IGS-M-IN-101(4)	Sep. 2015
Approved	مصوب

شرکت ملی گازایران

مدیریت پژوهش و فنآوری

امورتدوین استانداردها

IGS

مشخصات فنی خرید

کنتورهای گاز نوع دیافراگمی

Gas Meters Diaphragm Type

Fax:(9821)-8487-5032

igs@nigc.ir

دفترمدیرعامل

شرکت ملی گازایران

تاریخ : ۱۳۹۴/۱۱/۲۶
شماره : گ ۰/دب ۰/۳۸۲- ۱۷۵۶۷

ابلاغ مصوبه هیأت مدیره

اصلاحیه شماره(۱) - موضوع ابلاغ مصوبه شماره گ ۰/دب ۰/۳۵۳ - ۱۷۵٦۷ مورخ ۱۳۹٤/۱۰/۱٤

مدیر محترم پژوهش و فناوری
مدیر محترم گازرسانی
رئیس محترم امور فناوری اطلاعات و ارتباطات

باسلام،

به استحضار می‌رساند در جلسه ۱٦٦۹ مورخ ۱۳۹٤/۱۱/۱۸ هیات مدیره، نامه شماره گ۹/۰۱۰/۱٦۱۳۹٤ مورخ ۹٤/۱۱/۷ مدیر پژوهش و فناوری درمورد تصویب نهایی استاندارد تحت عناوین " مشخصات فنی کنتورهای گاز نوع دیافراگمی" به شماره استاندارد IGS-M-IN-101(4) ودستورالعمل بازرسی کنتورهای گاز نوع دیافراگمی به شماره استاندارد IGS-I-IN-101(0) مطرح و مورد تصویب قرارگرفت .

این مصوبه در حکم مصوبه مجمع عمومی شرکت‌های تابعه محسوب و برای کلیه شرکت‌های تابعه لازم الاجرا می‌باشد و ابلاغ مصوبه شماره گ ۰/دب ۰/ ۳۵۳ ـ ۱۷۵٦۷ مورخ ۹٤/۱۰/۱٤ کان لم یکن می‌گردد .

ناصر آبگون
دبیر هیات مدیره

رونوشت : مدیرعامل محترم شرکت ملی گاز ایران و نایب رئیس هیات مدیره
: معاون محترم مدیر عامل
: اعضای محترم هیات مدیره
: مشاور محترم مدیر عامل و رئیس دفتر
: مدیر محترم توسعه منابع انسانی
: مدیر محترم مخابرات و تلستری
: رئیس کل محترم امور حسابرسی داخلی
: رئیس محترم امور حقوقی
: رئیس محترم امور مجامع

Table of contents

1. Scope

This specification covers the minimum requirements for design, material, fabrication, painting, marking, testing, inspection, packing and packaging of diaphragm type gas meters, used to measure volume of natural gas for domestic and commercial consumers.

2. Normative references

Throughout this standard specification the following standards and codes are referred to. The editions of these standards and codes that are in effect at the time of publication of this standard specification are a part of this standard specification. The applicability of changes in standards and codes that occur after the date of this standard specification shall be mutually agreed upon by the purchaser and supplier and/or manufacturer.

1. ANSI B1.1: Unified inch screw threads (UN and UNR thread form)
2. ANSI B16.5 Pipe Flanges and flanged fitting NPS ½ through NPS 24 m.IS
3. ASTM B85 : Standard specification for Aluminum alloy die casting
4. ASTM B117:Practice for operating salt spray(fog) apparatus
5. ASTM D 09 (2014): Standard Practices for preparation of Aluminum and Aluminum – alloy surface for painting.
6. EN 549:Rubber material for seal and diaphragm for gas appliances and gas equipments
7. EN 1359:Diaphragm gas meter
8. IGS-M-CH-033: Specification for Iranian natural gas quality
9. IGS-M-IN-101(3) : Specification for diaphragm gas meter
10. ISO 228-1:Pipe threads pressure-tight joints are not made on the threads
11. ISO 1817:Determination of the effect of liquids
12. ISO 3574 :Cold-reduced carbon steel of commercial drawing qualities
13. ISO 12944 : Paints and varnish – corrosion of steel structures by protective paint system

3. Definitions

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

3.1 Actual flow rates

Flow rate at the gas pressure and gas temperature conditions prevailing in the gas distribution line in which the meter is fitted, at the meter inlet

3.2 Working pressure

Difference between the pressure of the gas at the inlet of the meter and the atmospheric pressure

3.3 Maximum working pressures (P_{max})

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

3.4 Pressure absorption

Difference between the pressures measured at the inlet and outlet connections of the meter whilst the meter is operating

3.5 Error of indication, *E*
Value which shows the relationship in percentage terms of the difference between the volume indicated by the meter and the volume which has actually passed through the meter, to the latter volume
Note 1 to entry: Error of indication, as a percentage, is calculated using the equation

$E=100(V_i-V_c)/V_c$

Where
V_i is the indicated volume
V_c is the volume which has actually passed through the meter.

3.6 Maximum permissible errors – initial (MPE)
Those errors of indication which are permitted when first determining the accuracy of a meter, prior to any other tests being carried out

3.7 Maximum permissible errors - endurance
Those errors of indication which are permitted during and on completion of the endurance test

3.8 Cyclic volume (*V*)
Volume of gas corresponding to the working cycle of the gas meter
Note 1 to entry: 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.

3.9 Meter error curve
Plot of average error of indication against actual flow rate

3.10 Volume flow rate (*Q*)
Actual volume of gas passing through the diaphragm gas meter

3.11 Minimum flow rate (Q_{min})
Lowest flow rate at which the gas meter provides indications that satisfy the requirements regarding MPE

3.12 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

3.13 Overload flow rate
Highest flow rate at which the meter operates for a short period of time without deteriorating.

3.14 Maximum flow rate (Q_{max})
Highest flow rate at which the gas meter provides indications that satisfy the requirements regarding MPE

3.15 Routine test
Conformity test made on each individual items during or after manufacture.

3.16 Type test
Conformity test made on one or more items respective of the Production

3.17 Lot
Part or all of a consignment that may comprise part of all of or more than one batch

4. Requirements

4.1 Service and design conditions

This specification is primarily based on EN1359.Special or additional requirements are specified as followings:

4.1.1 The natural gas specification is in accordance with IGS-M-CH-033.

4.1.2 The Ambient temperature range is -29˚C to +60˚C.

4.1.3 Normal Inlet Pressure is 18 mbar.

4.1.4 The meter shall have easy moving part without stresses over operation duration.

4.1.5 The meter shall be constructed from quality materials in a workmanlike manner.

4.1.6 The meter designation (G-rate), Q_{max} , Q_{min} , Q_t values of maximum flow rates values of the upper limits of the minimum flow rates shall be one of those given in Table 1.

Designation	Q_{max} m^3/h	Upper limits of Q_{min} m^3/h	Q_t m^3/h
G 2.5	4	0,025	0,4
G4	6	0,04	0,6
G6	10	0,06	1,0
G10	16	0,1	1,6
G16	25	0,16	2,5
G25	40	0,25	4,0
G40	65	0,4	6,5
G65	100	0,65	10,0
G100	160	1	16,0

Table1-Designation and flow values

4.1.7 The maximum working pressure of the meter shall not be less than 100 mbar.

4.1.8 All meters shall be capable of meeting the requirements for a minimum ambient temperature range of −29 °C to +60 °C

4.1.9 The gas temperature range shall be within the -10˚c to +55˚c.

4.1.10 The meter shall be suitable for installation in open locations (outdoor without any protection) with condensing humidity.

4.1.11 The gas meter error shall be adjusted as close as possible to zero. The individual errors of indication of the meter shall be within the initial permissible error limits specified in Table 2(When tested by the method (a)).

Flow rate m3/h	Maximum permissible errors	
	Initial	Endurance
$Q_{min} \leq Q < 0,1\ Q_{max}$	±3%	±6%
$0,1Q_{max} \leq Q \leq Q_{max}$	±1,5%	±3%

Table 2-Error Limits

4.1.12 The meter error shall be adjusted as close to zero as the adjustment and maximum permissible errors allow, without favoring any party.

4.1.13 Measuring stability of meter shall be such that the errors of indication found at each of the specified test flow rates from $0.1Q_{max}$ to Q_{max}, shall not differ by more than 0, 6 %.

4.1.14 After exposure the meter to an overload flow rate of $1,2Q_{max}$ the error of indication shall remain within the maximum permissible error - initial limits specified in Table 2.

4.1.15 The error of indication of meter after aging test shall be within the maximum permissible errors - endurance, given in Table 2.

4.1.16 The error of indication of meter after humidity test shall remain within the maximum permissible error- initial limits specified in Table 2

4.1.17 The average pressure absorption of a meter, over a measuring cycle, with a flow of air with a density of 1, 2 kg/m3, at a flow rate equal to Q_{max}, shall not exceed the values given in Table 3.

Designation	Q_{max} m^3/h	Maximum permissible pressure absorption(mbar)	
		Initial	Post endurance
G 2,5 to G10	4 to 16 inclusive	2	2,2
G16 to G40	25 to 65 inclusive	3	3,3
G65 and G100	100 and 160	4	4,4

Table 3- Pressure absorption

4.1.18 The starting flow rate shall not be greater than those specified in Table 4.

Destination	Q_{max} m^3/h	Maximum starting flow rate dm^3/h
G2,5 , G4	4 and 6	5
G6	10	8
G10,G16	16 and 25	13
G25	40	20
G40,G65	65 and 100	32
G100	160	50

Table 4- Starting flow rates

4.1.19 The cyclic volume of any meter shall not be less than the cyclic volume given in table 5 and shall be indicated on the index plate.
The measured value at base condition shall be within ±5% of the indicated value.

