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IGS

Iranian Gas Standards

مشخصات فنی خريد

رگولاتورهای گازطبیعی برای فشارورودی 5 تا 100 بار

Gas Pressure Regulators for Nominal Inlet Pressure 5 to 100 bar (72-1450 psig)

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دفتر مدیرعامل

ابلاغ مصوبه هیأت مدیره

مدیر محترم پژوهش و فناوری

باسلام،

به استحضار می رساند در جلسه ۱۳۷۱ مورخ ۶/ ۵/ ۱۳۸۸ هیأت مدیره، نامه شماره گ۹/۰۰۰/۵۱۰۶۳ مورخ ۸۸/۴/۲۴ آن مدیریت درمورد تصویب نهایی استاندارد تحت عنوان "رگولاتورهای فشار قوی گاز طبیعی با فشار ورودی ۵ تا ۱۰۰ بار" به شماره استاندارد IGS-IN-202(0):2009 مطرح و مورد تصویب قرار گرفت.

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شماره ۱۵۱۶۲

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1 Scope

This standard specification covers the minimum requirements for design, fabrication, testing, inspection, coating, marking, packing and packaging of gas pressure regulators:

- for nominal inlet pressures 5 to 100 bar ;
- used at an ambient temperature range from -29^{0}C to + 60^{0}C

Which operate with natural gas composition mixtures specified in(IGS-CH-033(0):2004).

This specification applies to regulators which use the pipeline gas as a source of control energy and can be used external sources as an additional option for the purpose of ON-OFF control. These regulators have no continuous discharge of gas into the atmosphere but temporary discharges from safety devices can occur.

This specification does not apply to:

- industrial process control valves ;
- regulators upstream from / on / in domestic gas – consuming appliances which are installed downstream of domestic gas meters

2 References (Normative)

Throughout this standard specification the following standards, codes and reports are referred to. The editions of these standards and codes that are in effect at the time of publication of this standard specification (2009) shall, to the extent specified herein, form 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.

2.1. BS EN 334:2005
Gas pressure regulators for inlet pressures up to 100 bar

2.2. IGS-CH-033(0):2004
Pipeline quality natural gas

2.3. API 5L
Specification for line pipe

2.4. ASTM A 105/A105M -05
Standard specification for carbon steel forgings for piping applications

2.5. ASTM A 193/A 193M - 08 b
Standard specification for alloy- steel and stainless steel bolting materials for high temperature or high pressure service and other special purpose applications .

2.6. ASTM A 194/A 194 M -09
Standard specification for carbon and alloy steel nuts for bolts for high pressure or high temperature service, or both.

2.7. ASTM A 216/A 216 M -08
Standard specification for steel castings, carbon, suitable for fusion welding, for high – temperature service

2.8. ASTM B 85/B 85 M -08
Standard specification for aluminum – alloy die castings

2.9. ASTM B 117-07
Standard practice operating salt spray (FOG) Apparatus

2.10. ANSI/ ASME B1.20.1 -1983(R2001)
Pipe threads, general purpose (Inch)

2.11. ANSI /ASME B1.1-2003
Unified inch screw threads, UN and UNR thread form

2.12. BS 381 C: 1996
Specification for colours for identification, coding and special purposes

2.13. BE EN ISO 2409:2007, BS 3900-E6:2007
Paints and varnishes .Cross – cut test
(BS EN ISO 2409:2007 replaces BS EN ISO 2409:1995, BS 3900- E6:1992 , which has been withdraw .)

2.14. ISO 1817:1999
Rubber, vulcanized – determination of the effect of liquids

2.15. ISO 48:1994
Rubber, vulcanized or thermoplastic determination of hardness (hardness between 10 IRHD and 100 IRHD)

2.16. ISO 37:2005
Rubber, vulcanized or thermoplastic – determination of tensile stress – strainproperties

2.17. ISO 815:1991
Rubber, vulcanized or thermoplastic – determination of compression set at ambient , elevated or low temperatures

2.18. ISO 1431-1:2004
Rubber, vulcanized or thermoplastic –resistance to ozone cracking

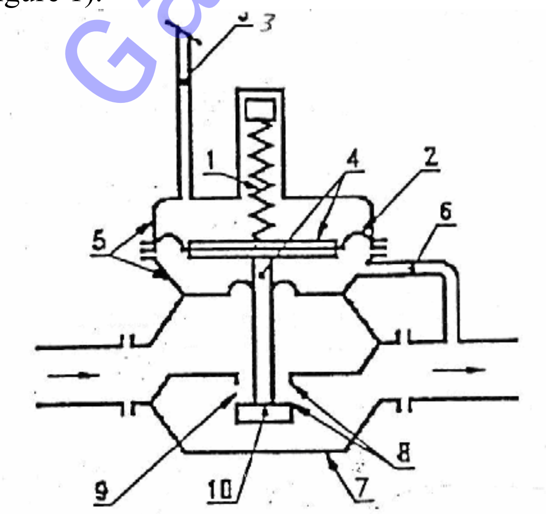
3 Definitions

3.1 Gas pressure regulator

Device which maintains the outlet pressure constant independent of the variation in inlet pressure and / or flow rate within defined limits.

3.2 Direct acting gas pressure regulator

Regulator in which the energy required to move the control member is supplied by the controller (see example in figure 1).



