on the test gases and that on air at each flow rate shall satisfy the limits specified in Table 7.

Table 7 Mean Error Difference between Gas and Air
(*Clause* 7.4.1)

Flow rate *Q* (m^3/h)	**Maximum mean error difference**	
	Class 1.0	**Class 1.5**
$Q_{min} \leq Q < Q_t$	2 %	3 %

$Q_t \leq Q \leq Q_{max}$	1 %	1.5 %

7.4.2 *Test Procedure*

Carry out the test as described in **7.1.2a)** at 25 ± 2°C using the test gases in turn specified in **5.6.2.2 b)** and any other test gas by agreement with the Test House, which shall be marked on the meter (*see* **6.1**). Use test results from testing the meter in accordance with **7.1.2a)** and **7.4.2** above and check the fulfilment of requirements of **7.4.1**.

7.5 Starting Flow Rate (Low Flow Registration)

7.5.1 *Requirements*

When tested by the method given in **7.5.2**, the starting flow rate shall not be greater than those specified in Table 8.

Table 8 Starting Flow Rates (Low Flow Registration)
(*Clause* 7.5.1)

Q_{max} (m^3/h)	**Starting flow rate (Q_{start}) (for static meters)** (dm^3/h)	**Starting flow rate (Q_{start}) (for moving)** (dm^3/h)
2.5	4	3
4	6.25	5
6	10	5
10	15	8
16	25	13
25	40	13
40	62.5	20
65	100	32
100	162.5	32
160	250	50

7.5.2 *Test Procedure*

Run the meter under test at Q_{max} for 10 min, using air at laboratory temperature. Leave the meter under test at rest for a period of at least 2 hours. Connect the meter under test in series with, and upstream of, a flow measuring instrument of known accuracy and traceability, and a flow regulating device having resolution of at least 0.1 dm^3/h. Check the leak tightness of the complete test apparatus and supply air at ambient temperature up to a maximum pressure of 2 mbar and maintain the flow rate at the maximum allowable starting flow rate.

At this starting flow rate, ascertain that the meter under test registers continuously for minimum 60 minutes for G6 and below; 30 minutes for above G6 meters.

Record the result as pass or fail.

NOTES

1. This test does not check the metrological characteristics of the meter.
2. In case of moving meters, do not add lubricant for the test.

7.6 Overload Flow Rate (High Flow Registration)

7.6.1 *Requirements*

a) When tested as per **7.6.2**, after exposure to an overload flow rate of Q_r as given in Table 1, the error of indication shall remain within the MPE-Initial limits specified in Table 3a and Table 3b as applicable. The deviation from the initial error shall not be more than one third of the maximum permissible error (MPE).
b) A gas meter shall meet the following requirements, after being exposed to an overload of $1.2Q_{max}$ for a period of 1 hour:
   1) The maximum permissible errors shall be as mentioned in **7.1.1** ; and
   2) The difference of error from initial value shall be less than one-third of MPE.

NOTE — Overload flow rate is typically 1.2 times of Q_{max}.

7.6.2 *Test Procedure* — Supply the gas meter with air for 1 h at a flow rate of Q_r. Determine the error of indication as specified in **7.1.2 c)**.

Record the result as a pass or fail.

7.7 Zero Flow

7.7.1 *Requirements*

Neither the meter display nor the internal register shall change in value (increase or decrease) when the meter is tested by the method given in **7.7.2**.

NOTE — This requirement refers to stationary operating conditions. This condition does not refer to the response of the gas meter to changed flow rates.

7.7.2 *Test Procedure*

This test is to be carried out at -10°C, 20°C and 55°C as below:

a) Fill the meter with air at atmospheric pressure and seal the inlet and outlet ports of the meter with gas tight fittings. Allow the meter to stabilize at the test temperature so that meter is free from flow pulsations. Record the meter display and the internal register of the meter. Then store for 24 h at the test temperature. Record the meter display and internal register and subtract the respective first readings from the second readings to indicate any registration change.
b) Repeat the test at each test temperature.

7.8 Pressure Drop

7.8.1 *Requirements*

The mean pressure drop of a meter, with a flow of air of density as mentioned in **5.6.2.1 c)** at a flow rate equal to Q_{max}, shall not exceed the values given in Table 9.

Table 9 Pressure Drop
(*Clauses* 7.8.1, 8.3.9.1 and B-2.1.1.1)

Q_{max} (m^3/h)	Meter Size	Maximum permissible values for mean Pressure Drop	
		Initial test	Subsequent tests
2.5 to 16 inclusive	G1.6 to G 10	2	2.2
25 to 65 inclusive	G 16 to G 40	3	3.3
100 and 160	G 65 to G 100	4	4.4

7.8.2 Test Procedure

a) Supply the meter under test with a flow of air at a flow rate equal to Q_{max} for a minimum of 10 cycles. Measure the differential pressure across the meter for at least one cyclic volume using a suitable measuring instrument, accurate to 0.1 mbar.
b) The distance between the pressure test points and the meter connections shall not exceed three times the nominal connection diameter.
c) Record the differential pressures as above and calculate the mean value.
d) Maximum permissible pressure drop for meters subjected to any test including endurance shall follow the values given in the subsequent tests.

7.9 Environment and Humidity (Closed and Open Locations)

7.9.1 *Requirements (Closed Location)*

Before and after testing in accordance with **7.9.2**, the error of indication shall remain within the MPE-Initial limits as specified in Table 3a and 3b as applicable and the index and markings shall remain legible.

7.9.2 *Test Procedure – Environment and Humidity (Closed Location)*

Test one meter for error of indication in accordance with **7.1.2 c)** and then in accordance with IS 101 (Part 6/Sec 1) for a duration of 120 h. Then retest the meter for error of indication in accordance with **7.1.2 c)** and visually inspect it for legibility of the index and the markings. Record the result as a pass or fail.

7.9.3 *Requirements (Open Location)*

Before and after testing in accordance with **7.9.4**, the error of indication shall remain within the MPE-Initial limits as specified in Table 3a and 3b as applicable and the index and markings shall remain legible.

7.9.4 *Test Procedure – Environment and Humidity (Open Location)*

Test one meter for error of indication in accordance with **7.1.2 c)** and then in accordance with IS 101 (Part 6/Sec 1) for a duration of 340 h. Then retest the meter for error of indication in accordance with **7.1.2 c)** and visually inspect it for legibility of the index and the markings. Record the result as a pass or fail.

7.10 Influence of Other Devices Attached to the Meter

7.10.1 *Requirements*

If any device (Ancillary devices, for example, flow detection before this, is clearly visible on the indicating device, means for testing, verification) that the manufacturer permits to be connected to the meter influences its metrological performance, then this influence shall be less than one-fifth the MPE mentioned in Table 3a and 3b as applicable. When not connected to an attachable ancillary device, the exposed ends of the drive shaft if any shall be suitably protected as mentioned in test **7.10.2 b)**. The connection between the measuring transducer and the intermediate gearing if any shall not break or alter after the test **7.10.2 c)**.

NOTE — An additional functionality device is covered by **12** of this document.

7.10.2 *Test Procedure – Influence of Other Devices*

a) Test 1 meter 10 times for error of indication at Q_t, varying the flow rate between each test by at least $0.05Q_{max}$. Then attach the influencing device to the meter and determine the error of indication at Q_t again 10 times. Calculate the mean of each set of results. The difference between the means of the 2 errors of indication shall be less than one-fifth the MPE mentioned in Table 3a and 3b as applicable. Report the result as pass or fail.
b) Visually inspect that, the exposed ends of the drive shaft are suitably protected.
c) Apply overload torque of three times the permissible torque as indicated in markings as per **4.3.2.1** and **4.3.2.2**.

8 CONSTRUCTION AND MATERIALS

8.1 General

No additional lubricants shall be required during the life of the meter. The meter connections shall be fitted with suitable non-sealing plugs or covers to prevent the entry of foreign matter during transit and storage.

8.2 Resistance to Interference

8.2.1 *Mechanical Interference*

8.2.1.1 *Requirements*

The meter shall be constructed in such a way that any mechanical interference capable of affecting the measuring accuracy causes permanent visible damage to the meter or the verification or protection marks.

8.2.1.2 *Test procedure*

By visual inspection.
Report the result as pass or fail.

8.2.2 *Electromagnetic Interference*

The meter shall conform to the requirements of **10** of this document.

8.3 Robustness

8.3.1 *General*

Meters meeting the requirements of **8.3** are suitable for use in locations with vibration and shocks of low significance, for example, they can be floor mounted or fastened to light supporting structures and will be subject to negligible vibrations and shocks including, but not limited to local blasting or pile driving activities, or slamming doors.

8.3.2 *Meter Case*

The external surface of the meter case, which is in direct contact with the ambient air, and the internal surface of the meter case, which is in direct contact with the gas, shall be of sufficient thickness to meet the requirements of this standard.

8.3.3 *External Leak Tightness*

8.3.3.1 *Requirements*

The meter shall be leak tight under normal conditions of use. When tested in accordance with **8.3.3.2**, no leakage shall be observed.

8.3.3.2 *Test procedure*

Test the meter in three stages as follows:

a) Pressurize the meter under test, at normal laboratory temperature, with air to 25 mbar and carry out the test either 1) or 2) given below.
b) Then pressurize the meter under test, at normal laboratory temperature, with air to a minimum of 1.5 times the declared maximum working pressure and not less than 350 mbar and carry out the test either 1) or 2) given below.
c) Then allow the pressure to reduce to atmospheric pressure, then re-pressurize the meter under test, at normal laboratory temperature, with air to 25 mbar and carry out the test either 1) or 2) given below.

For each stage test by either:

1) Immerse the complete meter (at least upto 10 mm below the water level) without its index in water (if removable) and observe it for leakage for 30 s after any external trapped air has been dispersed, after which no leakage should be observed; or
2) Use any equivalent procedure utilizing calibrated and certificated test equipment with a declared resolution and full traceability.

Record the results of all three tests and report as pass or fail.

NOTE — For routine test this test can be done on meter casing.

8.3.4 *Resistance to Internal Pressure (Static)*

8.3.4.1 *Requirements*

Resistance to internal pressure tests shall be carried out with no interruptions to the gas flow including, but not limited to, valves in the open position (if provided). When tested in accordance with the method given in **8.3.4.2**, any residual deformation of the unpressurized meter case shall not exceed 0.75 percent

of the linear dimension over which it is measured. After the test, the meter case shall remain leak tight in accordance with **8.3.3**.

8.3.4.2 *Test procedure*

Pressurize the meter under test, at normal laboratory temperature, with air to a minimum of 1.5 times the declared maximum working pressure and not less than 350 mbar. Maintain the test pressure for 30 min and then release. Ensure that the rate of pressurization or depressurization does not exceed 350 mbar/s. Record the result as pass or fail.

8.3.5 *Meter Case Sealing*

8.3.5.1 *Requirements*

Mechanical means for sealing shall be provided for the gas-containing components of the meter case, where the failure of any seals and/or adhesives can cause external leakage, for example, at the junction of the top and bottom case of the meter.

8.3.5.2 *Test procedure*

Conduct a visual inspection of a fully assembled meter case to confirm the presence of appropriate mechanical means of sealing. Record the result as pass or fail.

8.3.6 *Connections*

8.3.6.1 *Orientation*

8.3.6.1.1 *Requirements*

The connections of meters with top mounted two pipe connections shall have the centrelines of these connections within 1° of vertical, with respect to the horizontal plane of the meter.

The distance between the centrelines of the connections, measured at the free end of the connections, shall be within ± 0.5 mm of the nominal distance between centrelines, or within ± 0.25% of the nominal distance between centrelines, whichever is the greater, and the centrelines shall be within 1° of being parallel.

The free ends of the connections shall be level within 2 mm, or within 1 percent of the nominal distance between the centrelines of the connections, whichever is the greater, with respect to the horizontal plane of the meter.

8.3.6.1.2 *Test procedure*

Take measurements using appropriate instruments, capable of measuring to an accuracy better than that required in **8.3.6.1.1**.

Record the result as pass or fail.

8.3.6.2 *Threads and flanges for single and two pipe meters*

8.3.6.2.1 *Requirements*

The threads of threaded meter connections on two pipe meters shall be as specified by the meter manufacturer.

Flanges of flanged meter connections shall have dimensions which are in accordance with one of the types of flanges given in IS 6392 as declared by the meter manufacturer.

NOTE — The fact that the dimensions are taken from IS 6392 does not denote that the meter has a pressure rating of 10 bar.

8.3.6.2.2 *Test procedure*

Measurements are taken using appropriate instruments capable of measuring to an accuracy better than that required in **8.3.6.2.1**.

8.3.6.3 *Strength*

8.3.6.3.1 *Torque*

8.3.6.3.1.1 *Requirements (tolerances to be given as per OIML)*

The meter connection shall be subjected to the appropriate torque specified in Table 10, in accordance with **8.3.6.3.1.2,** and shall then conform to the following:

a) External leak tightness (*see* **8.3.3**); and
b) Any residual rotational deformation of the meter connection shall not exceed 2°.

Table 10 Torque and Bending Moment
(*Clauses* 8.3.6.3.1.1, 8.3.6.3.2.1 and B-2.1.1.3)

Nominal connection diameter		**Torque value**	**Bending moment, M**
(Inches)	**DN**, (mm)	(Nm)	(Nm)
(½)	15	$50\ ^{+5\%}_{-0}$	10
¾	20	$80\ ^{+5\%}_{-0}$	20
1	25	$110\ ^{+5\%}_{-0}$	40
1 ¼	32	$110\ ^{+5\%}_{-0}$	40
1 ½	40	$140\ ^{+5\%}_{-0}$	60
2	50	$170\ ^{+5\%}_{-0}$	60
2 ½	65	$170\ ^{+5\%}_{-0}$	60
3	80	$170\ ^{+5\%}_{-0}$	60
4	100	$170\ ^{+5\%}_{-0}$	60
5	125	$170\ ^{+5\%}_{-0}$	60

8.3.6.3.1.2 *Test procedure*

Firmly support the case of the meter under test and apply the appropriate torque value to each connection in turn using a suitable torque wrench. Measure the residual rotational deformation of each meter connection. After the torque test carryout external leak test as per **8.3.3**.

Report the result as pass or fail.

8.3.6.3.2 *Bending moment*

8.3.6.3.2.1 *Requirements*

Each meter shall be subjected to the bending moment given in Table 10 in accordance with **8.3.6.3.2.2** and, during and after the test, the meter shall remain leak tight in accordance with **8.3.3**.

Before the bending moment test, the meter under test shall be tested in accordance with the method given in **7.1.2 d)**. The errors of indication shall be within the allowed MPE limit, given in Table 3a and for meters with gas pressure and /or temperature conversion device given in Table 3b.

After the test, the residual deformation of the connections shall not exceed 5°.

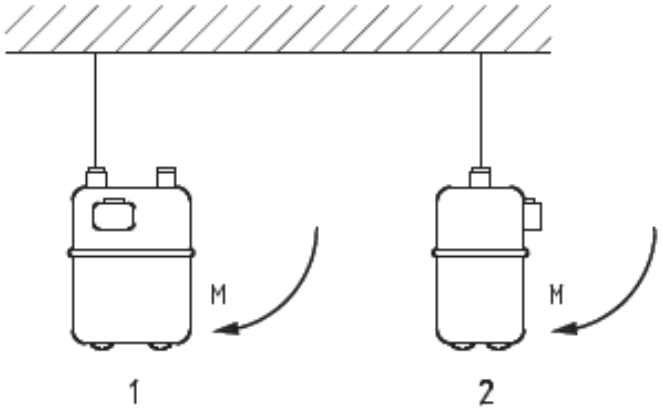
After the bending moment test, the meter under test shall be retested in accordance with the method given in **7.1.2 d)**. The errors of indication shall be within the allowed MPE-Subsequent limit, given in Table 3a and for meters with gas pressure and/or temperature conversion device given in Table 3b.

8.3.6.3.2.2 *Test procedure*

Rigidly support the meter under test by one of its connections (*see* Fig. 1a) and subject to the appropriate bending moment for a period of 2 min. Use different meters for the lateral test(s) and the fore and aft test.

Repeat the lateral bending moment test on the other meter connection, but for the fore and aft test, support the meter by both connections.

Report the result as pass or fail.



a) Two pipe

Key

1 Lateral
2 Fore and after (both ports rigidly connected)
M Bending moment

FIG. 1A ARRANGEMENT FOR BENDING MOMENT TEST

8.3.7 *Resistance to Vibration*

8.3.7.1 *Requirements*

Before and after the vibration tests, the error of indication shall be within the maximum permissible initial error limits, given in Table 3a and for meters with gas pressure and/or temperature conversion device given in Table 3b and the meter shall remain leak tight when tested in accordance with **8.3.3**.

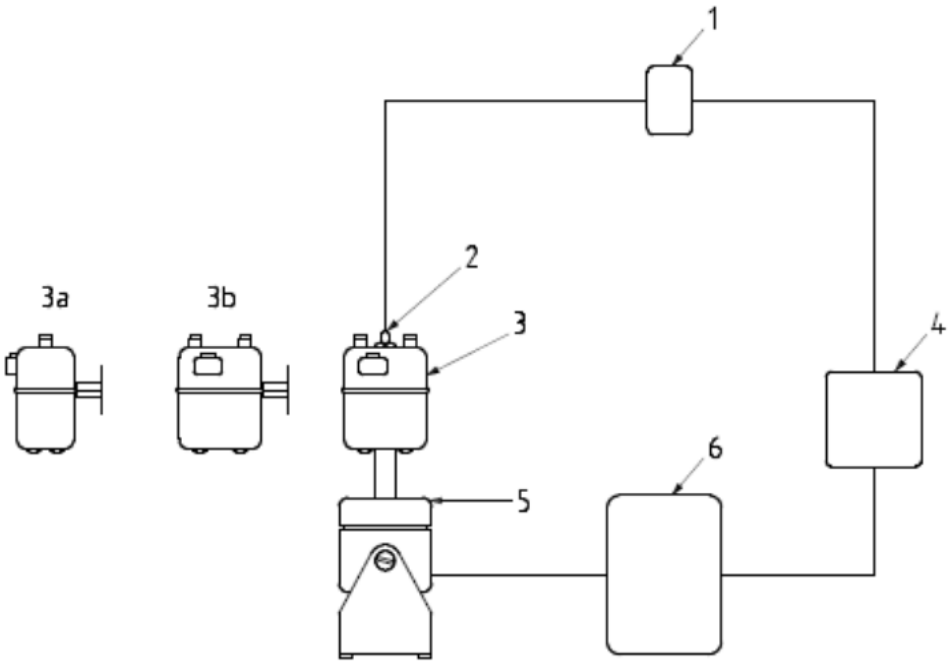
The resistance to vibration is determined by vibrating the meter under test using an electro-dynamic shaker. The test shall be conducted in accordance with IS/IEC 60068-2-6.

8.3.7.2 *Test procedure*

Carry out the error of indication test specified in **7.1.2 c)**, to ensure that the accuracy of the meter under test is within the maximum permissible initial error limits, given in Table 3a and for meters with gas pressure and/or temperature conversion device given in Table 3b, and confirm that the meter under test is leak tight, by carrying out the test described in **8.3.3**.

Secure the meter under test to the vibration test rig, as shown in Fig. 1b using a horizontal clamp across the top of the meter. Meter shall always be mounted in installation orientations. If more installation orientations are defined by manufacturer, then this test shall be carried out for all orientations but on separate meter samples.

The apparatus described in Fig. 1b shall be used to undertake the test.



Key

1 Charge amplifier, used to condition the output from the piezoelectric transducer (2)
2 Accelerometer (piezoelectric transducer)
3 Meter under test (vertical plane), mounted to spindle of electrodynamic shaker (5)
3a Meter under test (fore and aft plane)
3b Meter under test (lateral plane)
4 Automatic vibration exciter control, capable of being used in a sweeping mode in which the frequency is cycled between a pair of selected frequencies, alternatively increasing and decreasing
5 Electrodynamic shaker, driven by an amplified sine wave from a voltage generator
NOTE — The head of the shaker can be rotated through 90° for fore and aft planes (*see* 3a and 3b)
6 Power amplifier, suitable for anything the power of the accelerometer

FIG. 1B LAYOUT OF THE VIBRATION TEST APPARATUS

Input and output ports shall be capped properly. The clamping force should be sufficient to restrain the meter under test without causing damage or distortion to the meter case.

Subject the meter under test to a swept frequency of between 10 Hz and 150 Hz at a sweep rate of 1 octave per min with a peak acceleration of $2g_n$ for 20 sweeps in the vertical plane, 20 sweeps in the fore-aft plane and 20 sweeps in the lateral plane. The displacement amplitude shall be limited to 0.35 mm.

Recheck the error of indication of the meter under test by carrying out the test specified in **7.1.2 c)** and confirm the leak tightness by carrying out the test described in **8.3.3**.

Report the result as pass or fail.

NOTE — An octave is a band of frequency where the upper frequency limit of the band is exactly twice the lower limit, for example, 10 Hz to 20 Hz, 20 Hz to 40 Hz, 40 Hz to 80 Hz and 80 Hz to 160 Hz. Therefore, the time taken to sweep from 10 Hz to 100 Hz at a sweep rate of 1 octave per minute is 3 min 15 s.

8.3.8 *Resistance to Impact*

8.3.8.1 *Requirements*

After being subjected to an impact load using the method described in **8.3.8.3**, the meter shall remain leak tight when tested in accordance with **8.3.3**.

8.3.8.2 *Apparatus*

The test apparatus consists of a hardened steel hemispherical tipped striker and a rigid smooth-bore tube in which the striker is capable of sliding freely (*see* Fig. 2).

The total mass of the striker is 3 kg. There are two sizes of striker tip, one with a radius of 1 ± 0.1 mm, the other with a radius of 4 ± 0.2 mm (*see* Fig. 3).

8.3.8.3 *Test procedure*

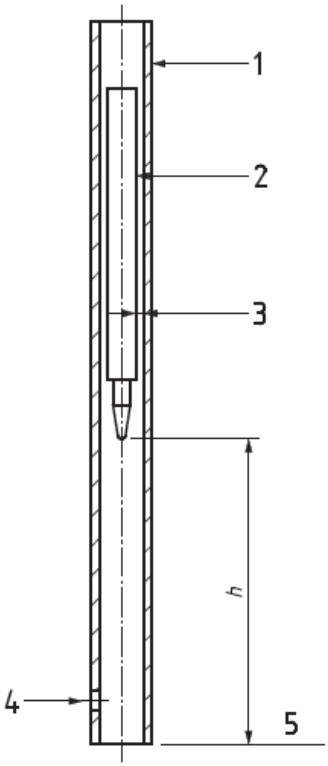
a) Carry out the external leak tightness test in accordance with **8.3.3**.

b) Use each size of striker tip during the test, but do not subject any test area on any one-meter sample to more than one impact. If the same area is selected for testing with each size of striker tip, use a second meter sample.

c) For each strike, rigidly support the meter under test on a firm base with the intended area of impact. This can be any area of the meter case, providing the striker can hit the case perpendicular to the most unfavourable chosen plane. Place the end of the guide tube on the chosen impact area of the meter under test. Allow the striker to fall freely and vertically through the tube onto the test area. The striker tip falls from a height of h mm above the test area, where:

1) For the 1 mm striker, h is 100 mm, producing an impact energy of 3 J (+/- 1%).
2) For the 4 mm striker, h is 175 mm, producing an impact energy of 5 J (+/- 1%).
3) The height/mass may be fine adjusted to get the required energy level.
4) Again, carry out the external leak tightness test in accordance with **8.3.3**.

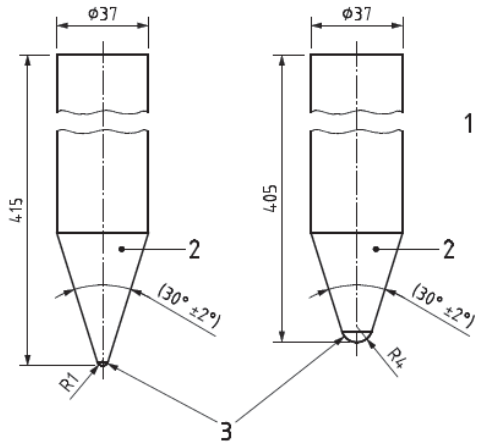
Report the result as pass or fail.



Key

1 Smooth bore rigid tube
2 Hardened hemispherical tipped striker, mass 3 kg
3 Radial clearance (0.5 ± 0.25 mm)
4 Vent hole
5 Meter level h height in mm above the test area (*see* **8.3.8.3**)

FIG. 2 IMPACT TEST APPARATUS



Key

1 Striker, total mass 3 kg
2 Steel tip, angle 30° ± 2°
3 Hardened steel ball; R1 = 1 (+/-0.1 mm) mm radius, R4 = 4 mm (+/- 0.2 mm) radius (*see* Fig. 3)

FIG. 3 TYPICAL HEMISPHERICAL TIPPED STRIKERS USED IN IMPACT TEST

8.3.9 *Resistance to Mishandling*

8.3.9.1 *Requirements*

The meter shall withstand the handling required during its transport and installation. Before testing in accordance with **8.3.9.2**, the meter under test shall conform to the following:

a) After testing in accordance with **8.3.3.2** the requirements of **8.3.3.1** for external leak tightness shall be met;
b) After testing in accordance with **7.1.2 c)**, the errors of indication are within the allowed MPE-initial limit given in Table 3a and for meters with gas pressure and/or temperature conversion device given in Table 3b; and
c) After testing in accordance with **7.8.2**, the pressure drop is within the allowed initial maximum permissible pressure drop given in Table 9.

After undergoing the mishandling test described in **8.3.9.2**, the meter under test shall conform to the following requirements:

a) When retested in accordance with **8.3.3.2** the meter still meets the requirements for external leak tightness in **8.3.3.1**;
b) When retested in accordance with **7.1.2 c)**, the meter's errors of indication are within the allowed MPE-Subsequent limit given in Table 3a and for meters with gas pressure and/or temperature conversion device given in Table 3b; and

c) When retested in accordance with **7.8.2** the average pressure drop is within the subsequent maximum permissible value given in Table 9.

8.3.9.2 *Test procedure*

Hold the meter under test, with no packaging, in the upright position (in its horizontal plane), and drop vertically, from rest, on to a flat, hard (for example, concrete), horizontal surface from a height as given in Table 11. The heights given refer to the distance from the bottom of the meter under test to the surface onto which it will fall.