Designation	Q_{max} (m^3/h)	Cycling Volume (dm^3)
G 2.5	4	1.2
G 4	6	2
G 6	10	3.5
G10	16	6
G 16	25	10
G 25	40	18
G 40	65	30
G 65	100	55
G 100	160	100

Table 5-Cycling Volume

4.1.20 No lubricants shall be required during the life of the meter.

4.1.21 The meter shall be constructed in such a way that any mechanical interference capable of affecting the measuring accuracy results in permanently visible damage to the meter or the verification or protection marks by visual inspection.

4.1.22 The meter shall be leak tight under normal operating conditions

4.1.23 The meter shall be resistance to internal pressure of 1.5 times the maximum working pressure or 350mbar, whichever is the greater.

Any residual deformation of the unpressurized meter case shall not exceed 0,75 % of the linear dimension over which it is measured. After the test, the meter case shall remain leak tight.

4.1.24 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, e.g. at the junction of the top and bottom case of the meter.

4.1.25 The meter shall have two pipe connections.

4.1.26 The connections of meters from G2.5 to G25 inclusive shall be top mounted.

4.1.27 The connections of meters from G2.5 to G25 inclusive shall be male straight threaded according to ISO 228/1.

4.1.28 The connections of meters from G40 to G100 inclusive shall be top or side mounted such that specified in data sheet.

4.1.29 The connections of meters from G40 to G100 inclusive shall be flange type.

4.1.30 Meter flanges shall be raised face, serrated finish according to ANSI B16.5 to match welding neck flanges ANSI class 150.

4.1.31 Provision shall be made in the design for sealing the meter inlet and outlet connections.

4.1.32 The centerlines of top connections shall be within 1°of vertical, with respect to the horizontal plane of the meter.

4.1.33 The centerlines of side connections shall be within 1°of horizontal, with respect to the vertical plane of the meter.

4.1.34 The meter connections sizes shall be as specified in table 6.

Designation	Q_{max} (m^3/h)	Size(in)
G 2.5	4	1 1/4
G 4	6	
G 6	10	
G10	16	2
G 16	25	
G 25	40	
G 40	65	3
G 65	100	
G 100	160	4

Table 6- Connection sizes

4.1.35 The distance between the centerlines/face to face of the connections, measured at the free end of the connections, shall be within ±0,5 mm of the nominal distance between centerlines/face to face or within ±0,25 % of the nominal distance between centerlines/face to face whichever is the greater.

4.1.36 The centerlines and face to face shall be within 1º of being parallel.

4.1.37 The free ends of the connections shall be level within 2 mm, or within 1 % of the nominal distance between the centerlines or face to face of the connections, whichever is the greater.

4.1.38 The meter connections shall be subjected to the appropriate torque specified in Table 7 and shall then conform to the following:
-external leak tightness;
-any residual rotational deformation of the meter connection shall not exceed 2°.

Nominal connection diameter		**Torque value N.m**	**Bending moment N.m**
Inches	DN		
1	25	110	40
1 1/4	32	110	40
2	50	170	60
3	80	170	60
4	100	170	60

Table 7-Torque and bending moment

4.1.39 The meter shall confirm error of indication test method (c) and an error of indication check at Q_{min} shall be carried out . Then meter shall be subjected to the bending moment given in Table 7. During and after the test, the meter shall remain leak tight.

After the test:
-The residual deformation of the connections shall not exceed 5°.
-The meter shall be retested in accordance with the error of indication test method(c), plus an error of indication check at Q_{min}. The errors of indication shall be within the allowed endurance maximum permissible error limit given in Table 2.

4.1.40 The meter shall remain leak tight and its error of indication shall be within the initial permissible limits given in Table 2, before and after being subjected to the vibration.

4.1.41 The meter shall remain leak tight after being subjected to impact.

4.1.42 The meter shall withstand the handling required during its transport and installation. Before testing the meter shall conform to the following:
a) Error of indication, 4.1.11;
b) Pressure absorption, 4.1.17;
c) External leak tightness, 4.1.22.

After undergoing the mishandling test, the meter shall conform to the following requirements:
i) Its errors of indication are within the allowed endurance maximum permissible error limit (method(C));
ii) The post endurance maximum permissible value for average pressure absorption.

iii) It is still leak tight

4.1.43 Before and after testing in -29˚C and -60˚C according to storage temperature range test, the meter shall be within the initial permissible error limits

4.1.44 The meter shall be equipped with the magnetic index drive.

4.1.45 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 (i.e. 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 the endurance test.

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

4.1.46 Meters shall be fitted with a device to prevent the registration of reverse flow. This device shall not allow the registration of more than 50 cyclic volumes when subjected to reverse flow.

4.1.47 Samples of the meter shall conform to the durability requirement according to test section.

4.1.48 Over the gas temperature range between the flow rates of Q_{min} and Q_{max}, the errors of indication of meters shall be within the maximum permissible initial limits given in Table 2.

4.1.49 Over the ambient temperature range, between the flow rates of Q_{min} and Q_{max},the errors of indication of meters shall remain within the maximum permissible endurance limits given in Table2 throughout the expected life of the meter.

4.1.50 Meters shall be fitted with a metrologically controlled mechanical index.

4.1.51 The index shall be easily readable without the use of tools.

4.1.52 The index shall operate satisfactorily for the normal life of the meter under normal conditions of use.

4.1.53 The index shall be non-resettable.

4.1.54 The index shall be non-volatile.

4.1.55 The index shall be protected with a metrological seal. Provision shall be made in the design the indicating device from unauthorized interference.

4.1.56 An index shall have at least a sufficient number of numerals to ensure that the volume passed during 8 000 hr a flow rate of Q_{max} does not return all of the numerals to their original positions.

4.1.57 The numerals shall indicate in cubic meters, decimal multiples or sub-multiples of a cubic meter.

4.1.58 The symbol m^3 shall be marked on the index plate/display close to the number wheels of the index.

4.1.59 The numerals indicating the sub-multiples of the cubic meter shall be clearly distinguishable from the other numerals (i.e. by red color) and they shall be separated from the other numerals by a clearly marked decimal sign.

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

4.1.61 Indexes shall be designed in such a way that testing of the meters can be carried out with sufficient accuracy in a reasonable time, and the resolution of the index shall be such as to conform to Table 8.

Designation	Q_{max} m^3/h	Numbering every dm^3	Maximum scale invertal of a mechanical index dm^3
G2,5-G6	4 to 10 inclusive	1	0.2
G10-G65	16 to 100 inclusive	10	2
G100	160	100	20

Table 8 — Resolution of meter index

4.1.62 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 −29 °C to 60 °C.

4.1.63 A complete revolution of an index drum shall, during the last tenth of its travel, i.e. from 9 to 0, cause the advance of the next higher drum by one unit.

4.1.64 The index shall be remain legible after humidity test.

4.1.65 No sealant , grease or adhesive shall be used for sealing purpose on valve covers, grids , diaphragm and pan assembly.

4.1.66 All screws, bolts and nuts shall conform to ANSI B1.1.

4.2 Materials

4.2.1 All components of meter shall be suitable for pressure, temperature and other operating conditions.

4.2.2 The meter case shall be made from carbon steel according to ISO 3574 (ST 14) or die cast aluminum according to ASTM B85.

4.2.3 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.

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

4.2.5 All parts of meter exposed to external atmosphere shall be able resistance to salt spray and humidity.

4.2.6 All parts of meters exposed to internal atmospheres and all gas containing components shall be resistance to humidity test.

4.2.7 The index window and its surround shall be made of suitable materials to satisfy the test requirements as followings:

4.2.7.1 Held firmly in position, both as supplied, and after being subjected to the meter ageing test.

4.2.7.2 Withstand the humidity test.

4.2.7.3 Index window and surround test.

4.2.8 The diaphragms shall be made of reinforced rubber material.

4.2.9 The diaphragms shall remain flexible when the meter is operated normally.

4.2.10 The diaphragms shall be leak tight at normal operating condition.

4.2.11 Diaphragms and other non-rubber components in the gas path shall be able to resist the effects of constituents of the gaseous atmosphere in which they operate.

4.2.12 Diaphragm and other non-rubber components in the gas path shall be resistant to ageing throughout the normal life of the meter.

4.2.13 The diaphragms and other components shall be deemed to be satisfactory, after test series (a) or (b).

4.2.13.1 Test series a:
a.1 Toluene/ISO-Octane vapor test
a.2 Water Vapor test
a.3 Aging test

4.2.13.2 Test series b:
b.1 Diaphragm material tests
b.2 Elastomer and non metallic material tests

4.2.14 All non-rubber components in the gas path shall be deemed satisfactory after test series (a) of 4.2.13.

4.2.15 Rubber/elastomeric components in the gas path with the exception of the diaphragms shall conform to EN 549:1995 or the requirements of test series (b) of 4.2.13.(Elastomer test of this specification)

4.2.16 Valve and valve seat of meter shall be gas grade Bakelite.

4.2.17 Diaphragm casing may be plastic for meter with designation of G2.5, G4 and G6. For meters with designation of G10, G16, G25, G40, G65, and G100, diaphragm casing shall be pressed steel and suitably protected from corrosion.