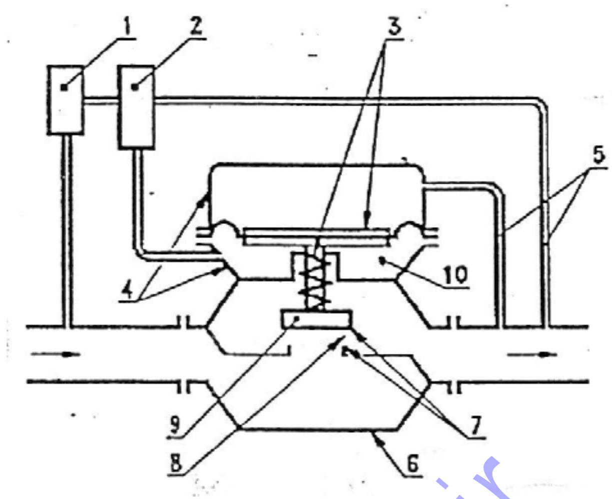
1 Setting element	6 Sensing line
2 Detector element	7 Regulator body
3 Breather / exhaust line	8 Valve seats
4 Actuator	9 Seat ring
5 Casing of actuator	10 Control member

1+2= Controller

Figure 1 : Example of a direct acting regulator

3.3 Pilot controlled gas pressure regulator (indirect acting)

Regulator in which the energy required to move the control member is supplied by a pilot (see example in figure 2).



1 Fixture
2 Pilot
3 Actuator
4 Casing of actuator
5 Sensing / process line
6 Regulator body
7 Valve seats
8 Seat ring
9 Control member
10 Motorization chamber

Figure 2: Example of a pilot controlled regulator

3.4 Fail open regulator

Regulator whose control member automatically tends to open when the main diaphragm fails or when the energy required to move the control member fails.

Note: The definition in this clause is based on typical control failure modes.

3.5 Fail close regulator

Regulator whose control member automatically tends to close when the main diaphragm fails or when the energy required to move the control member fails.

Note: The definition in this clause is based on typical control failure modes.

3.6 Regulator size, nominal inlet diameter

Nominal size of the inlet connection

3.7 Nominal outlet diameter

Nominal size of the outlet connection

3.8 Main components

Parts including normally: control member, regulator body, actuator, controller, pilot (only in pilot controlled regulators)

Note: The regulator might include additional devices such as a shut – off device, a monitor, a relief valve and other fixtures. The Figures 1 and 2 serve as examples.

3.9 Control member

Movable part of the regulator which is positioned in the flow path to restrict the flow through the regulator.
Note: A control member may be a plug, ball, disk, vane, gate, diaphragm, etc.

3.10 Body
Main pressure containing envelope which provides the fluid flow passageway and the pipe end connections .

3.11 Valve seats
Corresponding sealing surfaces within a regulator which make full contact only when the control member is in the closed position.

3.12 Seat ring
Part assembled in a component of the regulator to provide a replaceable seat.

3.13 Actuator
Device or mechanism which changes the signal from the controller into a corresponding movement controlling the position of the control member.

3.14 Casing of actuator
Housing of the actuator which may consist of two chambers under pressure.
Note: When the pressure in each chamber is different from atmospheric pressure, the chamber at the higher pressure is termed the "motorization chamber".

3.15 Controller
Device which normally includes:
- a setting element, normally a spring, to obtain the set value of the controlled variable ;
- a detector element, normally a diaphragm, for the controlled variable.

3.16 Pilot device which includes:
- A setting element to obtain the set value of the controlled variable;
- A detector element for the controlled variable;
- A unit which compares the set value of the controlled variable with its feedback value ;
- A system which provides the motorization energy for the actuator.

3.17 Main diaphragm
Diaphragm, the function of which is to detect the feedback of the controlled variable and / or the diaphragm provides the thrust to move the control member.

3.18 Pressure containing parts
Parts whose failure to function would result in a release of the retained fuel gas to the atmosphere which include bodies, control member , bonnets, the casing of the actuator, blind flanges and pipes for process and sensing lines .

3.19 Accessories
Parts or minor devices connected to the regulator.

3.20 Sensing and process lines
Lines which connect impulse points to the regulator.
Note: Sensing and process lines may be integrated into the regulator or external to the regulator. Those lines with no internal flow are termed "sensing lines"; those with internal flow are termed "process lines".

3.21 Breather line
Connection line between the controller and / or pilot and atmosphere to equalize the pressure on the detector element when it changes its position in normal operating conditions.
Note: In the event of a fault in the detector.

3.22 Exhaust line

Connection line between the regulator or its fixture and atmosphere for the safe exhausting of gas in the event of failure of any part.

3.23 Fixtures

Functional devices connected to the main components of the regulator (see 3.8)

3.24 Inlet pressure, P_u

Gas pressure at the inlet of the regulator.

3.25 Outlet pressure, P_d

Gas pressure at the outlet of the regulator.

3.26 Differential pressure, Δp

Difference between two values of pressure at two different points.

3.27 Standard conditions

Absolute pressure of 1,013 25 bar and temperature of 15.56 ^{0}C (288, 71 K $\cong$ 289K).

3.28 Gas volume

Volume of gas at standard conditions . It is expressed in m^3 .