Table 11 Drop Height
(*Clause* 8.3.9.2)

Q_{max} (m^3/h)	**Height of dropping** (m)
up to 10	0.5
16 to 65	0.3
100 and 160	0.2

Report the result as pass or fail.

8.4 Corrosion Protection

8.4.1 *General*

Meters, to which only decorative coatings (that is, coatings not intended to contribute to corrosion protection) are to be applied, shall be tested before application of the coating. Such decorative coatings shall not adversely affect the corrosion resistance of the meter.

All parts of meters shall be able to resist any corrosive substances contained in the internal and external atmospheres that they can expect to be exposed to during normal conditions of storage and use.

All tests shall be performed on the gas-containing components of the meter itself or on sample plaques. Sample plaques shall only be used in place of a component if no forming operations are carried out on the component after the protective finish is applied else finished component shall be tested.

Sample plaques, if used, shall be 100 mm × 100 mm, their thickness being that of the component they are replacing. The finishes on items supplied for test shall have been fully dried and cured.

Attack on the edges or up to 2 mm from the edge of sample plaques shall be ignored if the component it replaces has no exposed edges when installed in the finished meter.

8.4.2 *External Corrosion*

8.4.2.1 *Scratch resistance of the protective coating*

When tested using the method given in IS 101 (Part 5/Sec 1 & 2) using a loading of 19.5 N, corrodible base material shall not be exposed.

Where a metallic protective coating is applied directly onto a metal surface, the indicator lamp will light without any penetration of the surface. In this case the surface shall be visually inspected for penetration.

8.4.2.2 *Adhesion of the protective coating*

When tested in accordance with cross cut adhesion test given at **6** of IS 101 (Part 5/Sec 2). The coated panel is considered to satisfy the test if no peeling or removal of the film is observed.

8.4.2.3 *Impact resistance of the protective coating*

When tested using the method given in IS 101 (Part 5/Sec 5) for impact resistance using a falling height of 0.5 m and with the depth of the indentation limited to 2.5 mm, there shall be no cracking or loss of adhesion of the protective coating.

During the test, place the surface of the test piece which would normally be the outside surface of the meter, so that it faces upwards.

8.4.2.4 *Chemical resistance of the protective coating*

8.4.2.4.1 *Requirements*

After testing in accordance with **8.4.2.4.2**, any blistering of the protective coating shall be less than that given as the degree of blistering 2/(S2) in Fig. 1 a) of ISO 4628-2, and the degree of corrosion shall be not greater than that given as Ri 1 in table 1 of ISO 4628-3.

The sample used for these tests shall be complete meters.

8.4.2.4.2 *Test procedure*

Test in accordance with IS 101 (Part 7/Sec 2), **4.4**, procedure A (using a single phase liquid), using a test period of 168 h.

During the tests, immerse at least 30 percent of the sample in the liquid, including the area at which the meter case joins the meter connection, a separate sample being used for each of the following liquids:

a) Mineral oil - ASTM oil Nr.2 according to ASTM D 471 (Aniline point 93 ± 3°C / Viscosity 19.2 mm^2/s to 21.5 mm^2/s at 99°C)
b) Ethanol (C_2H_5OH)
c) 5 percent aqueous solution of sodium salts of sulphated broad cut primary alcohol, chain length C9 to C13, pH values 6.5 to 8.5 (for example, Shell Teepol HB72) ($N_2SO_4(CH_2)_xOH$)

8.4.2.5 *Resistance to salt spray*

The sample used for this test shall be a complete meter for sizes of meter having a Q_{max} of up to and including 10 m^3/h and a representative part of the meter, which include at least one connection, for meters above this size.

When tested in accordance with IS 5528, using a salt solution with the pH-Value given in IS 5528, **5.2.2** (neutral salt spray test), the sample shall be exposed to the salt spray over 500 h and the degree of corrosion of the base material shall not be greater than that given as Ri 1 in ISO 4628-3, Table 1.

8.4.2.6 *Resistance to humidity*

The sample used for this test shall be a complete meter for sizes of meter having a Q_{max} of up to and including 10 m^3/h and a representative part of the meter, which includes at least one connection, for meters above this size.

When tested in accordance with IS 101 (Part 6/Sec 1) using a test duration of 500 h, any blistering of the coating shall be less than that given as the ratio density 2/size 2 ISO 4628-2, and the degree of corrosion of the base material shall be not greater than that given as Ri 1 in ISO 4628-3, Table 1. The test shall be carried out on representative parts of the meter, for example deep-drawn parts, which should be cut out of a sample meter.

Report the result as pass or fail.

8.4.3 *Internal Corrosion*

8.4.3.1 *Adhesion of the protective coating*

When tested in accordance with **8.4.2.2**, the coated panel is considered to satisfy the test if no peeling or removal of the film is observed.

8.4.3.2 *Impact resistance of the protective coating*

When tested in accordance with **8.4.2.3**, there shall be no cracking or loss of adhesion of the protective coating at the side, which is normally the inner side.

8.4.3.3 *Chemical resistance of the protective coating*

When tested in accordance with **8.4.2.4**, the blistering of the protective coating shall be less than that given as the ratio density 2/size 2 in ISO 4628-2, and the degree of corrosion of the base material shall not be greater than that given as Ri 1 in ISO 4628-3, Table 1.

8.4.3.4 *Resistance to humidity*

When tested in accordance with **8.4.2.6** using a test duration of 48 h, any blistering of the coating shall be less than that given as the ratio density 2/size 2 in ISO 4628-2, and the degree of corrosion of the base material shall not be greater than that given as Ri 1 in ISO 4628-3, Table 1.

8.5 Resistance to Storage Temperature Range

8.5.1 *Requirements*

Before and after testing in accordance with **8.5.2** the meter shall be within the MPE-Initial error limits specified in Table 3a and for meters with gas pressure and/or temperature conversion device given in Table 3b.

Also, the variation in error shall be within one-half the MPE limits specified in Table 3a and 3b as applicable.

8.5.2 *Test Procedure*

For each meter under test (*see* Fig. 5):

a) Carryout test as per **7.1.2 c)** using air at temperature 20 ± 1°C.
b) For this test gas meter should be considered as non-heat dissipating equipment.
c) Meter should be placed in environmental chamber in such a way that there is no flow of air through it. For this purpose, input and output ports shall be capped.
d) Over a period of at least 2 h bring the meter under test to a temperature of -20°C and maintain it at this temperature for 24 h with no gas flowing through it. Input & output ports shall be sealed properly before putting it to test.
e) Over a period of at least 2 h, return the meter to normal laboratory ambient temperature and test it in accordance with **7.1.2 c)** using air at temperature 20 ± 1°C.
f) Over a period of at least 2 h bring the meter under test to a temperature of 70°C and maintain it at this temperature for 24 h with no gas flowing through it. Input & output ports shall be sealed properly before putting it to test.
g) Over a period of at least 2 h, return the meter to normal laboratory ambient temperature and test it in accordance with **7.1.2 c)** using air at temperature 20 ± 1°C.

Report the result as pass or fail.

8.6 Optional Features (To be declared by Manufacturer)

8.6.1 *Electrical Insulating Feet*

8.6.1.1 *Requirements*

If insulating feet are provided on the meter, there shall be a minimum of 4 and they shall give a minimum clearance of 5 mm at the base of the meter.

After carrying out the test specified in **8.6.1.2**, the electrical resistance measured shall not be less than 100 kΩ.

Whilst carrying out the 650 V AC test specified in **8.6.1.2**, there shall be no breakdown of the insulation.

8.6.1.2 *Test procedure*

Place the meter under test on a flat metal plate and apply a potential of 500 V DC between the metal plate and each meter connection in turn for 60 s. Measure the electrical resistance between the metal plate and each connection successively.

Then apply a potential of 650 V AC between the metal plate and each meter connection, successively, for 60 s.

Report the result as pass or fail.

8.6.2 *Magnetic Index Drive*

8.6.2.1 *Requirements*

If a magnetic index drive is provided on the meter, the torque transmission of the magnetic drive unit shall be at least three times that required to drive the index when all of the index digits are in motion (that is, all the nines to all the zeros) and when measured after the index has been operated to record an equivalent volume of gas to that passing through the meter during the entirety of any endurance test carried out on the meter.

NOTE — Additional devices, such as reed switches, are considered to be part of the index.

8.6.2.2 *Test procedure*

Run a new index assembly, which has been supplied by the manufacturer, with the reading being approximately all the nines minus a reading equivalent to an equivalent volume of gas to that passing through the meter during the endurance test. The test is run until the reading is all the nines. Measure the torque to move the index drives to the all zeros position. Compare this measured torque with the available torque of the magnetic drive unit of the meter under test.

Report the result as pass or fail.

8.6.3 *Devices to Prevent the Registration of Reverse Flow*

8.6.3.1 *Requirements*

Meters fitted with a device to prevent the registration of reverse flow shall not allow the registration of volume (in m^3) more than 5 cyclic volumes in m^3, when subjected to reverse flow.

8.6.3.2 *Test procedure*

Note the index of the meter under test. Connect a source of pressure of 20 ± 3 mbar to the meter outlet, the meter inlet being open to atmosphere but controlled such that flow rate shall be adjusted to Q_{max}. Observe the index until it has stopped decreasing and again note the reading of the index.

Calculate the registration of reverse flow as the initial index reading noted minus the final index reading noted.

Report the result as pass or fail.

8.6.4 *Devices to Prevent Reverse Flow*

8.6.4.1 *Requirements*

Meters fitted with a device to prevent reverse flow shall not pass a reverse flow of more than 2.5 percent of Q_{max} (for example, for a meter having a Q_{max} of 6 m^3/h, reverse flow shall not exceed 0.15 m^3/h).

8.6.4.2 *Test procedure*

Connect a source of pressure to the meter outlet, via a flow measurement device, so that the pressure at the meter outlet is 20 ± 3 mbar with the meter inlet open to the atmosphere. Measure the average reverse flow through the meter under test using the flow measurement device.

Report the result as pass or fail.

8.6.5 *Pressure Measuring Point*

8.6.5.1 *Requirements*

The pressure measuring point shall be provided on the meter and it shall:

a) Be fixed by mechanical means (that is, not only relying on solder, brazing or adhesive);
b) Have a hole, through the pressure measuring point, the diameter of which shall be less than 1 mm; and
c) Before and after carrying out tests specified in **8.6.5.2**, the meter shall remain leak tight when tested in accordance with **8.3.3**.

8.6.5.2 *Test procedure*

Measure the diameter of the hole through the pressure measuring point.

Test the meter for leak tightness in accordance with **8.3.3**.

Apply a torque of 8 Nm to the body of the pressure measuring point in a clockwise and anti-clockwise direction and then release. Drop a mass of 0.5 kg from a height of 250 mm, through a vertical tube of 40 mm maximum diameter on to the outer extremity of the body diameter of the pressure measuring point.

Recheck the meter under test for leak tightness in accordance with **8.3.3**.

Report the result as pass or fail.

8.6.6 *Resistance to High Temperatures*

8.6.6.1 *Requirements*

The meter shall be resistant to high temperatures and shall conform to the following requirement and shall be marked in accordance with **6.1**.

When tested in accordance with **8.6.6.3**, the leakage rate of the meter case shall not exceed 150 dm^3/h for meters of size up to and including those having a Q_{max} of 40 m^3/h, or 450 dm^3/h for meters of sizes Q_{max} of 65 m^3/h and above.

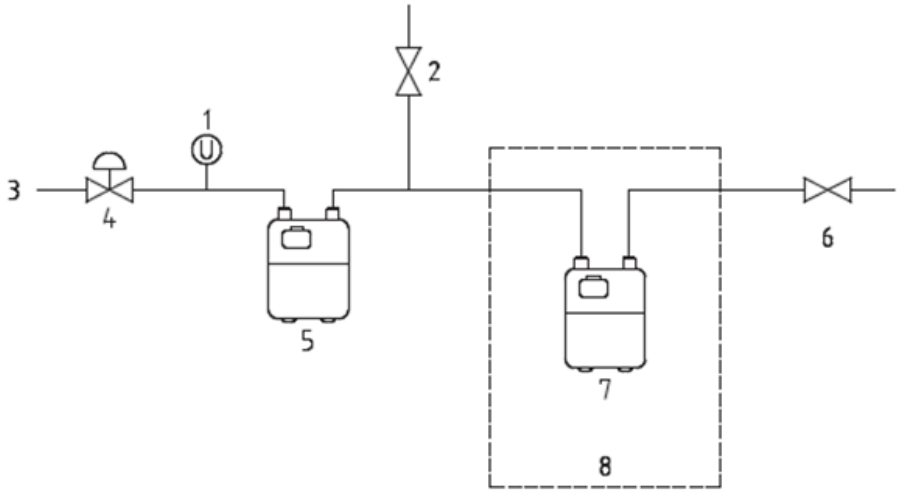
Remove the battery/electronics prior to testing at high temperature.

NOTE — To avoid blocking of the outlet connections by condensation of materials distilled from the internal components of the meter under test, it is to carry out the test on an empty meter case with finished coatings if any, supplied as such by the manufacturer.

8.6.6.2 *Apparatus*

Furnace, capable of allowing an ambient temperature rise conforming to the curve defined in IS/ISO 834-1. The internal dimensions of the furnace shall allow the installation of the meter under test and its connections to be in identical positions to those used in practice.

Pressure regulator, capable of maintaining a constant pressure equal to 100 ± 5 mbar during the complete test.



Key

1 Manometer
2 Bleed valve
3 Inlet
4 Pressure regulator
5 Check meter
6 Air purge valve
7 Meter (or meter box) under test 8 furnace

FIG. 4 EXAMPLE OF A HIGH TEMPERATURE TEST APPARATUS

8.6.6.3 *Test procedure*

If meter under test is a complete meter, remove the battery/electronics prior to testing at high temperature. Connect the meter (or the meter case) under test to the inlet and outlet connections and install the assembly in the center of the furnace using supports if necessary (*see* Fig. 4).

NOTES

1. Where an empty meter case is being tested, it is necessary to take into account the mass of the metering apparatus and, if necessary, a metal weight piece equivalent to the mass of the metering apparatus is to be put on the case.

With the bleed valve closed, pressurize the meter under test to 100 ± 5 mbar with nitrogen and verify no leakage before raising the temperature.

2. 100 mbar is the test pressure for resistance to high temperatures which shall not be confused with p_{max}.

With the meter under the nitrogen test pressure, increase the temperature of the furnace in accordance with the temperature rise curve of IS/ISO 834-1.

When the pressure is stabilized to 100 mbar and temperature at the coldest point of the meter under test reaches 650°C, set the furnace temperature to maintain a constant temperature of 650°C for a period of 30 min.

During the complete test, maintain the pressure in the meter under test at the test pressure by means of the bleed valve. Record the leakage rate as registered using metering periods not exceeding 5 min. Calculate the leakage as the metered nitrogen volume divided by the measuring time.

Report the result as pass or fail.

8.6.7 *Gas Meters Provided with a Built-In Gas Temperature and/or Pressure Conversion Device*

Tests for gas meters provided with a built-in gas pressure and/or temperature conversion device are same as normal gas meters except requirements, which are separately mentioned in respective clauses of this standard.

8.6.8 *Additional Functionalities*

Requirements for additional functionalities are given in **12** of this document.

9 MECHANICAL PERFORMANCE

9.1 Meter Assembly

9.1.1 *Meter Error of Indication at Gas Temperature Limits*

9.1.1.1 *Requirements*

Over the gas temperature and ambient temperature range (-10°C to 40°C), at the flow rates of Q_{min}, Q_{max}, and any one of the flow rates between Q_t to Q_{max} as defined in **7.1.2 a)**, the errors of indication of meters shall be within the maximum permissible initial limits given in Table 3a.

For meter with gas pressure and/or temperature conversion device, the errors of indication of meters shall be within the maximum permissible initial limits given in Table 3b.

9.1.1.2 *Test procedure*

Install the meter to be tested in a temperature-controlled chamber which is supplied with air at normal laboratory temperature, t_1, (20 ± 1°C), with a constant pressure not exceeding the maximum working pressure of the meter under test and a relative humidity such that its dew point is at least 10 K lower than the test temperature.

Lower and maintain the temperature of the chamber to (-10 0^{+2})°C. Pass the air through a heat exchanger then to meter under test, so that the temperature of the air entering the meter is (-10 0^{+2})°C (*see* Fig. 5). Make sure that the temperatures of the air, the meter and the temperature inside the temperature-controlled cabinet are within 1 K.

Stabilize the temperatures, and keep within ± 1.0 K during the measurement periods. After verifying that the temperature t_2 is stable within the above limits, that is, (-10 0^{+2})°C, check the error of indication of the meter under test using the method given in **7.1.2 d)**, except that the above temperature is maintained, using the equation given below.

Verify that this error of indication is within the MPE-Initial limits given in Table 3a and for meter with gas pressure and /or temperature device Table 3b. Carryout this test at (+40-2^{+0}) °C. Verify that this error of indication is within the MPE-Initial limits given in Table 3a and for meter with gas pressure and/or temperature conversion device, given in Table 3b.

$$V_c = V_{in} \frac{T_2}{T_1} \frac{P_1}{P_2} \qquad (5)$$

where

V_c Actual volume passed through the meter, in m^3;
V_{in} Actual volume passed into the temperature-controlled chamber, in m^3;
T_1 (t_1 + 273.15), in Kelvin;
T_2 (t_2 + 273.15), in Kelvin;
P_1 Absolute pressure measured at the inlet of temperature-controlled chamber, in Pa;
P_2 Mean value of absolute pressure measured at the meter inlet, in Pa.

And

$$E = \left(\frac{V_i - V_c}{V_c} \right) \times 100 \qquad (6)$$

where

E Error indication, expressed as a percentage;
V_i Volume indicated by the meter, in m^3;
V_c Actual volume passed through the meter, in m^3.

Verify that this error of indication is within the MPE-Initial limits given in Table 3a and for meter with gas pressure and/or temperature conversion device table 3b.

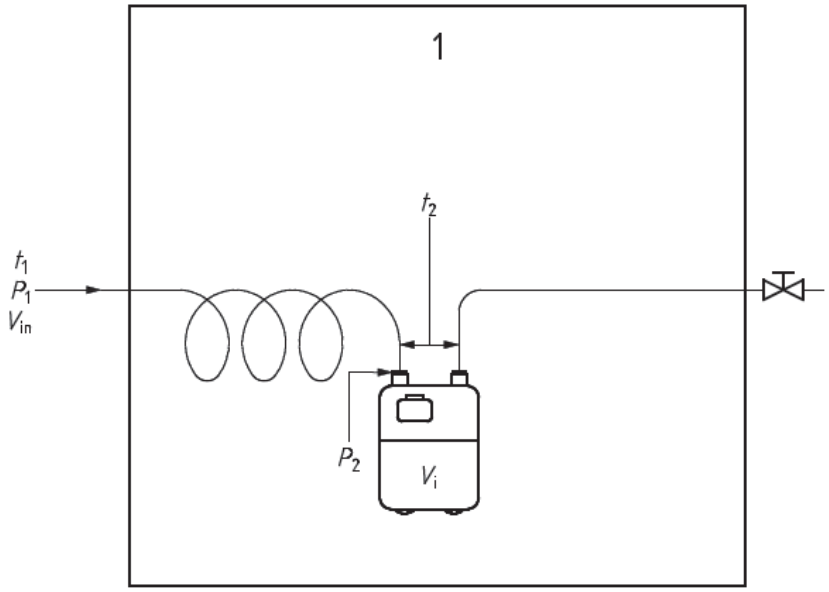


FIG. 5 EXAMPLE OF TEST RIG FOR DECLARED GAS AND AMBIENT TEMPERATURES TESTS

9.1.2 *Error of Indication Subject to Ambient Temperature Limits*

9.1.2.1 *Requirements*

Over the ambient temperature range declared by the manufacturer, between the flow rates of Q_{min} and Q_{max}, the errors of indication of meters shall remain within the MPE-Subsequent limits given in Table 3a. For meter with gas pressure and/or temperature conversion device, the errors of indication of meters shall remain within the MPE-Subsequent limits given in Table 3b.

9.1.2.2 *Test procedure*

Check the error of indication of the meter under test using the method given in **7.1.2 d)**, at (20 ± 1°C). Verify that this error of indication is within the MPE-Initial limits given in Table 3a and for meter with gas pressure and/or temperature conversion device Table 3b.

Install the meter to be tested in a temperature-controlled chamber which is supplied with air at normal laboratory temperature, t_1, (20 ± 1°C), with a constant pressure not exceeding the maximum working pressure of the meter under test and a relative humidity such that its dew point is at least 10 K lower than the test temperature.

Lower and maintain the temperature of the chamber to (-100^{+2}) °C. Pass the air through a heat exchanger then to meter under test, so that the temperature of the air entering the meter is (-100^{+2}) °C (*see* Fig. 5). Run the meter for 22 h at Q_{max} at minimum ambient temperature is (-100^{+2}) °C. On completion of this running period raise the temperature of the chamber and maintain at ($+55\text{-}2^{+0}$) °C. Pass the air through a heat exchanger then to meter under test, so that the temperature of the air entering the meter is ($+55\text{-}2^{+0}$)°C (*see* Fig. 5).

Run the meter for 22 h at Q_{max} at minimum ambient temperature is $(+55\text{-}2^{+0})$°C. On completion of this running period check the error of indication of the meter under test using the method given in **7.1.2 d)**, at (20 ± 1°C).

Verify that this error of indication is within the MPE-Subsequent limits given in Table 3a and that for meter with gas pressure and/or temperature conversion device, the errors of indication of meters is within the MPE-Subsequent limits given in Table 3b.

9.1.3 *Error of Indication Where the Gas and Ambient Temperatures Are Not Equal*

9.1.3.1 *Requirements*

Between the flow rate Q_t and Q_{max} when the ambient temperature differs by 20°C from the gas temperature, the errors of indication of the meter shall be within the MPE-Subsequent limits given in Table 3a and for meter with gas pressure and/or temperature conversion device, the errors of indication of meters shall remain within the MPE-Subsequent limits given in Table 3b.

9.1.3.2 *Test procedure*

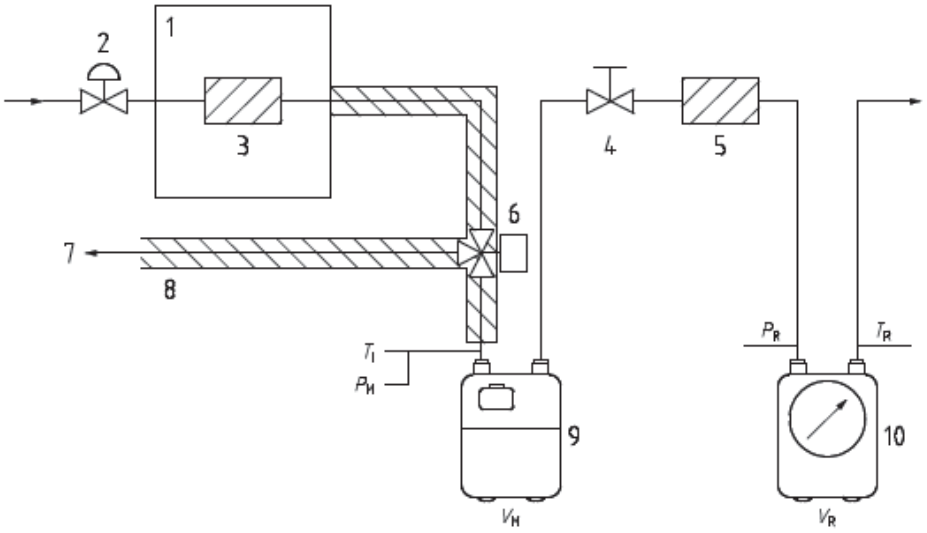
Carry out the following test in a laboratory ambient temperature T_m of (20 ± 1°C). Place the meter under test in a test rig (*see* Fig. 6). Carry out the test using a meter at T_m = 20 ± 1°C, for the duration of the test and using dry air at a flowing temperature of T_i = 40 ± 1°C. The difference in laboratory temperature at the test meter and at the reference standard shall not exceed 1 K.

Stabilize operating conditions before the volume measurements are taken. Determine the volume indicated and passed for each of the flow rates $0.1Q_{max}$, $0.4Q_{max}$ and Q_{max}. Calculate the error in the volume indicated by the equation given in **9.1.1.2**.

Repeat the test, but using dry air at a flowing temperature, T_i = (00+5)°C and a meter in an ambient temperature, T_m = 20 ± 1°C.

NOTES
1. Alternatively, the test can be performed while using the following temperature conditions;
2. Air flowing temperature, T_i, at = 20 ± 1°C and the meter ambient temperature, T_m, 40 ± 1°C; and
3. Air flowing temperature, T_i, at = 20 ± 1°C and the meter ambient temperature, T_m, (00+5)°C;

Verify that this error of indication is within the MPE-Subsequent limits given in Table 3a and that for meter with gas pressure and/or temperature conversion device, the errors of indication of meters is within the MPE-Subsequent limits given in Table 3b.



Key

1 Temperature-controlled cabinet
2 Pressure regulator
3 Heat exchanger
4 Flow regulator valve
5 Heat exchanger
6 Three way valve with actuator
7 Exhaust
8 Insulated pipework
9 Meter under test
10 Reference meter

FIG. 6 EXAMPLE OF TEST RIG USED FOR TESTS WHERE THE TEMPERATURE AT THE METER INLET IS NOT EQUAL TO THE AMBIENT TEMPERATURE OF THE AIR SURROUNDING THE METER

9.2 Index

9.2.1 *Construction Details*

9.2.1.1 *Requirements*

Meters shall be fitted with a metrologically controlled mechanical or electronic index. The index shall be easily readable without the use of tools.

In addition to the requirements given in **9.2**, an electronic index shall also conform to the requirements of **12** of this standard.

The index shall operate satisfactorily for the normal life of the meter under normal conditions of use. The index shall be non-resettable, non-volatile and protected with a metrological seal.

An index shall have at least a sufficient number of numerals to ensure that the volume passed during 8000 h at a flow rate of Q_{max} does not return all of the numerals to their original positions.