4.2.18 The material specification and standards of each parts of meter shall be specified by meter manufacturer.

4.2.19 All screw, bolts and nuts shall be stainless steel or corrosion resistance plated steel.

4.2.20 The Adhesive that used for connecting the gas containing component ,shall be resistance to water , odorized natural gas , ambient temperature and other operating conditions. These material shall conform to the requirement that is specified in rubber elastomeric components test.

5. Inspection and Test

Inspection procedure shall be according to IGS-I-IN-101(0).

5.1. Test types

5.1.1 Factory testing

Meters shall be checked during manufacture, according to the Manufacture's Quality Assurance system which shall conform to EN ISO 9001 or an equivalent.

5.1.1.1 Routine Tests:

Individual meter testing, prior to dispatch, shall be carried out according to the checklist in table 9 on each manufactured meter.

Subject	Clause
Error of indication	5.2d
Pressure absorption	5.3
Meter cases sealing	5.10
Preventing the registration of reveres flow	5.19
Connection	4.1.27,4.1.30,4.1.31
External Leak tightness	5.8
Indicating devise sealing	4.1.55
Index resolution	4.1.61
Marking	7.1 , 7.4
Painting	6.4

Table9 - Checklist for the individual meter

5.1.1.2 Other Factory Testing:
Other meter testing, prior to dispatch, shall be carried out according to the checklist in table 10 On one meter per every 500 numbers of manufactured meters or two meter per each lot, whichever is greater.

Subject	Clause
Error of indication	5.2.a
Starting flow rate	5.4
Metrological Stability	5.5
Overload	5.6
Cyclic Volume	5.7
Connections	4.1.32,4.1.33 ,4.1.34,4.1.35,4.1.36, 4.1.37
Index	4.1.57 ,4.1.58, 4.1.59, 4.1.62
Used sealant	4.1.65
Adhesion of protective coating	5.16.2
Painting	6.5
Marking	7.2
Documentation	8.8

Table10 - Checklist for randomly selected meter

5.1.1.3 Test report
All meter report shall be issued by the manufacturer for each meter, in which all results according to Table are stated.

5.1.2 Type test
5.1.2.1. Each type of meter (G rate and Model) shall be subjected to the series of tests specified in table 11
5.1.2.2 Type test shall be performed by authorized independent laboratories.
5.1.2.3 Type test certificates are valid while there aren't any changes in material, design, dimension, assembly and manufacturing process of meters and their components . These certificates shall be renewing every two years.

Subject	Clause
Errors of indication	5.2.a
Pressure absorption	5.3
Starting flow rate	5.4
Metrological stability	5.5
Overload flow rate	5.6
External leak tightness	5.8
Resistance to internal pressure	5.9
Connections	4.1.26,4.1.27,4.1.28,4.1.29,4.1.30, 4.1.31,4.1.32,4.1.33,4.1.34,4.1.35,4.1.36,4.1.37
Meter indicating device sealing	4.1.55
Marking	7
Cyclic Volume	5.7
Index	4.1.50, 4.1.51. 4.1.53, 4.1.54, 4.1.56 ,4.1.57,4.1.58 , 4.1.59, 4.1.60,4.1.61, 4.1.62, 4.1.63
Meter case sealing	5.10
Connection Torque	5.11
Bending moment	5.12
Vibration	5.13
Impact	5.14
Mishandling	5.15
Coating and painting	5.16 , 6.4, 6.5
Storage Temperature	5.17
Magnetic Index Drive	5.18
Preventing the registration of reverse flow	5.19
Durability	5.20
Error of indication test at declared gas temperature	5.21
Error of indication test at ambient temperature limits	5.22
Humidity	5.23
Index windows and surround Impact	4.2.7,5.24
Meter case	4.2.2
Adhesive	4.2.20
Screw, nut and bolt	4.1.67
Diaphragm and other material	5.25
Marking	7
Documentation	8

Table 11- Checklist for type test

5.2 Errors of indication test

Thermally stabilize the meter to be tested for a minimum of 4 h at the temperature of the test laboratory.

Carry out the error of indication test using air at 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}.

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 shall be greater than two times repeating the last decimal or first number of indicator.

a. Carry out this test six times at each of the flow rates Q_{min} , 3 Q_{min} , 0.1 Q_{max} , 0.2 Q_{max} , 0.4 Q_{max} , 0.7 Q_{max} and Q_{max}.

b. Carry out this test three times at each of the flow rates Q_{min}, 3 Q_{min} , 0 ,1Q_{max}, 0 , 2 Q_{max}, 0,4 Q_{max} , 0,7 Q_{max} and Q_{max} .

c. Carry out this test three times at each of the flow rates 0,1 Q_{max} , 0,4 Q_{max} and Q_{max} ;

d. Carry out this test one times at each of the flow rates Q_{min}, 0,1Q_{max}, and Q_{max} ,

Note: ensuring that the flow rates between each individual test are different (i.e. it is not permissible to carry out consecutive tests at the same flow rate).

Calculate the six or three errors of indication at each of the flow rates using the equation given in 3.5 Calculate the mean of the three errors of indication and record the results as the error curve of the meter.

5.3 Pressure absorption test

Supply the meter under test with a flow of air of density 1, 2 kg/m3, at a flow rate equal to Q_{max} measure the differential pressure across the meter with a suitable measuring instrument, accurate to two decimal places.

The distance between the pressure test points and the meter connections shall not exceed three times the nominal connection diameter.

Record the maximum and minimum differential pressures over at least one measuring cycle, and calculate the mean value.

5.4 Starting flow rate test

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 2 h to 4 h.

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 accurate to two decimal places.

Check the leak tightness of the complete test apparatus.

Supply air at ambient temperature up to a maximum pressure of 2 mbar.

Maintain the flow rate at the maximum allowable starting flow rate. At this maximum starting flow rate ascertain that the meter under test registers continuously for at least two cyclic volume. Record the result as pass or fail.

5.5 Metrological stability

Using the calculated errors of indication, obtained when carrying out the initial error of indication test in 5.2a) at flow rates 0,1 Q_{max}, 0,2 Q_{max}, 0,4 Q_{max}, 0,7 Q_{max} and Q_{max}, check that for each flow rate the spread of the six individual results is within 0,6 %. Record the result as a pass or fail.

5.6 Overload flow rate
Supply one meter with air for one hour at a flow rate of 1,2Q_{max}. Determine the error of indication as specified in 5.2c). Record the result as a pass or fail.

5.7 Cyclic volume test
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.

5.8 External leak tightness test
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.
Immerse the meter, without its index, in water and observe it for leakage for 30 seconds after any external trapped air has been dispersed, after which no leakage should be observed.

5.9 Resistance to internal pressure test
Pressurize the case of the meter under test progressively with air or water to 1,5 times the maximum working pressure or at least 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.

5.10 Meter case sealing test
Conduct a visual inspection of a fully assembled meter case to confirm the presence of appropriate mechanical means of sealing.

5.11 Connection torque test
Firmly support the case of the meter under test and apply the appropriate torque value specified table 7 to each connection in turn using a suitable torque wrench. Then:
- Carry out the leak test
- Measure the rotational deformation of meter connection.

5.12 Bending moment test
Rigidly support the meter under test by one of its connections (see Figure 1) and subject to the appropriate bending moment specified in table 7 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.

