A. Proposal Details

Part - 1

Organization Type: Industry/Industry Association

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Part - 2

5. Proposed title of Standard	Pressure Regulator of flowrates up to 2.5 scmh and inlet pressure up to 100 mbar
6. Aspect	Product Specification
7. Define subject of standard	This document specifies the product requirements for Pressure Regulators for use with natural gas (Specific Gravity up to 0.6) at gas flow rates up to 2.5 scmh.
8. Most Relevant Technical Department	PGD (Production and General Engineering Department)

Part - 3

9. Scope of proposed standard	This document specifies the product requirements for Pressure Regulators for use with natural gas (Specific Gravity up to 0.6) at gas flow rates up to 2.5 scmh.
10. Purpose and Justification	At present, there are more than one million domestic customers who are being supplied Piped Natural Gas (PNG) by various City Gas Distribution (CGD) entities across the nation, and the customer base is expanding at a very rapid rate. The subject pressure regulators are installed inside the premises of customers. It is proposed to formulate an Indian technical standard to cater to the subject material, which is directly affecting millions of people.
11. Likely users of standards and their inputs	City Gas Distribution companies supplying Piped Natural Gas (PNG), manufacturers of pressure regulators
12. Any related standards/series of standard/system standard required to make this subject standard complete	EN 88-1, IGEM GM PRS3 (Type A regulator)
13. When the final standard would be required	31-03-2025
14. Any specific problem being faced without this standard	The aim of formulating this standard is to ensure safety standards for products which are inside the house of domestic customers using Piped Natural Gas (PNG) and is affecting millions of people across the nation.
15. Bearing with Govt legislation regulation, etc	PNGRB Technical Standards & Specifications including Safety Standards for City or Local Natural Gas Distribution Networks (also known as T4S)
16. Name and address of manufacturers/ implementing/ industries/ purchasing organization /component supplier/ raw material supplier, if any	Users: City Gas Distribution (CGD) entities across the country. Manufacturers: Kabsons (Hyderabad), Greenglobe (Mumbai), Vanaz (Pune), Mesura Nirmal (Vadodara), etc.

17. Status of the industry in the country	The City Gas Distribution (CGD) entities across the country are using subject product as per their respective technical specifications and are procuring the same from manufacturers namley Kabsons (Hyderabad), Greenglobe (Mumbai), Vanaz (Pune), Mesura Nirmal (Vadodara), etc.
18. Availability of test facilities in the country	1) Fluid Control Research Institute (FCRI), Palakkad (Kerala state), 2) Yadav Measurements, (Udaipur)
19. Whether related to variety reduction, export, health, safety consumer protection, mass consumption, energy conservation, technology transfer, technology upgradation, protection of environment & other National priorities	Safety consumer protection, mass consumption
20. Whether subject requires consideration to be given to women/girl issues in line with Sustainable Goal 5 of the UN. If so, whether the issues are proposed to be addressed suitably in the proposed standard	Not applicable
21. Relevant supportive document (download docs)	1. Attachment
22. R & D work done in india	Regulator developed by CGD entities in consultation with manufacturers
23. Any foreign collaboration (give details)	Nil
24. Liaison with any organisation(s)	Nil
25.A. Preparatory work	Outline attached and draft can be prepared
25.B. Preparatory work (Details)	Please find attached broad outline of technical specifications Attachment
26. Whether this project can be funded by your organization	To be discussed
27. Whether your organisation would be interested to opt for BIS Standard Mark once the standard is published?	Yes
28. Any Other Attachment (extra)	

B. Action Logs

Technical Specification for **Pressure Regulators** for Natural Gas (and suitable manufactured gases) for use at maximum inlet pressure up to 100 mbar(g)

CONTENTS

SECTION 1 – PRODUCT REQUIREMENTS

1. SCOPE

a. This document specifies the product requirements for Pressure Regulators (for compliance to this technical specification, EN 88-1 and IGEM/GM/PRS3 (Type A regulator) standards) for use with natural gas (S.G. 0.60) at gas flow rates up to 2.5 m^3/h. Regulator to this specification shall also be in line with all the prevailing requirements of PNGRB Technical Standards & Specifications including Safety Standards for City or Local Natural Gas Distribution Networks (also known as T4S). Regulators to this specification shall be suitable for installation with the diaphragm in the horizontal or vertical plane and shall be suitable for normal inlet pressures up to 100 mbar, and any abnormal inlet pressures up to 165 mbar, without change in performance when the inlet pressures returns to normal.

b. The specification applies to independent regulators with right-angled inlet and outlet connections of ¾" x ¾" BSPT (female).

c. Section 2 deals with the quality assurance obligations placed on the manufacturer.

2. REFERENCES

This Specification makes reference to a number of other standards and documents. Unless otherwise specified; the latest editions of the standards mentioned herein this specification, including all addenda and revisions, shall apply.

All pressures quoted in this specification are in Gauge.

3. MATERIALS

3.1 General requirements

3.1.1. The regulator shall be constructed of materials conforming to appropriate Indian or International Standards.

3.1.2 The quality of materials and the dimensions used and the method of assembling the various parts shall be such that construction and performance characteristics are safe. Moreover the performance characteristics shall not alter significantly during a reasonable life when the regulators is installed and used according to the manufacturer's instructions. Under these circumstances, all components shall withstand any mechanical, chemical and thermal conditions, to which they may be subjected during service.