The numerals shall indicate in cubic metres, decimal multiples or sub-multiples of a cubic metre. The symbol m^3 shall be marked on the index plate/display close to the number wheels/display of the index.

The numerals indicating the sub-multiples of the cubic metre shall be clearly distinguishable from the other numerals and they shall be separated from the other numerals by a clearly marked decimal sign.

In cases in which the last numeral indicates in decimal multiples of a cubic metre, the index plate shall be marked with either:

a) One or more fixed zeros as appropriate, after the last numeral; or
b) The indication x10, x100 etc., in such a way that the reading is always given in cubic metres.

The minimum height of the numerals for the metrological data shall be 4 mm and the minimum width shall be 2.4 mm.

Indexes shall be designed in such a way that testing the meters can be carried out with sufficient accuracy in a reasonable time and the resolution of the index shall conform to Table 12.

It shall be possible to read the index clearly and correctly, within an angle of 15° from normal to the window, within the ambient temperature range of -10°C to 55°C.

Table 12 Resolution of meter index
(*Clause* 9.2.1.1)

Q_{max} (m^3/h)	**Numbering Every (**dm^3)	**Maximum scale interval of a mechanical index** (dm^3)	**Maximum resolution of an electronic index**
up to 10 inclusive	1	0.2	The increment of the test element or pulse shall occur at least every 60 s at Q_{min}
16 to 100 inclusive	10	2	
160	100	20	

For a mechanical index, a complete revolution of a drum shall, during the last tenth of its travel, that is, from 9 to 0, cause the advance of the next higher drum by one unit.

NOTE — For a mechanical index, the test element can be a continuously moving drum bearing a scale, where each subdivision on the drum is regarded as an increment of the test element.

For an electronic index, the maximum resolution shall be achieved without any special equipment or software and may be activated in a test mode, in which case it shall be described in the operational manual. In case there is no specific test element available the least significant digit of the indicating device is considered as a test element. If a meter with an electronic index is constructed in such a way that the signal

of the measuring part is produced in discrete steps this internal resolution shall be equivalent or more accurate than the increment of the test element.

Example:

> Diaphragm gas meters with an electronic index, with a maximum flow rate Q_{max} of 6 m^3/h and a minimum flow rate of 40 dm^3/h need to have a test element of at least 40/60 = 0.67 dm^3. Also, the resolution of the transfer of the rotation of the measuring part into electronic pulses needs to be at least 0.67 dm^3/pulse.

For electronic index, the segmental display index shall have a facility to display all its segments (that is, display registers all 8 s) and then display no segments (that is, blank display). This shall either occur periodically, the period not to exceed one minute, for a maximum duration of 5 s, or, through the use of an injected test signal.

When the above display is discontinued, the display shall automatically revert to reading its updated volume measurements and the memory register shall not have been disturbed.

If test signal injection is used, the means of initiating this test signal injection shall be capable of being sealed such that unauthorized interference is detectable, and such that the metrological seal need not be broken to operate this facility.

9.2.1.2 *Test procedure*

Conduct a visual inspection to check conformance to **9.2.1.1**. For segmental display index requirements, conduct a visual inspection and by using suitable measuring equipment where appropriate, time the various states of display. If appropriate to the test, inject the test signal in accordance with the method agreed between the manufacturer and the test house.

9.2.2 *Index Windows and Surround*

9.2.2.1 *Requirements*

The index window and its surround shall be made of materials which shall withstand the impact test given in **9.2.2.2** and shall be held firmly in position, both as supplied, and after being subjected to the ageing test given in **9.3.3**.

9.2.2.2 *Test procedure*

Drop a solid steel ball of 25 mm diameter 3 times from a height of 350 mm on to the center of the index window, normal to its plane, whilst the window, fitted in the meter as in operation, is maintained at a temperature of (-5 ± 1)°C.

9.3 Components in Gas Path

9.3.1 *Toluene/Iso-Octane Vapour Test*

9.3.1.1 *Requirements*

For pre-test as per **9.3.1.4.1**, the error of indication, using air, when checked by the method given in **7.1.2 c)**, shall be within the MPE-Initial limits given in Table 3a.

For meter with gas pressure and/or temperature conversion device, the errors of indication of meters shall be within the MPE-Initial limits given in Table 3b.

For Test-1 as per **9.3.1.4.2**, at the end of each 7-day period during Test 1, the error of indication, when checked by the method given in **7.1.2 c)**, shall not have changed by more than 3 percent from that determined at the pre-test.

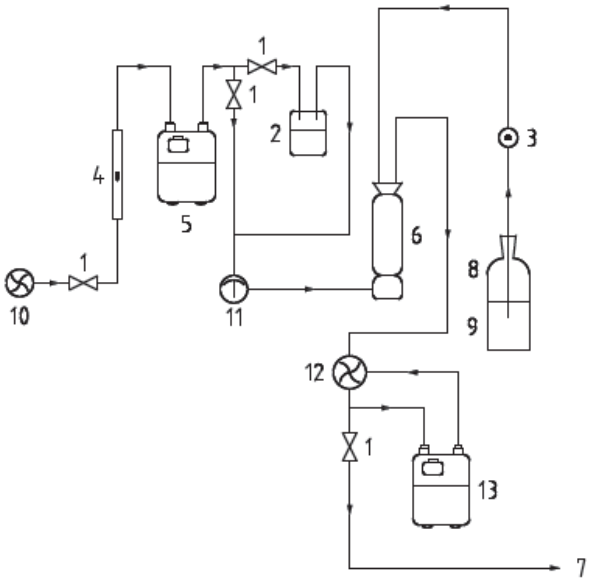
On completion of Test 2, given in **9.3.1.4.3**, the error of indication, when checked by the method given in **7.1.2 c)**, shall be within the MPE-Initial limits given in Table 3a.

For meter with gas pressure and/or temperature conversion device, the errors of indication of meters shall be within the MPE-Initial limits given in Table 3b.

9.3.1.2 *Apparatus*

An example of typical apparatus is given in Fig. 7. The apparatus consists of the following components:

a) Meter exercise rig, open to atmosphere, fitted with a suitable circulating pump or blower.
b) Nitrogen supply with a flow rate measurement capability (flow meter, meter or both), relative humidity control, comprising a water reservoir and valves capable of giving a relative humidity of (65 ± 10) %.
c) The relative humidity is measured by a hair or paper hygrometer or by a moisture meter.
d) Solvent addition: the toluene/iso-octane mixture is added to the top of the vaporization tower by means of a micro-metering pump. The tower has a bottom diffuser plate and is filled with alternate layers of small glass beads and cotton fabric (or other material) to give a large surface area. The tower is surrounded with a heating blanket, which produces a high temperature at the blanket/tower interface to speed up vaporization.



Key

1 Valve(s)
2 Water reservoir for moisture adjustment
3 Micro-metering pump
4 Rotameter
5 Meter for volume test
6 Vaporization tower filled with alternate layers of glass beads and cotton fabric and surrounded by a blanket
7 Exhaust
8 Toluene/iso-octane reservoir
9 Solvent addition
10 Blower
11 Hygrometer
12 Circulating blower
13 Meter under test

FIG. 7 TYPICAL APPARATUS FOR TOLUENE/ISO-OCTANE VAPOUR TEST

9.3.1.3 *Reagents - toluene/iso-octane mixture with nitrogen*

Toluene has a molecular mass of 92.13 g/mol and density of 0.86694 g/ml in liquid stage. Iso-octane has a molecular mass of 114.23 g/mol and a density of 0.6918 g/ml in liquid stage. Nitrogen gas has a molecular mass of 28.0134 g/mol and a density of 1.2506 g/l in gaseous stage.

Since 1 mole liquid occupies 22.4 l of gas at NTP:

a) 92.13 g = 106 ml toluene will occupy 22.4 l at NTP.
b) 114.23 g = 165 ml of iso-octane will occupy 22.4 l at NTP.

Prepare a mixture 3 percent by volume of a 30 percent toluene/70 percent iso-octane mixture with nitrogen by carefully mixing 95.4 ml liquid, that is, 0.9 percent toluene with 346.5 ml liquid, that is, 2.1 percent iso-octane and adding this 441.9 ml liquid mixture to 2 240 l of nitrogen carrier gas. This is equivalent to 0.197 ml liquid/l of N_2 carrier gas.

NOTE — The actual amount of solvent to be added to the system is dependent on the carrier gas flow rate and the conditions inside the tower.

9.3.1.4 *Test procedure - toluene/iso-octane vapour test*

9.3.1.4.1 *Pre-test*

Before testing in accordance with **9.3.1.4.2** and **9.3.1.4.3**, carryout the error of indication test in accordance with **7.1.2 c)**, using air.

9.3.1.4.2 *Test 1 — toluene/iso-octane vapour test*

Exercise the meter under test with nitrogen, to which approximately 3 percent by gaseous volume of a 30 percent toluene/70 percent iso-octane mixture has been added (*see* **9.3.1.3**), for a maximum of 42 days (1 008 h) at (20 ± 2)°C, (65 ± 10) % relative humidity and a flow rate of not less than $0.25Q_{max}$.
Allow the toluene/iso-octane mixture (*see* **9.3.1.3**) to percolate down the tower and vaporize. Introduce the carrier gas, at a controlled flow rate, through the diffuser at the bottom of the tower where it picks up the vaporized solvent. Pass the gaseous mixture into the exercise rig where it is circulated through the meter under test. A fresh supply of solvent is continuously added to give a stable concentration.

The error of indication of the meter under test is checked every 7 days (168 h), using air, as per **7.1.2 c)**, until a steady state of error of indication is attained.

Ensure steady-state conditions. Steady-state is considered to be attained if the movement in registration between two consecutive tests is less than the expanded uncertainty of measurement as calculated using IS 17288, or if there is a reverse in the movement over a period of 14 days (336 h).

When removing the meter from the exercise rig in order to check the error of indication at the seven-day intervals, the meter ports shall be sealed to prevent the ingress of air until the error of indication is about to be checked.

Use the same equipment for the initial meter error of indication check as for the intermediate and final error of indication checks.

9.3.1.4.3 *Test 2 — toluene/iso-octane vapour test*

After Test 1, exercise the meter under test with air for a further period of 7 days (168 h) at (20 ± 2)°C, (65 ± 10) % relative humidity and a flow rate of not less than $0.25Q_{max}$.

Remove the meter. When removing the meter from the exercise rig in order to check the error of indication, the meter ports shall be sealed to prevent the ingress of air until the error of indication is about to be checked.
Check the error of indication of the meter under test using air, as per **7.1.2 c)**.

Use the same equipment for the initial meter error of indication check as for the final error of indication checks.

9.3.2 *Water Vapour Test*

9.3.2.1 *Requirements*

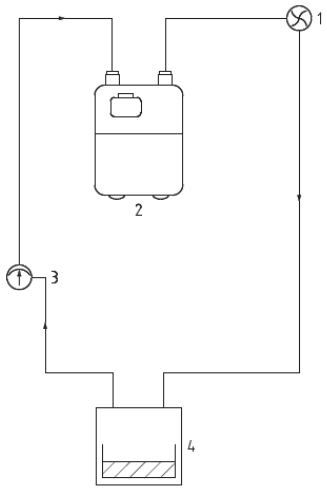
After test **9.3.2.2 a)**, **b)** and **d)**, the errors of indication of meters shall be within the maximum permissible initial limits given in Table 3a.

For meter with gas pressure and/or temperature conversion device, the errors of indication of meters shall be within the maximum permissible initial limits given in Table 3b.

After the test **9.3.2.2 c)** the error of indication shall not change by more than 3 percent from that determined after test **9.3.2.2 a)**.

9.3.2.2 *Test procedure*

a) Carry out the error of indication test, specified in **7.1.2 c)** using air.
b) Connect the meter to a water vapour test rig (*see* Fig. 8).



Key

1 Circulating blower
2 Meter under test
3 Hygrometer
4 Saturated solution for humidity control

FIG. 8 EXAMPLE OF APPARATUS FOR WATER VAPOUR TEST

In Fig. 8, the meter (2) is shown connected to a test rig which consists of a closed circuit containing a suitable circulating pump or blower (1), a chamber containing either a saturated solution of potassium acetate (CH_3COOK) to give a relative humidity of 20 percent at 20°C, or a saturated solution of potassium hydrogen sulphate ($KHSO_4$) to give a relative humidity of 86 percent at 20°C (4), and a hygrometer with a range of 0 % to 100 % relative humidity (3).

Exercise the meter with air having a relative humidity of less than 20 percent for 7 days (168 h) at (20 ± 2)°C and a flow rate of not less than $0.25Q_{max}$.

On completion, carry out the error of indication test, using air, as specified in **7.1.2 c)**.

c) On completion of this low humidity performance test, exercise the meter with air having a relative humidity of (85 ± 5) % for a maximum of 42 days (1 008 h) at (20 ± 2)°C and a flow rate of not less than $0.25Q_{max}$. Check the meter error of indication every 7 days (168 h), using air and the method given in **7.1.2 c)**, until a steady-state of error of indication is attained (*see* **9.3.1.4**). At this point check the meter error of indication using the method given in **7.1.2 c)**, to confirm that the error of indication has not changed by more than 3 percent from that determined at the start of the test.

d) Exercise the meter with air having a relative humidity of less than 20 percent for at least 7 days (168 h) at (20 ± 2)°C and a flow rate of not less than $0.25Q_{max}$.

On completion, carry out the error of indication test, using air, as specified in **7.1.2 c)**.

9.3.3 *Ageing*

9.3.3.1 *Requirements*

Where more than one installation orientation is specified by the manufacturer, a meter shall be tested in each orientation on separate samples.

Following the ageing test given in **9.3.3.2**, the error of indication shall be within the MPE-Subsequent limits given in Table 3a.

For meter with gas pressure and/or temperature conversion device, the errors of indication of meters shall remain within the MPE-Subsequent limits given in Table 3b.

9.3.3.2 *Test procedure*

Test the meter as specified in **7.1.2 c)** using a temperature selected by the manufacturer from the appropriate values given in Table 13.

Exercise the meter, together with its index, at the temperature selected by the manufacturer, on air at the same temperature and at a regulated flow rate of between $0.2Q_{max}$ and $0.3Q_{max}$ for the appropriate time period given in Table 13.

Table 13
(*Clause* 9.3.3.2)

Temperature (°C)	**Time period** (Days)
70 ± 2	50
60 ± 2	100
50 ± 2	200

On completion of the test, return the meter to normal laboratory temperature and carry out the error indication test, as specified in **7.1.2 c)**, to ensure that the accuracy of the meter is within the MPE-Subsequent limits given in Table 3a, and the accuracy of meter with gas pressure and/or temperature conversion device, is within the MPE-Subsequent limits given in Table 3b.

10 ELECTROMAGNETIC COMPATIBILITY AND REQUIREMENTS

10.1 Immunity to Electromagnetic Disturbances

10.1.1 *General*

The meter/AFD shall be designed and manufactured in such a way to tolerate the effects of magnetic fields, electrostatic discharge and other electromagnetic disturbances.

10.1.2 *Permanent Magnetic Fields*

10.1.2.1 *Requirements*

When tested in accordance with **10.1.2.2**, shall meet the following requirements;
For the test **10.1.2.2 a)** and **c)**, the errors of indication of meters shall be within the maximum permissible initial limits given in Table 3a.
For meter with gas pressure and/or temperature conversion device, the errors of indication of meters shall be within the maximum permissible initial limits given in Table 3b.
The functionalities of the AFD as declared by the manufacturer shall remain operable without any loss of data.
For the test **10.1.2.2 b)**, the difference in mean errors and the errors during the positioning of a permanent magnet that generates a magnetic field of 200 mT ± 10% at Q_{max}, shall not exceed one third of the MPE initial limits, given in Table 3a, and for meter with gas pressure and/or temperature conversion device, given in Table 3b.

10.1.2.2 *Test procedure*

In case of AFD2 & AFD3, ensure the AFD is connected to the meter in accordance with the manufacturer's instructions.

a) Stabilize the meter/AFD to room temperature. Check the functionalities of the AFD as declared by the manufacturer. Then check the error of indication of the meter under test using the method given in **7.1.2 c)**, at (20 ± 1°C).
b) Place the magnet on all surfaces of the AFD in a grid pattern 4 cm wide. Test on every point of the grid at Q_{max}. In case of AFD1 the magnet is applied on the whole meters as stated above.
c) Retest the meter but again, stabilizing the meter/AFD to room temperature. Check the functionalities of the AFD as declared by the manufacturer. Then check the error of indication of the meter under test using the method given in **7.1.2 c)**, at (20 ± 1°C).

10.1.3 *Electrostatic Discharge*

This clause is applicable to all gas meters having electronic circuits.

10.1.3.1 *Requirements*

When tested in accordance with **10.1.3.2**, shall meet the following requirements;

a) For the test **10.1.3.2 a)** and **c)**, the errors of indication of meters shall be within the maximum permissible initial limits given in Table 3a. For meter with gas pressure and/or temperature conversion device, the errors of indication of meters shall be within the maximum permissible initial limits given in Table 3b.

b) The difference in **10.1.3.2 a)** and **c)** respective mean errors shall not exceed one third of the MPE initial limits, given in Table 3a, and for meter with gas pressure and/or temperature conversion device, given in Table 3b.
c) The functionalities of the AFD as declared by the manufacturer shall remain operable without any loss of data during and after the test.

10.1.3.2 *Test procedure*

In case of AFD2 & AFD3, ensure the AFD is connected to the meter in accordance with the manufacturer's instructions.

a) Stabilize the meter/AFD to room temperature. Check the functionalities of the AFD as declared by the manufacturer. Then check the error of indication of the meter under test using the method given in **7.1.2 c)**, at (20 ± 1°C).
b) With no flow through the meter, test the meter in accordance with IS 14700 (Part 4/Sec 2) / IEC 61000-4-2 using 10 contact discharges to each of:
    i. The conductive surfaces;
    ii. A horizontal;
    iii. A vertical coupling plane with a charge voltage of 6 kV at intervals of a minimum of 1 s, with the battery fitted.

    Again, with no flow through the meter, test the meter in accordance with IS 14700 (Part 4/Sec 2) / IEC 61000-4-2 using 10 air discharges (to insulating surfaces) with a charge voltage of 8 kV at intervals of a minimum of 1 s, with the battery fitted.

    During the test, connect the inlet boss of the meter under test to the 'ground plane'. Confirm there has been no loss of data.
c) Retest the meter but again, stabilizing the meter/AFD to room temperature. Check the functionalities of the AFD as declared by the manufacturer. Then check the error of indication of the meter under test using the method given in **7.1.2 c)**, at (20 ± 1°C).

10.1.4 *Radio Frequency Electromagnetic Field*

This clause is applicable to all gas meters having electronic circuits.

10.1.4.1 *Requirements*

During the test specified in **10.1.4.2 a)**, the AFD register/meter index shall neither increment nor decrement and the additional functionalities declared by the manufacturer shall remain operable and without loss of data.

During the test specified in **10.1.4.2 b)**, the flow rate calculated from the meter readings at Q_{max} shall not vary by more than three times the MPE initial limits, given in Table 3a, and for meter with gas pressure and/or temperature conversion device, given in Table 3b.

After testing in accordance with **10.1.4.2 b)**, the additional functionalities declared by the manufacturer shall remain operable and without loss of data and the mean errors at Q_{max} shall be within the MPE initial

limits, given in Table 3a, and for meter with gas pressure and/or temperature conversion device, given in Table 3b.

10.1.4.2 *Test procedure*

In case of AFD2 & AFD3, ensure the AFD is connected to the meter in accordance with the manufacturer's instructions.

For below test a) and b), where the frequency range is swept incrementally, the step size shall not exceed 1 percent of the preceding frequency value.

The dwell time of the amplitude modulated carrier at each frequency shall not be less than the time necessary for the EUT (Equipment Under Test) to be exercised and to respond correctly, but shall in no case be less than 0.5 s. The expected most critical frequencies (for example, clock frequencies) shall be analyzed separately.

a) Set the flow rate to zero. Read the volume register and non-volatile memory. Test the meter in accordance with IS 14700 (Part 4/Sec 3) / IEC 61000-4-3, under the classification E1:
   1) Frequency band: 80 MHz to 3000 MHz
   2) Test field strength: 10 V/m
   3) Amplitude modulation: 80 percent, 1 kHz sine wave

   Read the volume register and non-volatile memory and compare with the value before the high frequency test. Check the functionalities of the AFD as declared by the manufacturer.

b) Arrange the test equipment so that it is possible to pass air through the test meter while it is being subjected to the electromagnetic field.

   NOTE — One way of achieving this is to use a sonic nozzle between the meter outlet and a vacuum line.

   Test the meter under the conditions given below. During the test, read the index and elapsed time at suitable intervals. From these readings, calculate the corresponding flow rates.

   Stabilize the meter/AFD to laboratory temperature and test the meter three times at Q_{max} in accordance with the method given in **7.1.2 c)** and determine its error of indication. Maintain the meter at Q_{max} and subject the meter/AFD to the range of high frequency field in accordance with IS 14700 (Part 4/Sec 2) / IEC 61000-4-2, under the classification E1:
   1) Frequency band: 80 MHz to 3 000 MHz
   2) Test field strength: 10 V/m
   3) Amplitude modulation: 80 percent, 1 kHz sine wave

   With the high frequency field switched off, check the functionalities of the AFD as declared by the manufacturer and for no loss of data. Retest the meter/AFD in accordance with the method given in **7.1.2 c)** and determine its error of indication at Q_{max} at laboratory temperature.

10.1.5 *Electromagnetic Induction (Power Frequency)*

This clause is applicable to all gas meters having electronic circuits.

10.1.5.1 *Requirements*

When tested in accordance with **10.1.5.2 a)**, the AFD register/index shall neither increment nor decrement and the additional functionalities declared by the manufacturer shall remain operable and without loss of data.

During the test described in **10.1.5.2 b)**, error of indication at $0.2Q_{max}$ shall not vary by more than three times the MPE initial limits, given in Table 3a, and for meter with gas pressure and/or temperature conversion device, given in Table 3b, during any of the eight periods of the test without showing an error flag (excluding any error flag designed to appear when entering a test mode).

After testing in accordance with **10.1.5.2 b)**, the additional functionalities declared by the manufacturer shall remain operable and without loss of data and the mean errors at $0.2Q_{max}$ shall be within the MPE initial limits, given in Table 3a, and for meter with gas pressure and/or temperature conversion device, given in Table 3b.

10.1.5.2 *Test procedure*

In case of AFD2 & AFD3, ensure the AFD is connected to the meter in accordance with the manufacturer's instructions.

a) Set the flow rate to zero. Read the volume register and non-volatile memory. Test the meter /AFD to test level 4 of IS 14700 (Part 4/Sec 8) / IEC 61000-4-8 for 5 min for the continuous field test and 3 s for the short duration test. Read the volume register and non-volatile memory and compare with the value before the electromagnetic induction power frequency.

b) Arrange the test equipment so that it is possible to pass air through the test meter while it is being subjected to the electromagnetic field.

NOTE — One way of achieving this is to use a sonic nozzle between the meter outlet and a vacuum line.

Test the meter under the conditions given below. During the test, read the index and elapsed time at suitable intervals. From these readings, calculate the corresponding flow rate.

Stabilize the meter/AFD to laboratory temperature and test the meter at $0.2Q_{max}$ in accordance with the method given in **7.1.2 c)** and determine its error of indication.

During this test the meter/AFD shall be subjected to electromagnetic induction (power frequency) in accordance with test level 4 of IS 14700 (Part 4/Sec 8) / IEC 61000-4-8 for 1 min in each of eight orientations, four with the with meter in installed condition but power frequency magnetic coil horizontal at 0°, 90°, 180° and 270°. The test is repeated with meter rotated at 90°.

With the power frequency switched off, check the functionalities of the AFD as declared by the manufacturer and for no loss of data. Retest the meter/AFD in accordance with the method given in **7.1.2 c)** and determine its error of indication at $0.2Q_{max}$ at laboratory temperature.

10.1.6 *Electromagnetic Induction (Pulsed Field)*

This clause is applicable to all gas meters having electronic circuits.

10.1.6.1 *Requirements*

The meter shall satisfy the following requirements.

During test described in **10.1.6.2 a)**, the AFD register/meter index shall neither decrement nor increment and the additional functionalities declared by the manufacturer shall remain operable and without loss of data.

During the test specified in **10.1.6.2 b)**, error of indication at $0.2Q_{max}$ shall not vary by more than half of the MPE initial limits, given in Table 3a, and for meter with gas pressure and/or temperature conversion device, given in Table 3b, during any of the eight periods of the test without displaying an error flag (excluding any error flag designed to appear when entering a test mode).

After testing in accordance with **10.1.6.2 b)**, the additional functionalities declared by the manufacturer shall remain operable and without loss of data and the mean errors at $0.2Q_{max}$ shall be within the MPE initial limits, given in Table 3a, and for meter with gas pressure and/or temperature conversion device, given in Table 3b.

10.1.6.2 *Test procedure*

In case of AFD2 & AFD3, ensure the AFD is connected to the meter in accordance with the manufacturer's instructions.

a) Set the flow rate of the meter to zero. Read the volume register and non-volatile memory. Test the meter/AFD in accordance with test level 4 of IS 14700 (Part 4/Sec 9) / IEC 61000-4-9 for 1 min in each of eight orientations, four with the meter in installed condition but pulsed magnetic coil horizontal at 0°, 90°, 180° and 270°. The test is repeated with meter rotated at 90°. Read the volume register and non-volatile memory and compare with the value before the pulsed field test.
b) Arrange the test equipment so that it is possible to pass air through the test meter while it is being subjected to the pulsed field.

   NOTE — One way of achieving this is to use a sonic nozzle between the meter outlet and a vacuum line.

   Test the meter under the conditions given below. During the test, read the index and elapsed time at suitable intervals. From these readings, calculate the corresponding flow rates.

   Stabilize the meter/AFD to room temperature and test the meter at $0.2Q_{max}$ in accordance with the method given in **7.1.2 c)** and determine its error of indication. During this test the meter/AFD shall be subjected to a pulse field in accordance with test level 4 IS 14700 (Part 4/Sec 9) / IEC 61000-4-9 for 1 min in each of eight orientations, four with meter in installed condition but pulsed magnetic coil horizontal at 0°, 90°, 180° and 270°. The test is repeated with meter rotated at 90°.