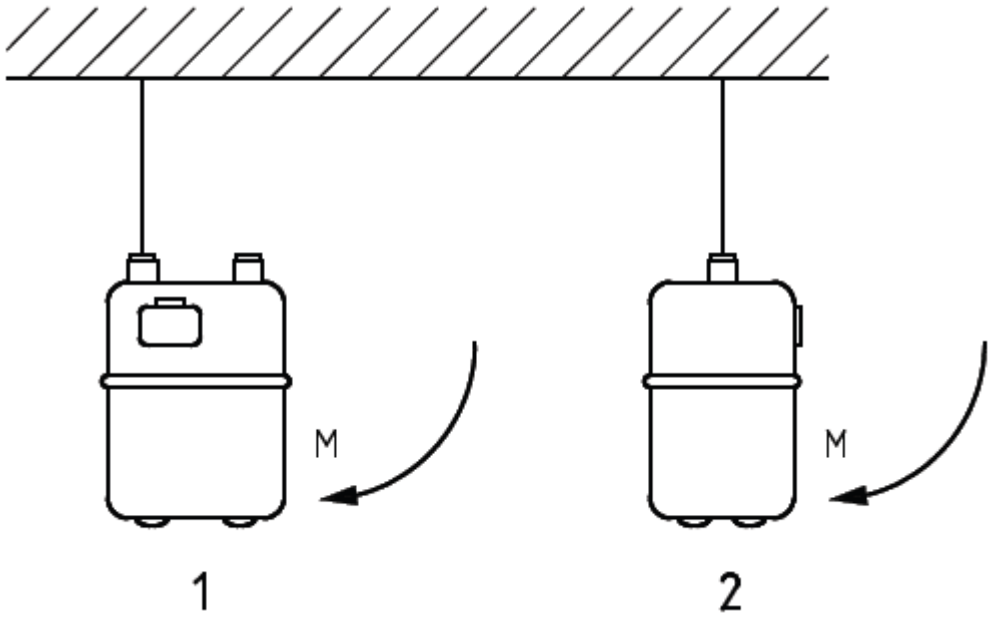


Figure 1 – arrangement for bending moment test

5.13 Vibration test

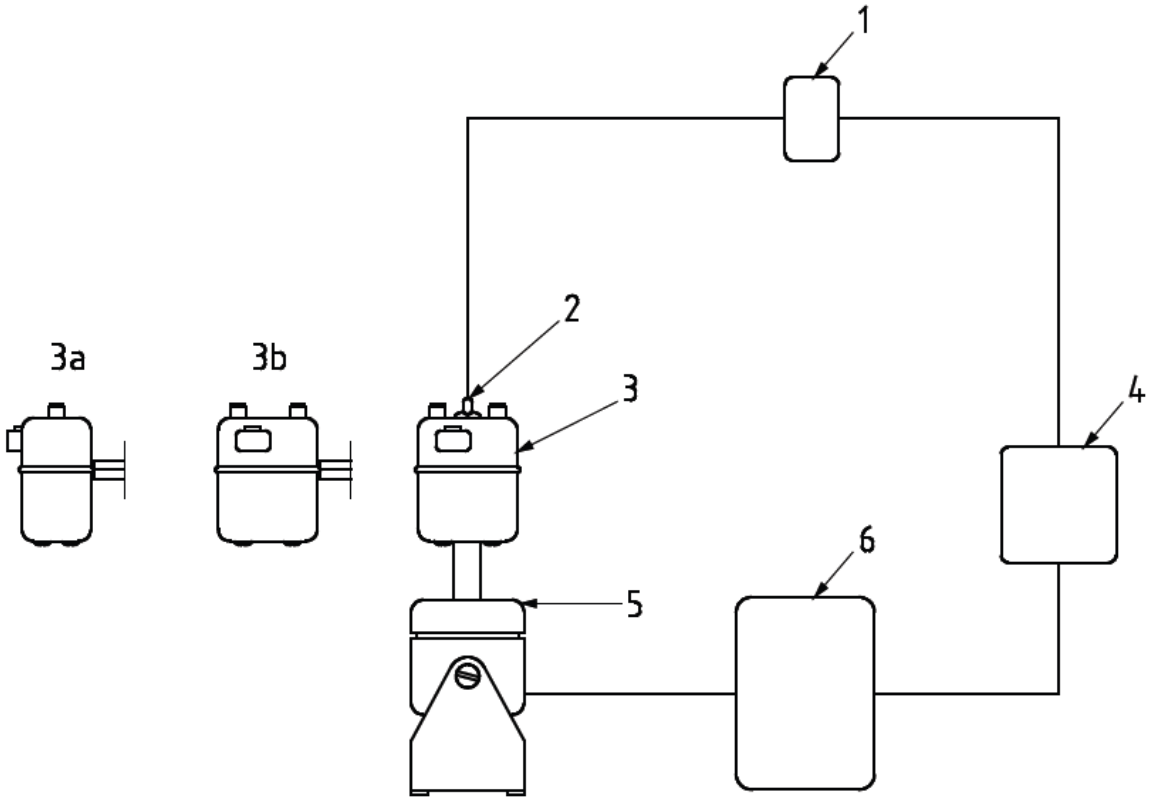
Carry out the error of indication test specified in 5.2c), to ensure that the accuracy of the meter under test is within the maximum permissible initial error limits and confirm that the meter is leak tight.

Secure the meter under test to the vibration test rig, as shown in Figure 2, using a horizontal clamp across the top of the meter. 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 (±5 %) at a sweep rate of 1 octave per minute with a peak acceleration of $2\ g_n$ (±5 %), for 20 sweeps in the vertical plane, 20 sweeps in the fore-aft plane and 20 sweeps in the lateral plane.

Recheck the error of indication of the meter under test, by carrying out the test specified in 5.2c) and confirm the leak tightness by carrying out the test described in 5.8.

NOTE: An octave is a band of frequency where the upper frequency limit of the band is exactly twice the lower limit, e.g. 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 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 electrodynamics shaker (5)
3. a) Meter under test (fore and aft plane)
3. b) 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, alternately increasing and decreasing
5 Electrodynamics shakers, driven by an amplified sine wave from a voltage generator
NOTE: The head of the shaker can be rotated through 90º for fore and aft and planes (see 3a) and 3b)).

6 Power amplifier, suitable for amplifying the power of the accelerometer

Figure 2 — Layout of the vibration test apparatus

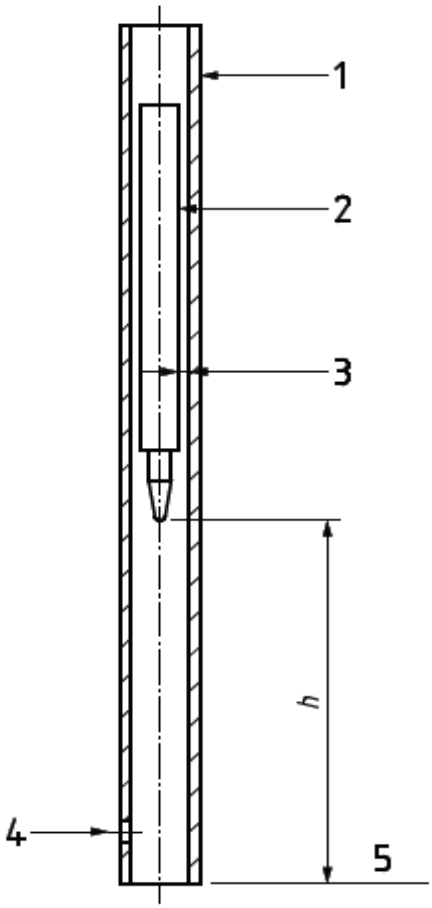
5.14 Impact test
Use each size of striker tip during the test, but do not subject any test area on any one meter sample to more than one impact. In the case of the same area being selected for test with each size of striker tip, use a second meter sample.

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 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:
a) For the 1 mm striker, h is 100 mm thus producing an impact energy of 3 J; and
b) For the 4 mm striker, h is 175 mm thus producing impact energy of 5 J.

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 Figure 3).

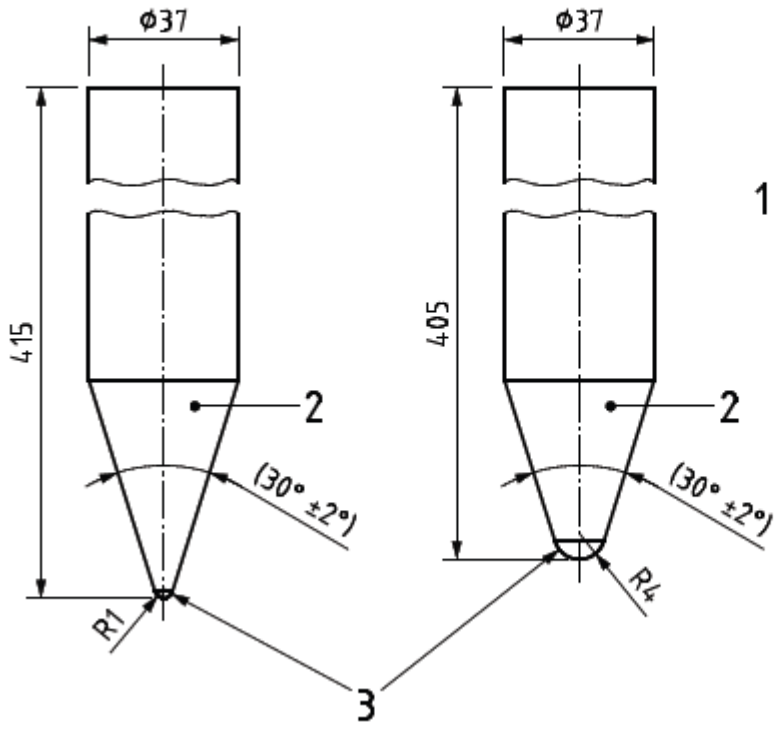


Key
1 Smooth bore rigid tube
2 Hardened hemispherically tipped striker, mass 3 kg
3 Radial clearance (0,5 ± 0,25 mm)
4 Vent hole
5 Meter level

Figure 3 — Impact test apparatus

The total mass of the striker is 3 kg. There are two sizes of striker tip, one having a radius of 1 mm, the other having a radius of 4 mm (see Figure 4).

Dimensions in mm



.

Key
1 Striker, total mass 3 kg
2 Steel tip, angle 30°± 2°
3 Hardened steel ball; R1 = 1 mm radius, R4 = 4 mm radius

Figure 4 — Typical hemispherical tipped strikers used in impact test

5.15 Mishandling test

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, horizontal surface from a height as given in Table 12. The heights given refer to the distance from the bottom of the meter under test to the surface onto which it will fall.

Designation	Height of dropping m
G2,5 to G10	0,5
G16 to G65	0,3
G100 to G160	0,2

Table 12 — Drop height

5.16 Coating test

5.16.1 Scratch resistance of the protective coating

When tested using the method given in ISO 1518-1:2011, 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 is to be visually inspected for penetration.

5.16.2. Adhesion of the protective coating

When tested using the method given in ISO 2409:2013, the result shall be less than classification 2 given in ISO 2409:2013.

5.16.3 Impact resistance of the protective coating

When tested using the method given in ISO 6272-2:2011 for impact resistance using a falling height of 0,5 m and with the depth of the indentation is 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.