3.2. Housing

3.2.1 The main casing components of the regulator (e.g. body and spring cover) shall be cast in aluminum alloy LM 4, LM 6, LM 24 or LM 25 to BS EN 1559-1 and BS EN 1559-4 or equivalent. Radiographic testing of 1 No. sample per lot shall be carried out, and test for checking the chemical compostion of the finished product shall also be carried out in 2 Nos. samples per heat. These tests shall be carried out in NABL approved lab and the vendor has to make the necessary arrangements. The discontinuity (porosity) in the body of the casing shall not be more than grade 5, as per ASTM E 155.

3.2.3 Physical properties of Meter regulator body and cover shall be as per BS EN 1706. In case Tensile properties for selected sample fall below the value as specified in BS EN 1706; retest selecting another sample shall be carried out. In case tensile properties for both the sample falls below the specified value, the same shall not be less than 75% of the specified value, as mentioned in IS 617.

3.2.4 Parts of the housing separating a gas-carrying compartment from the atmosphere shall be manufactured only of metallic materials. This also applies to parts of the housing that are separated by a diaphragm from the gas-carrying compartment.

NOTE: This requirement does not preclude the use of non-metallic sealing gaskets or other non-metallic parts of the regulator which support a sealing gasket.

3.2.5 Zinc alloys shall not be used for gas-carrying parts, or parts which could affect the safe operation of the regulator. Other components may be made of zinc alloy A to BS EN 12844, the casting being made in accordance with the recommendation of BS 5338 or equivalent.

3.3 Resistance to corrosion

3.3.1 Any part, including springs, in contact with the gas or the surrounding atmosphere, shall be manufactured from corrosion-resistant materials or shall be suitably protected. Spring shall be designed to be fatigue-resistant The corrosion protection for spring and other moving parts shall not be impaired by any movement.

3.4 Adhesives

3.4.1 Adhesives shall remain effective throughout the storage and working life of components.

3.5 Polymeric components

3.5.1 General

The elastomeric material of seals, diaphragms, valve pads and valve seating shall be homogenous, free from porosity, inclusions, grit, blisters and surface imperfections

visible to the naked eye. Such components shall contain no level of porosity that would significantly affect the strength of the component.

Attention shall be given to the use of appropriate materials and design including the avoidance of stress raisers. Where plastic materials are used within the regulator, they shall be designed such that manufacturing processes do not result in excess stresses that can cause premature failure of the components. Assembly methods shall be such as to minimise stress levels particularly residual stresses following assembly.

3.5.2 Resistance to lubricants

The resistance of elastomers to lubricants shall be checked by the oil immersion test as per A.1.1 of Appendix A. After this test, the change of mass of the elastomer shall be between ±10%.

3.5.3 Resistance to gas

The resistance of elastomers to gas when in contact with gas shall be checked by the immersion test using n-pentane (minimum 98% by mass of n-pentane, estimated by gas chromatography) carried out according to A.1.2 of Appendix A. After this test, the change of mass of the elastomer shall be between –15% & +5%.

4. Finish

All parts, including those with protected surfaces (e.g., plated, powder coated, or coated with paint) shall withstand the humidity test of Appendix B, and should not show signs of corrosion, lifting, or blistering that are visible to the naked eye.

5. Torsion and bending

Regulators shall be constructed such that they have adequate strength to withstand likely mechanical stress to which they may be subjected during installation and service.

6. Design and dimensions

6.1 General requirements

6.1.1 The regulator configuration and external dimensions shall conform to Figure 1. Connection bosses shall be such as to permit the use of metric spanners to BS 192-1 or equivalent.

6.1.2 The assembly of the regulator body and the top cover shall be with external screws and shall not be of crimped design.

6.1.3 External screws on regulators shall conform to BS EN ISO 7045 type Z, but with standard or thread rolling type metric threads, and shall be electroplated to BS EN ISO 4042 grade Zn5 or mechanically plated to a comparable thickness and quality.

6.1.4 Screws which have to be removed for servicing or those securing or supporting gas-carrying components shall not be of the thread cutting type. They may be of the thread forming type which, when removed leave a thread suitable for a machine threaded screw.

6.1.5 Holes for screws, pins etc., which are used for the assembly of parts shall not penetrate gas ways. The wall thickness between these holes and gas ways shall at least be 1 mm.

6.1.6 The regulator shall not chatter or hunt when being tested for performance characteristics.

6.1.7 Each regulator shall be provided with an adjustable spring loading device to regulate the outlet pressure. The adjuster shall have an adjustment cover. Holes shall be provided in the adjustment cover and in an appropriate position on the regulator body for sealing by locking wire or plastic seal. This adjustment shall be accessible to authorised personnel only and facilities for sealing the adjustment (e.g., with locking wire or sealed cap) shall be provided to prevent unauthorised interference. It shall not be possible to adjust the regulator or remove / disassemble the adjustment cover or associated components and replace without visible evidence of access to the adjustment.