   With the pulsed field switched off, check the functionalities of the AFD as declared by the manufacturer and for no loss of data. Retest the meter/AFD in accordance with the method given in **7.1.2 c)** and determine its error of indication at $0.2Q_{max}$ at laboratory temperature.

10.1.7 *Radio Interference Emission*

This clause is applicable to all gas meters having electronic circuits.

10.1.7.1 *Requirements*

When tested in accordance with **10.1.7.2**, the electromagnetic interference generated by the AFD/meter shall satisfies class B radio interference limits in IS/CISPR 32 at zero flow.

10.1.7.2 *Test procedure*

In case of AFD2 & AFD3, ensure the AFD is connected to the meter in accordance with the manufacturer's instructions.

Check that the AFD/meter satisfies class B radio interference limits in IS/CISPR 32 at zero flow.

10.2 Immunity to Electromagnetic Disturbances for Meters / AFD's with External Ports

10.2.1 *General*

This clause is applicable to all gas meters having electronic circuits. The applicability of the requirements given in this clause depends on type of external ports available on meter / AFD.

10.2.2 *Radio Frequency Common Mode*

10.2.2.1 *Requirements*

When tested in accordance with **10.2.2.2**, the AFD register/meter index shall neither increment nor decrement and where the AFD/meter includes additional registers or stores of data these shall not be affected. Other additional functionalities declared by the manufacturer shall remain operable and without loss of data.

10.2.2.2 *Test procedure*

In case of AFD2 & AFD3, ensure the AFD is connected to the meter in accordance with the manufacturer's instructions.

Record the meter index and AFD data prior to performing the test described below.

Perform the test as described in IS 14700 (Part 4/Sec 6) / IEC 61000-4-6, as detailed in Table 14, at zero flow.

Note the meter Index and AFD data and confirm that no unexpected changes in data have occurred.

Table 14 Radio Frequency Tests
(*Clause* 10.2.2.2)

Port	Test conditions	Units	Basic standards	Remarks	Performance criterion

Signal	0.15 to 80 10 80	MHz V %AM (1KHz)	IS 14700 (Part 4/Sec 6) / IEC 61000-4-6	The test level is the r.m.s. value of the un-modulated carrier [a, b]	A
AC / DC Power	0.15 to 80 10 80	MHz V %AM (1KHz)	IS 14700 (Part 4/Sec 6) / IEC 61000-4-6	The test level is the r.m.s. value of the un-modulated carrier [a, b]	A
[a)] The test level can also be defined as the equivalent current into a 150 Ω load. [b)] Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification may exceed 3 m.					

10.2.3 *Fast Transient Bursts*

10.2.3.1 *Requirements*

When tested in accordance with **10.2.3.2**, the AFD register/meter index shall neither increment nor decrement and where the AFD/meter includes additional registers or stores of data these shall not be affected. Other additional functionalities declared by the manufacturer shall remain operable and without loss of data.

10.2.3.2 *Test procedure*

In case of AFD2 & AFD3, ensure the AFD is connected to the meter in accordance with the manufacturer's instructions.

Note the Meter Index and AFD data and check the functionalities as declared by the manufacturer prior to performing the test described below.

Perform the test as described in IS 14700 (Part 4/Sec 4) / IEC 61000-4-4, as detailed in Table 15, at zero flow.
Again, note the Meter Index and AFD data and check the functionalities as declared by the manufacturer and confirm that no unexpected changes in data have occurred.

Table 15 Fasten Transient Bursts Test
(*Clause* 10.2.3.2)

Port	**Test conditions**	**Units**	**Basic standards**	**Remarks**	**Performance criterion**
Signal	± 1 5/50 5	KV (open circuit test voltage) Tr/Th ns	IS 14700 (Part 4/Sec 4) / IEC 61000-4-4	Capacitive clamp used [a]	B

		Repetition Frequency kHz			
AC / DC Power	± 2 5/50 5	KV (open circuit test voltage) Tr/Th ns Repetition Frequency kHz	IS 14700 (Part 4/Sec 4) / IEC 61000-4-4	None	B
The duration of the test shall not be less than 1 min for each amplitude and polarity. [a] Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification may exceed 3 m.					

10.2.4 *Surges*

10.2.4.1 *Requirements*

When tested in accordance with **10.2.4.2**, the AFD register/meter index shall neither increment nor decrement and where the AFD/meter includes additional registers or stores of data these shall not be affected. Other additional functionalities declared by the manufacturer shall remain operable and without loss of data.

10.2.4.2 *Test procedure*

In case of AFD2 & AFD3, ensure the AFD is connected to the meter in accordance with the manufacturer's instructions.

Note the Meter Index and AFD data and check the functionalities as declared by the manufacturer prior to performing the test described below.

Perform the test as described in IS 14700 (Part 4/Sec 5) / IEC 61000-4-5, as detailed in Table 16, at zero flow.
Again, note the Meter Index and AFD data and check the functionalities as declared by the manufacturer and confirm that no unexpected changes in data have occurred.

Table 16 Surge Tests
(*Clause* 10.2.4.2)

Port	**Test conditions**	**Units**	**Basic standards**	**Remarks**	**Performance criterion**
Signal (Unsymmetrical lines) line to earth line to line	1,2/50 (8/20) ± 1 ± 0.5	Tr/Th µs kV (o/c test voltage) kV (o/c test voltage)	IS 14700 (Part 4/Sec 5) / IEC 61000-4-5		

Signal (symmetrical lines) line to earth line to line	1,2/50 (8/20) ± 1 N/A	Tr/Th µs kV (o/c test voltage) N/A	IS 14700 (Part 4/Sec 5) / IEC 61000-4-5		
Signal (Shielded I/O and communication lines) line to earth line to line	1,2/50 (8/20) ± 0.5 N/A	Tr/Th µs kV (o/c test voltage) N/A	IS 14700 (Part 4/Sec 5) / IEC 61000-4-5		
AC / DC Power line to earth line to line	1,2/50 (8/20) ± 2 ± 1	Tr/Th µs kV (o/c test voltage) kV (o/c test voltage)	IS 14700 (Part 4/Sec 5) / IEC 61000-4-5		

10.2.5 *DC Mains Voltage Variation*

10.2.5.1 *Requirements*

During the test described in **10.2.5.2**, the error of indication of the meter at $0.2Q_{max}$ shall not vary more than half the MPE initial limits, given in Table 3a, and for meter with gas pressure and/or temperature conversion device, given in Table 3b, during any of the following voltage levels.

AFD/Meter shall automatically flag/detect high-level conditions at voltage level U_{nom} + 10 %.

AFD/Meter shall automatically flag/detect low-level conditions at voltage level U_{nom} - 15 %.

10.2.5.2 *Test procedure*

In case of AFD2 & AFD3, ensure the AFD is connected to the meter in accordance with the manufacturer's instructions.

Arrange the test equipment so that it is possible to pass air through the test meter while it is being subjected to the voltage variation.

NOTE — One way of achieving this is to use a sonic nozzle between the meter outlet and a vacuum line.

Test the meter under the conditions given below. During the test, read the index and elapsed time at suitable intervals. From these readings, calculate the corresponding flow rate.

Stabilize the meter/AFD to room temperature and test the meter at $0.2Q_{max}$ in accordance with the method given in **7.1.2 c)** and determine its error of indication. Measurements shall be taken after a period, sufficient for achieving temperature stability for each voltage level.

During this test the meter/AFD shall be subjected to voltage variation, first at voltage level U_{nom} + 10 %, and then, at voltage level U_{nom} - 15 %, in accordance with IEC 60654-2 .

Check AFD/Meter for flag/detection of low/high-level conditions.

10.2.6 *AC Mains Voltage Variation*

10.2.6.1 *Requirements*

During the test described in **10.2.6.2**, the error of indication of the meter at $0.2Q_{max}$ shall not vary more than half the MPE initial limits, given in Table 3a, and for meter with gas pressure and/or temperature conversion device, given in Table 3b, during any of the following voltage levels.

AFD/Meter shall automatically flag/detect high-level conditions at voltage level U_{nom} + 10 %.

AFD/Meter shall automatically flag/detect low-level conditions at voltage level U_{nom} - 15 %.

10.2.6.2 *Test procedure*

In case of AFD2 & AFD3, ensure the AFD is connected to the meter in accordance with the manufacturer's instructions.

Arrange the test equipment so that it is possible to pass air through the test meter while it is being subjected to the voltage variation.

NOTE — One way of achieving this is to use a sonic nozzle between the meter outlet and a vacuum line.

Test the meter under the conditions given below. During the test, read the index and elapsed time at suitable intervals. From these readings, calculate the corresponding flow rate.

Stabilize the meter/AFD to room temperature and test the meter at $0.2Q_{max}$ in accordance with the method given in **7.1.2 c)** and determine its error of indication. Measurements shall be taken after a period, sufficient for achieving temperature stability for each voltage level.

During this test the meter/AFD shall be subjected to voltage variation, first at voltage level U_{nom} + 10 %, and then, at voltage level U_{nom} - 15 %, in accordance with IEC/TR 61000-2-1.

Check AFD/Meter for flag/detection of low/high-level conditions

10.2.7 *AC Mains Voltage Dips and Short Interruptions*

(Test Applicable if electrical/electronic equipment is powered with external source)

10.2.7.1 *Requirements*

When tested in accordance with **10.2.7.2**, shall meet the following requirements;

a) For the test **10.2.7.2 a)** and **c)**, the errors of indication of meters shall be within the maximum permissible initial limits given in Table 3a.
b) For meter with gas pressure and/or temperature conversion device, the errors of indication of meters shall be within the maximum permissible initial limits given in Table 3b.

c) The difference in [**10.2.7.2 a)** and **c)**] respective mean errors shall not exceed half the MPE initial limits, given in Table 3a, and for meter with gas pressure and/or temperature conversion device, given in Table 3b.
d) The functionalities of the AFD as declared by the manufacturer shall remain operable without any loss of data during and after the test.

10.2.7.2 *Test procedure*

In case of AFD2 & AFD3, ensure the AFD is connected to the meter in accordance with the manufacturer's instructions.

Arrange the test equipment so that it is possible to pass air through the test meter while it is being subjected to the AC voltage dips and interruptions.

NOTE — One way of achieving this is to use a sonic nozzle between the meter outlet and a vacuum line.

Test the meter under the conditions given below. During the test, read the index and elapsed time at suitable intervals. From these readings, calculate the corresponding flow rate.

a) Stabilize the meter/AFD to room temperature and test the meter at $0.2Q_{max}$ in accordance with the method given in **7.1.2 c)** and determine its error of indication.
b) Carryout out the voltage dips and short interruptions disturbance test as per IS 14700 (Part 4/Sec 11) / IEC 61000-4-11 or Table 17 while flow being continued.
A test generator is to be used which is suitable to reduce the amplitude of the AC mains voltage for the required period of time.
The performance of the test generator shall be verified before connecting the EUT. The mains voltage reduction tests shall be repeated 10 times with intervals of at least 10 seconds between the tests.
The test pulses shall be continuously applied during the measuring time.
c) Retest the meter but again, stabilizing the meter/AFD to room temperature. Check the functionalities of the AFD as declared by the manufacturer. Test the meter at $0.2Q_{max}$ in accordance with the method given in **7.1.2 c)** and determine its error of indication.

Table 17 AC Mains Voltage Dips and Short Interruptions
(*Clause* 10.2.7.2)

Test (1, 2)		**test a**	**test b**	**test c**	**test d**	**test e**	**Unit**
Voltage reduction	Reduction to	0	0	40	70	80	%
	Duration in sec	0.5	1	10 / 12 (1)	25 / 30 (1)	250 / 300 (1)	Cycles

NOTES
1. These values are for 50 Hz / 60 Hz, respectively.
2. All 5 tests (a, b, c, d and e) are applicable; it is possible that any of the tests fail while the other tests pass.

10.2.8 *Voltage Dips, Short Interruptions and Voltage Variations on DC Mains Power Disturbance Test*

(Test Applicable if electrical/electronic equipment is powered from external source)

10.2.8.1 *Requirements*

When tested in accordance with **10.2.8.2**, shall meet the following requirements;

a) For the test **10.2.8.2 a)** and **c)**, the errors of indication of meters shall be within the maximum permissible initial limits given in Table 3a.
b) For meter with gas pressure and/or temperature conversion device, the errors of indication of meters shall be within the maximum permissible initial limits given in Table 3b.
c) The difference in (**10.2.8.2. a)** and **c)**) respective mean errors shall not exceed half the MPE initial limits, given in Table 3a, and for meter with gas pressure and/or temperature conversion device, given in Table 3b.
d) The functionalities of the AFD as declared by the manufacturer shall remain operable without any loss of data during and after the test.

10.2.8.2 *Test procedure*

In case of AFD2 & AFD3, ensure the AFD is connected to the meter in accordance with the manufacturer's instructions.

Arrange the test equipment so that it is possible to pass air through the test meter while it is being subjected to the AC voltage dips and interruptions.

NOTE — One way of achieving this is to use a sonic nozzle between the meter outlet and a vacuum line.

Test the meter under the conditions given below. During the test, read the index and elapsed time at suitable intervals. From these readings, calculate the corresponding flow rate.

a) Stabilise the meter/AFD to room temperature and test the meter at $0.2Q_{max}$ in accordance with the method given in **7.1.2 c)** and determine its error of indication.
b) Carryout out the Voltage dips, short interruptions and voltage variations on DC mains power disturbance test as per IEC 61000-4-29 or Table 18 while flow being continued.
   A test generator as defined in the referred standard shall be used. Before starting the tests, the performance characteristics of the generator shall be verified.
   The EUT shall be exposed to voltage dips and short interruptions for each of the selected combinations of amplitude and duration, using a sequence of three dips/interruptions and intervals of at least 10 seconds between each test event. The most common operating modes of the EUT shall be tested three times at 10 second intervals for each of the specified voltage variations.
   If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measuring time.

Table 18 Voltage dips, Short Interruptions and Voltage Variations on DC Mains Power Disturbance Test
(*Clause* 10.2.8.2)

Test severity level		**The following levels shall be applied:**	**Unit**
Voltage dips	Amplitude	40 and 70	% of the rated voltage
	Duration (1)	10; 30; 100	ms

Short interruptions	Test condition	High impedance and/or low impedance	
	Amplitude	0	% of the rated voltage
	Duration (1)	1; 3; 10	ms
Voltage variations	Amplitude	85 and 120	% of the rated voltage
	Duration (1)	0.1; 0.3; 1; 3; 10	s
NOTE — (1) All intervals are to be tested			

c) Retest the meter but again, stabilizing the meter/AFD to room temperature. Check the functionalities of the AFD as declared by the manufacturer. Test the meter at $0.2Q_{max}$ in accordance with the method given in **7.1.2 c)** and determine its error of indication.

10.2.9 *Ripple on DC Mains Power*

10.2.9.1 *Requirements*

During the test described in **10.2.9.2**, the error of indication of the meter at $0.2Q_{max}$ shall be within MPE initial limits, given in Table 3a, and for meter with gas pressure and/or temperature conversion device, given in Table 3b.

This test does not apply to instruments connected to battery charger systems incorporating switch mode converters.

10.2.9.2 *Test procedure*

In case of AFD2 & AFD3, ensure the AFD is connected to the meter in accordance with the manufacturer's instructions.

Arrange the test equipment so that it is possible to pass air through the test meter while it is being subjected to the ripple on DC.

NOTE — One way of achieving this is to use a sonic nozzle between the meter outlet and a vacuum line.

Test the meter under the conditions given below. During the test, read the index and elapsed time at suitable intervals. From these readings, calculate the corresponding flow rate.

Stabilise the meter/AFD to laboratory temperature and test the meter at $0.2Q_{max}$ in accordance with the method given in **7.1.2 c)** and determine its error of indication during ripple on DC mains power test.
A test generator as defined in the referred standard shall be used. Before starting the tests, the performance of the generator shall be verified. The test comprises subjecting the EUT to ripple voltages such as those generated by traditional rectifier systems and/or auxiliary service battery chargers overlaying on DC power supply sources. The frequency of the ripple voltage is the applicable power frequency or its multiple (2, 3 or 6), dependent on the rectifier system used for the mains. The waveform of the ripple, at the output of the test generator, has a sinusoid linear character.

The test level is 2 percent and is peak-to-peak voltage expressed as a percentage of the nominal DC voltage.

The test shall be applied for at least 10 min or for the time period necessary to allow a complete verification of the EUT's operating performance.

11 CLIMATIC REQUIREMENTS AND TESTS (SPECIFIC TO GAS METERS WITH ELECTRONIC CIRCUITS)

11.1 General

This clause is applicable to all gas meters having electronic circuits.

The meter/AFD shall be designed and manufactured in such a way to tolerate the effects of Dry heat, Cold and damp heat cycle.

11.2 Dry Heat Test (Non-Condensing)

11.2.1 *Requirements*

In addition to the requirements of **8.5.1**, after the test it shall be verified that no loss of data has occurred and no loss of functionality.

11.2.2 *Test Procedure*

This test is carried out along with the test describe in clause **8.5.2** (at 70℃).

11.3 Cold Test

11.3.1 *Requirements*

In addition to the requirements of **8.5.1**, after the test it shall be verified that no loss of data has occurred and no loss of functionality.

11.3.2 *Test Procedure*

This test is carried out along with the test describe in clause **8.5.2** (at -20℃).

11.4 Damp Heat Cyclic Test (Condensing)

11.4.1 *Requirements*

Before testing in accordance with **11.4.2**, the meter under test shall conform to the following:

a) Test in accordance with **7.1.2 c)**, the errors of indication are within the allowed MPE-initial limit given in Table 3a and for meters with gas pressure and/or temperature conversion device given in Table 3b.
b) After testing in accordance with **11.4.2**, the meter under test shall conform to the following:
Test in accordance with **7.1.2 c)**, the errors of indication are within the allowed MPE-initial limit given in Table 3a and for meters with gas pressure and/or temperature conversion device given in Table 3b and it shall be verified that no loss of data has occurred and no loss of functionality.
Also, the variation in error shall be within one-half the MPE limits specified in Table 3a and 2b.

11.4.2 *Test Procedure*

a) Carry out the errors of indication test in accordance with **7.1.2 c)** using air.
b) Carry out damp heat cyclic test as follows;
For this test gas meter should be considered as non-heat dissipating equipment.
Meter should be placed in environmental chamber in such a way that there is no flow of air through it. For this purpose, input and output ports shall be capped.
The test consists of exposure to cyclic temperature variation between 25°C and the upper temperature 55 ± 2°C, maintaining the relative humidity above 95 percent during the temperature change and low temperature phases, and at (93 ± 3) % at the upper temperature phases.

Condensation is expected to occur on the EUT during the temperature rise.

The 24 hours cycle consists of:
1) Temperature rise during 3 hours.
2) Temperature maintained at upper temperature level until 12 hours from the start of the cycle.
3) Temperature lowered to the lower temperature level within a period of 3 to 6 hours, the rate of fall during the first hour and a half being such that the lower temperature level would be reached in 3 hours.
4) Temperature maintained at lower temperature level until the 24 hours cycle is completed.

During the test, the meter shall be in normal operating condition.

The gas meter shall be subjected to an accuracy test both:
i. At reference conditions, before the increase of temperature and
ii. At reference conditions, at least 4 hours after the last cycle.

The test shall be conducted in accordance with IS/IEC 60068-3-4 and IS/IEC 60068-2-30. The change of temperature shall not exceed 1°C/min during heating up and cooling down.
The severities given in Table 19 shall apply.

Table 19 Severities
(*Clause* 11.4.2)

Severities	1	2
Temperature °C	40	55
Duration cycles	2	2

c) Carry out the errors of indication test in accordance with **7.1.2 c)**.

11.5 Damp Heat Steady State Test (Non-Condensing)

11.5.1 *Requirements*

Before testing in accordance with **11.5.2**, the meter under test shall conform to the following:

a) Test in accordance with **7.1.2 c)**, the errors of indication are within the allowed MPE-initial limit given in Table 3a and for meters with gas pressure and/or temperature conversion device given in Table 3b.

b) Test in accordance with **7.1.2 c)**, the errors of indication are within the allowed MPE-initial limit given in Table 3a and for meters with gas pressure and/or temperature conversion device given in Table 3b and it shall be verified that no loss of data has occurred and no loss of functionality.
c) The variation in errors after the tests **11.5.2 a)** and **b)** shall be within ½ the MPE initial limits specified in Table 3a and 2b.

11.5.2 *Test Procedure*

a) Carry out the errors of indication test in accordance with **7.1.2 c)** using air.
b) Carry out damp heat steady state test (non-condensing) as follows.

For this test gas meter should be considered as non-heat dissipating equipment.

Meter should be placed in environmental chamber in such a way that there is no flow of air through it. For this purpose, input and output ports shall be capped.

The test comprises exposure to the upper temperature 55 ± 3°C, and the constant relative humidity of (93 ± 3) % for a fixed period of 5 days. The EUT shall be handled such that no condensation of water occurs on it. The temperature rises from 25°C to 55°C shall be in 3 hours. Maintain this condition for 5 days.

Lower the temperature to 25°C and relative humidity 50 percent, within a period of 3 to 6 hours. Temperature is maintained at this reference condition for 24 hours. After completion of 24 hours, carry out the errors of indication test in accordance with **7.1.2 c)** at reference condition.

11.6 Vibration Test

11.6.1 *Requirements*

In addition to the requirements of **8.3.7.1**, after the test it shall be verified that no loss of data has occurred and no loss of functionality.

11.6.2 *Test Procedure*

This test is carried out along with the test described in **8.3.7.2**.

11.7 Mishandling

11.7.1 *Requirements*

In addition to the requirements of **8.3.9**, after the test it shall be verified that no loss of data has occurred and no loss of functionality.

11.7.2 *Test Procedure*

This test is carried out along with the test describe in clause **8.3.9**.

12. ADDITIONAL FUNCTIONALITY DEVICES (AFD)

The meter may be fitted with additional devices for metering or any electronic devices which helps the gas distributor or the consumer. The manufacturer shall mention the same about the kind of additional functionality device and shall confirm to the requirements mentioned in Annex D.

13. SCHEME OF TESTING

The type tests, acceptance tests and routine tests for the meter shall be as indicated in Table 20.

Table 20 Test Applicability
(*Clause* 13)

S.No.	Clause no.	Test name	D
	6	**MARKINGS**	
1.	6.1	All Meters	T
2.	6.2	Two Pipe Meters	T
3.	6.3	Additional markings for gas meters with additional functionality electronic device	T
4.	6.4	Durability and legibility of marking	T
	7	**METROLOGICAL PERFORMANCE AND REQUIREMENTS**	
5.	7.1	Errors of indication	T/A/R
6.	7.2	Weighted mean error (WME)	T
7.	7.3	Repeatability of error (only for air)	T/A
8.	7.4	Gas — air relationship	*T
9.	7.5	Starting flow rate (Low flow registration)	T
10.	7.6	Overload flow rate (High flow registration)	T
11.	7.7	Zero flow	*T
12.	7.8	Pressure drop	T/A/R
13.	7.9	Environment and humidity (closed and open locations)	T
14.	7.10	Influence of other devices attached to the meter	T
	8	**CONSTRUCTION AND MATERIALS**	
	8.2	**Resistance to interference**	
15.	8.2.1	Mechanical interference	T
16.	8.2.2	Electromagnetic interference	T
	8.3	**Robustness**	
17.	8.3.2	Meter case	T
18.	8.3.3	External leak tightness	T/A/R
19.	8.3.4	Resistance to internal pressure (static)	T
20.	8.3.5	Meter case sealing	T
	8.3.6	Connections	
21.	8.3.6.1	Orientation	T
22.	8.3.6.2	Threads and flanges for single and two pipe meters	T
	8.3.6.3	Strength	
23.	8.3.6.3.1	Torque	T
24.	8.3.6.3.2	Bending moment	T

S.No.	Clause no.	Test name	D
25.	8.3.7	Resistance to vibration	T
26.	8.3.8	Resistance to impact	T
27.	8.3.9	Resistance to mishandling	T
	8.4	**Corrosion Protection**	
	8.4.2	External corrosion	
28.	8.4.2.1	Scratch resistance of the protective coating	T
29.	8.4.2.2	Adhesion of the protective coating	T
30.	8.4.2.3	Impact resistance of the protective coating	T
31.	8.4.2.4	Chemical resistance of the protective coating	T
32.	8.4.2.5	Resistance to salt spray	T
33.	8.4.2.6	Resistance to humidity	T
	8.4.3	Internal Corrosion	
34.	8.4.3.1	Adhesion of the protective coating	T
35.	8.4.3.2	Impact resistance of the protective coating	T
36.	8.4.3.3	Chemical resistance of the protective coating	T
37.	8.4.3.4	Resistance to humidity	T
	8.5	**Resistance to storage temperature range**	T
	8.6	**Optional Features**	
38.	8.6.1	Electrical insulating feet	T
39.	8.6.2	Magnetic index drive	T
40.	8.6.3	Devices to prevent the registration of reverse flow	T
41.	8.6.4	Devices to prevent reverse flow	T
42.	8.6.5	Pressure measuring point	T
43.	8.6.6	Resistance to high temperatures	T
44.	8.6.7	Gas meters provided with a built-in gas temperature and/or pressure conversion device	T
45.	8.6.8	Additional functionalities	T
	9	**MECHANICAL PERFORMANCE**	
	9.1	**Meter assembly**	
46.	9.1.1	Meter error of indication at gas temperature limits	T
47.	9.1.2	Error of indication subject to ambient temperature limits	T
48.	9.1.3	Error of indication where the gas and ambient temperatures are not equal	T
	9.2	**Index**	
49.	9.2.1	Construction details	T
50.	9.2.2	Index windows and surround	T
	9.3	**Components in Gas Path**	
51.	9.3.1	Toluene/Iso-Octane Vapour Test	T
52.	9.3.2	Water Vapour Test	T
53.	9.3.3	Ageing	T
	10.	**ELECTROMAGNETIC COMPATIBILITY AND REQUIREMENTS**	
	10.1	**Immunity to electromagnetic disturbances**	T
54.	10.1.2	Permanent magnetic fields	T
55.	10.1.3	Electrostatic discharge	T