5.16.4 Chemical resistance of the protective coating

When tested in accordance with ISO 2812-1:2007, Clause 8, using a test period of 168 h, the result shall be less than that given as ratio density 2/size 2 given in ISO 4628-2:2003, and the degree of corrosion shall be not greater than that given as *R*i 1 in Table 1 of ISO 4628-3:2003.

The liquids of A.2.2 and A.3.1 of ISO 2812-1:2007 as well as 5 % aqueous solution of sodium salts of Sulphate broadcut primary alcohol, chain length C9 to C13 pH values 6, 5 to 8,5 shall be used.

5.16.5 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 10m^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 ASTM B 117 or ISO 9227:2012, using a salt solution with the pH-Value given in 3.2.2 of ISO 9227:2012 (neutral salt spray test), the sample shall be exposed to the salt spray over 500 h and the degree of corrosion shall not be greater than that given as *R*i 1 in Table 1 of ISO 4628-3:2003.

5.16.6 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 10m^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 EN ISO 6270-1:2001 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 in ISO 4628-2:2003, and the degree of corrosion shall be not greater than that given as *R*i 1 in Table 1 of ISO 4628-3:2003. The test shall be carried out on representative parts of the meter, e.g. deep-drawn parts, which should be cut out of a sample meter.

5.17 Storage temperature test

- Over a period of at least two hours bring the meter under test to a temperature of −29 °C, or lower if declared by the manufacturer, and maintain it at this temperature for three hours with no gas flowing through it.

- Over a period of at least two hours return the meter to normal laboratory ambient temperature and test it in accordance with 5.2 c).
- Over a period of at least two hours bring the meter under test to a temperature of +60 °C, or higher if declared by the manufacturer, and maintain it at this temperature for three hours with no gas flowing through it.
- Over a period of at least two hours return the meter to normal laboratory ambient temperature and test it in accordance with 5.2 c).

5.18 Magnetic index drive test

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 entirety of the endurance 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.

5.19 Preventing the registration of reverse flow test:

Note the index of the meter under test. Connect a source of pressure of 20 mbar to the meter outlet, the meter inlet being open to atmosphere. 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.

5.20 Durability

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 method 1 or 2.

a) The error of indication shall be within the maximum permissible error - initials given in Table 2 when tested in accordance with 5.2 b);
b) The pressure absorption shall be not more than that given in the initial maximum permissible pressure absorption column of Table 3.

During and on completion of the endurance test, all meters shall meet the following requirements:

i. The error of indication shall be within the maximum permissible errors - endurance given in Table 2 when tested in accordance with 5.2 b);

ii. The endurance error values over the flow range of 0,1 Q_{max} (Q_t) to Q_{max}, shall not differ by more than 2 % from the initial corresponding value;

iii. The pressure absorption shall be not more than that given in the post endurance column of Table 3;

iv. The external leak tightness shall be in accordance with 5.8.

The number of meters used for the endurance test is given in Table 13.

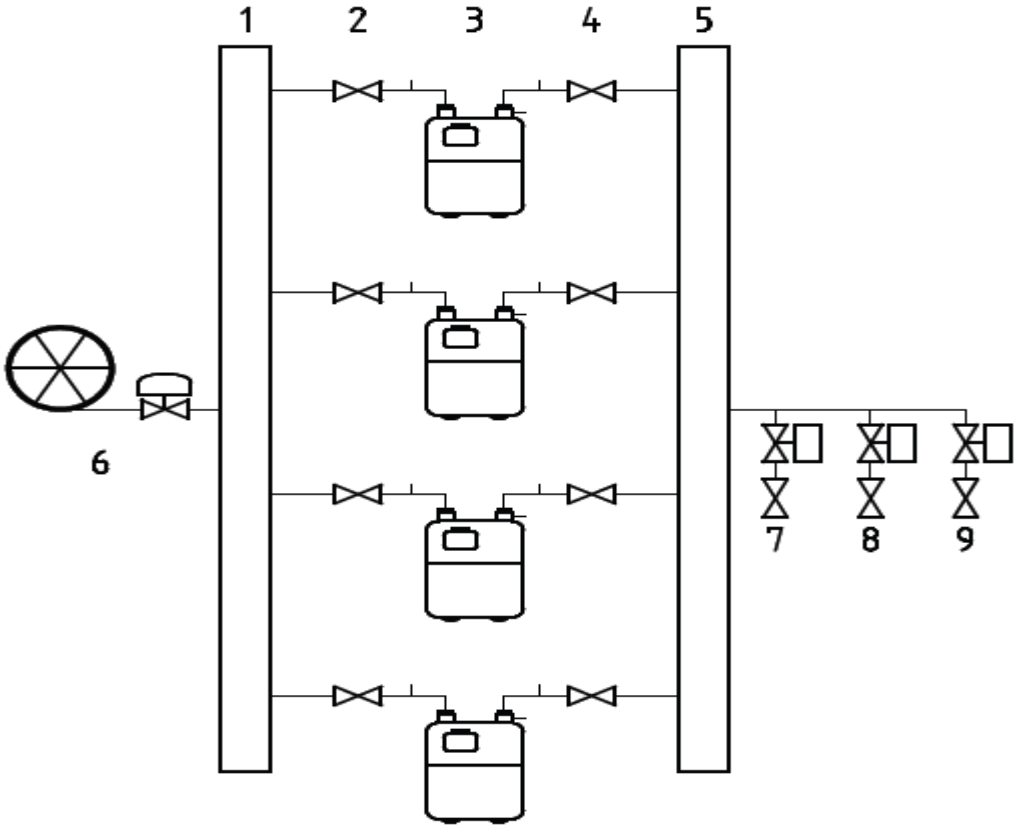
Designation	Q_{max}(m^3/h)	Number of meters to be tested
G2,5- G 6	4 to 10 inclusive	3
G10- G100	16 to 160 inclusive	2

Table 13 — Number of meters to be used for the endurance test

5.20.1 Test method 1:
Determine the error of indication of the meters under test with air. Exercise the meters in a cycling test rig (an example is shown in Figure 5) 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.

Cycle the meter for a nominal 16 seconds as shown in Figure 8 for randomly generated times within the following:
Cycle a)
- 2/3 of Q_{max}; for 5 ± 1 s
- 1/3 of Q_{max}; for 3 ± 1 s
Cycle b)
- 3/3 of Q_{max}; for 5 ± 1 s
- 0 flow for 3 ± 1 s
and continue with the same profile for a total of 450 000 cycles.



Key
1 Inlet manifold
2 Ball valve
3 Meter under test
4 Gate valve (balancing)
5 Outlet manifold
6 Low pressure air source
7 Solenoid with gate valve set to 1/3 Q_{max}
8 Solenoid with gate valve set to 1/3 Q_{max}
9 Solenoid with gate valve set to 1/3 Q_{max}

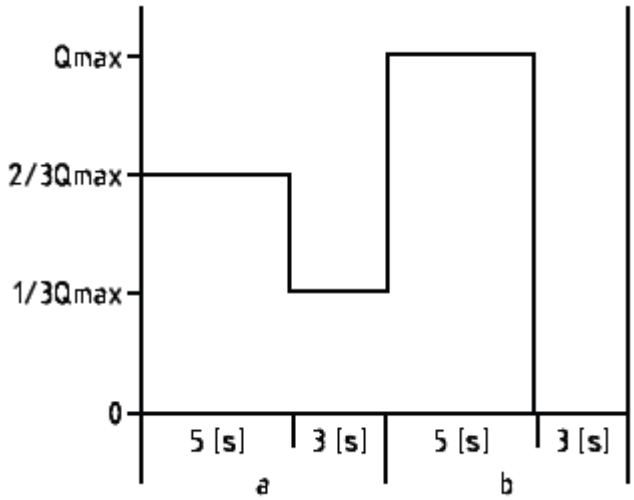


Figure 5- Profile of a 16 second cycle

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 shall be at the outlet of each meter and within 5 DN of the outlet manifold.

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 pipework shall be less than or equal to 5 m/s and the maximum volume, in dm^3, shall be 1/3 of the Q_{max} value of the meter under test, in m^3/h multiplied by the number of meters under test.
The flow control can be determined by using each meter under test.

5.20.2 Test method 2:

a) Meter shall operate at a flow rate of 115% of Q_{max} using natural gas for a period of 135 days in controlled ambient temperature of 20± 5°C. At the end purge the meter by at least 3m³ of air. then The meter shall meet the durability requirements specified in 5.20(i, ii, iii, iv)

b) When subjected the meter to 2000 cycles at 30 cycles / hr at internal pressures varying from 0 mbar to either maximum working pressure plus 200 mbar , or 345 mbar , whichever is the greater The assembled meter shall suffer no visible permanent distortion and shall meet external leak tightness test in accordance with 5.8.

Note : The meter should attain the test pressure in 20 s to 40 s. The rate of change of pressure shall not exceed 345 mbar/s .

5.21 Error of indication test at declared gas temperature
Install the meter to be tested in a temperature controlled chamber which is supplied with air at normal laboratory temperature, $t1$, in °C, a constant pressure not exceeding the maximum working pressure of the meter under test and having 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 (-29^{+2}_{-0}) °C

Pass the air through a heat exchanger, so that the temperature of the air entering the meter is the minimum gas temperature and then into the meter under test (see Figure 6).