6.1.8 It shall not be possible for the adjusting device to be set in such position as to keep the valve permanently open. Adequate steps shall be taken to ensure that the setting of the outlet pressure adjuster cannot be disturbed by vibration.

6.1.9 Breather holes shall be protected against blockage or shall be located so that they do not easily become blocked. They shall be so arranged that the diaphragms cannot be damaged by a thin object or a sharp cleaning device pushed through the hole.

6.1.10 The operating temperature range of the regulator shall be +15 ^{0}C to + 40 ^{0}C.

6.1.11 The inlet and outlet connections shall be threaded ¾” to ISO 7-1 / IS 554, with female tapered threads.

6.2 Performance

6.2.1 Test conditions

Unless otherwise specified, tests shall be carried out with air and at an ambient temperature of 20 ^{0}C $\pm$ 5 ^{0}C. All measured values shall be corrected to standard conditions, i.e., 15 ^{0}C, 1.01325 bar, dry.

Before carrying out any of the tests in 6.2, the regulator shall be set in accordance with C.2.1 of Appendix C.

6.2.2 Soundness

When the regulator is tested in accordance with C.1.1 of Appendix C at a pressure of 165 mbar ± 1 mbar, any leakage of air shall not exceed 15 cm^3/h.

6.2.3 Breather hole (with ruptured diaphragm)

When the regulator is tested with air at an inlet pressure of 100 mbar in accordance with C.1.2 of Appendix C, the total external leakage of air through the breather hole, pressure adjuster, etc. shall not exceed 190 dm^3/h.

6.2.4 Performance characteristic.

6.2.4.1 Outlet pressures with diaphragm horizontal

The regulator shall be initially set in accordance with C.2.1 of Appendix C. When the regulator, with the diaphragm in the horizontal plane, is tested with air in accordance with C.2.2, it shall satisfy the following criteria.

i) Outlet pressure at high flow rate: The outlet pressure shall be not less than 19 mbar nor greater than 24.5 mbar at an inlet pressure of 26 mbar ± 0.2 mbar & at an air flow rate of 2.50 m^3/h ± 0.08 m^3/h.

ii) Outlet pressure at low flow rate: The outlet pressure shall be not less than 19 mbar nor greater than 24.5 mbar at an inlet pressure of 100 mbar ± 1 mbar & at an air flow rate of 0.030 m^3/h ± 0.004 m^3/h.

iii) The outlet pressure shall not be less than 18 mbar (g) at an air flow rate of 2.50 m^3/h ± 0.08 m^3/h and at an inlet pressure of 100 mbar (g).

iv) Maximum outlet pressure setting: With the outlet pressure adjustment set at maximum, an inlet pressure of 50 mbar ±1 mbar and an air flow rate of 2.5 m^3/h ± 0.05 m^3/h, the outlet pressure shall not exceed 29 mbar.

6.2.4.2. Outlet pressures with diaphragm vertical

The regulator shall be initially set in accordance with C.2.1 of Appendix C. When the regulator, with the diaphragm in the vertical plane, is tested with air in accordance with C.2.2, it shall satisfy the following performance criteria:

i) Outlet pressure at high flow rate. The outlet pressure shall be not less than 18.5 mbar nor greater than 24.5 mbar at an inlet pressure of 26.0 mbar ± 0.2 mbar and at an air flow rate of 2.50 m^3/h ± 0.08 m^3/h.

ii) Outlet pressure at low flow rate. The outlet pressure shall be not less than 18.5 mbar nor greater than 24.5 mbar at an inlet pressure of 100.0 mbar ± 1.0 mbar and at an air flow rate of 0.030 m^3/h ± 0.004 m^3/h.

6.2.5 Lock-up

6.2.5.1 Lock-up with the diaphragm horizontal

The regulator shall be initially set in accordance with C.2.1 of Appendix C. When the regulator, with the diaphragm in the horizontal plane, is tested in accordance with C.2.3 of Appendix C, it shall satisfy the following criteria:

i) The lock-up pressure shall not exceed 30 mbar at any inlet pressure up to and including 100 mbar, and the total leakage of air shall not exceed 28 cm^3/h.

ii) The lock-up pressure shall not exceed 30 mbar at any inlet pressure from 100 mbar up to and including 165 mbar and the total leakage of air shall not exceed 60 cm^3/h.

6.2.5.2 Lock-up with the diaphragm vertical.

The regulator shall be initially set in accordance with C.2.1 of Appendix C. When the regulator, with the diaphragm in the vertical plane, is tested in accordance with C.2.3 of Appendix C, it shall meet the requirements specified in (i) and (ii) of 6.2.5.1.

6.2.6 Low pressure cut-off.

The regulator shall have a low pressure cut off device, which positively closes the regulator off when the inlet pressure falls in the range of 11 to 15 mbar (g). Vendor shall adjust the regulator set point with a tolerance of ± 1 mbar (g). There shall also be a re-pressurization safety device fitted in the regulator, which prevents the regulator from re-opening when the inlet pressure is restored, unless there is a downstream backpressure, i.e., all connected appliances have been turned off. The regulator shall otherwise re-open, and the low pressure cut off reset, when the inlet pressure is restored above the point of the cut off device.