S.No.	Clause no.	Test name	D
56.	10.1.4	Radio frequency electromagnetic field	T
57.	10.1.5	Electromagnetic induction (power frequency)	T
58.	10.1.6	Electromagnetic induction (pulsed field)	T
59.	10.1.7	Radio interference emission	T
	10.2	**Immunity to electromagnetic disturbances for Meters / AFD's with external ports**	
60.	10.2.2	Radio Frequency common mode	T
61.	10.2.3	Fast Transient Bursts	T
62.	10.2.4	Surges	T
63.	10.2.5	DC mains voltage variation	T
64.	10.2.6	AC mains voltage variation	T
65.	10.2.7	AC mains voltage dips and short interruptions	T
66.	10.2.8	Voltage dips, short interruptions and voltage variations on DC mains power disturbance test	T
67.	10.2.9	Ripple on DC mains power	T
	11	**CLIMATIC REQUIREMENTS AND TESTS (SPECIFIC TO GAS METERS WITH ELECTRONIC CIRCUITS)**	
68.	11.2	Dry heat test (non-condensing)	T
69.	11.3	Cold test	T
70.	11.4	Damp heat cyclic test (condensing)	T
71.	11.5	Damp heat steady state test (non-condensing)	T
72.	11.6	Vibration test	T
73.	11.7	Mishandling	T
	ANNEX B	**ADDITIONAL TEST FOR MOVING GAS METERS (DIAPHRAGM /ROTARY TYPE)**	
74.	B-1	**Cyclic volume**	T
75.	B-2	**Mechanical performance**	
76.	B-2.1	Durability	T

Abbreviations used above in the Table (Type of Meters) are as mentioned below:

D Diaphragm gas meter
T Type test
A Acceptance test
R Routine test
NA Not Applicable
* If Applicable

ANNEX A
(*Clause* 2)
NORMATIVE REFERENCES

IS No./Other Publications	*Title*
ASTM D471	Standard Test Method for Rubber Property — Effect of Liquids
EN 13757 (Part 1 to 8)	Communication systems for meters
IEC 60654-2 : 1979	Operating conditions for industrial process measurement and control equipment Part 2 Power
IEC/TR 61000-2-1 : 1990	Electromagnetic compatibility (EMC) Part 2 Environment — Section 1 Description of the environment — Electromagnetic environment for low-frequency conducted disturbances and signalling in public power supply systems
IEC 61000-4-29 : 2000	Electromagnetic compatibility (EMC) Part 4-29 Testing and measurement techniques — Voltage dips, short interruptions and voltage variations on D.C. input power port immunity tests
IEC 62054-21 : 2004	Electricity metering (A.C.) — Tariff and load control Part 21 Particular requirements for time switches
IS 101 (Part 5/Sec 1) : 1988	Methods of sampling and test for paints, varnishes and related products Part 5 Mechanical test on paint films Section 1 Hardness Tests (third revision)
IS 101 (Part 5/Sec 2) : 1988	Methods of sampling and test for paints, varnishes and related products Part 5 Mechanical test on paint films Section 2 Flexibility and adhesion (third revision)
IS 101 (Part 5/Sec 5) : 2019 / ISO 6272-2 : 2011	Methods of Sampling and Test for Paints, Varnishes and Related Products Part 5 Mechanical Tests Section 5 Impact resistance — Falling-weight test, small-area indenter
IS 101 (Part 6/Sec 1) : 1988	Methods of Sampling and Test for Paints, Varnishes and Related Products Part 6 Durability tests Section 1 Resistance to Humidity under conditions of condensation (third revision)
ISO 4628 (Part 2) : 2016	Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance Part 2 Assessment of degree of blistering

ISO 4628 (Part 3) : 2024	Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance Part 3 Assessment of degree of rusting
IS 101 (Part 7/Sec 2) : 1990	Methods of sampling and test for paints, varnishes and related products Part 7 Environmental tests on paint films Section 2 Resistance to Liquids (third revision)
IS 196 : 2024	Atmospheric conditions for testing (second revision)
IS 2643 : 2005 / ISO 228 -1 : 2000	Pipe threads where pressure-tight joints are not made on the threads — Dimensions, tolerances and designation (third revision)
IS 5528 : 2024 / ISO 9227 : 2022	Corrosion tests in artificial atmospheres — Salt spray tests (second revision)
IS 5572 : 2009	Classification of hazardous areas (other than mines) having flammable gases and vapours for electrical installation (third revision)
IS 6392 : 2020	Steel pipes flanges — Specification (first revision)
IS 13360 (Part 9/Sec 5) : 1999	Plastics — Methods of testing Part 9 Optical properties Section 5 Determination of haze and luminous transmittance of transparent plastics
IS 14700 (Part 4/Sec 2) : 2018 / IEC 61000-4-2 : 2008	Electromagnetic compatibility (EMC) Part 4 Testing and measurement techniques Section 2 Electrostatic discharge immunity test (second revision)
IS 14700 (Part 4/Sec 3) : 2023 / IEC 61000-4-3 : 2020	Electromagnetic compatibility (EMC) Part 4 Testing and measurement techniques Section 3 Radiated, radio-frequency electromagnetic field immunity test (second revision)
IS 14700 (Part 4/Sec 4) : 2018 / IEC 61000-4-4 : 2012	Electromagnetic compatibility (EMC) Part 4 Testing and measurement techniques Section 4 Electrical fast transient / burst immunity test (second revision)
IS 14700 (Part 4/Sec 5) : 2019 / IEC 61000-4-5 : 2017	Electromagnetic compatibility (EMC) Part 4 Testing and measurement techniques Section 5 Surge immunity test (first revision)
IS 14700 (Part 4/Sec 6) : 2016 / IEC 61000-4-6 : 2013	Electromagnetic compatibility (EMC) Part 4 Testing and measurement techniques Section 6 Immunity to conducted disturbances, induced by radio-frequency fields
IS 14700 (Part 4/Sec 8) : 2018 / IEC 61000-4-8 : 2009	Electromagnetic compatibility (EMC) Part 4 Testing and measurement techniques Section 8 Power frequency magnetic field immunity test (second revision)

IS 14700 (Part 4/Sec 9) : 2019 / IEC 61000-4-9 : 2016	Electromagnetic compatibility (EMC) Part 4 Testing and measurement techniques Section 9 Impulse magnetic field immunity test (second revision)
IS 14700 (Part 4/Sec 11) : 2021 / IEC 61000-4-11 : 2020	Electromagnetic compatibility (EMC) Part 4 Testing and measurement techniques Section 11 Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase (first revision)
IS 14700 (Part 6/Sec 1) : 2019 / IEC 61000-6-1 : 2016	Electromagnetic compatibility (EMC) Part 6 Generic standards Section 1 Immunity standard for residential, commercial and light-industrial environments (first revision)
IS 14700 (Part 6/Sec 2) : 2019 / IEC 61000-6-2 : 2016	Electromagnetic compatibility (EMC) Part 6 Generic standards Section 2 Immunity standard for industrial environments (first revision)
IS 15127 : 2024 / ISO 13686 : 2013	Natural gas — Quality designation (first revision)
IS 16046 (Part 2) : 2018 / IEC 62133-2 : 2017	Secondary cells and batteries containing alkaline or other non-acid electrolytes — Safety requirements for portable sealed secondary cells and for batteries made from them for use in portable applications Part 2 Lithium systems (second revision)
IS 16724 : 2018 / IEC 60079-14 : 2013	Explosive atmospheres — Electrical installations design, selection and erection
IS 16810 (Part 1) : 2018 / ISO 13849-1 : 2015	Safety of machinery — Safety related parts of control systems Part 1 General principles for design
IS 17288 : 2021 / ISO 5168 : 2005	Measurement of fluid flow — Procedures for evaluation of uncertainties
IS 17724 (Part 1) : 2023	Safety requirements for electrical equipment for measurement, control, and laboratory use Part 1 General requirements (IEC 61010-1 : 2010 + AMD 1 : 2016 + COR 1 : 2019, MOD)
IS 17863-2 : 2022 / ISO 4892-2 : 2013	Plastics — Methods of exposure to laboratory light sources Part 2 Xenon-arc lamps
IS/CISPR 32 : 2015	Electromagnetic compatibility of multimedia equipment — Emission requirements
IS/IEC 60068-2-6 : 2007	Environmental testing Part 2 Tests Section 6 Test Fc: Vibration (sinusoidal)

IS/IEC 60068-2-30 : 2005	Environmental testing Part 2 Tests Section 30 Test Db: Damp heat cyclic (12 h + 12 h cycle)
IS/IEC 60068-3-4 : 2023	Environmental testing Part 3 Supporting documentation and guidance Section 4 Damp heat tests (first revision)
IS/IEC 60079-0 : 2017	Explosive atmospheres Part 0 Equipment — General requirements (third revision)
IS/IEC 60529 : 2001	Degrees of protection provided by enclosures (IP code)
IS/IEC 60695-11-5 : 2016	Fire hazard testing Part 11 Test flames Section 5 Needle — Flame test method — Apparatus, confirmatory test arrangement and guidance (first revision)
IS/IEC 60695-11-10 : 2013	Fire hazard testing Part 11 Test flames Section 10 50 W Horizontal and vertical flame test methods
IS/IEC 60730-1 : 1999	Automatic electrical controls for household and similar use Part 1 General requirements
IS/IEC 61508-1 : 2010	Functional safety of electrical/ electronic/programmable electronic safety-related systems Part 1 General requirements (first revision)
IS/IEC 62056-21 : 2002	Electricity metering — Data exchange for meter reading, tariff and load control Part 21 Direct local data exchange
IS/ISO 834-1 : 1999	Fire-resistance tests — Elements of building construction Part 1 General requirements
IS/ISO/IEC 17050-1 : 2004	Conformity assessment — Supplier’s declaration of conformity Part 1 General requirements
OIML R137	Gas meters Part 1: Metrological and technical requirements Part 2: Metrological controls and performance tests

ANNEX B
(*Normative*)
ADDITIONAL TEST FOR MOVING GAS METERS (DIAPHRAGM /ROTARY TYPE)

B-1 CYCLIC VOLUME

B-1.1 Requirements - Cyclic Volume

The cyclic volume of any meter at base conditions shall be within ± 5 % of the cyclic volume indicated on the index plate.

B-1.2 Test Procedure - Cyclic Volume

The possible range of cyclic volume is determined by multiplying the value of the volume corresponding to one complete revolution of the test element, or the value of the smallest scale interval, by the transmission ratio of the measuring device to the indicating device, at the extreme of the transmission gear ratios. Report the result as pass or fail.

B-2 MECHANICAL PERFORMANCE

B-2.1 Meter Assembly

B-2.1.1 *Durability*

B-2.1.1.1 *Requirements*

Meters subjected to the endurance test shall be fitted with their indexes.
All sample meters shall meet the following requirements prior to undergoing the endurance test given in **B-2.1.1.2**:

a) The error of indication shall be within the MPE-Initial limits, given in Table 3a and for meters with gas pressure and/or temperature conversion device given in Table 3b, when tested in accordance with **7.1.2 b)**;
b) Following retesting for pressure drops in accordance with **7.8.2**, the pressure drop shall be not more than that given in the initial maximum permissible pressure drop column of Table 9.
During and on completion of the endurance test given in **B-2.1.1.2**, if test method option 1 (*see* Table 21) has been used, all meters shall meet the following requirements:

   1) The error of indication shall be within the MPE-Subsequent limits given in Table 3a and for meters with gas pressure and/or temperature conversion device given in Table 3b, when tested in accordance with **7.1.2 b)**;
   2) The endurance error values over the flow range of Q_t to Q_{max}, shall not differ by more than 2 percent from the initial corresponding value;
   3) Following retesting for pressure drop in accordance with **7.8.2** the average pressure drop is within the subsequent maximum permissible value given in Table 9; and
   4) The external leak tightness shall be in accordance with **8.3.3**.

During and on completion of the endurance test given in **B-2.1.1.2**, if test method option 2 (*see* Table 21) has been used, all meters shall meet the requirements of 1), 2), and 3) of above except that one meter is allowed to be outside the specified limits. All meters shall pass the leak tightness test in accordance with **8.3.3**.

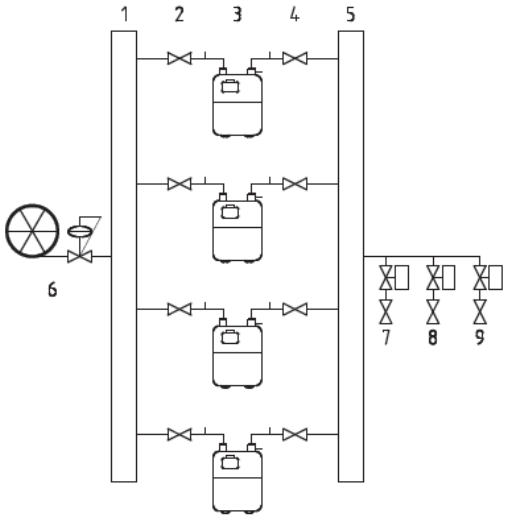
Test method and the number of meters used for the endurance test is given in Table 21.

Table 21 Test Methods and Number of Meters to Be Used for the Endurance Test
(*Clause* B-2.1.1.1)

Q_{max} (m^3/h)	**Number of meters to be tested**		**Test method**
	Option-1	**Option-2**	
Up to $10 m^3/h$	3	6	**B-2.1.1.2** : Endurance by cycling
16 m^3/h to 160 m^3/h	2	4	**B-2.1.1.3** : Endurance at Q_{max} (constant flow)

B-2.1.1.2 *Test procedure - endurance by cycling*

This test shall be used for meters with a Q_{max} of less than or equal to 10 m^3/h.



Key

1 Inlet manifold 2 ball valve
3 Meter under test
4 Gate valve (balancing)
5 Outlet manifold
6 Low pressure air source
7, 8, 9 Solenoid with gate valve set to one-third Q_{max} each

FIG. 9 EXAMPLE OF AN ENDURANCE TEST RIG FOR CYCLING

Determine the error of indication of the meters under test with air using the tests given in **7.1.2 b)**.

Exercise the meters in a cycling test rig (an example is shown in Fig. 9) using air at a temperature between 5°C and 40°C and pressure between 20 mbar to 25 mbar for a duration of 450 000 cycles.

During the test the maximum temperature variation shall be ± 10°C and the maximum pressure variation ± 3 mbar.

Remove the meters under test from the exercise rig after 25 000, 150 000, 300 000 and 450 000 cycles and determine their error of indication, using the same equipment as was used for the initial error of indication check.

Cycle the meter for a nominal 16 s as shown in Fig. 10 for times within the following:

Cycle a)

1) Two-third of Q_{max}; for (5 ± 1) s
2) One-third of Q_{max}; for (3 ± 1) s

Cycle b)

1) 3/3 of Q_{max}; for (5 ± 1) s
2) 0 flow for (3 ± 1) s

And continue with the same profile for a total of 450 000 cycles.

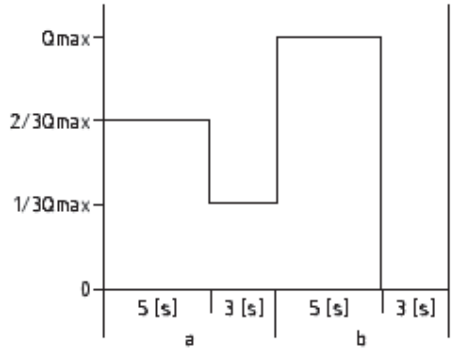


FIG. 10 PROFILE OF A 16S CYCLE

The solenoid valves shall be as close as possible to the outlet manifold and the response time of each valve shall be less than 100 ms.

The balancing valve (4) shall be at the outlet of each meter and within 5 DN of the outlet manifold (5). The manual device used to adjust the flow rate shall be placed at the outlet of the meters.

The nominal diameter of each valve shall be chosen so that the flow velocity is less than or equal to 5 m/s when calculated with the nominal diameter of the valve.

A data acquisition module and associated software shall be used to determine the sequencing of the cycling and the number of cycles completed between interim registration accuracy checks.

The capacity of the air source shall guarantee a pressure drop less or equal to 3 mbar during cycling. The flow speed in the inlet pipe shall be less or equal to 5 m/s. The pressure in the inlet pipe shall be verified before each test. The flow speed in the outlet pipe work shall be less than or equal to 5 m/s and the

maximum volume, in dm^3, shall be one-third of the Q_{max} value of the meter under test, in m^3/h multiplied by the number of meters under test.

NOTE — The flow control can be determined by using each meter under test.

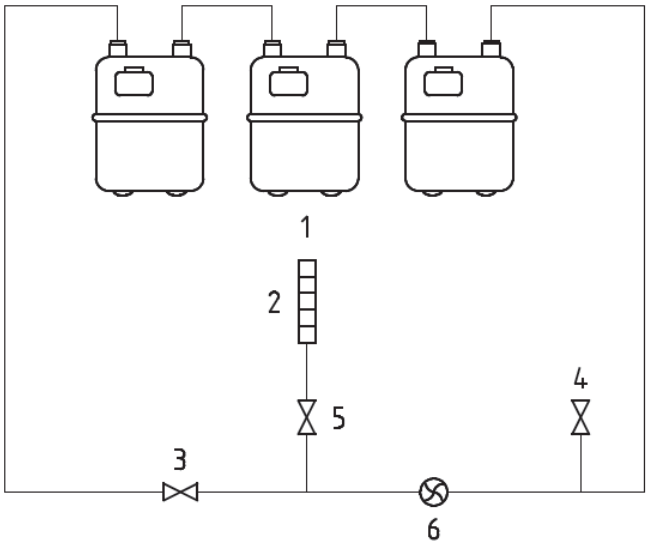
B-2.1.1.3 *Test procedure - endurance at Q_{max} (constant flow)*

This test shall be used for meters with a Q_{max} greater than 10 m^3/h. The number of meters used for the endurance test is given in Table 10.

Determine the error of indication of the meters under test with air using the tests given in **7.1.2 b)**, exercise the meters in a test rig (an example is shown in Fig. 11), using air, at a temperature between 15°C and 25°C and at a pressure not exceeding the maximum working pressure for a period of 5 000 h at Q_{max}.

Remove the meters under test from the exercise rig after $0.05V_{tot}$, $0.4V_{tot}$, $0.7V_{tot}$ and V_{tot}, (where V_{tot} is equal to the total volume of gas which will have passed through a meter if the meter is run at Q_{max} for 5000 h), and determine their error of indications on air, using the same equipment as was used for the initial error of indication check and under the same ambient conditions.

NOTES
1. The flow through the meters on test is regulated by the use of control valve (3) and a stopwatch.
2. The gas passes into the test rig via a control valve (4) where it is circulated through the meters by a suitable circulating pump or blower.
3. In order to maintain a fresh supply of gas through the circuit, control valve (5) is regulated to provide an exhaust flow of approximately 0.1 percent Q_{max}.



Key

1 Meters under test
2 Flow meter
3 Control valve
4 Control valve
5 Control valve

6 Circulating blower

FIG. 11 EXAMPLE OF AN ENDURANCE TEST RIG AT Q_{MAX}

When removing the meters from the exercise rig, prior to carrying out each error of indication check, immediately purge with 3 m^3 of air and cap the ports to avoid the ingress of moisture. Record the constituents of the distributed gas in the certification test report.

ANNEX C
(*Normative*)
ROUTINE AND ACCEPTANCE TESTS WHILE PRODUCTION REQUIREMENTS FOR GAS METERS

C-1 GENERAL

Meters shall be constructed in accordance with this standard, that is, IS 14439 and shall be manufactured under an appropriate quality management system. The meter error shall be adjusted as close to zero as the adjustment and MPEs allow, without favouring any party.

NOTE — Systems conforming to the ISO 9001-series or equivalent quality system standards, including traceability of critical components are considered appropriate quality management systems.

C-2 ROUTINE TESTS

C-2.1 General

There shall be documented production test procedures for following routine tests, which shall include along with acceptance and rejection criteria;

a) External leak tightness as per clause **8.3.3**
b) Error of indication as per clause **7.1.2 c)** and **9.1.1**
c) Pressure drop as per clause **7.8**
d) Markings as per clause **6**
e) Test medium (if other than air)

C-2.2 External Leak Tightness

Every meter shall be tested for external leak tightness as per **8.3.3**. Record as pass or fail for each meter.

C-2.3 Error of Indication

C-2.3.1 *Error of Indication as Per* **7.1.2 c)**

Carryout test as per **7.1.2 c)** and shall meet the requirements of **7.1.1**. The test equipment shall be traceable to a national or international reference standard and the expanded uncertainty of measurement shall be better than one-third of the maximum value of the parameter to be tested.

Verification of conformity with the metrological requirements can be done either:

a) By examination and testing of every meter; or
b) By statistical verification of conformity with the metrological requirements.

If tests are carried out on a statistical basis then the product control tests shall be carried out on lots of finished components using sampling procedures based on attributes, with:

1) Level of quality corresponding to a probability of acceptance of 95 percent, with a non-conformity of less than 1 percent;

2) Limit quality corresponding to a probability of acceptance of 5 percent, with a non-conformity of less than 7 percent.

C-2.3.2 *Error of Indication as per* **9.1.1** *for Meters with a Built-In Gas Pressure and/or Temperature Conversion Device as per* **9.1.1**

Meters meeting the requirements of **C-2.4** and the following shall be deemed to meet the metrological requirements.

The sampling plan shall be in accordance with Table 22. The inspection lot shall be of a homogeneous production produced in no more than 10 consecutive working days. All sample size meters shall pass the test.

Carryout test as per **9.1.1.2** and meters shall meet the requirements of **9.1.1.1**.

When an electronic temperature sensor is used, the random sample can be tested in the meter without flow at the temperatures of t_{min} -0+2°C and t_{max} -2+0°C. After thermal stabilization, the temperature sensor shall not deviate by more than 2°C from the reference temperature.

Table 22 Sampling Plan for Meters with Built-In Gas Pressure And / or Temperature Conversion Device
(*Clause* C-2.3.2)

Lot size	**Sample size**
1 to 150	3
151 to 1,200	5
1,201 to 35,000	8

The period of manufacture shall be traceable from the serial number and all relevant quality records shall relate either to a period of manufacture or a serial number. Such records shall be retained by the manufacturer for a minimum of five years.

C-2.4 Pressure Drop

Carryout out Pressure drop test as per **7.8** on every meter. Record as pass or fail for each meter.

C-2.5 Markings

Verify Markings as per **6** on every meter. Record as pass or fail for each meter.

C-2.6 Tests for Meters If Test Medium If Other Than Air Is Required.

C-2.7 Declaration of Conformity

The manufacturer shall provide a declaration of conformity to this Standard.

NOTE — IS/ISO/IEC 17050-1 gives guidance for a supplier's declaration of conformity.

C-2.8 Provision of Information

The manufacturer shall make available for each meter, or group of meters, the installation, operation, testing and maintenance manuals in written form, or electronic format including the name and address of the manufacturer and the date of issue, in a language which can be easily understood by end users, as determined by the Member State concerned, giving appropriate information including:

NOTES

1. It is the responsibility of the manufacturer to make available any amendments and revisions to this information.
   i. Safe use; gas family;
   ii. Rated operating conditions;
   iii. Battery (where field replaceable);
   iv. Meter calibration results;
   v. Installation conditions;
   vi. Instructions for operation, installation, and testing.

   Instructions for installation shall include a requirement for the meter to be level after installation. Groups of identical measuring instruments used in the same location or used for utility measurements do not necessarily require individual instruction manuals.

2. National standards, national legislation, or work instructions provided to meter installers can make the provision of installation or other instructions unnecessary or unwelcome. Information can be prepared but only supplied on request in most instances.

   EXAMPLE
   i. Position, closed or open locations, condensing or with non-condensing humidity;
   ii. Mechanical and electromagnetic environment classes;
   iii. Safety requirements concerning commissioning and de-commissioning procedures;
   iv. Safety requirements on filling/discharge of gas of/from the meter;
   v. Statement if a maintenance is necessary and a relevant instruction;
   vi. Hazards arising from misuse and particular features of the design when appropriate;
   vii. Conditions for compatibility with interfaces;
   viii. Provisions, if any, for transport and handling;
   ix. Position(s) of seals.

C-3 ACCEPTANCE TESTS

(As per OIML R137)

C-3.1 Lot

A lot shall be established consisting of meters considered having homogeneous characteristics. In particular, the type approval identification, meter type, and meter range shall be identical. The batches in a lot shall not cover a period of more than one year of production.

C-3.2 Samples

Samples shall be randomly taken from a lot.

NOTE — The number of samples can be freely chosen, taking into account the requirement in **C-3.3**.

C-3.3 Statistical Testing

The statistical procedure shall meet the following requirements: When the statistical control is based on attributes, the sampling system shall ensure:

a) An Acceptance Quality Level (AQL) of not more than 1 percent; and
b) A Limiting Quality (LQ) of not more than 7 percent.

The AQL is the maximum percentage of non-conforming items in a lot at which the lot has a probability of 95 percent to be accepted.

The LQ is the percentage of non-conforming items in a lot at which the lot has a maximum probability of 5 percent to be accepted.

ANNEX D
(*Clause* 12)
AFD (ADDITIONAL FUNCTIONAL DEVICE)

This Annexure to IS 14439 has been drafted as part of the work being undertaken by the PGD 26 committee to lay down standards for Additional Functional Devices for Gas meters. It is not necessary for the Additional Functionality Device (AFD) to incorporate all functions. This standard shall be providing specific requirements for the additional functionality that can be fitted to a gas meter. This standard includes requirements for gas valves integral within the meters or external to the meter and controlled by an AFD. Such gas valves are intended for interruption of the gas supply. A number of methods can provide the additional functionality for gas meters: these are illustrated below, *see* Fig. 12, and described in detail within this standard. The AFD can be integral to the gas meter, attached to the meter or remote from the meter.