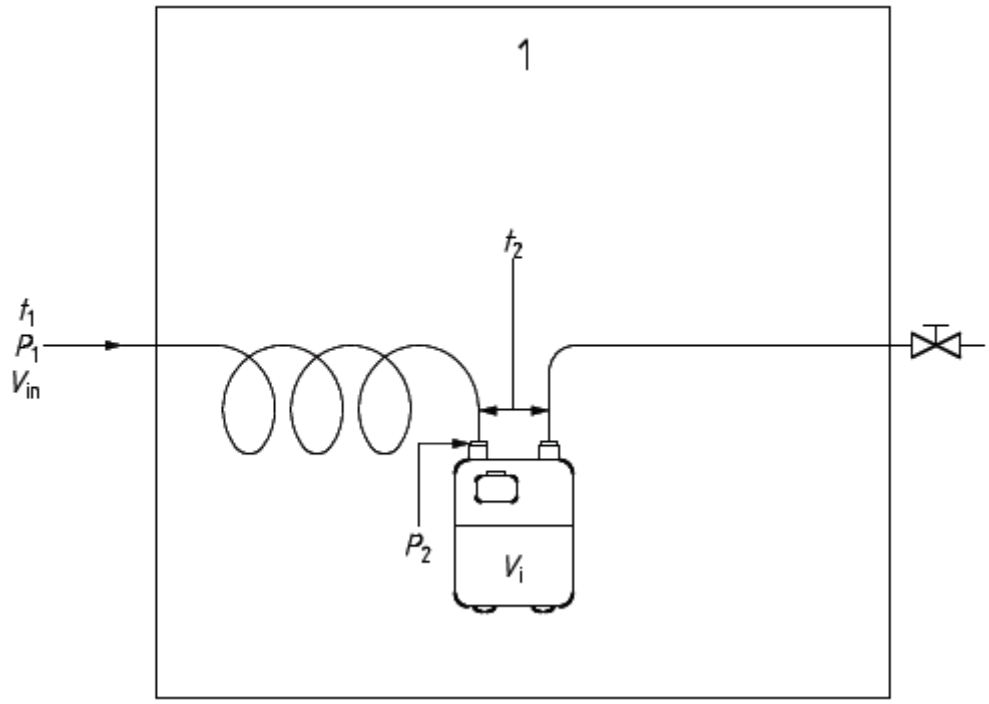


Figure 6 — Example of a test rig for test at declared gas and ambient temperature limits

Key
1 Temperature controlled air chamber

The test temperature *t*2, in °C, is the mean value of the temperature measured at the inlet and outlet of the meter.
After verifying that the temperature *t*2 is stable within the above limits, i.e. (-29^{+2}_{-0})°C, check the error of indication of the meter under test using the method given in 5.2 c) plus an error of indication check at Q_{min}, except that the above temperature is maintained, using the equation given below.

Verify that this error of indication is within the maximum permissible errors - initial given in Table 2.

Raise the temperature of the chamber and maintain at $(+60_{-2}^{+0})$°C, or higher if declared by the manufacturer.

Pass the air through a heat exchanger, so that the temperature of the air entering the meter is the maximum gas temperature declared by the manufacturer and then into the meter under test (see Figure 6).

After verifying that the temperature *t*2 is stable within the above limits, i.e. $(+60_{-2}^{+0})$ °C or higher, check the error of indication of the meter under test using the method given in 5.2c) plus an error of indication check at Q_{min} except that the above temperature is maintained, using the equation:

$V_C = V_{in} \cdot (T_2/T_1).(P_1/P_2)$

Where:

*V*c is the actual volume passed through the meter, in m^3;
*V*in is the actual volume passed into the temperature controlled chamber, in m^3;
*T*1 is (*t*1 - 273, 15), in Kelvin;
*T*2 is (*t*2 - 273, 15), in Kelvin;

*P*1 is absolute pressure measured at the inlet of the temperature controlled chamber, in Pa;
*P*2 is the mean value of absolute pressure measured at the meter inlet, in Pa.

and

E=(Vi-Vc)/Vc.100

Where:

E is the error indication, expressed as a percentage;
*V*i is the volume indicated by the meter, in m^3;
*V*c is the actual volume passed through the meter, in m^3.

Verify that this error of indication is within the maximum permissible errors - initial given in Table 2.

5.22 Error of indication test at ambient temperature limits:
Check the error of indication of the meter under test using the method given in 5.2c) plus an error of indication check at Q_{min}.

Verify that this error of indication is within the maximum permissible initial errors given in Table 2.

Install the meter to be tested in a temperature controlled chamber which is supplied with air at normal laboratory temperature, *t*1, in °C, a constant pressure not exceeding the maximum working pressure of the meter under test and having 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 (-29_{-0}^{+2}) °C.
Pass the air through a heat exchanger, so that the temperature of the air entering the meter is the minimum ambient temperature and then into the meter under test (see Figure 6).
Run the meter for 22 h at Q_{max} at the minimum ambient temperature . On completion of this running period raise the temperature of the chamber and maintain at (60-2) °C.
Pass the air through a heat exchanger so that the temperature of the air entering the meter is the maximum ambient temperature and then into the meter under test (see Figure 6).
Run the meter for 22 h at Q_{max} at the maximum ambient temperature.
On completion of this running period check the error of indication of the meter under test using the method given in 5.2c) plus an error of indication check at Q_{min}.

Verify that this error of indication is within the maximum permissible errors - endurance given in Table 2.

5.23 Humidity test:
The error of indication shall be tested in accordance with 5.2 c). One meter shall be tested for error of indication and shall then be tested in accordance with EN ISO 6270-1 for a duration of 340 hours. The meter shall then be retested for error of indication and shall be visually inspected for legibility of the index and the markings.

5.24 Index windows and surround test
Both as supplied , and after being subjected to the accelerated ageing tests specified in 5.24.5 . samples of window panes or moulding shall comply with 5.24.1, 5.24.2, 5.24.3 . The accelerated ageing tests shall be performed on samples that have not previously been subjected to the flammability test (5.24.4) .

5.24.1 Visual inspection
The window pane or moulding shall show no crazing or blisters. The portion through which the index is viewed shall be transparent, and shall not cause visual distortion of the matter to be viewed within an angle of 15° from the normal to the window.

5.24.2 Rigidity
With the window fitted on the meter as in operation, and at a temperature of 60± 2°C, a 10 mm diameter timber rod applied normal to any external part of the window or moulding with a force of 200 n shall not cause it to touch any moving part of the mechanism.

5.24.3 Impact
Drop a solid steel ball of 25 mm diameter three times from a height of 350 mm on to the centre of the index window, normal to its plane, whilst the window, fitted in the meter as in operation, is maintained at a temperature of (−29 , ± 01 ºC).

5.24.4 Flammability
The window shall be tested in accordance with BS 2782: method 140e: 1982 . For this test, the test piece shall be positioned centrally with its external face downwards on the centre of the wire grid. The material shall comply with the following requirements.

(A) The period of time for which the test piece glows or flames from the instant the ethanol burns out shall not exceed 5 s.
(B) Any material that may have dropped from the specimen shall not continue to burn.
(C) The percentage of the area of the underside of the test piece that is charred or scorched shall not exceed 20%.
(D) The length of that part of any edge of the underside of the test piece that is charred or scorched shall not exceed 50mm.

5.24.5 Accelerated ageing
Subject one sample window pane or moulding to ultraviolet exposure test and loss of volatile plasticizer specified in 5.24.5.1 and 5.24.5.2 subject another sample to the tests specified in 5.24.5.3 After these ageing tests, and before being given the flammability test, the samples shall still fit the meter.

5.24.5.1 Ultraviolet exposure test
Expose the window of the indicating device and the name plate to the effects of ultra-violet radiation for five periods, each of eight hours duration, using a suspended sun lamp which has been used 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 energy of at least 765 W/m^2 over 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.

5.24.5.2 Loss of volatile plasticizer:
The sample shall be heated in air at 100 ±3°C for 24 hr .in this test the window pane or molding shall be reasonably supported so as not to encourage deformation.

5.24.5.3 Resistance to chemical substances:
The sample shall be constrained as it will be in the meter and then totally immersed, in turn and in the order listed, in the following technically pure substances at 20± 3°C:

(A) Sodium carbonate (20% m/m) for 2 hr :
(B) Paint thinners (approximately 50% aromatic and 50% aliphatic hydrocarbons e.g. 50% 0 – xylene and 50% n – heptanes) for 1 hr. The sample shall be cleaned with distilled water and carefully dried with cotton wool after each immersion.