The low pressure cut-off device shall operate with the regulator in either the vertical or horizontal plane.

The low pressure cut-off device shall be tested with the regulator placed in a test rig comprising:

- A compressed air supply, regulated at 30 mbar.

- ❖ An inlet control valve.
- ❖ A pressure measuring point upstream of the regulator, to which a 0-40 mbar manometer is attached.
- ❖ The regulator, set to 21 mbar outlet pressure.
- ❖ A flow meter.
- ❖ 1.5 metre of 15 mm copper outlet pipe.1 burner hot plate, with simmer setting.

The test will be conducted with one appliance burner in the open position, on simmer setting. The cut off shall be tested by slowly reducing the air supply pressure and noting the pressure on the manometer at which the cut off operates. The supply pressure will be slowly restored to 30 mbar, and allowed to stabilise for 1 minute. With the burner still in the open position, the total leakage of air shall not exceed 28 dm^3/h, when measured at the flowmeter. When the burner is then turned to the closed position, the regulator cut off shall immediately reset. The test shall be carried out 3 times for repeatability.

6.3 Mechanical life

When the regulator is tested in accordance with Appendix D, it shall satisfy the requirements of 6.2.2, 6.2.4 and 6.2.5. Diaphragms shall show no sign of perforation, cracking deformation or delamination.

7. Factory setting and sealing

7.1 Unless otherwise specified by Mahanagar Gas, the regulators shall be set with the diaphragm in the horizontal plane to give a pressure at the outlet of the regulator of 22 mbar +0.75 mbar / -0.25 mbar, at an airflow rate of 1.50 m^3/h ± 0.05 m^3/h and at an inlet pressure of 30 mbar ± 1 mbar.

7.2 The regulator shall be adequately sealed so as to prevent its setting from being interfered with without breaking of the seal. (see 6.1.5)

8. Marking and labeling

8.1 Marking

8.1.1 Each regulator shall be clearly marked with an arrow, cast or embossed in the casing, indicating the direction of gas flow.

8.2 Labeling

8.2.1 Each regulator shall be marked (see 8.2.2) with the following information, either on an irremovable label or directly cast, stamped or ink-jet printed onto the housing with markings so as to be legible and durable:

- ❖ Manufacturer’s name, abbreviated or in full

- ❖ The text “METER REGULATOR”
- ❖ The maximum inlet pressure, i.e., ‘P_{max} = 100 mbar’
- ❖ The nominal outlet pressure, i.e., ‘P_O = 21 mbar’
- ❖ Maximum flow rate, i.e., ‘Q_{max} = 2.5 scmh’
- ❖ A sequential serial number, traceable to the manufacturer’s production records

8.2.2 The lettering on the label shall not be less than 3 mm high and not less than 0.75 mm thick

- ❖ Marking and labels shall be able to withstand the humidity test in Appendix B and withstand 40 ^{0}C $\pm$ 5 ^{0}C for 28 days (see Appendix D) without signs of lifting or blistering of the label visible to the naked eye and without loss of legibility of the markings.

- ❖ The month and year of manufacture shall be embossed clearly in legible condition and on a visible location on each of the meter regulator, prior to dispatch to buyer organization. The embossing shall be in the format mm – yyyy.

9. Protection and packaging

9.1 The regulator shall be adequately packed for protection against damage and deterioration during all stages of processing, storage and delivery.

9.2 Meter Regulator shall be individually packed & sealed in clear uncoloured bags / covers of appropriate durable materials.

9.3 Bags, containing regulators, shall be packed in suitable boxes, providing protection against accidental damage. Each box shall be labeled with the following:

i. Manufacturer’s name, abbreviated or in full
ii. The week number or the sequential numbers, traceable to the manufacturer’s production records
iii. The number of regulators in the box
iv. The words ‘METER REGULATORS’

SECTION 2 – QUALITY ASSURANCE REQUIREMENTS

10. Scope

This section specifies the Mahanagar Gas minimum quality assurance requirements for products covered in **Section 1** of this specification.

11. Quality Plan

11.1 <u>General</u>

11.1.1 The supplier shall provide a Quality Plan, which demonstrates to Mahanagar Gas that the items supplied conform to the requirements of this specification. The materials shall be supplied with Quality Records like Material Test Certificates (MTC), type test reports, shop testing reports, guarantee certificates, etc.

11.1.2 The Quality Plan shall include, but not limited to, following elements.

- ❖ Purpose
- ❖ Nominated contact
- ❖ Design control
- ❖ Control of bought-in material
- ❖ Control of parts manufacture
- ❖ Control of sub-assembly
- ❖ Control of product assembly and test
- ❖ Inspection, measuring and test equipment
- ❖ Product audit
- ❖ Non-conforming product
- ❖ Statistical techniques
- ❖ Control of packaging and delivery
- ❖ Product identification and traceability
- ❖ Quality records
- ❖ Control of spare parts

11.1.3 Any changes to the quality plan shall be agreed between National Grid Gas and the supplier before introduction.

12. Access for designated Quality Assurance personnel of buyer organization

12.1 The supplier shall provide access and facilities to designated Quality Assurance personnel of buyer organization to visit production lines, quality audit areas, warehouses and other appropriate premises to check that the products or component parts conform to this specification and that the Quality Plan is being effectively operated.