3.29 Volumetric flow rate, Q

Volume of gas which flows through the regulator in unit time.
It is expressed in m^3/h at standard conditions.

3.30 Sound pressure level, L_{PA}

Sound pressure frequency weightings A in accordance with EN 61672-1.

3.31 Controlled variable, X

Variable which is monitored by the controlling process .

Note: In this document, only the outlet pressure "P_d" is considered as the controlled variable.

3.32 Disturbance variable, Z

Variables acting from outside on the controlling process. In the case of regulators with the outlet pressure as the controlled variable, disturbance variables are essentially.

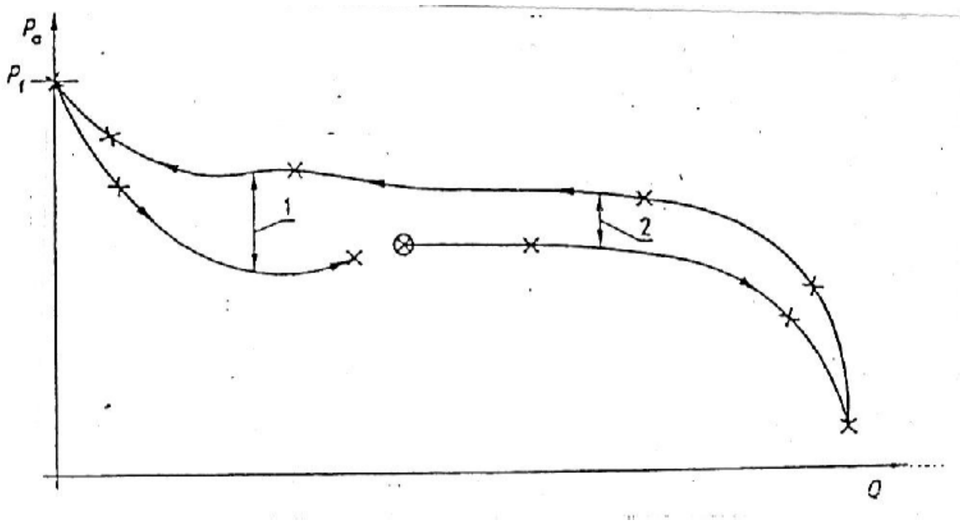
- Fluctuations in the inlet pressure, P_u ;
- Changes in the volumetric flow rate, Q.

3.33 Set point, P_{ds}

Nominal value of the controlled variable .
Note: the set point is not directly measurable but determined as shown in figure 4 .

3.34 Performance curve

Graphic representation of the controlled variable as a function of the volumetric flow rate.
Note: This curve is determined by increasing and then decreasing the volumetric flow rate with constant inlet pressure and set point (see figure 3)



1 Max. hysteresis band
2 Hysteresis band
⊗ Start setting
× Measured values

Figure 3: Performance curve (P_{ds} constant, P_u constant)

3.35 Accuracy
Average, expressed as a percentage of the set point, of the absolute maximum values of the positive and negative control deviation within the operating range.

3.36 Accuracy class, AC
Maximum permissible value of the accuracy.

3.37 Inlet pressure range, b_{pu}
Range of the inlet pressure for which the regulator ensures a given accuracy class. Note: The inlet pressure range is characterized by its limit values P_{umax} and P_{umin} .

3.38 Maximum accuracy flow rate
Lowest value of the maximum volumetric flow rate up to which, for a given set point and within the ambient temperature range specified , a given accuracy class is ensured :

- at the lowest inlet pressure (see figure 4) Q_{max}, P_{umin}
- at the highest inlet pressure (see figure 4) Q_{max} , P_{umax}
- at an intermediate inlet pressure between P_{umax} and P_{umin} (see figure4) Q_{max}, P_u

3.39 Lock – up time, t_f
Time taken for the control member to move from an open position to the closed position.

3.40 Lock – up pressure, p_f
Pressure that occurs at the measuring point of the controlled variable when the control member is in the closed position.
Note: The lock – up pressure corresponds to the outlet pressure at the volumetric flow rate Q = 0 in the performance curve (see figure 3). It results when the time taken for a change in volumetric flow rate from Q to zero is greater than lock- up time of the regulator.

3.41 Lock – up pressure class, SG

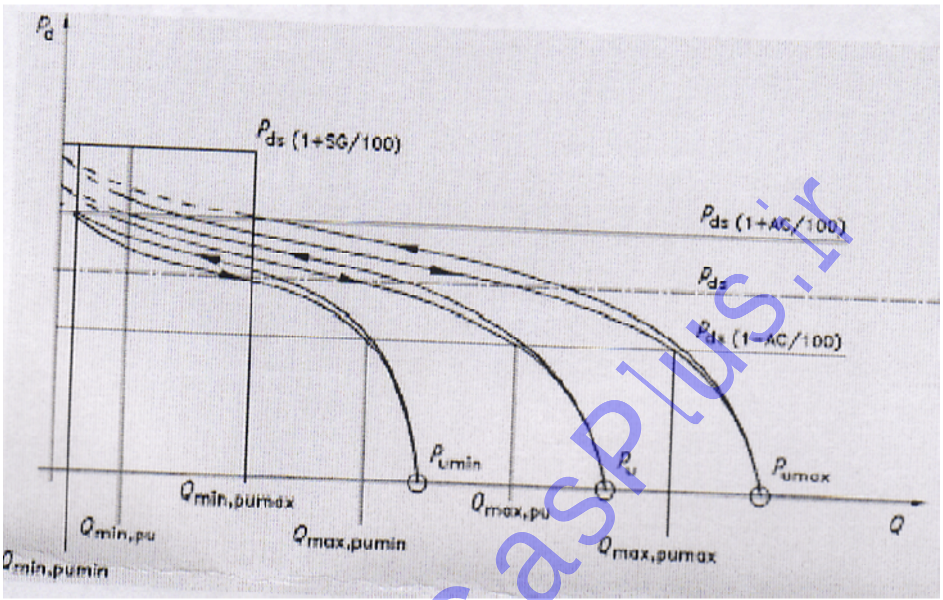
Maximum permissible positive difference between the actual lock –up pressure and the set point expressed as a percentage of the set point e.g .