5.25 Diaphragm and other material tests:

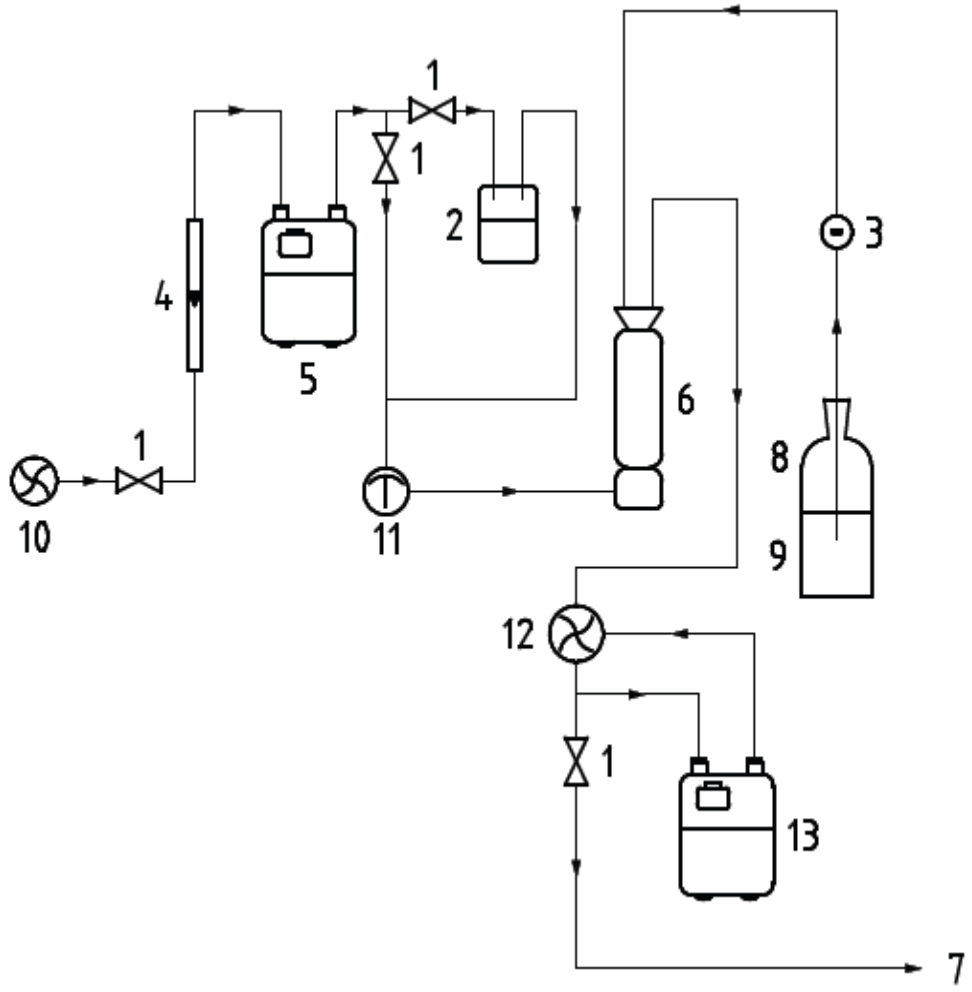
5.25.1 Test series a):

a.1) Toluene/iso-octane vapor test
Before testing the meter, the error of indication, using air, shall be within the maximum permissible error - initial limits given in Table 2, when tested in accordance with 5.2 c). At the end of each seven day period during Test 1, the error of indication, when checked by the method given in 5.2 c), shall not have changed by more than 3 % from that determined at the start of the test.

On completion of Test 2,the error of indication, when checked by the method given in 5.2 c), shall be within the maximum permissible error - initial limits given in Table 2.

a.1.1 Apparatus
An example of typical apparatus is given in Figure 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).
c) Relative humidity control, comprising a water reservoir and valves 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: 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

Figure 7 — Typical apparatus for toluene/iso-octane vapor test

a.1.2 Toluene/iso-octane mixture with nitrogen

Prepare a mixture 3 % by volume of a 30 % toluene/ 70 % iso-octane mixture with nitrogen by carefully mixing 95,4 ml toluene with 346,5 ml iso-octane and adding 441,9 ml of this mixture to 2 240 l of nitrogen carrier gas. This is equivalent to 0,197 ml per liter of 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.

a.1.3 Toluene/iso-octane vapor test procedure

Allow the toluene/iso-octane mixture (see a1.2) 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.
Ensure steady state conditions. Steady state is considered to be attained if the movement in registration between two consecutive tests is less than the uncertainty of measurement as calculated using ISO 5168, 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 need be sealed, to prevent the ingress of air, until the error of indication is about to be checked.

Test 1 — Toluene/iso-octane vapor test

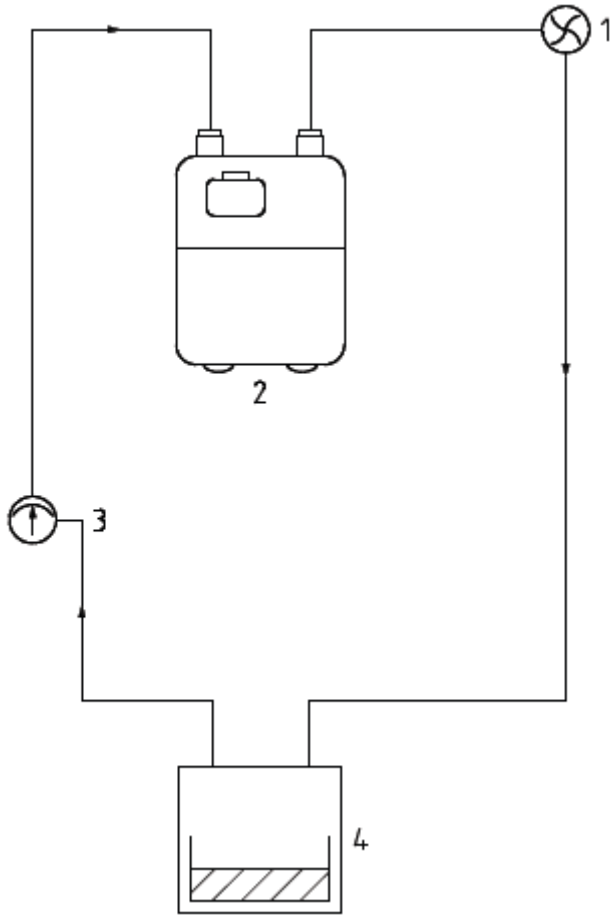
Exercise the meter under test with nitrogen, to which approximately 3 % by gaseous volume of a 30 % toluene/70 % iso-octane mixture has been added (see a1.2) for a maximum of 42 days (1008 h) at (20 ± 2) ºC, (65 ± 10) % relative humidity and a flow rate of not less than 0,25 Q_{max}.
The error of indication of the meter under test is checked every seven days (168 h), using air, until a steady state of error of indication is attained.

Test 2 - Toluene/iso-octane vapor test

After Test 1, exercise the meter under test with air for a further period of seven days (168 h) at (20 ± 2) ºC, (65 ± 10) % relative humidity and a flow rate of not less than 0,25 Q_{max}. Check the error of indication of the meter under test using air.

a.2 Water vapor test

Carry out the error of indication test, specified in 5.2 c), to ensure that the accuracy of the meter under test is within the limits of the maximum permissible error - initials. Connect the meter to the water vapor test rig (see Figure 8).



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

Figure 8 — Typical apparatus for water vapor test

In Figure 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 (CH3COOK) to give a relative humidity of 20 % at 20 ºC, or a saturated solution of potassium hydrogen sulphat (KHSO4) to give a relative humidity of 86 % at 20 ºC (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 % for seven days (168 h) at (20 ± 2) ºC and a flow rate of not less than 0,25 Q_{max}. At this point check the error of indication of the meter under test, using the method specified in 5.1.2 c), to confirm that the error of indication is within ±1,5 %.
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) ºC and a flow rate of not less than 0,25 Q_{max}. Check the meter error of indication every seven days (168 h), using air and the method given in 5.1.2 c), until a steady state of error of indication is attained (see 7.3.3.4). At this point check the meter error of indication using the method

given in 5.2 c), to confirm that the error of indication has not changed by more than 3 % from that determined at the start of the test.
Exercise the meter with air having a relative humidity of less than 20 % for at least seven days (168 h) at (20 ± 2) ºC and a flow rate of not less than 0,25 Q_{max}.
Carry out the error of indication test, using air at normal laboratory conditions, as specified in 5.2. c), to confirm that the accuracy of the meter is still within the maximum permissible error - initial limits.
The error of indication of meter after aging test shall be within the maximum permissible errors - endurance, given in Table 2.

a.3 Ageing test :
Test the meter as specified in 5.2. c) using a temperature selected by the manufacturer from the appropriate values given in Table 29.
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 0,2$Q_{max}$and 0,3 Q_{max} for the appropriate time period given in Table 14

Temperature C˚	Time Period Days
70±20	50
60±20	100
50±20	200

Table 14 — Temperature/times of ageing periods

5.25.2 Test series b) :

b.1 Diaphragm material tests:

b.1.1 General:
Diaphragm shall be homogeneous, uniform, free from porosity grit , blisters and defects visible to the naked eye , even after cutting .

b.1.2 Thickness:
The thickness variation of diaphragm shall not be greater than ±10% .

b.1.3 Identification :
The manufacturer name of trade mark, batch number and date of manufacture shall be indicated on the diaphragm.

b.1.4 Hydrocarbon mixture :
When a test piece is immersed and allowed to swell freely in a mixture of toluene and heptanes in the proportion 1 : 1 by volume at 20± 5°C for 7 days , the change in area shall not be greater than 5% of the original area . after immersion and drying to constant mass at room temperature, the extracted material shall not exceed 12% by mass of the original mass of the test pieces, and the area shall not differ from the original area by more that 5%.
The material shall not show any sign of delamination or blistering.

Note 1: the volume ration of liquid to test piece should be not less than 50: 1 .