NOTE: The Quality Assurance personnel will be called upon to attend the factory regularly, on a daily basis if necessary, to carry out quality audits on finished products and spare parts, to investigate reported defects and to confirm that the supplier's quality control ensures that the agreed requirements are consistently achieved.

12.2 The supplier shall make available, on request, the appropriate quality records, drawings and other control documents.

12.3 The supplier shall carry out all Type Test (mentioned in Appendix A, B, C and D) ones in a three years, and shall make avaialble all the records at the time of Inspection.

13. Validation of initial production

At the start of each contract, no delivery of a new product shall be made until a satisfactory examination of initial production has been completed by buyer organization and the supplier has demonstrated the effectiveness of the Quality Plan.

14. QUALITY ASSURANCE PLAN (QAP)

Sr. No.	Description	Characteristics	Type of Check	Quantum of Check	Reference Documents	Acceptance Norm	Format of Record	Scope		Remarks
								Vendor	TPIA	
1	Meter Regulator (¾")	Chemical Composition for Raw Material for Meter Regulator Body and Cover	Chemical Analysis	Two sample per heat	BS EN 1559-4 or equivalent grade LM 4 / LM 6 / LM 24 / LM25	As per Tech Spec	MTC (Material Test Certificate)	Perform	Witness	Review of report issued by NABL approved Lab in case the chemical analysis done by wet analysis method by TPIA
2		Physical Properties of Meter Regulator Body and Cover	Physical Testing	1 No. sample / heat	BS EN 1559-4 or equivalent grade LM 4 / LM 6 / LM 24 / LM25		MTC	Perform	Witness	Witness Physical tests at NABL approved Lab by TPIA
3		Chemical Composition for springs	Chemical Analysis	1 No. sample / lot	Spring: AISI 304 / AISI 316		MTC	Perform	Review	Review of report issued by NABL Lab by TPIA
4		Radiography Test	Non- Destructive Test	1 No. sample / lot	Tech Spec		Radiography film and test report	Perform	Review	Review of radiography reports and films (100%) by TPIA.
5		Test on Elastomeric Components	Mechanical Test	1 No. sample / lot	Tech Spec		Vendor inspection reports	Review	Review	Vendor and TPIA has to review the test report.
6		Breather hole with rupture diaphragm	Functionality Test / Operation	1 No. sample / lot	Tech Spec		Inspection Report	Perform	Witness	Witness the test by TPI
7		Dimensions of Assembly	Dimensional Check	10%	Tech Spec		Inspection Report	Perform	Witness	Vendor has to carry out 100 % Inspection and TPI has to witness randomly 10% from the lot.
8		Soundness Test	Functionality Test / Operation	10%	Tech Spec		Inspection Report	Perform	Witness	
9		Performance Characteristics	Functionality Test / Operation	10%	Tech Spec		Inspection Report	Perform	Witness	
10		Lock-up pressure test	Functionality Test / Operation	10%	Tech Spec		Inspection Report	Perform	Witness	
11		Low Pressure Cut off Test	Functionality Test / Operation	10%	Tech Spec		Inspection Report	Perform	Witness	
12		Factory Setting and Sealing	Visual	10%	Tech Spec		Inspection Report	Perform	Witness	
13		Marking and Labeling	Visual	10%	Tech Spec		Inspection Report	Perform	Witness	
14		Protection and Packing	Visual	10%	Tech Spec		Inspection Report	Perform	Witness	
Type tests										
15	Meter Regulator (¾")	Elastomers	Functionality Test	1 No. / lot	Tech Spec	As per Tech Spec	MTC	Perform	Review	Vendor has to carry out the performance test once in three years. TPI has to review the vendors Inspection Reports.
16		Protective Coating	Functionality Test	1 No. / lot	Tech Spec		Vendor Inspection Report	Perform	Review	
17		Regulators	Functionality Test	1 No. / lot	Tech Spec		Vendor Inspection Report	Perform	Review	
18		Mechanical Life Test	Mechanical Test	1 No. / lot	Tech Spec		Vendor Inspection Report	Perform	Review	
REMARKS	1. All dimensions are in mm unless otherwise specified.									
	2. All the measuring instruments shall be duly calibrated at the time of inspection									
	3. Calibration certificates of all the measuring instruments shall be reviewed by TPI at the time of inspection, along with the Master calibration certificate of the measuring instruments from which the instruments are calibrated. A copy of same shall be submitted along with inspection report.									
	4. After satisfactory inspection, the TPI agency to apply their mark (stamp / sticker / embossing / etc.) on each regulator in close proximity to the location where the Sr. No. of the regulator is marked. Also, TPI has to apply their mark (stamp / sticker / embossing / etc.) on the outer packing of the regulator, after verifying the information mentioned in the technical specifications. Wherever applicable photograph (If allowed at the works of vendor) should be taken and shall be included in the inspection report.									