$$SG = \frac{P_f - P_{ds}}{P_{ds}} .100$$

3.42 Minimum flow rate

The largest value of the minimum volumetric flow rate down to which , for a given set point and within the ambient temperature range specified , stable conditions are obtained :

- at the lowest inlet pressure (see figure 4) Q min , P_{umin}
- at the highest inlet pressure (see figure 4) Qmin, P_{umax}
- at an intermediate inlet pressure between P_{umax} and P_{umin} (see figure 4) Qmin , P_u



O= Q_{max} with the control member at the limit imposed by the mechanical stop

Figure 4: Family of performance curves indicating maximum accuracy flow rates and minimum flow rates (pds constant, stable conditions)

3.43 Lock – up pressure zone

Zone between the volumetric flow rate Q= 0 and minimum flow rate Qmin, P_u for each corresponding inlet pressure and set point (see figure 5)

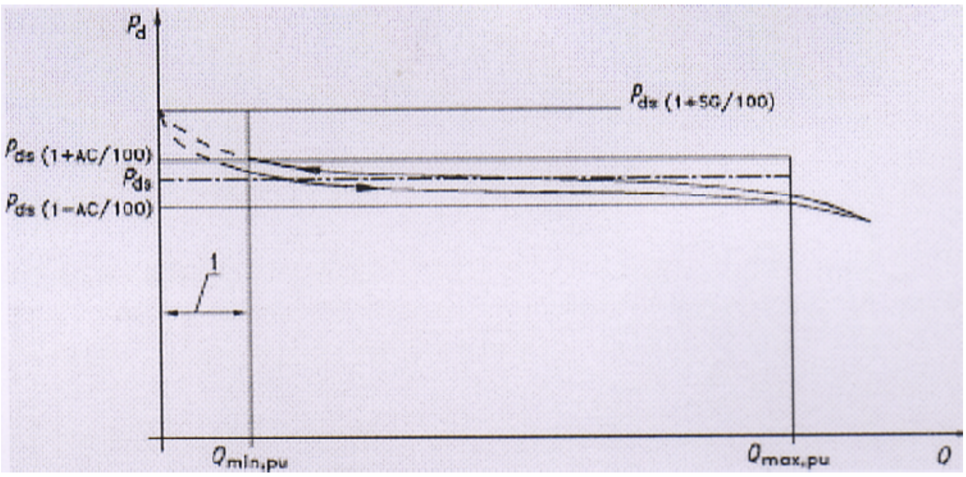
3.44 Class of lock – up pressure zone, SZ

Maximum permissible lock – up pressure zone for specified:

- inlet pressure P_u or inlet pressure range b_{pu} :
- set point P_{ds} or specific set range w_{ds} or set range w_d .

Which is expressed as the percentage of Q_{min} , P_u to Q_{max} , P_u , i . e .

$$SZ = \frac{Q\min, P_u}{Q\max, P_u}.100$$



Key
1 Lock-up pressure zone

Figure 5- Performance curve indicating lock – up pressure zone (stable condition)

3.45 Test pressure
Pressure applied to a section of the regulator for a limited period of time in order to prove certain characteristics .

3.46 Maximum inlet pressure, P_{umax}
Highest inlet pressure at which the regulator can continuously operate within specified conditions.

3.47 Permissible outlet pressure, P_{dmax}
Highest outlet pressure at which the regulator can continuously operate within specified conditions.

3.48 Maximum allowable pressure, PS
Maximum pressure for which the body and its inner metallic partition walls are designed in accordance with the strength requirements in this document.

3.49 Limit pressure, P_L
Pressure at which yielding becomes apparent in any component of the regulator or its fixtures.

3.50 Operating temperature range
Temperature range at which the regulator components and fixtures are capable of operating continuously.

3.51 Integral strength regulator
Regulator in which the pressure containing parts have a design pressure equal to the maximum allowable pressure PS.

3.52 Differential strength regulator
Regulator in which some of the pressure containing parts have a design pressure less than the maximum allowable pressure PS.

3.53 Designer
Company that designs and constructs regulating facilities and purchases high pressure gas regulator.

3.54 Manufacturer
Company that designs, manufactures sells and delivers high pressure gas regulator.

3.55 Operator

Company that operates high pressure gas regulator and performs normal maintenance.