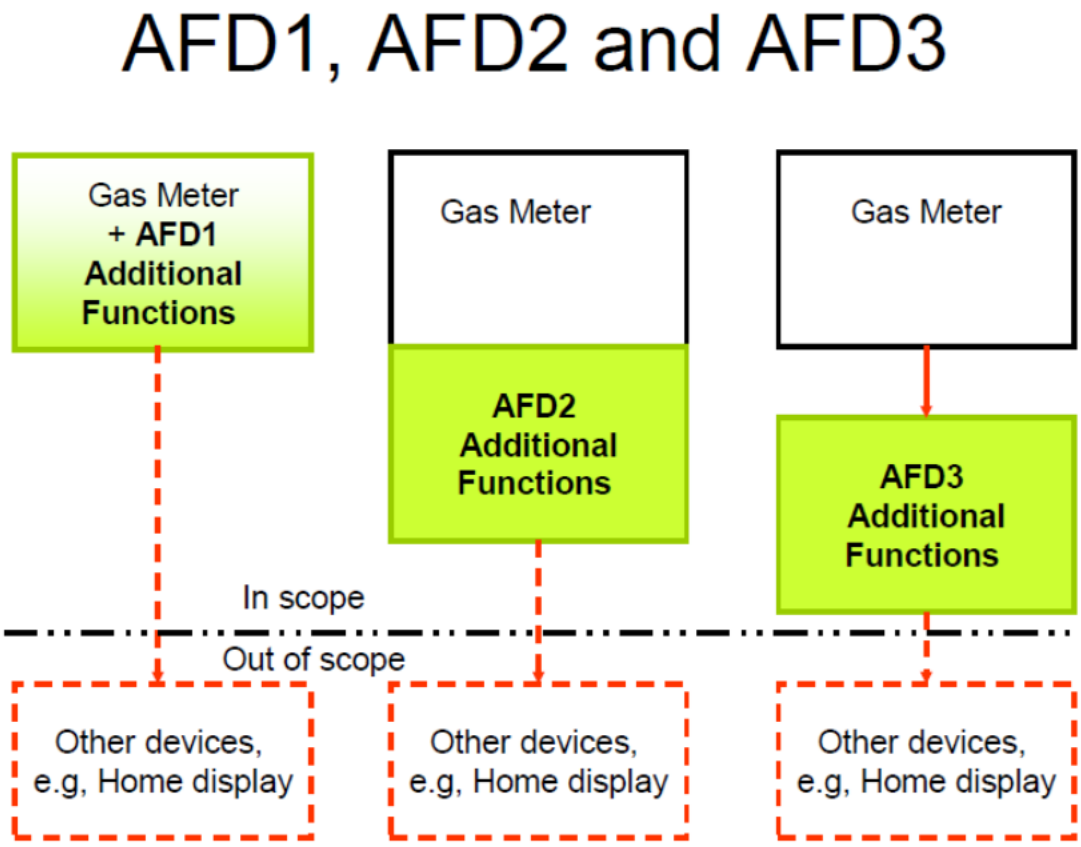


FIG. 12 ADDITIONAL FUNCTIONALITY DEVICE

D-1 SCOPE

This Standard specifies the additional requirements and tests for gas meters, conforming to IS 14439, which have battery powered devices providing additional functionalities that form part of the gas meter (hereafter referred to as meter) or contained in an Additional Functionality Device (AFD). It also covers the additional requirements when an electronic index is used rather that a mechanical one.

This specification is applicable to family gases covered under IS 14439. This Standard specifies the construction requirements for electronic components, but detailed communication protocols are kept out of scope. In general, it is recommended to allow all communication protocol that are open and that can achieve the required functionality. AFD suppliers shall share the communication protocol in order to achieve the interoperability of the AFD with gateways or other forms of data concentrators. Communication technology approved by DoT shall only be used.

This Standard applies to AFDs that are installed in locations with vibration and shocks of low significance and in:

a) Closed locations (indoor or outdoor with protection as specified by the manufacturer) with condensing or with non-condensing humidity, or, if specified by the manufacturer:
b) Open locations (outdoor without any covering) with condensing humidity or with non-condensing humidity,
c) Locations liable to temporary saturation, and in locations with electromagnetic disturbances corresponding to those likely to be found in residential, commercial buildings or similar buildings.

This Annexure does not cover the changing of metrological software within the meter or the upload / download of metrological software. The standard cover internal / external cut-off valves.

D-2 GENERAL REQUIREMENTS

D-2.1 Meter

A meter shall comply with IS 14439 standards.

D-2.2 Meters with Electronic Index

Where a meter conforming to **D-2.1** is equipped with a primary electronic index, the electronic index and its associated software and hardware shall meet the requirements of Annex E (electronics index) and the relevant parts of this standard and the meter standard.

D-2.3 Suitability – AFD/Meter Combination

The AFD shall be connected to the meter and tested as a combined unit in all the tests given in **D-2.4** to **D-2.13** to ensure the connection of the AFD to the meter has no metrological influence. The connection of the AFD to the meter or any labelling on the meter/AFD shall not obscure or damage the metrological seals of the meter. The AFD shall work as the same minimum operating condition as the meter**,** as applicable.

The index on the meter shall not be obscured by the connection of the AFD and the index shall be accessible to the consumer without the use of tools and shall be unambiguously displayed within the index. The manufacturer of the AFD shall declare the conditions for compatibility with any interface and meters.

D-2.4 Types of Additional Functionality Devices

The additional functionality shall be provided by one of the following devices:

a) AFD1;

b) AFD2;
c) AFD3.

In the case of an AFD1, all functions shall be within the same casing as the meter.
In the case of an AFD2, the AFD2 shall be directly attached to the meter.
In the case of an AFD3, the AFD3 shall be connected to the meter.

D-2.5 AFD1

D-2.5.1 *Requirements*

When tested in accordance with **D-2.5.2**, the AFD shall have no influence on the metrological characteristics of the meter.

D-2.5.2 *Test*

Test the meter with the AFD1 incorporated according to this standard, to ensure conformity.

D-2.6 AFD2

D-2.6.1 *Requirements*

a) When tested in accordance with **D-2.6.2 a)**, the AFD shall have no influence on the metrological characteristics of the meter.
b) If the AFD provides a facsimile of the meter's results, it shall be tested in accordance with **D-2.6.2 b)** to ensure these results are identical to that on the meter.
c) When tested in accordance with **D-2.6.2 c)**, the AFD shall operate with the interfaces specified by the manufacturer and display the information as specified by the manufacturer.
d) There shall be the possibility to be able to apply a protective seal between the AFD and the meter.

D-2.6.2 *Test*

a) Fit the AFD to the meter and undertake the relevant tests specified in **D-2** and **D-5** of this standard.
b) Examine the meter and AFD and ensure these results are identical to that on the meter.
c) Verify the AFD is interoperable with those interfaces specified by the manufacturer.
d) Examine the meter and AFD and ensure there is the possibility to apply a protective seal between the AFD and the meter.

D-2.7 AFD3

D-2.7.1 *Requirements*

a) When tested in accordance with **D-2.7.2 a)**, the AFD shall have no influence on the metrological characteristics of the meter.
b) If the AFD provides a facsimile of the meter's results, it shall be tested in accordance with **D-2.7.2 b)** to ensure these results are identical to that on the meter.
c) The AFD manufacturer shall specify the types of interface with which it is compatible.

D-2.7.2 *Test*

a) Fit the AFD to the meter in accordance with the AFD manufacturer's instructions and repeat the relevant tests.
b) Examine the meter and AFD and ensure that the results on AFD are identical to that on the meter.
c) Undertake an assessment of the documented evidence provided by the manufacturer.

D-2.8 Resistance to High Ambient Temperature

If the manufacturer declares the meter associated with any AFD1 or AFD2 is resistant to high ambient Temperatures, the connection or incorporation of the AFD shall not affect its resistance to high ambient temperature. AFD shall comply in accordance with **8.6.6.1** of IS 14439, resistance to high temperature.

D-2.9 Climatic Environments

D-2.9.1 *Closed Location*

AFD shall meet the requirements of IP54 as per IS/IEC 60529.

D-2.9.2 *Open Location*

AFD2 and AFD3 shall meet the requirements of IP65 as per IS/IEC 60529.

D-2.9.3 *Location Liable to Temporary Saturation*

AFD shall meet the requirements of IP67 as per IS/IEC 60529.

D-2.9.4 *Mechanical (Vibration) Class*

D-2.9.4.1 *Requirements*

As declared by the manufacturer, the AFD shall retain its functions before and after being subjected to the vibration test described in **D-2.9.4.2**.

D-2.9.4.2 *Test*

In the case of an AFD2 it shall be directly attached to the meter. Carry out the functions test to secure that the functions of the AFD are correct. Secure the AFD under test to the vibration test rig, a diagrammatic layout of which is shown in Fig. 13, by means of a horizontal clamp across the top of the AFD.

In Fig. 13, the AFD under test (2) is shown mounted to the spindle of an electrodynamic shaker (1), which is driven by an amplified sine wave from a voltage generator. The head of the shaker can be rotated through 90° for the fore-aft and lateral planes.

The acceleration level is sensed using an accelerometer (3) (piezoelectric transducer) whose output is conditioned using a charge amplifier (4).

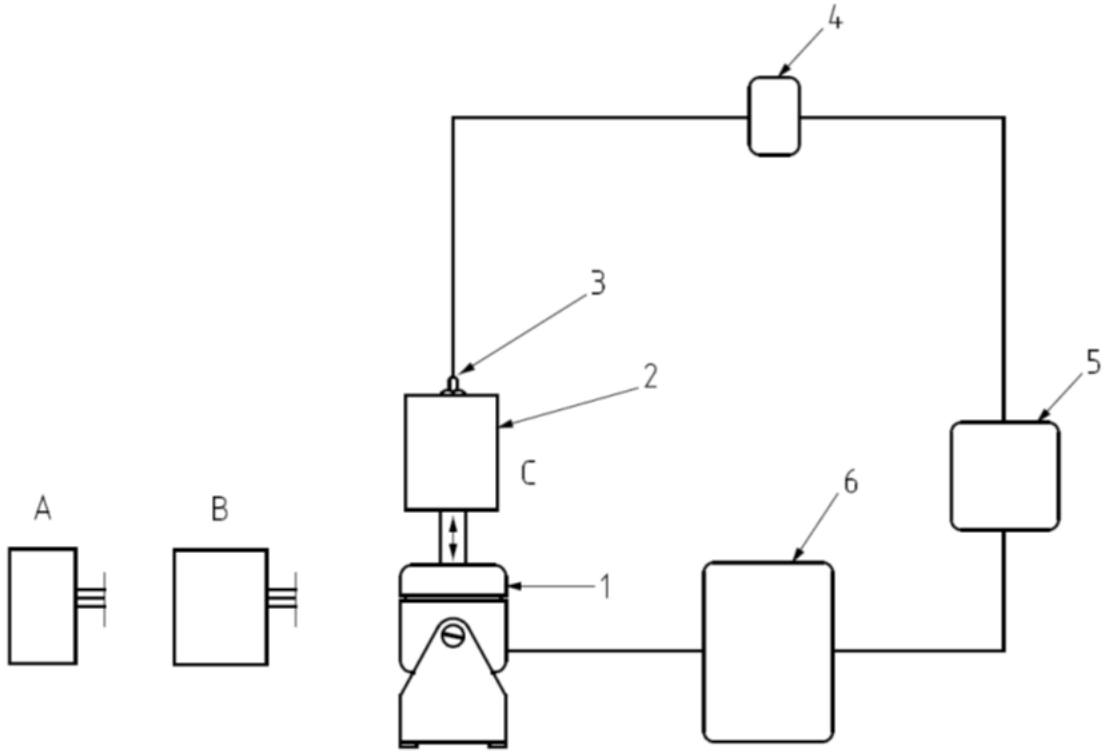
An automatic vibration exciter control (5), which is inserted between the conditioned accelerometer signal and the power amplifier (6), is used in a sweeping mode in which the frequency is cycled between a pair of selected frequencies, alternatively increasing and decreasing.

Subject the AFD under test to a swept frequency of between 10 Hz and 150 Hz (± 5 %) at a sweep rate of 1 octave per minute with a peak acceleration of $2g_n$ (± 5 %), for 20 sweeps in the vertical plane, 20 sweeps in the fore-aft plane and 20 sweeps in the lateral plane.

Recheck the functions of the AFD under test.

The clamping force should be sufficient to restrain the AFD under test without causing damage or distortion to the AFD case.

NOTE — An octave is a band of frequency where the upper frequency limit of the band is exactly twice the lower limit, for example, 10 Hz to 20 Hz, 20 Hz to 40 Hz, 40 Hz to 80 Hz and 80 Hz to 160 Hz. Therefore, the time taken to sweep from 10 Hz to 100 Hz at a sweep rate of 1 octave per minute is 3 min 15 s.



Key

1 Electrodynamic shaker
2 AFD
3 Accelerometer
4 Charge amplifier
5 Automatic vibration exciter control
6 Power amplifier
A AFD for-aft plane

B AFD lateral plane
C AFD vertical plane

FIG. 13 DIAGRAMMATIC LAYOUT OF THE VIBRATION TEST APPARATUS

D-2.9.6 *Temperature Range*

As a minimum, the AFD shall be capable of meeting the requirements for the minimum storage temperature range of ≤ -20°C to ≥ 60°C.

An AFD1 shall have at least the same ambient temperature range as the meter.

D-2.10 Safety Requirements

D-2.10.1 *Pressure Drop*

Any additional functionality shall not cause the pressure drop to be greater than that required by the appropriate meter standard.

NOTES
1. IS 14439 has requirements for the pressure drop of the meter. Pressure at the appliance is very important to safe use of gas, especially for older appliances which may lack flame failure detection.
2. Correct operation of valves and their impact on pressure drop is given in **D-5.13**.

D-2.10.2 *Use in Hazardous Areas*

When the manufacturer declares that the meter/AFD is suitable for use in hazardous zones as defined in IS 16724 / IEC 60079-14, the manufacturer shall declare the zone for which it is intended and shall identify the route to compliance as defined in IS/IEC 60079-0. The general requirements for construction and marking of the meter/AFD shall then comply with IS/IEC 60079-0 or IS 16724 / IEC 60079-14.

Electrical Safety — The manufacturer of the AFD shall declare:

a) Any electrical safety requirements;
b) Suitable environments where it can be fitted;
c) How to install, maintain and use it.

When the AFD incorporates a radio communications device it shall meet the general safety requirements as defined in IS 17724 (Part 1).

D-2.10.3 *Radio Communication*

When the AFD incorporates a radio communications device it shall be approved by WPC (Wireless Planning & Coordination)

D-2.11 Resistance to Mishandling

D-2.11.1 *Requirement*

The AFD shall withstand the handling required during its transport and installation. Before testing in accordance with **D-2.11.2**, the meter under test shall conform to the following:

a) The AFD shall function as specified by the manufacturer;
b) If the meter incorporates a valve, it shall be tested for pressure drop in accordance with the appropriate meter standard and shall not exceed the initial maximum pressure drop value given in the appropriate meter standard;
c) After undergoing the mishandling test described in **D-2.11.2**, the AFD under test shall conform to the following requirements;
d) The AFD function as specified by the manufacturer;
e) If the meter incorporates a valve check, the post endurance maximum permissible pressure drop value given in the appropriate meter standard is not exceeded;
f) The valve is in the same position as before the test was performed; and
g) Visual check for any damage

D-2.11.2 *Test*

Hold the AFD or meter (if incorporating a valve) under test, with no packaging, in the upright position (in its horizontal plane), and drop vertically, from rest, on to a flat, hard, horizontal surface from a height as given in Table 23. The heights given refer to the distance from the bottom of the AFD or meter under test to the surface onto which it will fall. If the meter incorporates a valve, undertake the test with the valve in the open and closed position.

Table 23 Drop Height

(*Clause* D-2.11.2)

Q_{max} (m^3/h)	**Height of dropping** (m)
1 to 10	0.5
16 to 40	0.3

D-2.12 Immunity to Electromagnetic Disturbances

D-2.12.1 *General*

The meter/AFD shall be designed and manufactured in such a way to tolerate the effects of magnetic fields, electrostatic discharge and other electromagnetic disturbances.

D-2.12.2 *Permanent Magnetic Fields*

D-2.12.2.1 *Requirements*

When tested in accordance with **D-2.12.2.2**, the difference in mean errors and the errors during the positioning of a permanent magnet that generates a magnetic field of 200 mT shall not exceed one third of the MPE specified in the appropriate meter standard. The functionalities of the AFD as declared by the manufacturer shall remain operable without any loss of data.

D-2.12.2.2 *Test*

Ensure the AFD is connected to the meter in accordance with the manufacturer's instructions. Stabilize the meter/AFD to room temperature and test the meter three times at Q_{max} and $0.2Q_{max}$ in accordance with the appropriate meter standard. Place the magnet on all surfaces of the AFD in a grid pattern 4 cm wide. Test on every point of the grid at Q_{max}. Retest the meter but again, stabilizing the AFD to room temperature and test the meter three times at Q_{max} and $0.2Q_{max}$ in accordance with the appropriate meter standard.

D-2.12.3 *Electrostatic Discharge*

D-2.12.3.1 *Requirements*

When tested in accordance with **D-2.12.3.2**, the difference in mean errors shall not exceed one third of the MPE specified in the appropriate meter standard and the additional functionalities of the AFD as declared by the manufacturer shall remain operable without any loss of data.

D-2.12.3.2 *Test*

Ensure the AFD is connected to the meter in accordance with the manufacturer's instructions. Stabilise the meter/AFD to room temperature and test the meter three times at Q_{max} and $0.2Q_{max}$ in accordance with the appropriate meter standard. With no flow through the meter, test the meter in accordance with IS 14700 (Part 4/Sec 2) / IEC 61000-4-2 using 10 contact discharges to each of:

a) The conductive surfaces;
b) A horizontal;
c) A vertical coupling plane with a charge voltage of 6 kV [IS 14700 (Part 6/Sec 1) and IS 14700 (Part 6/Sec 2)] at intervals of a minimum of 1 s, with the battery fitted.

With no flow through the meter, test the meter in accordance IS 14700 (Part 4/Sec 2) / IEC 61000-4-2 using 10 air discharges (to insulating surfaces) with a charge voltage of 8 kV [IS 14700 (Part 6/Sec 1) / IEC 61000-6-1 and IS 14700 (Part 6/Sec 2) / IEC 61000-6-2] at intervals of a minimum of 1 s, with the battery fitted.

During the test, connect the inlet boss of the meter under test to the 'ground plane'. Retest the meter but again stabilize the meter/AFD to room temperature and test the meter three times at Q_{max} and $0.2Q_{max}$ in accordance with the appropriate meter standard. Confirm there has been no loss of data.

D-2.12.4 *Radio Frequency Electromagnetic Field*

D-2.12.4.1 *Requirements*

During the test specified in **D-2.12.4.2 a)**, the meter index shall neither increment nor decrement and the additional functionalities declared by the manufacturer shall remain operable and without loss of data.

During the test specified in **D-2.12.4.2 b)**, the flow rate calculated from the meter readings shall not vary by more than three times the *MPE* and after testing in accordance with **D-2.12.4.2 b)**, the mean errors shall be within the *MPE* specified in the standard.

D-2.12.4.2 *Test*

Ensure the AFD is connected to the meter in accordance with the manufacturer's instructions.

a) Set the flow rate to zero. Read the volume register and non-volatile memory Test the meter in accordance with IS 14700 (Part 4/Sec 3) / IEC 61000-4-3, under the classification E1:
    1) Frequency band : 80 MHz to 3 000 MHz
    2) Test field strength : 10 V/m
    3) Amplitude modulation : 80 percent, 1 kHz sine wave

    Read the volume register and non-volatile memory and compare with the value before the high frequency test.
b) Arrange the test equipment so that it is possible to pass air through the test meter while it is being subjected to the electromagnetic field.

NOTE — One way of achieving this is to use a sonic nozzle between the meter outlet and a vacuum line.

Test the meter under the conditions given below. During the test, read the index and elapsed time at suitable intervals. From these readings, calculate the corresponding flow rates.

Stabilize the meter/AFD to room temperature and test the meter three times at Q_{max} in accordance with the appropriate meter standard and determine its MPE. Maintain the meter at Q_{max} and subject the meter/AFD to the range of high frequency field in accordance with IS 14700 (Part 4/Sec 3) / IEC 61000-4-3, under the classification E1:

1) Frequency band : 80 MHz to 3 000 MHz
2) Test field strength : 10 V/m
3) Amplitude modulation : 80 percent, 1 kHz sine wave

With the high frequency field switched off retest the meter/AFD in accordance with the appropriate meter standard at Q_{max} and ensure the meter is still within its MPE.

Confirm there has been no loss of data and the mean errors have remained within the *MPE* specified in the standard.

D-2.12.5 *Electromagnetic Induction (Power Frequency)*

D-2.12.5.1 *Requirements*

When tested in accordance with **D-2.12.5.2 a)**, the AFD register/index shall neither increment nor decrement and the additional functionalities declared by the manufacturer shall remain operable and without loss of data.

During the test described in **D-2.12.5.2 b)**, the flow rate calculated from the meter readings shall not vary by more than six times the MPE specified in the appropriate meter standard, during any of the eight periods of the test without showing an error flag (excluding any error flag designed to appear when entering a test mode).

After testing in accordance with **D-2.12.5.2 b)**, the mean errors shall be within the MPE of the appropriate meter standard.

D-2.12.5.2 *test*

a) Set the flow rate to zero. Read the volume register and non-volatile memory. Test the meter /AFD to test level 4 of IS 14700 (Part 4/Sec 8) / IEC 61000-4-8 for 5 min for the continuous field test and 3 s for the short duration test. Read the volume register and non-volatile memory and compare with the value before the electromagnetic induction power frequency.
b) Arrange the test equipment so that it is possible to pass air through the test meter while it is being subjected to the electromagnetic field.

NOTE — One way of achieving this is to use a sonic nozzle between the meter outlet and a vacuum line.

Test the meter under the conditions given below. During the test, read the index and elapsed time at suitable intervals. From these readings, calculate the corresponding flow rate.

Stabilize the meter/AFD to room temperature and test the meter at $0.2Q_{max}$ in accordance with the appropriate meter standard. During this test the meter/AFD shall be subjected to electromagnetic induction (power frequency) in accordance with test level 4 of IS 14700 (Part 4/Sec 8) / IEC 61000-4-8 for 1 min in each of eight orientations, four with the meter horizontal at 0°, 90°, 180° and 270°, and four with the meter vertical at 0°, 90°, 180° and 270°.

With the power frequency switched off, retest the meter/AFD in accordance with the appropriate meter standard at $0.2Q_{max}$.

Confirm there has been no loss of data.

D-2.12.6 *Electromagnetic Induction (Pulsed Field)*

D-2.12.6.1 *Requirements*

The meter shall satisfy the following requirements. During test described in **D-2.12.6.2 a)**, the meter index shall neither decrement nor increment and the additional functionalities declared by the manufacturer shall remain operable and without loss of data.

During the test specified in **D-2.12.6.2 b)**, the flow rate calculated from the meter readings shall not vary by more than half of the MPE specified in the appropriate meter standard, during any of the eight periods of the test without displaying an error flag.

After testing in accordance with **D-2.12.6.2 b)**, the mean errors shall be within the MPE specified in the appropriate meter standard.

D-2.12.6.2 *Test*

a) Set the flow rate of the meter to zero. Read the volume register and non-volatile memory. Test the meter/AFD in accordance with test level 4 of IS 14700 (Part 4/Sec 9) / IEC 61000-4-9 for 1 min in each of eight orientations, four with the meter horizontal at 0°, 90°, 180° and 270°, and four with the meter vertical at 0°, 90°, 180° and 270°. Read the volume register and non-volatile memory and compare with the value before the pulsed field test.

b) Arrange the test equipment so that it is possible to pass air through the test meter while it is being subjected to the pulsed field.

NOTE — One way of achieving this is to use a sonic nozzle between the meter outlet and a vacuum line.

Test the meter under the conditions given below. During the test, read the index and elapsed time at suitable intervals. From these readings, calculate the corresponding flow rates.

Stabilize the meter/AFD to room temperature and test the meter at $0.2Q_{max}$ in accordance with the appropriate meter standard. During this test the meter/AFD shall be subjected to a pulse field in accordance with test level 4 IS 14700 (Part 4/Sec 9) / IEC 61000-4-9 for 1 min in each of eight orientations, four with the meter horizontal at 0°, 90°, 180° and 270°, and four with the meter vertical at 0°, 90°, 180° and 270°.

With the pulsed field switched off, retest the meter/AFD in accordance with the appropriate meter standard at $0.2Q_{max}$.

Confirm there has been no loss of data.

D-2.12.7 *Radio Interference Emission*

D-2.12.7.1 *Requirements*

When tested in accordance with **D-2.12.7.2**, the electromagnetic interference generated by the AFD shall be limited.

D-2.12.7.2 *Test*

Check that the AFD satisfies class B radio interference limits in IS/CISPR 32 at zero flow.

D-2.13 Immunity to Electromagnetic Disturbances for Meters/AFD's with External Ports

D-2.13.1 *General*

Where meters / AFD's include DC power or signal ports the requirements defined in **D-2.13.2.1**, **D-2.13.3.1** and **D-2.13.4.1** shall apply.

D-2.13.2 *Radio Frequency Common Mode*

D-2.13.2.1 *Requirements*

When tested in accordance with **D-2.13.2.2**, the meter index shall neither increment nor decrement and where the AFD includes additional registers or stores of data these shall not be affected.

D-2.13.2.2 *Test*

Ensure the AFD is connected to the meter in accordance with the manufacturer's instructions. Record the meter index and AFD data prior to performing the test described below.

Perform the test as described in IS 14700 (Part 4/Sec 6) / IEC 61000-4-6, as detailed in Table 24. Note the meter Index and AFD data and confirm that no unexpected changes in data have occurred.

Table 24 Radio Frequency Tests
(*Clause* D-2.13.2.2)

Port	Test conditions	Units	Basic standards	Remarks	Performance criterion
Signal	0.15 to 80 10 80	MHz V %AM (1KHz)	IS 14700 (Part 4/Sec 6) / IEC 61000-4-6	The test level is the r.m.s. value of the un-modulated carrier [a, b]	A
AC / DC Power	0.15 to 80 10 80	MHz V %AM (1KHz)	IS 14700 (Part 4/Sec 6) / IEC 61000-4-6	The test level is the r.m.s. value of the un-modulated carrier [a, b]	A
[a] The test level can also be defined as the equivalent current into a 150 Ω load. [b] Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification may exceed 3 m.					

D-2.13.3 *Fast Transient Bursts*

D-2.13.3.1 *Requirements*

When tested in accordance with **D-2.12.3.2**, the meter index shall neither increment nor decrement and where the AFD includes additional registers or stores of data these shall not be affected.