Appendix A. Type tests on elastomers (See Clause No. 3.5.2, 3.5.3)

A.1 Tests on elastomers

The tests shall be carried out with the finished components or parts of the finished component. Where the finished component has a volume of less than 1 cm^3, a sufficient number of components shall be used to provide a volume of not less than 1 cm^3. Where the elastomeric material is part of a composite component (e.g., a rubber / metal component) sufficient elastomeric material shall be removed from the sample (s) to provide a volume of not less than 1 cm^3.

A. 1.1. Resistance to lubricants.

Method:

The test shall be carried out according to BS ISO 1817 or equivalent concerning the gravimetric method, but the duration of immersion shall be 168 hours $\pm$ 2 hours in oil No. 2 (BS ISO 1817) or equivalent at 40 $^0C \pm 2\ ^0C$.

Determine the relative change of mass, Dm, using the following formula :

$D_m = \{(m_2-m_1)/m_1\} \times 100;$
Where,
m_1 is the initial mass of the test piece in air;
m_2 is the mass of the test piece in air after immersion.

Performance:

The change of mass of the elastomer shall conform to the requirements in Clause No. 3.5.2.

A.1.2. Resistance to gas

Method:

The test shall be carried out according to 8.2 of BS ISO 1817 or equivalent concerning the gravimetric method, and Clause 9 concerning the determination of extracted soluble matter, but under the following conditions :

1. The duration of immersion shall be 72 h $\pm$ 2 h at 23 $^0C \pm 2\ ^0C$ in n-pentane (normal pentane)

2. Dry the test pieces for a period of 168 h $\pm$ 2 h in oven at 40 $^0C \pm 2\ ^0C$ at atmospheric pressure

3. Determine the relative change of mass, D_m, with reference to the initial mass of the test piece, using the following formula:

   $D_m = \{(m_4-m_3) / m_3\} \times 100;$

   where,
   m_3 is the initial mass of the test piece in air
   m_4 is the mass of the test piece in air after drying.

Performance:

The change of mass of the test piece shall conform to the requirements in Clause No. 3.5.3.

Appendix B. Type test on protective coatings (see Clause No. 4)

Resistance to humidity test

Apparatus

The apparatus shall consist of a closed cabinet, in which the relative humidity is maintained at not less than 95% by cycling the temperature of a water bath continuously over a range from 42 ^{0}C to 48 ^{0}C, thereby ensuring that copious condensation occurs on the samples under test.

Method

The regulator shall be placed in a chamber at a temperature cycling between 42 ^{0}C and 48 ^{0}C and with a relative humidity exceeding 95% for 48 hours. The regulator shall then be removed from the chamber and examined with the naked eye for signs of corrosion, lifting or blistering of the surface. The regulator shall be left for 24 hours at an ambient temperature of 20 ^{0}C $\pm$ 5 ^{0}C and then examined again.

Performance

The decorative finish or surface shall conform to the requirements in Clause No. 4.

Appendix C. Type Tests on regulators (see Clause No. 6.2)

C.1 External soundness tests

Method:

The required air pressure is applied at both inlet and outlet connections of the regulator simultaneously; any leakage from the regulator is measured by a suitable flow indicator situated in the air supply.

The accuracy of measurement of pressure shall be ±2 %.

C.1.1 Complete regulator test

The complete regulator is mounted on the test equipment and pressurised to 165 mbar ±1 mbar. The leakage rate shall not exceed that specified in Clause No. 6.2.2.

C.1.2 Regulator test after diaphragm rupture

Any diaphragm which separates the gas-carrying compartment from the atmosphere shall be ruptured. Any support plate which obstructs the flow through the rupture shall be perforated so as not to restrict the air flow. O-rings, seals and gaskets shall not be removed during the test. The inlet and outlet of the regulator are pressurised to 100 mbar ± 1 mbar. The leakage rate shall not exceed that specified in 6.2.3.

C.2 Performance tests

C.2.1 Test setting conditions

Before carrying out the tests in C.2.2, C.2.3 and C.2.4 the regulator, with the diaphragm in the horizontal plane, shall be set to an outlet pressure of 22 mbar + 0.75 mbar / -0.25mbar, at an air flow rate of 1.5 m^3/h and at an inlet pressure of 30 mbar + 1 mbar.

C.2.2 Performance characteristics test

Method:

Air is supplied to the apparatus shown in Figure 2. Straight lengths of smooth bore pipe are used for connections to the regulator under test.

The accuracy of measurement of pressure and flow shall be ± 2%.

Performance

The performance of the regulator shall conform to Clause No. 6.2.4.

C.2.3 Lock-up test

Method

Air is supplied to the apparatus shown in Figure 3. For this test, item (8) shall be a vessel of 630 ml ± 10 ml (e.g., an E6 meter having an internal volume within this range.) The solenoid valve (12) is kept fully open during the test.

With the shutoff valve (5) open & the flow meter isolating valve (3) closed, the rate setting valve (13) is slowly closed in not less than 5s & the regulator is held under these conditions at constant temperature: Lock-up conditions shall be established within 10 min. At this time the flow meter isolating valve (3) shall be opened & shut-of valve (5) closed, and the leakage measured at the flow meter (4).

The accuracy of measurement shall be ±2%.