3.56 Set range , W_d

Whole range of set points which can be obtained from a regulator by adjustment and/or the replacement of some components (i.e. replacement of the valve seat or setting element e.g. spring)

3.57 Specific set range, W_{ds}

Whole range of set points which can be obtained from a regulator by adjustment and with no replacement of its components .

3.58 Safety factor

Ratio of the limit pressure P_L to the maximum allowable pressure PS applied to :

- the regulator body : S_b;
- the other pressure containing parts of the regulator : S

4 Requirements

4.1 Design & Service Conditions

The regulator shall have easy moving parts without stresses and be constructed of quality materials in a workmanlike manner in order to attain gas tightness , stability of performance and sustained accurate regulation over a period of time and over the range of operating conditions with minimum of maintenance , when regulating natural gas . Such regulator shall have the general characteristics listed below:

4.1.1 The regulator shall be for outdoor installation and all its parts shall be resistant to atmospheric corrosion as well as the continuous attack of odorized natural gas & methanol.

4.1.2 The ambient temperature range for the regulator should be at a minimum -29^{0}C to 60^{0}C (-20^{0}F to 140^{0}F). This ambient temperature range applies to the regulator body with and without gas flow, pilot, sensing lines, etc.

4.1.3 Standard volume measured at 1.01325 BARA (14.696 PSIA) and 15.56^{0}C (60^{0}F).

4.1.4 The regulator shall fail to open / or close according to data sheet.

4.1.5 The regulator shall be so designed that externally tight and internally sealed .

4.1.6 In case of integrated (same body) safety devices i.e. gas safety shut – off devices and / or a monitor and specific safety devices in accordance with 4.1.6.1 shall be functionally independent from the regulator.

This requirement is met if the function of the regulator is not affected in the event of the failure of one or more of the following safety device components:

- closure member ;
- soft seat (of the seat ring);
- actuator ;
- casing of actuator;
- controller;
- pilot ;
- sensing and process lines

Further, when the integrated safety devices utilizes pipeline gas as a sorce of energy for its operation this shall be taken from upstream of the regulator.
When the integrated safety device is a slam shut device or a cut off device or a monitor, the motorization energy for regulator when a piloted controlled type, shall be provided by the gas downstream from the safety device .

4.1.6.1 Differential strength pressure regulator.
such regulators have pressure containing parts which in the event of a failure are protected from pressure reaching P_{umax} by specific safety devices e.g. relief valves , a vent tapping or a bleed via the sensing or process lines .
These pressure containing parts shall have the maximum pressure P_{max} reached in the event of a failure and the limit pressure P_L complying with the following requirement:
$P_L \geq S \times P_{max}$

4.1.6.2 Integral strength pressure regulator
Those parts subjected to inlet pressure under normal operating conditions, or those that become pressure containing parts in the event of a failure (casing of actuator, pilot, fixture, etc), shall have a limit pressure P_L and a maximum allowable pressure PS , complying with the following requirements:
$P_L \geq S \times PS \geq S \times P_{umax}$

4.1.7 End connections may be one of the following:
- Flanged connections in accordance with ANSI B 16.5 classes 150,300,600
- Flangeless type (wafer body) suitable for installation between 2 flanges according. To ANSI B 16.5
- Threaded connections females, NPT in accordance with ANSI/ASME B 1.20.1 (for class 150 and sizes up to and including 2").

4.1.8 The inlet and outlet connections of regulator shall be in – line. Direction of flow shall be permanently embossed on the valve.

4.1.9 The valve linkage shall be solid type, pivot pins or rivets so designed that they can not workloose in the assembled regulator.

4.1.10 Capacity shall be based on minimum inlet pressure and specified outlet pressure .

4.1.11 The regulator shall give 100% lock – up at times of no flow condition .

4.1.12 The outlet pressure of regulator shall not rise or fall more than 5% with:
1- Flow variation between zero and full capacity of regulator .
2- Inlet pressure variation between minimum and maximum.

4.1.13 For classes 150 and above , the type of regulator shall be pilot operated with flanged end connections confirming to ANSI/ASME B 16.5 , raised face , serrated finish and less than class 150 , the type of regulator should be spring loaded or pilot operated with screwed end connections , female , NPT according to ANSI/ASME B 1.201 or flanged end as above .

4.1.14 threading of all screws (except the adjusting screws), bolts and nuts shall be according to ANSI B1.1.

4.1.15 A dry type and replaceable filter with 3-5 micron cleaning capability shall be provided with pilot.

4.1.16 Loading spring for pilot shall be mounted and guided in such a manner as to prevent malfunctioning and shall be easily replaceable and protected against corrosion. Adjustment screw shall be protected against tampering by means of a suitable seal cap or cover.

4.1.17 Orifice and valve assembly shall be easily accessible .

4.1.18 The slots for closure member shall be identical in shape , size , positioning , high quality finish and precisions.

4.1.19 The closures member shall be undergo precision hardening treatment to achieve superior hardness and yield strength ensuring superior resistance to erosion , abrasion and wear .

4.1.20 At maximum capacity of regulator and maximum differential pressure across the regulator, noise level shall not exceed 85 dB. Test requirements according to section 5.2.9.

4.1.21 Regulator shall conform to accuracy ±2.5% set pressure within inlet pressure range.

4.1.22 Lock –up pressure
Maximum permissible positive difference between the actual lock – up pressure and the set point shall be 5% of set point.