D-2.13.3.2 *Test*

Ensure the AFD is connected to the meter in accordance with the manufacturer's instructions. Note the Meter Index and AFD data prior to performing the test described below. Perform the test as described in IS 14700 (Part 4/Sec 4) / IEC 61000-4-4 as detailed in Table 25. Note the meter Index and AFD data and confirm that no unexpected changes in data have occurred.

Table 25 Fasten Transient Bursts Test
(*Clause* D-2.13.3.2)

Port	Test Conditions	Units	Basic Standards	Remarks	Performance Criterion
Signal	± 1	KV (open circuit test voltage)	IS 14700 (Part 4/Sec 4) / IEC 61000-4-4	Capacitive clamp used [a]	B
	5/50	Tr/Th ns			
	5	Repetition frequency kHz			
DC Power	± 1	KV (open circuit test voltage)	IS 14700 (Part 4/Sec 4) / IEC 61000-4-4	None	B
	5/50	Tr/Th ns			
	5	Repetition frequency kHz			

[a] Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification may exceed 3 m.

D-2.13.4 *Surges*

D-2.13.4.1 *Requirements*

When tested in accordance with **D-2.13.4.2**, the meter index shall neither increment nor decrement and where the AFD includes additional registers or stores of data these shall not be affected.

D-2.13.4.2 *Test*

Ensure the AFD is connected to the meter in accordance with the manufacturer's instructions. Note the Meter Index and AFD data prior to performing the test described below. Perform the test as described in IS 14700 (Part 4/Sec 5) / IEC 61000-4-5 as detailed in Table 26. Note the meter Index and AFD data and confirm that no unexpected changes in data have occurred.

Table 26 Surge Test
(*Clause* D-2.13.4.2)

Surge test					
Port	**Test Conditions**	**Units**	**Basic Standards**	**Remarks**	**Performance Criterion**
Signal	N/A	N/A	N/A	N/A	N/A
DC Power	1,2/50 (8/20)	Tr/Th µs	IS 14700 (Part 4/Sec 5) / IEC 61000-4-5		
line to earth	± 2	kV (o/c test voltage)			
line to line	± 1	kV (o/c test voltage)			

D-3 SECURITY

D-3.1 General

The AFD shall be constructed in such a way that any unauthorized intervention shall either cause permanently visible damage to the AFD or its protective seals, or set an alarm which shall be visible on the AFD's display (if available) and memorized in the event register. Any physical seals shall be visibly fixed, and easily accessible.

D-3.2 Software, Data and Hardware Security

D-3.2.1 *Requirement*

When tested in accordance with **D-3.2.2**, the requirements below shall be met. All available connections, ports and interfaces of the AFD which can be used for unauthorized adjustment of the AFDs characteristics and additional functionality shall be effectively secured and protected against unauthorized interference by protective seals.

No access shall be allowed to software/firmware by unauthorized persons. Software and data shall be protected against accidental or intentional changes by the breaking of a physical seal or by using an electronic seal.

For electronic seals, the following requirements shall be met:

a) Access shall only be obtained by using a password or a code;
b) Any unauthorized intervention shall be registered in the event log and identify the type of intervention, and where available include its date and time.

Unauthorized access shall cause permanently visible damage to the AFD or its protective seal.

D-3.2.2 *Test*

Compliance with the above requirements shall be checked by visual inspection and evaluation of the manufacturer's Technical Documentation.

D-3.3 Firmware Upgrade

Any firmware upgrade shall be validated (in laboratory on one sample at least) to ensure that it is not affecting any functionality and metrology of the meter. For this validation, following test shall be done on meter after affecting the firmware upgrade:

a) No change in volume register;
b) Accuracy checking at Q_{max}, Q_t, Q_{min} - allowed change in error - one-third of MPE;
c) AFD functionalities.

This standard does not cover Software/firmware metrological upgrades; however, it does allow non-metrological upgrades providing there is clear separation between the metrological and / or non-metrological functions.

The procedure for updating firmware shall not affect the on-going measurement of the meter and the calibration of the meter.

Firmware download shall only be carried out when the correct AFD has been identified, authentication has been made and data integrity check has been completed.

Downloading and the subsequent installation of software shall take place automatically to ensure that the software protection and security remains unchanged and is not compromised by manual interferences.

The target device shall be equipped with a fixed relevant software part that contains all the functions necessary for checking the following characteristic: authentication, integrity and traceability. If one of the checks fails, the instrument shall be capable of detecting if the download or installation failure.

If the download or installation is unsuccessful or is interrupted, the original status of the AFD shall be unaffected.

On successful completion of the installation, all protective means shall be restored to their original state unless there is an authorization to change them. The new software shall be activated immediately or at a fixed date and time.

Following any upgrade, the information/functionality of the AFD shall be as declared by the manufacturer. Any data still present shall be the same as prior to the upgrade.

Typical routine given below is an example of an Acceptable Solution.

A utility program resident in the fixed part of the software that:

a) Handshakes with the sender and checks for consent;
b) Automatically inhibits measurement unless correct measurement can be guaranteed;
c) Automatically downloads of relevant software to a secure holding area;
d) Automatically checks the integrity and authenticity of the downloaded software;
e) Automatically installs the software into the correct location;
f) Takes care of housekeeping, for example, deletes redundant files, etc.; and
g) Initiates the appropriate fault handling procedures if a fault occurs.

In addition, special consideration of the control of the valve should be made during the firmware upgrade process.

D-3.4 Software Identification

Any firmware identifier shall be easily available. The software shall have an unambiguous identifier that is inextricably linked to the software itself and that is easily retrievable. The identifier shall be presented on command or during operation without the use of special tools. Any modification of the software shall have a new identifier.

D-4 POWER SYSTEM

D-4.1 General

For an AFD1, the battery shall be integral to the meter. For an AFD2, the battery shall either be integral to AFD or to the meter.

During the battery exchange, all information contained within the AFD shall be retained. Following the battery exchange, any clock shall maintain the correct time. Where the battery is intended to operate for the full life of the AFD, then there shall be no access to the battery except by disassembly of the AFD. The device shall assess the remaining battery life on a regular basis by assessing the operating conditions defined by the manufacturer. The device shall provide diagnostic indicators which allow the meter operator to identify specific usage of the meter.

Power shall be prioritized as the battery nears end of life.

The following order of priority is recommended:

1. Safety (including the unexpected operation of the valve);
2. Metrology;
3. Local data logging and calculations; and
4. Communications and valve closure.

D-4.2 Battery

D-4.2.1 *General*

The manufacturer shall specify the type of battery used.

D-4.3 Battery Life

D-4.3.1 *Requirements*

As per **D-4.3.2**

D-4.3.2 *Battery Test procedure*

The test comprises exposure of the EUT to the specific low battery level condition during a period sufficient for achieving temperature stability and for performing the required measurements. The maximum internal impedance of the battery and the minimum battery supply voltage level (U_{bmin}) are to be specified by the manufacturer of the instrument. In case of simulating the battery by using an alternative power supply source such as in bench testing, the internal impedance of the specified type of battery shall also be simulated.
The alternative power supply shall be capable of delivering sufficient current at the applicable supply voltage.

The test sequence is as follows:

a) Let the power supply stabilize at a voltage as defined within the rated operating conditions and apply the measurement and/or loading condition.
b) Record:
    1) The data defining the actual measurement conditions including date, time and environmental conditions,
    2) The actual power supply voltage.
        i. Perform measurements and record the error(s) and other relevant performance parameters.
        ii. Verify compliance with the requirements
        iii. Repeat the above procedure with actual supply voltage at U_{bmin} and again at $0.9U_{bmin}$
        iv. Verify compliance with the requirements.

The maximum internal impedance of the battery is to be specified by the manufacturer of the instrument.

D-4.4 Battery Compartment

D-4.4.1 *Requirements*

When tested in accordance with **D-4.4.2**, the battery compartment shall be sealed such that there shall be visual evidence of tamper or other unauthorized interference.

The manufacturer shall apply an electronic or physical seal to the battery compartment of the AFD after fitting the battery.

Cells and batteries shall be of a type from which there can be no spillage of electrolyte or they shall be enclosed to prevent damage by the electrolyte to components. Any leak from the battery shall be contained in the battery compartment and shall not damage the corrosion protection requirements of the meter/AFD. The battery shall be chemically isolated from the electronic components of the meter or its index / display under installed conditions.

D-4.4.2 *Test*

Examine the manufacturer's declaration, technical documentation and undertake a visual inspection.

D-4.5 Battery replacement

D-4.5.1 *Requirements*

a) When tested in accordance with **D-4.5.2**, any battery shall be replaceable without breaking any metrological seal. Access to the battery and other non-metrological compartments shall be available without damaging metrological seal, for example, after opening the battery cover. Protection shall be ensured by non-metrological sealing.
b) When tested in accordance with **D-4.5.2**, the battery replacement shall be:
    1) Accessible from the front of the AFD and be so designed that the battery can be replaced by authorized personnel without removing the AFD from the installation or its fixings;
    2) Designed in a way that it is possible to perform the mechanical procedure of the battery exchange within 2 min and that the metrological authority seal is not broken when replacing the battery;
    3) Such that battery connections can only be made with the correct polarity.
c) When tested in accordance with **D-4.5.2**, following the battery replacement the gas valve shall be in the open or closed position as declared by the manufacturer.

D-4.5.2 *Tests*

a) Remove the battery in accordance with the manufacturer's instructions.
b) When changing the battery in accordance with the manufacturer's instructions, note the time taken to complete the task of changing the battery connections (this does not include the mechanical tasks for getting access to the battery). In addition, ensure the metrological authority seal is not broken.
c) Check by visual inspection that the battery connections are made with correct polarity.
d) Remove the battery in accordance with the manufacturer's instruction and confirm the manufacturer's declaration.

D-4.6 Battery Lifetime Totalizer

D-4.6.1 *Requirement*

The AFD shall incorporate a battery lifetime totalizer.

D-5 ADDITIONAL FUNCTIONALITIES

D-5.1 General

Additional functionality shall be at the discretion of the manufacturer. Any additional functionality shall comply with this clause. Additional functionality above and beyond that described in this clause shall be allowed providing the additional functionality does not influence the metrological characteristics of the meter.

This standard only covers gas valves within the meter case.

D-5.2 Display

The manufacturer shall declare what information can be displayed, and as agreed mutually between manufacturer and purchaser.

D-5.2.1 *General*

This section specifies general requirements for an electronic display that may be incorporated in the meter and / or AFD1, AFD2 or AFD3.

The manufacturer shall declare what information can be displayed.

Minimum following information shall be available.

a) Date and time;
b) Meter serial number;
c) Cumulative Volume;
d) Valve status if present;
e) Battery status.

Above information may also be displayed.

D-5.2.2 *Requirements*

When tested in accordance with **D-5.2.3**, information shall be indicated either on:

a) The display fitted to the meter;
b) The display of an AFD1, AFD2 or AFD3;
c) A combination of the above;
d) The method by which the information and flags is displayed shall take one of the following forms:
    1) By means of direct user action, for example, the depression of push buttons. If after a minimum of 30 s and a maximum of 255 s there has been no user operation, the display shall revert to showing the cumulative volume or switch off;
    2) By means of automatic and sequential scrolling through the information. The identification and the unit of each quantity or parameter that can be indicated shall be clearly shown next

to or upon the display unit. The manufacturer shall declare what information can be displayed.

D-5.2.3 Test By visual inspection.

D-5.3 Diagnostics

The manufacturer shall declare any diagnostic registers and events and the method of retrieving the data.

D-5.4 Metrological Influence

The AFD shall have no inadmissible influence on the metrological characteristics of the meter.

D-5.4.1 *Requirement*

When tested in accordance with **D-5.4.2**, the AFD shall have no inadmissible influence on the metrological characteristics of the meter. The equipment used for this test shall have an expanded uncertainty of measurement of not greater than one fifth of the MPE.

D-5.4.2 *Test*

Connect the meter and AFD complete with all its additional functionalities operable and in series with a reference standard. Record the start index of the reference standard and that which is under test. This shall be undertaken at the start of each test. With air passing through the meter stream at Q_{min} and Q_{max}, operate each additional function that could have an effect on the metrological characteristics of the meter separately. Operate each additional function continuously for 1 h or for a minimum of 10 operations at Q_{min} and Q_{max}. Compare the index reading of the reference standard to the meter under test and ensure that the reading has not deviated by more than one fifth of the MPE.

D-5.5 AFD Connections

Any wired or wireless connections to the AFD shall allow the sending and/or receiving of signals/pulses. The method of connection used shall be described in the manufacturer's instructions.

D-5.6 Input to AFD

D-5.6.1 *General*

The input to the AFD2 or AFD3 shall be in the form of incremental volume pulses or data stream. For AFD1, the manufacturer shall choose the appropriate solution.

D-5.6.2 *Requirement (For AFD2 and AFD3 Only)*

The input for an AFD shall either be provided via a connector, fixed lead, optical or wireless. The AFD shall be marked how to connect the input, which shall also be detailed in the AFD manufacturer’s instructions.
Incorrect connection shall be eliminated by design.

The AFD manufacturer's instructions shall include the electrical characteristics and parameters, the type and method of connection, installation, operating system of the AFD. The communication between the meter and AFD shall be compatible by the use of an open standard or one that is publicly available.

When tested in accordance with **D-5.6.3**, a signal described by the manufacturer shall be detected.

D-5.6.3 *Test*

Connect in accordance with the manufacturer's instructions and ensure a pulse or data stream is recognized and correct assembly is obvious.

Step 1: Connect the AFD with the gas meter as per the manufacturer’s instructions.
Step 2: Check the mechanical index reading and the reading on the AFD are synchronized. In case if it is not synchronized, synchronize the reading as per manufacturer’s instructions. For devices without display, check if the index reading and reading on the server are synchronized, and the meter serial number and the test device serial number are the same on the server.
Step 3: Apply airflow equivalent to $0.2Q_{max}$ to the gas meter. Check if the meter index is moving. The test will be conducted for 20 pulses.
Step 4: After 20 pulses note the variations in the index value of the gas meter and reading on the AFD display or the server.
Step 5: The increment in the index value and reading on AFD display/server should be the same.

D-5.7 Output from AFD

D-5.7.1 *General*

The output from the AFD shall be either in the form of incremental volume pulses or data stream. The output shall either be provided via a connector, fixed lead, optical or wireless. The AFD shall be marked how to connect the output, which shall also be detailed in the manufacturer’s instructions. Incorrect connection shall be eliminated by design.

The manufacturer's instructions shall include the electrical characteristics and parameters, the type and method of connection, installation, operating and maintenance requirements.

D-5.7.2 *Requirement*

When tested in accordance with **D-5.7.3**, an output signal or data stream shall be detected.

D-5.7.3 *Test*

Connect the AFD in accordance with the manufacturer's instructions and ensure a signal is recognized.

D-5.8 Data Storage

D-5.8.1 *General*

The manufacture shall declare how to access the stored data. The AFD shall be capable of storing static data, for example, supplier/site/meter information.

Stored data shall be retained in the event of battery failure.

D-5.8.2 *Interval Data Storage*

Interval stored data shall be time stamped configurable over specific time periods. The AFD manufacturer shall specify sufficient memory to store readings for at least four months, and as agreed mutually between manufacturer and purchaser. Stored readings shall enable the index value at the time stamp to be easily calculated as well as indicating the alarm status and the active tariff rate, time stamp, where applicable.

D-5.8.3 *Event Data Storage*

The AFD shall be capable of recording and storing one or more of the following events:

a) Clearing of stored data;
b) Fault event;
c) Corruption of data base;
d) Activation of change of tariff programme;
e) Activation of firmware upgrade;
f) Resetting and clearing of data base;
g) Low battery voltage;
h) battery replacement;
j) Opening and closing of valve;
k) Setting of the clock; and
m) Perceived tamper events, for example, fraud attempts.

The list above is not exhaustive. As per agreement between User and Supplier of device. There shall be enough memory to store at least 100 events and each event shall be identifiable. Memory shall be deleted on a first in first out basis. At the discretion of the manufacturer, priority shall be given to certain types of events which shall not be deleted unless the removal is carried out by a suitably authorized person.

D-5.9 Time Interval Accuracy

D-5.9.1 *Introduction*

Stored data shall be time stamped. It is recommended that the time stamp within the AFD uses UTC. The manufacture shall declare how to access the time interval data. Time interval data shall be retained in the event of battery failure. The accuracy shall be suitable for its intended use.

D-5.9.2 *Requirements*

Test in accordance with **D-5.9.3**, if the manufacturer declares that the AFD has a clock. The test shall be confirmed that the accuracy of the clock in accordance with the requirements of IEC 62054-21, **7.5.2**.
The design of the interval functionality shall guarantee that the sum of interval values will be equal the change of the main register.

D-5.9.3 *Test*

Consider the manufacturer's evidence and ensure it is correct

D-5.9.4 *Requirements*

Test in accordance with **D-5.9.5**, if the manufacture declares that the AFD is able to manage and display local time, this shall be displayed on the AFD.

D-5.9.5 *Test*

By inspection.

D-5.9.6 *Requirement*

When tested in accordance with **D-5.9.7**, the meter and AFD shall only have one reference clock or both clocks shall be synchronized.

D-5.9.7 *Test*

By inspection.

D-5.9.8 *Requirement*

When tested in accordance with **D-5.9.9**, the clock accuracy shall be maintained according to a strategy determined by the manufacturer.

D-5.9.9 *Test*

By inspection.

D-5.9.10 *Requirements*

If the manufacturer declares that the AFD has a clock that can be synchronized with the meter, when tested in accordance with **D-5.9.11**, it shall be possible to carry out this synchronization.
A record shall also be placed in the event log showing what action was taken.

D-5.9.11 *Test*

Using the manufacturer's procedure, synchronize the clock on the AFD to that on the meter and verify an event has been recorded in the log.

D-5.9.12 *Requirements*

If the manufacturer allows setting of the clock, when tested in accordance with **D-5.9.13**, it shall only be achieved by the use of an electronic seal or the breaking of a physical seal. A record shall also be placed in the event log showing what action was taken.

D-5.9.13 *Test*

Using the manufacturer's procedure, use the password or break the physical seal, as appropriate and check the event log shows the action that has taken place.

D-5.10 Energy Calculation within the AFD (Optional)

Where the manufacturer considers it appropriate to allow an upload of values to determine the energy usage, this shall be permitted.

> NOTE — Further information can be found in relevant IS standards; however, these possibilities may be subject to national requirements.

D-5.11 Tariffs

Where a manufacturer declares that the AFD has the ability to display and support a tariff, the measured values shall be used as the basis on the price to pay and the meter/AFD shall have sufficient registers and memory to support the tariff structure. In addition, one or more of the following requirements could apply:

a) The meter/AFD shall be able to receive the gas characteristics (for example, calorific value, estimated pressure and/ or temperature) and the cost per unit of energy via a secure communication system;
b) The meter/AFD shall be able to display and/or to calculate the price to pay;
c) The customer shall, without the use of tools, be able to view the elements that make up the tariff structure;
d) A method of providing a tariff update in advance with an activation time and date shall be provided;
e) The meter/AFD shall have a programmable billing period and a method of storing snapshot readings at the end of each billing period.

D-5.12 Display/Human Interface

Displayed data that is consumer relevant shall be easily legible and available without the use of tools.

D-5.13 Gas Valve (Integral Type Only) and System

D-5.13.1 *General*

The valve requirements below are only intended for interruption of the gas supply and shall not replace any valve intended to isolate the gas supply, for example, an Emergency Control Valve or similar. It shall not be regarded as a thermal or safety shut off valve.

Any changes that affect consumer usage of a gas meter or gas supply to the home, shall involve a thorough consideration of human factor risks prior to implementation. The restoration of the gas supply has significant risks associated with it, as such, it is essential that systems ensure that the restoration of the supply at the gas meter/AFD is undertaken in a safe manner in the physical presence of customer/ supplier representative.

D-5.13.2 *Design Quality*

D-5.13.2.1 *Requirements*

When tested in accordance with **D-5.13.2.2**, the manufacturer shall provide a risk analysis that demonstrates that the risks associated with operation of the valve are acceptable. The failure of any single

part of the meter/AFD shall not cause the valve to unexpectedly open or partially open once it has closed unless this is caused by failure of the valve components directly responsible for sealing of the valve.

D-5.13.2.2 *Test*

The manufacturer's evidence is to be examined to prove compliance by the following:

a) Performance level C of IS 16810 (Part 1), or SIL 2 of IS/IEC 61508-1, to determine a satisfactory Safety Integrity Level, and then show that this level is appropriate and the meter design achieves the level determined; and
b) Document Failure Modes, Effects, and Controls Analysis. Consider unexpected opening of the valve, and the possibility of a valve open or close process leaving the valve in a partially open condition.

D-5.13.3 *Valve Operation*

D-5.13.3.1 *Requirements*

a) When tested in accordance with **D-5.13.3.2.1** (ensuring credit is available), the valve shall not be capable of opening without direct manual intervention at the meter, or the meter/AFD shall incorporate a check for an uncontrolled release of gas.
b) When tested in accordance with **D-5.13.3.2.2**, the valve opening procedure shall either:
    1) Place a notice on the meter which instructs the local operator how activate the valve to prevent an uncontrolled release of gas; or
    2) Incorporate a check for an uncontrolled release of gas. There shall be automatic closure of the valve or no opening of the valve if there is an uncontrolled release of gas; or
    3) Both 1) and 2).
c) If a valve closure procedure is declared by the manufacturer following an event, then each declared event shall be tested in accordance with **D-5.13.3.2.3** to ensure the valve closes correctly.
d) When tested in accordance with **D-5.13.3.2.4**, check a flag is displayed indicating a fault has occurred and this is recorded on event log.
e) When tested in accordance with **D-5.13.3.2.5**, ensure the valve closes correctly and no flag is displayed indicating a fault has occurred.

D-5.13.3.2 *Test*

D-5.13.3.2.1 — Examine the design of the meter to determine that it is not possible for the valve to operate without manual intervention at the meter, or in accordance with **D-5.13.3.2.2 b)**.

D-5.13.3.2.2 — Perform tests a) to c) as appropriate:

a) Undertake the valve opening procedure and verify the presence of an instruction to the operator how to prevent an uncontrolled release of gas.
b) Ensure the valve in the meter is in the open position. Set the flow rate from the meter (air with density 1.2 kg/m^3 and a pressure of 75 mbar) at 10 percent above that specified by the meter manufacturer and close the valve. Instruct the valve to open and verify it remains closed or closes after uncontrolled release of air has been detected.
c) Test the meter in accordance with a) and b) above.

D-5.13.3.2.3 — Simulate the events as declared by the manufacturer and confirm an ordered shut down of the valve has taken place.

D-5.13.3.2.4 — Prevent the valve from operating, for example, by insertion of an obstruction. Initiate the valve operation procedure by the various modes possible and monitor the valve control circuits to ensure a valve operation is attempted. Repeat the attempts to operate the valve for a minimum of three times, or the number of times declared by the manufacture, whichever is the greater, until the retry limit is reached.

D-5.13.3.2.5 — Attempt to operate the valve repeatedly until the manufacturer's declared retry limit is reached. Repeat the above test until one minus the attempted valve closure number used and then remove the obstruction.

D-5.13.4 *Valve Performance*

D-5.13.4.1 *General*

The opening and closing of the valve shall be managed so that it does not become a safety issue.

D-5.13.4.1.1 *Requirement*

When tested in accordance with **D-5.13.4.1.2**:

a) Unexpected opening of the valve shall cause an event.
b) At the discretion of the manufacturer the meter/AFD shall be configured not open its valve while any resettable fault events remain un-cleared.
c) The valve shall not require any external electrical power to keep its position.
d) The method used to activate a valve shall be secure to prevent communication errors or malicious interference causing unintended operation.

D-5.13.4.1.2 *Test*

a) The valve is to be forced to open by both mechanical and electrical means. Following operation, the presence of a tamper alarm is to be verified.
b) The valve is to be closed by a means that generates a resettable fault. Following closure, attempts are to be made to reopen the valve without clearing the fault. The fault is then to be cleared and the valve reopened.
c) Ensure the valve in the meter is in the closed position. Set the pressure to 75 mbar at the meter inlet and disconnect the power supply; leave the valve in the closed position for at least 6 h. After the test period, check the valve is still in the closed position. Re-energize the valve and place the valve in the open position and leave the valve in the open position for at least 6 h. After the test period, check the valve is still in the open position.
d) Review the precautions taken by the manufacturer.

D-5.13.4.2 *Display of valve related information*

D-5.13.4.2.1 *Requirement*

When tested in accordance with **D-5.13.4.2.2**, the meter/AFD shall display:

a) A warning message prior to allowing the valve to be opened, if **D-5.13.3.1 a)** and **c)** is used;
b) Whether the valve is open or closed;
c) If the valve fails to close when instructed;
d) If the check for an uncontrolled release of gas in-accordance with **D-5.13.3.1 b)** was not successful.

D-5.13.4.2.2 *Test*

Open the valve and examine the display for the presence of an appropriate "valve opening" warning message.

The meter is to be operated in accordance with the manufacturer's instructions to ensure that the meter displays the status of the valve.

D-5.13.4.3 *Electrical safety*

D-5.13.4.3.1 *Requirement*

When tested in accordance with **D-5.13.4.3.2**, where the manufacturer specifies that the electrical components of the valve are built into the gas-ways within the meter, these components of the valve shall be suitable, for use in a zone 2 area, as defined in IS 5572.

D-5.13.4.3.2 *Test*

The manufacturer is to provide evidence of compliance to the relevant part of the IS/IEC 60079 series.

D-5.13.4.4 *Pressure drop*

D-5.13.4.4.1 *Requirement*

When tested in accordance with **D-5.13.4.4.2**, the total pressure drop across the meter with a valve incorporated shall not exceed that specified in the appropriate meter standard.

D-5.13.4.4.2 *Test*

With the meter connected to an air supply with air of density 1.2 kg/m^3 with the valve in the open position, a flow rate of Q_{max} is to be passed through the meter. The pressure drop of the measuring element including any valve (in the open position) is to be determined by a suitable measuring device with an accuracy of at least ± 5 %.

D-5.13.4.5 *Valve closing*

D-5.13.4.5.1 *Requirement*

When tested in accordance with **D-5.13.4.5.2**, the rate of leakage through the valve is at the discretion of the manufacturer and shall not exceed the values given in Table 27.