Performance

The lock-up characteristics of the regulator shall conform to Clause No. 6.2.5.

Appendix D. Mechanical life test (see 6.4)

Method

The regulator is placed in an ambient temperature of 40 ^{0}C $\pm$ 5 ^{0}C, with inlet and outlet connections open to the atmosphere, for 28 days. At the end of this period, the regulator is subjected to an accelerated mechanical life test at room temperature. The accelerated mechanical life test shall be so arranged that the diaphragms and valve pads operate in the normal mode and over the full stroke 5000 times at a rate of not less than 120 cycles/hour, with the diaphragm in the horizontal plane, and for a further 5000 times at the same rate with the diaphragm in the vertical plane.

Performance

After the test, the regulator shall satisfy the requirements of Clause No. 6.2.2, 6.2.4 and 6.2.5 and the diaphragms shall show no signs of perforation, cracking, permanent deformation or delamination.

Figure 1: Dimensions

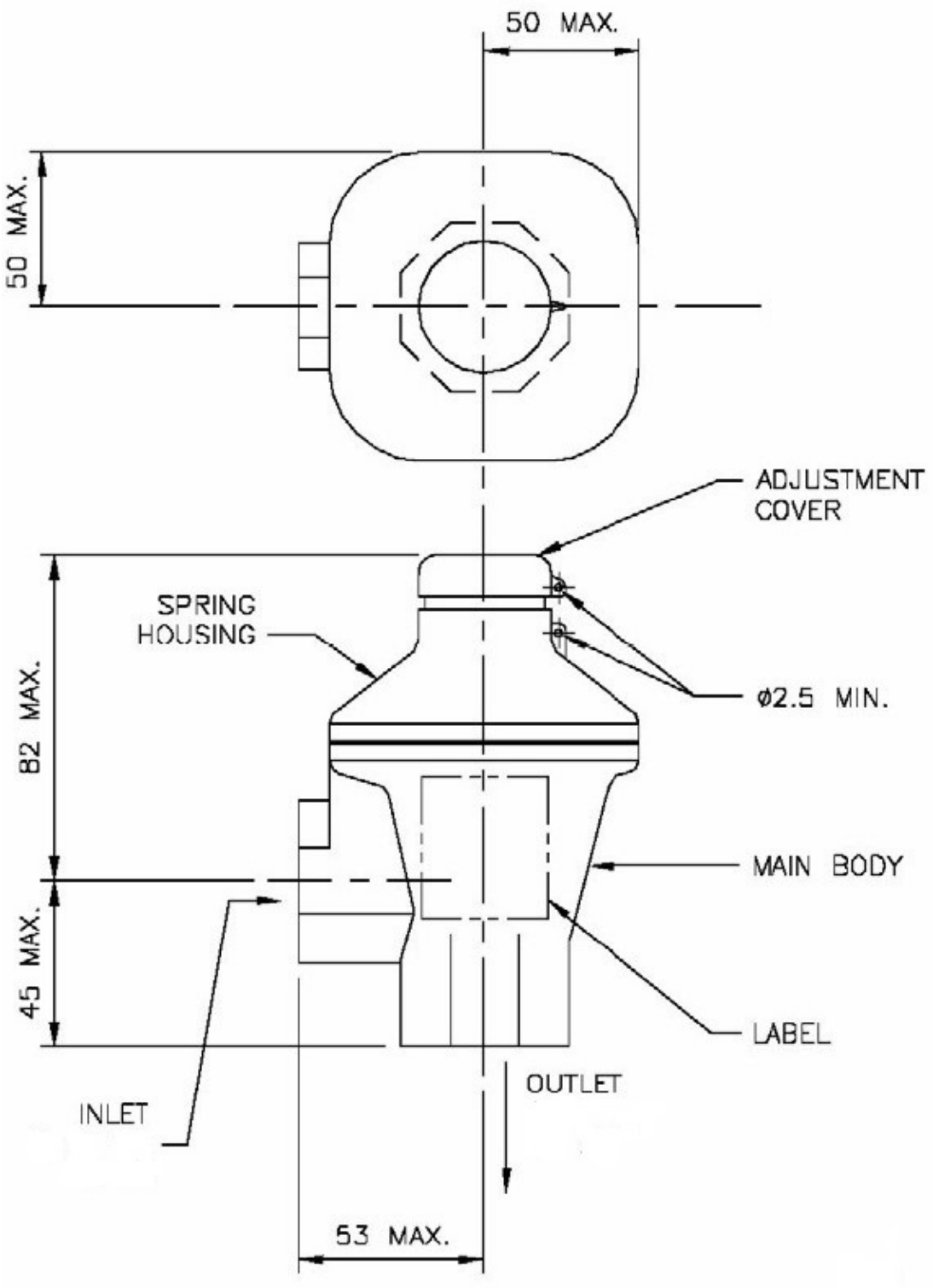
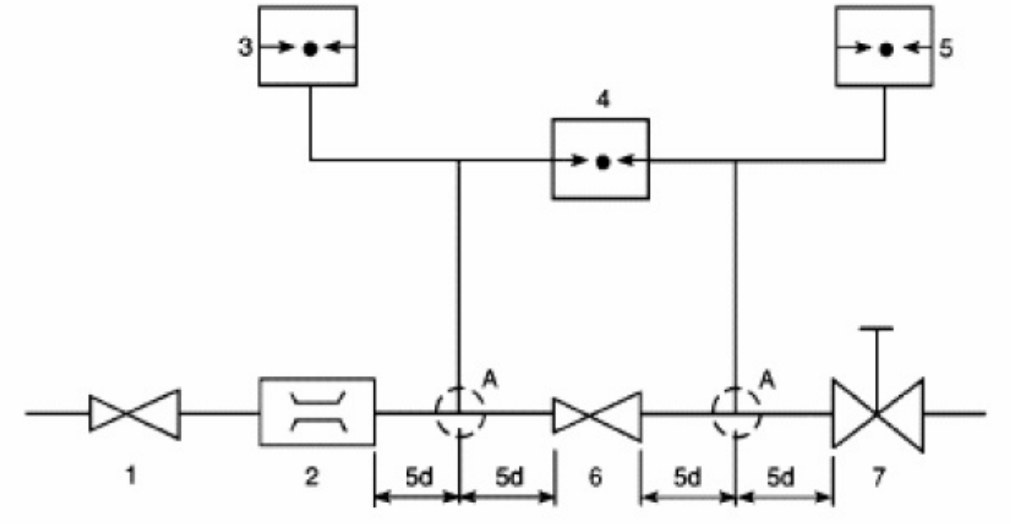