4.2 Materials

4.2.1 Internal metallic parts shall be durably constructed of a corrosion resistant material such as stainless or corrosion resistant plated steel. Valve mechanism (such as orifice, valve stem, valve seat, closure , …) shall be stainless steel type 316. All metallic parts shall meet the requirement of salt spray test (section 5.2.10) .

4.2.2 Material of regulator valve body shall be at least cast carbon steel according to ASTM A 216 grade WCB or forged carbon steel according to ASTM A 105 or seamless pipe according to API 5L suitable for -29^{0}C to 60^{0}C ambient temperature .

4.2.3 Nuts, bolts and screws shall be steel according to ASTM A194 grade 2H, ASTM A193 grade B7 and ANSI B1.1 respectively.

4.2.4 All tubes and sensing lines shall be stainless steel type 316.

4.2.5 Pilot body material shall be at least cast carbon steel, according to ASTM A216 grade WCB or forged carbon steel according to ASTM A105 or die cast aluminum according to ASTM B85 or forged brass according to ASTM B283 grade C 37700.

4.2.6 Diaphragm shall be made of synthetic reinforced rubber material.

4.2.7 Non – metallic parts material of regulator such as diaphragm, sleeve, "0" rings, etc shall be resistant to odorized natural gas and not to reduce its service life or result in sluggish operation of unit at maximum and minimum temperature specified.
Test requirements for these materials shall be according to test item 5.2.11 of inspection, test and certification section.

5 Inspection, Tests & Certificates

5.1 <u>Inspection documents</u>

Prior to the shipment of each regulator to the designer or the operator, the manufacturer shall perform the specified tests and checks on the regulators. The results of all tests and checks performed shall be documented and reported.
This report shall include minimum the following items:
At least one copy of the complete report in form of electronic file with Pdf format or hard copy shall be sent to the designer or the operator and one copy retained in the manufacturer's files. The manufacturer shall ensure that the complete report is available to the operator for 10 years.

a. The name and address of the manufacturer
b. The name and address of the test facility
c. The model and serial number
d. The date (s) of the test
e. The name and title of the person (s) who conducted the tests
f. A written description of the test procedures
g. A descriptions of any variations or deviations from the required test conditions

5.2 <u>Tests</u>

5.2.1 Visual inspection

Visual inspection including checking of workmanship, coating, connection, internal parts, nameplate, packing, etc.
No apparent imperfection shall be observed.

5.2.2 Dimensional check

The dimensional checks are including the compliance of the regulator construction with the pertinent assembly drawing and the dimensional conformity of pressure containing parts with the applicable drawings.

5.2.3 Materials check

The verification of the material used shall be carried out by the review of material certificates and test reports (if requested by inspector) in compliance with this specification (section 4.2).

5.2.4 Hydrostatic test

All pressure containing parts of each regulator including those parts that may become pressure containing parts in the event of a failure, shall be pressure tested. The test shall be carried out according to the following table for 5 minutes. No leakage or permanent deformation shall be observed.

Pressure class	Min. test pressure (PSI)
150	425
300	1100
600	2175

Table 1: pressure values for the strength test

5.2.5 External leak test

The test shall be carried out at ambient temperature with air or gas at the test pressure according to the table 2 for at least 1 minute. No leakage shall be observed during the test.

Chambers subjected or that can be subjected to gas pressure

>outlet pressure ,Pa	≤ outlet pressure , Pa
Test pressure	
1.1 design pressure , P_d	1.2 max. set pressure , Pas

Table 2: pressure values in the external leakage test

5.2.6 Outlet pressure range test

The pilot of regulator shall be capable to adjust the outlet pressure between the required specified limit with minimum inlet pressure and flow rate which is determind by the manufacturer.

5.2.7 Performance test

5.2.7.1 General conditions

This test shall be carried out in accordance with EN 334:2005 item 7.7.7.1

5.2.7.2 Determination of the flow coefficients

The test shall be carried out in accordance with EN 334:2005 item 7.7.7.2

5.2.7.3 Accuracy class test

At different inlet pressures and capacities from minimum to maximum and set pressure, the regulator shall be tested to meet the accuracy class.

5.2.7.4 Between minimum and maximum inlet pressure with flow variation between minimum and maximum capacity of regulator, the outlet pressure shall be within accuracy class of regulator and remain constant without any fluctuation at any fixed situation.

5.2.7.5 Lock – up test

For adjusted regulator with maximum inlet pressure and no flow condition, the outlet pressure shall not rise more than 5% of the set pressure.

5.2.7.6 Droop test

For adjusted regulator with minimum inlet pressure and maximum capacity, the outlet pressure of regulator shall not dropt more then 5% of the set pressure.

5.2.7.7 Performance curve

The performance curve of regulator shall be plotted for passing flow from zero to maximum capacity of regulator at minimum and maximum inlet pressure. When flow is between zero and minimum capacity (Qmin.), the outlet pressure shall not exceed from lock – up pressure limit and when flow is between minimum and maximum capacity , the outlet pressure shall be within the accuracy class. The performance curve shall be smooth and without any fluctuation.

5.2.8 Ambient test

The regulator shall be installed in a suitable thermostatically controlled enclosure. To start the check, the test medium shall be brought to the relevant temperature.