D-5.13.4.5.2 *Test*

With the meter connected to an air supply of density of approximately 1.2 kg/m^3, at a flow rate of Q_{max}, the test pressure given in Table 27, close the valve at each of the specified pressures. Following closure, the leak rate past the valve is to be determined by a suitable measuring device with an accuracy of at least ± 5 %.

Table 27 Maximum Gas Valve Internal Leakage
(*Clause* D-5.13.4.5.1 and D-5.13.4.5.2)

Maximum gas valve Internal leakage requirements (m^3/h)		
Test pressures	Type 1 upto G 10	Type 2 G 16 and above
At 20 mbar	0.001	0.005
At 75 mbar	0.001	0.005
At 150 mbar or P max of the meter, whichever is the greater	0.005	0.005

D-5.13.4.6 *Valve opening*

D-5.13.4.6.1 *Requirement*

When tested in accordance with **D-5.13.4.6.2**, the valve shall be able to open under normal operating conditions, against an inlet pressure of 75 mbar.

D-5.13.4.6.2 *Test*

The pressure at the inlet of the meter shall be set to 75 mbar. The outlet of the meter shall be connected to a throttle that will limit flow through the meter to Q_{max} with 75 mbar at the inlet.
The meter is to be instructed to open the valve in the way envisaged in normal operation. The valve shall open normally.

D-5.13.4.6.3 *Resistance to toluene/iso-octane and water vapour*

When tested in accordance with **F-3**, the rate of leakage through the valve shall meet the requirements given in Table 27.

D-5.13.4.7 *Storage temperature range*

D-5.13.4.7.1 *Requirement*

When tested in accordance with **D-5.13.4.7.2**, the rate of leakage through the valve shall meet the requirements of **D-5.13.4.5.1**.

D-5.13.4.7.2 *Test*

Maintain the meter with the valve in the open position under test, with no gas flowing through it, under the following conditions:

a) 3h at a temperature of -20°C, or lower if declared by the manufacturer;
b) 3h at a temperature of 60°C, or higher if declared by the manufacturer.

At the end of the test, the meter with the valve under test is returned to normal laboratory ambient temperature. A valve closure is then to be initiated. When the valve is in the closed position, it is to be tested in accordance with **D-5.13.4.5.2** to determine the internal leakage rate.

D-5.13.4.8 *Endurance*

D-5.13.4.8.1 *Requirement*

When tested in accordance with **D-5.13.4.8.2**, the valve shall operate for 4 000 cycles. Following 4 000 cycles operation the valve shall comply with the internal leakage requirement in **D-5.13.4.5.1**.

D-5.13.4.8.2 *Test*

With the meter connected to an air supply at a pressure between 25 mbar and 50 mbar, the valve is to be cycled open/closed/open at a frequency not exceeding 1 operation per 5 second for 4 000 cycles in accordance with **F-2**. After 4 000 cycles, the valve is to be tested in accordance with **D-5.13.4.5.2** to determine the internal leakage rate.

D-5.13.4.9 *Resistance to contaminants in the gas stream*

D-5.13.4.9.1 *Requirement*

When tested in accordance with **D-5.13.4.9.2**, all three meters shall comply with **D-5.13.4.5.1**.

D-5.13.4.9.2 *Test*

Test a minimum of three meters. Where more than one installation orientation is specified by the manufacturer, test a minimum of three meters in each orientation.

The test equipment used for this test need not have absolute traceability provided that each meter is tested on equipment that does have such traceability prior to commencing the test.

Test the meter in accordance with **D-5.13.4.5.2**.

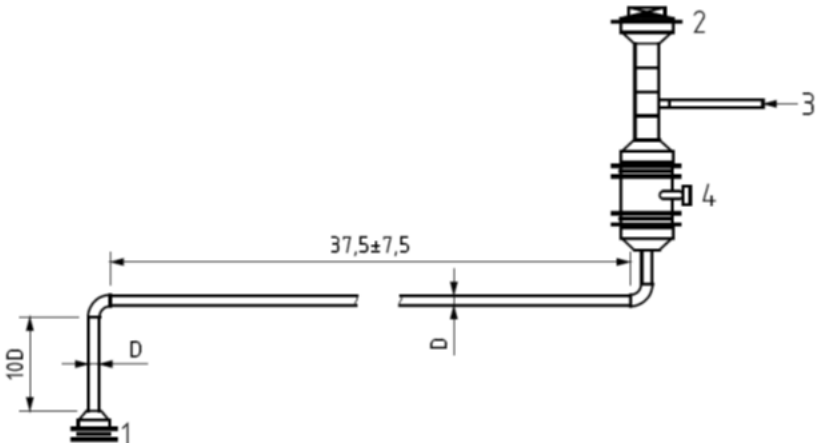
Attach the meter to a dust rig that has 10*D* of vertical pipe before the meter and pass air through the meter for 5 minutes at Q_{max}. Stop the air supply and add 5 grams of 300 to 400 grade dust to the rig inlet. Start the air supply and maintain a flow of Q_{max} for a further 5 min.

Repeat this procedure with 5 g of each dust grade in the order 200 to 300, 100 to 200 and 0 to 100.

Test the meter in accordance with **D-5.13.4.5.2**.

For meters covered by this European Standard, D = 15 mm.

Dimensions in Millimeters



Key

1 Meter
2 Dust inlet (screwed plug)
3 Air supply (fan)
4 Fast acting full bore valve

FIG. 14 EXAMPLE OF A TYPICAL TEST RIG FOR THE ADDITION OF DUST

Referring the meter to be tested and fitted with a filter on the outlet to minimize the dust passing through the outlet to Fig. 14, the apparatus consists of the following components:

a) 10*D* of vertical parallel bore pipe, to connect to the meter inlet;
b) A removable screwed plug, for the addition of dust;
c) A ball valve, to release the dust;
d) A length of straight pipe 30*D* to 45*D* in length, to ensure that all dust is airborne before entering the meter;
e) Copper pipework with soldered or compression fittings is preferred. Steel pipe fittings are not recommended as the dust will adhere to the screw threads.

Other designs of test rig may be used, so long as the following requirements are met.

Check the effectiveness of a test rig design on a regular basis, using a test box. This is to ensure that when 20 g of dust is added using the procedure mentioned above at least 18 g is deposited inside the test box fitted to the rig outlet. Ensure that the test box has a similar volume and shape to the meter to be tested and fitted with a filter on the outlet to minimize the dust passing through the outlet.

Four separate batches of dust shall be used with 95 percent of the particles in each batch in the appropriate size range given below:

1) 0 µm to 100 µm, Average size (50 ± 10) µm;
2) 100 µm to 200 µm, Average size (150 ± 10) µm;
3) 200 µm to 300 µm, Average size (250 ± 10) µm;
4) 300 µm to 400 µm, Average size (350 ± 10) µm.

Each of the above batches shall have a composition by mass of:

i. Black iron oxide (Fe_3O_4), 79 percent
ii. Red iron oxide (FeO), 12 percent
iii. Mineral silica flour (SiO), 8 percent
iv. Paint residual flake, 1 percent

Close the valve and confirm that the leak rate does not exceed the values given in **D-5.13.4.5.1**.

D-5.14 Registers

A register to the AFD shall be fitted at the manufacturer's discretion.

D-5.15 Prepayment System with Valve

The meter/AFD shall be capable of accepting information that the consumer has made payment for energy/volume whether or not the valve is closed.

The meter/AFD shall maintain a balance that shows how much payment or energy/volume remains until the valve is closed. The meter/AFD shall be capable of displaying this balance to the consumer.

The valve shall close according to the manufacturers declared procedure.

Where the balance held by the meter/AFD is at an appropriate level, the meter/AFD shall only allow an authorized user (declared by the manufacturer) to re-open the valve.

Where the balance held by the meter/AFD is maintained in currency values (rather than volume or mass) then the meter/AFD shall also display the tariff structure which is applied (*see also* **D-5.8**).

At the manufacturer's discretion, prepayment functions shall include one or more of the following:

a) A function to have an emergency balance available, which can be invoked by the consumer;
b) A function that prevents closure of the valve for the purposes of prepayment during times of day, week, or year (non-disconnect/friendly credit);
c) A function that maintains an additional separate balance on the meter/AFD for accrued customer debt, which is reduced as a function of time, payment information, or a combination of the two;
d) An alternative method of accepting information that the customer has made payment for energy, for example, to be used when the primary communications have failed; and
e) Any other function related to payment.

D-5.16 History of Consumption

D-5.16.1 *Requirement*

At the discretion of the manufacturer, he may provide data which will allow gas consumption for specific periods of time to be displayed on the meter/AFD.

D-5.16.2 *Test*

By visual inspection.

D-5.17 Memory

D-5.17.1 *General*

D-5.17.1.1 *Requirement*

When tested in accordance with **D-5.18.1.2**:

a) The volatile and non-volatile memory shall have a capacity which is sufficient for the intended purpose;
b) Overwriting of data shall not occur before the end of the data storage period that is foreseen and documented by the manufacturer; and
c) Non-volatile memory shall be updated automatically and periodically according to the reading interval, but this updating shall be at least every 6 h.

D-5.17.1.2 *Test*

Inspect manufacturer's documentation.

D-5.17.2 *Access Profiles*

D-5.17.2.1 *Requirement*

When tested in accordance with **D-5.17.2.2**, the manufacturer shall declare access profiles to different data set, commands and configurations. Ensure different combinations operate correctly and ensuring any other combination is inoperable.

D-5.17.2.2 *Test*

Perform tests using different combinations.

D-5.17.3 *Non-Volatile Memory*

D-5.17.3.1 *Cumulative volume*

D-5.17.3.1.1 *Requirement*

When tested in accordance with **D-5.17.3.1.2**, the recorded cumulative volume shall be shown by the display and stored in a non-volatile storage device for a minimum of 36 months. The manufacturer shall declare the memory retention time.

D-5.17.3.1.2 *Test*

Confirm by visual inspection. The memory retention time can be based on calculations from data for the relevant components, or from the results of manufacturer's own relevant tests.

D-5.17.3.2 *Updating*

D-5.17.3.2.1 *Requirement*

The non-volatile memory shall:

a) Be accessible at the extremes of the ambient temperature range; and
b) Be maintained without any power source across the maximum and minimum storage temperatures, as declared by the manufacturer.

When tested in accordance with **D-5.17.3.2.2 a)**, the non-volatile memory shall remain accessible and unchanged at the extremes of the temperature range.

When tested in accordance with **D-5.17.3.2.2 b)**, there shall be no difference between the readings before and after the test.

D-5.17.3.2.2 *Test*

a) Extreme ambient temperature range:

    1) Access the information in the non-volatile memory as specified by the manufacture;
    2) Prevent any registration;
    3) Note the information which is in the non-volatile memory;
    4) Subject the AFD to the extremes of ambient temperature, as specified by the manufacturer, for a minimum of 3 h at each temperature;
    5) At each of the temperature extremes, at the end of the dwell time, read the information from the non-volatile memory; and
    6) Compare the information as noted in 3) and 5) above.

b) Power source:

    1) Access the information in the non-volatile memory as specified by the manufacture;
    2) Simulate a flow rate equal to Q_{max} for a period of 5 min;
    3) Confirm that the simulated flow rate has been registered;
    4) Prevent further registration;
    5) Note the information which is in the non-volatile memory;
    6) Leave the AFD at room temperature for a minimum of 6 h 5 min;
    7) Disconnect the non-volatile memory from the power supply and subject the AFD to the minimum and maximum storage temperatures, as specified by the manufacturer, for a minimum of 3 h at each Temperature;
    8) Reconnect the power supply;
    9) Note information in the non-volatile memory; and
    10) Compare the information as noted in 5) and 9) above.

D-6 MARKING

D-6.1 Requirements

When tested in accordance with **D-6.2**, the AFD shall as a minimum be marked as follows:

a) The number and date of this standard;
b) Identification mark or name of the manufacturer;
c) Serial number and year of manufacture;
d) If the AFD is declared as meeting the requirements of EN 60079 then the marking requirements of EN 60079 shall apply;
e) Mark with IP 65 (IS/IEC 60529) and additionally with H3, when suitable for use in an open location;
f) Mark with IP 67 (IS/IEC 60529), when suitable for use in locations liable for temporary saturation;
g) Ambient temperature range -10 °C and 55 °C; and
h) Any additional marking as required by legislation.

With the exception of b) and c), if all applicable information cannot be shown on the AFD this shall be provided on the packaging or with the AFD literature.

D-6.2 Test

This test is carried out by visual inspection.

D-7 DOCUMENTATION

The following are the conditions for compatibility with interfaces.

D-7.1 General

The following information shall be provided with each AFD or group of AFD's used in the same location. However, any safety related information required by consumer shall be provided with each AFD.

D-7.2 Declaration of Conformity

D-7.3 Technical Documentation

A full set of technical documentation shall accompany the AFD when the AFD is submitted for test. This shall include a sealing drawing describing the method of sealing.

D-7.4 Instruction Manual

The operating instructions shall be available in written form or electronic format and shall identify the name and address of the manufacturer and the date of issue.

Each AFD, or group of AFD's, shall be delivered with installation, operation and maintenance manuals, in a language acceptable by the user and easily understandable, giving appropriate information on:

1) Safe use;
2) Gas family;
3) Rated operating conditions;
4) Possible installation positions;
5) Mechanical and electromagnetic environment classes;
6) Safety requirements concerning commissioning and de-commissioning procedures;
7) Statement if a maintenance is possible and a relevant instruction;
8) Hazards arising from misuse and particular features of the design when appropriate;
9) Way of controlling the proper installation and operation;
10) Provisions, if any, for transport and handling;
11) How to trace the right spare parts;
12) Storage requirements for spare parts if relevant;
13) A description of each of the additional functionalities;
14) The type of communication protocol used;
15) Electrical compatibility and safety.

ANNEX E
(*Normative*)
ELECTRONIC INDEX

E-1 GENERAL

When a meter conforming to IS 14439 is equipped with a primary electronic index, this annex and the relevant parts of this standard and the appropriate meter standard shall be used to demonstrate conformity. In addition to meeting the relevant requirements of this standard, a meter with the electronic index shall, in all circumstances, withstand the influence factors and disturbances as defined in the appropriate meter standard. All the constituent elements of an electronic index shall be constructed of materials having appropriate quality to resist the various forms of degradation which can occur under normal operating conditions as specified by the manufacturer. Additional indications shall not be able to be confused with any other indications on the meter.

E-2 DISPLAY

E-2.1 Requirements

The display on any meter shall have a means to demonstrate that the display is operating correctly.

E-2.2 Test

Confirm by visual inspection and that the display is functioning correctly.

E-3 DISPLAY RESET

E-3.1 Requirements

On the display of any meter/AFD it shall not be possible to reset the metrological result without breaking the metrological seal.

E-3.2 Test

Confirm by visual inspection. Using suitable equipment and commands, supplied by the manufacturer, attempt to reset.

E-4 TEST SIGNAL

E-4.1 Requirement

If test signal injection is used, when tested in accordance with **E-4.2**, the means of initiating this test signal injection shall be capable of being sealed such that unauthorized interference is detectable, and such that the metrological seal need not be broken to operate this facility.

E-4.2 Test

By visual inspection.

E-5 NON-VOLATILE MEMORY

E-5.1 Requirements

Non-volatile memory shall be incorporated into any AFD that processes metrological and/or financial data. The non-volatile memory shall be continuously updated at least every 6 h and shall:

a) Be accessible at the extremes of the ambient temperature range, as declared by the manufacturer; and
b) Be maintained without any power source across the maximum and minimum storage temperatures, as declared by the manufacturer.

When the AFD is tested in accordance with **E-5.2 a)**, the non-volatile memory shall remain accessible and constant at the extremes of the temperature range.

When the AFD is tested in accordance with **E-5.2 b)**, there shall be no difference between the index readings recorded in 3) and 6).

E-5.2 Test

a) Access to non-volatile memory

1) Determine a method for accessing the volume index in the non-volatile memory. Ensure that there is no difference between the two readings. The manufacturer shall declare how this can be performed;
2) Cap the meter to prevent any registration;
3) Note the meter/AFD index on the display and in the non-volatile memory;
4) Subject the meter or AFD to the extremes of ambient temperature, as specified by the manufacturer, for a minimum of 3 h at each temperature;
5) At each of the temperature extremes, at the end of the dwell time, read the volume index from the non-volatile memory.

b) Maintenance of non-volatile memory

1) Note the meter/AFD index;
2) Immediately apply a flow rate equal to Q_{max} to the meter for a period of 5 min;
3) Confirm that the meter/AFD has registered the gas flow, then cap the meter to prevent further registration and immediately note the new meter index, time and relevant information;
4) Leave the meter/AFD at room temperature for a minimum of 6 h 5 min after the time noted in 3) above;
5) Remove the battery and subject the meter/AFD to the minimum and maximum storage temperatures, as specified by the manufacturer, for a minimum of 3 h at each temperature;
6) Reconnect the battery and compare the current index reading with the reading noted in 3) above.

E-6 FLAGS AND ALARMS INFORMATION

E-6.1 Requirement

All flags and alarms shall be stored in the event log (*see* **D-5.8.3**). All information related to alarms shall be stored in a non-volatile memory after voltage interruptions. The manufacturer shall declare the form of the flags and the scope of information related to each alarm. Clearing of alarm flags shall require authorization. The resetting of the cleared alarm shall be possible only if the cause of the alarm has been eliminated. The reset device shall be capable of being sealed.

E-6.2 Test

By visual inspection.

E-7 INTERFACES

E-7.1 Requirement

Interfaces for communication shall meet the requirement given in the appropriate parts of EN 13757 series. Communication interfaces for connection to any home automation system shall meet the requirements from the appropriate parts of EN 13757 series.

E-7.2 Test

Confirm the communication meets the requirement given in the appropriate parts of EN 13757 series.

E-8 PORTS

E-8.1 Requirement

Where a local physical Interface is fitted it shall meet the requirements given in IS/IEC 62056-21.

E-8.2 Test

The manufacturer presents an appropriate test report, which could be from a third party.

E-9 DURABILITY

E-9.1 Requirement

If the electronic index assembly and its associated drive incorporates moving parts, when tested in accordance with **E-9.2.1** the electronic index shall register volume by detecting signals generated by the meter. When tested in accordance with **E-9.2.1** and **E-9.2.2**, the construction of all associated elements shall ensure the proper registering of the gas volume by the index during the lifetime of the meter. The input shall respond to every signal in such a manner that no signal is gained or lost; neither reverse nor zero flow shall be registered as an increase or decrease of the volume.

E-9.2 Test

E-9.2.1 *Signal Detection Test*

Test the electronic index indicating to the input the number of signals which is equivalent for durability test according to appropriate standard for the meter **(for example, 5 000 h at Q_{max} for meter conforming to this standard).** Stop signal being transmitted for at least 20 times in a period of 1 h in non-regular intervals. Record the number of signals that has been provided to the index input, using separated test device working independently from the index. After the test, compare the volume or number of signals registered in the index memory with the volume or signals indicated by separated device. The difference shall not exceed 0.05 percent. The test can be performed at the index associated with the drive.

E-9.2.2 *Reverse Flow Test*

When the meter does have a protection against the reverse flow, this point does not apply. Test the meter using methodology described in **E-9.2.1** indicating 10 sets of signals. Each set consists of at least 200 correct flow signals and at least 200 reverse flow signals. After the test, compare the number of signals registered for each direction in the index memory with the volume or pulses indicated by separated device and compare the difference.

ANNEX F
(*Normative*)
VALVE TYPE TEST PLAN

F-1 LIST OF TESTS

The valve shall be tested as part of a meter. Subject to agreement with the test house, these tests shall be made in conjunction with formal testing of the meter to the appropriate European Standard.

a) Three meters (incorporating valves) shall be subjected to H.2 All shall pass.
b) One meter (incorporating a valve) shall be subjected to H.3 and shall pass.
c) One meter (incorporating a valve) shall be subjected to H.4 and shall pass.
d) Two meter (incorporating a valve) shall be subjected to H.5 and shall pass.

If, after testing one meter in accordance with H.3, one meter in accordance with H.4 and two meters in accordance with H.5, the meters are found to comply with these clauses, the meters shall be deemed to be satisfactory.

F-2 ENDURANCE TEST

The meter shall be tested in accordance with **D-5.13.4.5.2**. The meter shall be filled with gas or air at the manufacturer's discretion. The valve within the meter shall be opened and closed a minimum of:

1) 400 cycles at the minimum temperature of the meter,
2) 400 cycles at maximum temperature of the meter, and
3) 3 200 cycles at test room temperature.

After each step, the meter shall pass the tests in **D-5.13.4.5.2**.

F-3 TOLUENE/ISO-OCTANE TEST

F-3.1 Sequence

Before carrying out the tests below, the meter (incorporating a valve) shall pass the test given in **D-5.13.4.5.2**. At the end of Test 1 the meter (incorporating a valve) shall pass the test given in **D-5.13.4.5.2**. At the end of Test 2 the meter (incorporating a valve) shall pass the test given in **D-5.13.4.5.2**.

F-3.2 Test 1

Pass through the meter (incorporating a valve) under test nitrogen to which has been added approximately 3 percent by gaseous volume of a 30 percent toluene/70 percent iso-octane mixture (*see* **9.3.1.4.2**) for 42 days (1 008 h) at (20 ± 2)°C, (65 ± 10) % relative humidity and a flow rate of not less than $0.25Q_{max}$ of the meter to which the meter is to be fitted.

NOTE — It is important that, when removing the meter from the exercise rig in order to check its operation that the ports be sealed, to prevent the ingress of air, until the meter operation is about to be checked.

F-3.3 Test 2

After Test 1, exercise the meter (incorporating a valve) under test with air for a further period of 7 days (168 h) at (20 ± 2)°C, (65 ± 10) % relative humidity and a flow rate of not less than $0.25Q_{max}$ of the meter on which the meter is to be used. Check the operation of the meter as specified in **D-5.13.4.5.2**.

F-3.4 Example of a Typical Apparatus

Referring to Fig. 7, the apparatus consists of the following components:

a) An exercise rig (A), open to atmosphere, fitted with a suitable circulating pump or blower.
b) A nitrogen supply with a flow rate measurement capability (B). (Rotameter, meter or both).
c) Relative humidity control (C), comprising a water reservoir and meters capable of giving a relative humidity of (65 ± 10) %. The relative humidity is measured by a hair or paper hygrometer or by a moisture meter.
d) Solvent addition (D). The toluene/iso-octane mixture is added to the top of the vaporization tower by means of a micro-metering pump. The tower has a bottom diffuser plate and is filled with alternate layers of small glass beads and cotton fabric (or other material) to give a large surface area. The tower is surrounded with a heating blanket which produces a high temperature at the blanket/tower interface to speed up vaporization.

ANNEX G
(*Informative*)
DOWNLOAD SOFTWARE

Example of an Acceptable Solution:

A utility program resident in the fixed part of the software that:

a) Handshakes with the sender and checks for consent;
b) Automatically inhibits measurement unless correct measurement can be guaranteed;
c) Automatically downloads of relevant software to a secure holding area;
d) Automatically checks the integrity and authenticity of the downloaded software;
e) Automatically installs the software into the correct location;
f) Takes care of housekeeping, e.g. deletes redundant files, etc.;
g) Initiates the appropriate fault handling procedures if a fault occurs.

ANNEX H
(*Informative*)
IMPLEMENTATION METHOD – CONFORMITY TO THE SM-CG ADDITIONALFUNCTIONALITIES (SMART METER COORDINATION GROUP)

Table 28 Additional Functionalities List

S.N.	SM-CG Additional functionalities	Items considered	Implementation method
1	Remote reading of metrological register(s) and provision to designated market organisation(s)	• Static data, for example, Supplier /Site/meter information • Output (Absolute data (direct index reading)/pulse for unit volume) • Storage and retrieval of data • Fraud detection • One way communication	5.6, 5.7, 5.8, 5.15, 5.17 Annex D – Storage and retrieval via communications port – memory required 5.6, 5.7 – Pulse / absolute encoder / direct index data 5.2, 5.9, 5.12, 5.17 Annex D – Display. Clock, memory and calculator E-6 Flags
2	Two-way communication between the metering system and designated market organisation(s)	• Communication channel(s) • Upload/download non-metrological software • Fraud detection	3.2 Port or interface 3.3 – Local or remote updates E-6 Flags
3	To support advanced tariffing and payment systems	• Ability to measure and record usage in different registers • Measurement of time • Prepayment/pay-as-you-go management • History of consumption • Peak hourly consumption • Demand metering (instantaneous peak)	5.8, 5.11 – Number of registers 5.9 – Clock 5.13, 5.15, 5.17 – System plus valve 5.2, 5.11, 5.12 Annex D – Retrieval from Registers, index & displays 5.11 – Not a priority 5.11 – Not a priority

		• Storage and retrieval of data • Human/Consumer interaction • Temperature, pressure, Z, CV • Interval metering • Calculation engine (for example, kWh, money)	5.2, 5.9, 5.12, 5.17 Annex D – Display, clock, memory and calculator 5.2, 5.11, 5.12, Annex D – Buttons/Display 5.10, 5.11 – Temp/pressure measured / CVDD or attributed 5.9, Clock, 5.17 Annex D – memory 5.2, 5.12, Annex D – Calculate or / display
4	To allow remote disablement and enablement of supply and flow	Status of the valve (open/closed) Safe reinstatement of supply consider Note: Flow limitation is not applicable for gas	5.13, E-6 – Flags/position status/ indicators 5.13 – Valve 5.13 – Safety interlock
5	To provide secure communication enabling the smart meter to export data for display and potential analysis to the end consumer or a third party designated by the end consumer	• Communication channel (s) • Human / Consumer interaction	3.2 - Port or interface 5.2, 5.11, 5.12, E-8 – Buttons/ display
6	To provide information via web portal/ gateway to an in-home/building display or auxiliary equipment	• Storage and retrieval of data • Human/Consumer interaction • History of consumption • Peak hourly consumption • Demand metering (instantaneous peak)	5.9, 5.17. Annex D Display, clock, memory and calculator 5.2, 5.11, 5.12, Annex D Buttons/Display 5.2, 5.11, 5.12, Annex D – Retrieval from Registers/ memory, Index and displays Not a priority Not a priority

For more information or copy of ISO standard please write to us at pgd@bis.gov.in