Figure 2: Performance characteristic test rig



d = 20 +0.5
-0

1. Adjustable regulator for inlet pressure
2. Flow meter
3. Inlet pressure gauge
4. Differential pressure gauge
5. Outlet pressure gauge
6. Regulator under test
7. Manual control valve

All dimensions are in mm.

Detail A

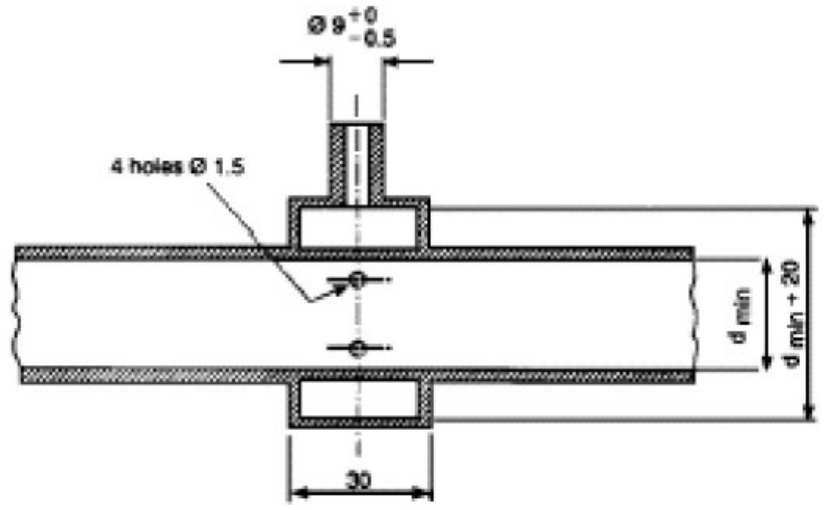
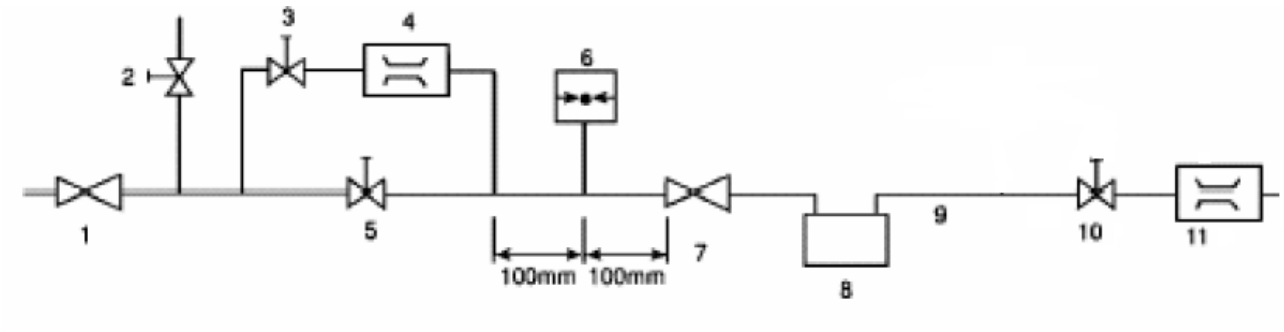


Figure 3: Lock-up test rig



NOTE - The flow meter (**11**) may be mounted upstream of the regulator under test.

1. Adjustable regulator for inlet pressure
2. Bleed point (to prevent lock-up of adjustable regulator)
3. Flow meter isolating valve
4. Sensitive flow meter, for lock-up test
5. Shut-off valve
6. Inlet pressure gauge
7. Regulator under test
8. Gas meter or vessel
9. 150 mm length of Ø 28 mm copper pipe to BS EN 1057
10. Rate setting valve
11. Flow meter.