The lock – up pressure under the following conditions shall be checked at the relevant temperatures:

- Max. inlet pressure /Min. outlet pressure
- Min. inlet pressure /Min. outlet pressure

The lock –up pressure at -20^0C limit temperature shall be 10% of set pressure.

At -29^0C the regulator shall operate without objectionable noise, malfunction, hunting, pulsation or chattering.

The lock – up pressure at other temperature (60^0C) shall be less than 5% of set pressure.

5.2.9 Sound level limitation test

The procedure for determining the sound level limitation test for regulator shall be according to EN 334 (methods for measuring the sound pressure level). The maximum . Noise level shall not exceed of 85 dB.

5.2.10 Coating test

Painting of regulator shall be checked as follows:

A: The color of paint shall be grey according to requirements as mentioned at "painting" section.

B: Thickness:

Thickness of paint shall be measured at five points on different sides of regulator. None of each individual point shall be less than 100 microns and difference between minimum and maximum measured values shall not exceed 20% of minimum of measured value.

C: Paint adhesion:

The test shall be done in accordance with BS3900 part E6 (2007) equivalent to ISO 2409(1992).

D: Salt spray test

All portion of the regulator exposed to the atmosphere shall be resistant to corrosion.

The coating shall withstand without blistering, peeling or under film corrosion for 500 hours salt spray test in accordance with ASTM B 117 carried out and certified by a national bureau of test and standard of the country of manufacturer. Salt spray test shall be carried out for all metallic parts of regulator such as body, levers, springs, pins, nuts, bolts, etc.

5.2.11 Non-metallic parts testing requirements (diaphragms, sleeves, "O" rings,…)

5.2.11.1 General

The non-metallic parts or components shall be homogeneous, free from porosity, inclusions, grit, blisters and surface imperfections visible with the naked eye, even after cutting.

5.2.11.2 Identification

The manufacturer name or trade marks, batch number and date of manufacture shall be indicated on the diaphragms, sleeves and prepared for "O" rings by manufacturer.

5.2.11.3 Hardness

When measured by the method described in ISO 48, the hardness of the test sample shall be within ±5 IRHD (International Rubber Hardness Degrees) of the nominal hardness declared by the manufacturer.

5.2.11.4 Tensile strength

The tensile strength shall be at least 9 MPa when tested according to ISO 37.

5.2.11.5 Elongation at break

The test shall be carried out according to ISO 37 and the result shall be minimum 200%.

5.2.11.6 Compression set

The compression set tests are carried out according to ISO 815 (type B test piece) under the following conditions and the results shall be expressed in percentage as specified :

- After 24 hour at 70 ^{0}C : 25%
- After 24 hour at -10 ^{0}C : 40%
- After 24 hour at -20 ^{0}C : 50%

5.2.11.7 Resistance to lubricants

The test shall be carried out according to ISO 1817:1999 clause 7.2 concerning the gravimetric method but the duration of immersion shall be (168±2) hr in oil No. 2 (IRM 902) (ISO 1817:1999) at the 70 ± 2^0C to determine the relative change of hardness and mass (△M) .
After this test, the change of hardness and mass shall be ±10 IRHD and between -10% and +15% respectively.

Calculate △M by using the following formula:

$$\triangle M = \frac{M_1 - M_0}{M_0} \times 100$$

Where:
M_0 is the initial mass of the test piece in air,
M_1 is the mass of the test piece in air after immersion
The test piece shall not show any sign of delamination , blistering or significant deterioration.

5.2.11.8 Hydrocarbon mixture test:
A- For diaphragms and sleeves:
When a test piece is immersed and allowed to swell freely in a mixture of toluene and heptane in the proportion 1:1 by volume at 20 ± 5^0C 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 piece, and the area shall not differ from the original area by more than 5%. The material shall not show any sign of delamination or blistering or significant deterioration.
Note 1: The volume ratio 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- For other rubber parts (such as "O" rings, …) :
The tests shall be carried out according to 8.2 of ISO 1817:1999 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) hr at (23 ±2) ^{0}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) hr in an oven at (40 ±2) ^{0}C atmospheric pressure
(C) Determine the relative change of mass, △M, with reference to the initial mass of the test piece, using the following formula:

$$\triangle M1 = \frac{M2-M1}{M1} \times 100$$

$$\triangle M2 = \frac{M3-M1}{M1} \times 100$$

Where:
M1 is the initial mass of the test piece in air,
M2 is the mass of test piece after immersion
M3 is the mass of the test piece in air after drying
After this test the change of mass (△M1, △M2) shall be as followings:

$(\triangle M1)\% = {}^{+10}_{-5}$ and $(\triangle M2)\% = {}^{+5}_{-8}$

The test piece shall not show any sign of delamination, blistering or significant deterioration.

5.2.11.9 Water test (for diaphragms and sleeves) :

When the test piece is immersed in distilled or deionized water and allowed to swell freely at $20 \pm 5^{0}C$ 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 or significant deterioration.