Note 2: to measure the change in area, it is recommended that the liquid – soaked test piece be placed quickly between two microscope slides.

b.1.5 Water :

When the test piece is immersed in distilled or deionized water and allowed to swell freely at 20± 5°C for 7 days, the change in area of the material shall not be greater than 5% of the original area of the test piece. after immersion and drying to constant mass in air at room temperature,, the extracted material shall not exceed 12% by mass of the original mass of the test piece and the area shall not differ from the original area by more than 5%. The difference in relative humidity between taking the original and final mass and area measurements shall not exceed ±10%.
The material shall not show any sign of delamination or blistering.

b.1.6 Accelerated ageing :

The stiffness of the test piece shall be measured at 20± 5°C, by torsion apparatus. the stiffness , when remeasured at 20± 5°C shall not have increased by more than 25% after the test piece has been subjected to a temperature of 70± 2°C in an air – circulating oven for 4 weeks . In addition, the test piece shall not show any sign of delamination, blistering or significant deterioration.

b.1.7 Low temperature flexibility :

The stiffness of the test piece shall be measured at 20± 5°C by torsion apparatus. the stiffness when measured at - 20± 1°C shall not have increased by more than 25% after the test piece has been subjected to this temperature in an environmental chamber for 20 min.

b.1.8 Porosity :

Diaphragm shall withstand a pressure of 50 mbar for 1 min without any leakage.

b.1.9 Ambient temperature tests :

The meter shall comply with tests nos. 5.2.c, 5.3, 5.8, when tested in an ambient temperature of 20 ± 2°C after each of the following periods of operation:
(a) 400 hr on air at 0.5 × Q_{max} in an ambient temperature of -29 ± 1°C.
(b) 400hr on air at 0.5 × Q_{max} in an ambient temperature of +60± 1°C.

note care should be taken to prevent condensation in the meter .

b.2. Elastomer and non metallic material tests:

b.2.1 General:

The tests shall be carried out with the finished component or with parts of the finished component. The elastomeric material shall be homogeneous, free from porosity, inclusions, grit, blisters and surface
imperfections visible with the naked eye

b.2.2 Resistance to lubricant:

The test shall be carried out according to 8.2 of ISO 1817 : 1985 concerning the gravimetric method but the duration of immersion shall be (168± 2) hr in oil No.2 (ISO 1817 : 1985 at the 100 ± 2°C ambient temperature determine the relative change of mass , Δ M , using the following formula:

$\Delta M = ((M_3 - M_1)/M_1).100$

Where:
M1 is the initial mass of the test piece in air.
M3 is the mass of the test piece in air after immersion.

After this test, the change of mass shall be between –10% and + 10% the test piece shall not show any sign of delamination, blistering or significant deterioration.

b.2.3 Resistance to gas:
The test shall be carried out according to 8.2 of Iso1817: 1985 concerning the gravimetric method and clause 9 concerning the determination of extracted soluble matter, but under the following conditions:

(a) The duration of immersion shall be (72± 2) HAT (23± 2°C in N – Pentane (minimum 98% by mass of N – pentane, estimated by gas chromatography)

(b) Dry the test pieces for a period of (168± 2) h in an oven at (40± 2) °C at atmospheric pressure

(c) Determine the relative change of mass, Δ M, with reference to the initial mass of the test piece using the following formula:

$\Delta M = ((M_3 - M_1)/M_1).100$

Where:
M1 is the initial mass of the test piece in air,
M5 is the mass of the test piece in air after drying.

After this test the change of mass shall be between – 15% and+ 5%.
The test piece shall not show any sign of delamination, blistering or significant deterioration .

b.2.4 Ambient temperature effect:
b.2.4.1 The elastomer material shall be placed in chamber maintained at -29± 1°C for 1 hr. The test piece shall have sufficient flexibility for its service.
The test piece shall not show any sign of delamination , blistering or significant deterioration.

b.2.4.2 After the elastomer material has been subjected to a temperature of 70 ± 2°C in an air – circulating oven for 168± 2 hr.
The test piece shall not show any sign of delamination, blistering or significant deterioration.

6 . Painting

6.1 The external surface of meter shall be thoroughly cleaned by removing all rust and mill scale. Surface to be painted shall be completely free from grease, grit and other foreign material.

6.2 Steel casting shall be painted according to ISO12944

6.3 Aluminum casing shall receive a chromate conversion coating., and shall be painted according to ASTM D-09

6.4 Final color shall be cream.ral code 9001 (RGB 250-244-227) .

6.5 The total thickness of painting shall not be less than 50 microns..

6.6 Test requirement for painting shall be in according to coating test.

7. Marking

7.1 Each meter shall be marked with at least the following information, either on the index or on a separate data plate in English.

a) The type approval mark and number (if appropriate);
b) The identification mark or name of the manufacturer;
c) The serial number of the meter;
d) Year of manufacture
e) Designation of meter (Grate)
f) The maximum flow rate, Q_{max} (m^3/h);
g) The minimum flow rate, Q_{min} (m^3/h);
h) The maximum working pressure, p_{max} (bar);
i) The nominal value of the cyclic volume, V (dm^3);
j) Accuracy class of the meter, e.g. Class 1,5;

7.2 All markings shall be in a clearly visible position.

7.3 All marking shall be durable under the normal conditions of the meter.

7.4 The meter shall be clearly and permanently marked with the direction of flow by means of an arrow between the connections.

7.5 All labels shall remain securely fixed, in that their edges shall not lift from the backing surfaces.

7.6 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 following tests:

-Vibration test
- Salt spray
- Storage temperature
- Aging
- Ultraviolet

8. Documentation

Supplier is required to complete and sign the attached data sheet(s) and as well as 2 sets of the following documentation in English together with technical quotation:

8.1 All technical information and original copies of printed catalog(s)

8.2 Full Parts list catalogue(s)

8.3 General drawing(s) showing outline dimensions
8.4 Manuals for installation, commissioning, operation and maintenance.

8.5 Typical pressure drop curve for air with density of 1.2 kg/m^3 and also gas with specific gravity of 0.65

8.6 Material test certificates of each parts of meter.

8.7 Type test certificates.

8.8 Factory testing reports

Note : After receiving the order the supplier shall submit 10 sets of above information for each 5000 NOS. of meters (Minimum 10 sets).

9. Packing and Packaging

9.1 The meter connections shall be fitted with suitable non-sealing plugs or covers to prevent the entry of foreign matter during transit and storage.

9.2 Each meter shall be put in a plastic bag.

9.3 Each plastic bag shall be housed in a cardboard box.

9.4 The cardboard boxes shall be housed in wooden cases according to NIGC packing instructions under protection, packing, marking and dispatching.

10. Guarantee

The supplier shall replace any meter that failed under normal usage for five years after putting in service**.** Unless otherwise shall be specified in data sheet.

Data Sheet [1]

(Normative)

To be filled by NIGC					To be filled by manufacture/Supplier				
Inquiry No :					Quotation no :				
Inquiry date :					Quotation date :				
NIGC Standard : IGS-M-IN-101 (4) : 2015					Catalogue No :				
					Standard :				
Item	Inquiring				Offered Data				
	Indent Item no	Grate	Q_{max} m3/h	Quantity required	Item	Offered Item no	G rate	Q_{max} m3/h	Quantity Offered

Manufacturer and Supplier Signature and Stamp :

(1) This data Sheet is an integrated part of IGS- M-IN-101(4) : 2015 and Should not be used separately.

Data Sheet (Continued)

Subject	Description	To be filled by NIGC	To be filled by manufacturer/ Supplier
General	Gas inlet temperature	From …˚c to….˚c	From …˚c to….˚c
	Normal gas inlet pressure	18 mbar	….mbar
	Maximum working pressure	More than 100 mbar	….mbar
	Ambient temperature range	From -29˚c to + 60˚c	From ….˚c to.. ..˚c
	Meter installation	Outdoor	Yes ☐ No☐
	Standard Condition	0.01013 bar and 15.56 ˚C	Yes ☐ No☐
Meter data	G rate	---	---
	Q_{min}	….m^3/h	….m^3/h
	Q_{max}	….m^3/h	….m^3/h
	Maximum pressure absorption	According to table 3	….m^3/h
	Cycling volume	According to table 5	….dm^3
	Connection Size	According to table 6	…. In
	Connection Type	Threaded ☐ flanged ☐	Yes ☐ No☐
	Connection thread	According ISO 228-1	Yes ☐ No☐
	Connection flange	According to ANSI B 16.5	Yes ☐ No☐
	Connection location	Side ☐ top ☐	Yes ☐ No☐
	Measuring unit	Cubic meter	Yes ☐ No☐
	Index type	Mechanical	Yes ☐ No☐
	Index drive	Magnetic	Yes ☐ No☐
	At reverse Flow	Prevent registration ☐	Yes ☐ No☐
		Prevent Flow ☐	Yes ☐ No☐

Material	Meter Case	Steel ☐ Die Cost Aluminum ☐	Steel ☐ Die Cost Aluminum ☐
	Index window	According to requirements Specified in 4.213	Yes ☐ No☐
	Diaphragm	Reinforced rubber material According to requirements Specified in 4.213	Yes ☐ No☐
	Valve and Valve Seat	Gas grade Bakelite	Yes ☐ No☐
	Plastic parts	----	--
	Diaphragm Casting	---	--
	Rubber parts	According to requirements Specified in 4.2.13	Yes ☐ No☐
Test Certificates	Routine test report	required for each meter	Yes ☐ No☐
	Other factory testing report	required for sample meters	Yes ☐ No☐
	Type test certificates	required for each type	Yes ☐ No☐
Guarantee	Guarantee period	5 years ☐ , …… years ☐ after putting the meter in normal service,	Yes ☐ No☐