5.2.11.10 Accelerated ageing test:

A- For diaphragms:
The stiffness of the test piece of diaphragms shall be measured at $20 \pm 5^{0}C$, by torsion apparatus (APP. "F" of BS 4161: part 5:1996). The stiffness when remeasured at $20 \pm 5^{0}C$ shall not have increased by more than 25% after the test piece has been subjected to a temperature of $70 \pm 2^{0}C$ in an air- circulating oven for 4 weeks . In addition, the test piece shall not show any sign of delamination , blistering of significant deterioration .
B- For sleeves:
Changes in hardness, tensile strength and elongation at break shall be measured in accordance with clauses 5.2.11.3, 5.2.11.4, 5.2.11.5 at a temperature of $70 \pm 1^{0}C$ in an air-circulating oven for 168^{+0}_{-2} hr.

B-1 The change in hardness shall be ±10 IRHD.
B-2 The change in tensile strength shall be ±15 %.
B-3 The elongation at break shall be between -25 % and +10 % .

The test piece shall not show any sign of delamination , blistering or significant deterioration.
C- For other rubber parts (such as "O" rings, …) :
After the elastomer material has been subjected to a temperature of $70 \pm 2^{0}C$ in an air- circulating oven for 168 ±2 hr , the test piece shall not show any sign of delamination , blistering or significant deterioration .

5.2.11.11 Low temperature flexibility test:

A- For diaphragms:
The stiffness of the test piece of diaphragms shall be measured at $20 \pm 5^{0}C$ by torsion apparatus (App."F" of BS 4161: part 5:1990). The stiffness when measured at $-20 \pm 1^{0}C$ shall not have increased by more than 25% after the test piece has been subjected to this temperature in an environmental chamber for 20 minutes.
B- For sleeves:
The test piece shall be placed in chamber maintained at $-29 \pm 1^{0}C$ for 24 hr. The test piece shall have sufficient flexibility for its service and shall not show any sign of delamination , blistering or significant deterioration .
C- For other rubber parts (such as "O" rings, …) :
The elastomer material shall be placed in chamber maintained at $-29 \pm 1^{0}C$ for 1 hr.
The test piece shall have sufficient flexibility for its service and shall not show any sign of delamination , blistering or significant deterioration .

5.2.11.12 Porosity test (for diaphragms and sleeves) :

A- For diaphragms:
A test piece shall be located between the two halves of the test chamber and a pressure equal to max. Differential pressure across the diaphragms shall be applied to the under side of the test piece for 1 minute.
No evidence of leakage shall be observed.

B- For sleeves:

A test piece shall be located between the two halves of the test chamber and a pressure equal to 40 BAR for class 300 and 70 BAR for class 600 across the sleeves shall be applied to under side of the test piece for 10 minutes .

No evidence of leakage shall be observed.

5.2.11.13 Pressure test:

For diaphragms and sleeves , a test piece shall be located between the two halves of the test chambers and a pressure, equal to 60 BAR for class 300 and 105 BAR for class 600 shall be applied to under side of the test piece for 10 minutes .

No evidence of deformation, rupture shall be observed.

5.2.11.14 Diaphragms thickness:

The thickness variation of diaphragms on the same section shall not be grater than ±10%.

5.2.11.15 Resistance to ozone

Test sample shall show no cracks when measured in accordance with the method described in ISO 1431-1, with the following test criteria:

- Duration of test 48^{+0}_{-2} h ;
- Concentration of ozone: 25 ± 5 pphm (parts per hundred million);
- Test temperature: 40 ± 2 ^{0}C ;
- Relative humidity: 55 ± 10 %
- Elongation of test sample: 20 ± 2 %;
- View with 7 - fold magnification.

5.3 <u>Inspection & certificates</u>

5.3.1 Prior to delivery of the regulator , the manufacturer should make the following documents available for inspector's review : material , welding and NDE tests reports and certificates , pressure test reports , performance functional reports and certificates correlated to serial number and commodity compliance certificate (with NIGC purchase order requirements).

5.3.2 The regulators of each delivery will be inspected according to terms and conditions of purchase order for 5% random samples choosen by inspector of each item (minimum one sample) (unless otherwise specified by mutually agreed inspection procedure base on capacity and quantity of each delivery).

Required tests, inspection & checking at the inspection are as follow:

1. Visual inspection
2. Dimensional check
3. Material check (test reports should be traceable)
4. Hydrostatic test
5. External leak test
6. Outlet pressure range test
7. Performance test †
8. Ambient test †
9. Sound level limitation test †
10. Coating test †
11. Non – metallic parts material test †

٢. Manufacturer shall submit test certificates verified by a national beaure of test and standard institute and NIGC inspector may select the samples for these tests.

6 Coating

The external surface of the regulator shall be thoroughly cleaned by removing all rust and mill scale. Surfaces to be painted, shall be completely free from grease, grit and other foreign materials. Regulator shall be painted with organic zinc rich system according to following table or plated. Final colour shall be grey according to BS 381 C- NO .631 (RAL ……….)

Test requirements for painting and plating shall be in accordance with coating test (section 5.2.10).

Reference	Binder	Main pigent	Volume solids (nominal %)	Main pigment in total pigment (weight % min.)	Dry – film thickness (µm per coat minimum advised)	Additional information
DF	Two- pack epoxy	Zinc dust	35	95	50	Quality covered by BS 4652, type 3. Maximum of 75 µm recommended by spray for each layer. an initial prefabrication primer may be only 25 µm

Table 3: organic zinc – rich paints

7 Marking

7.1. General requirements

Each regulator shall carry markings containing at least the following data:

- Manufacturer and / or registered trade – mark;
- Regulator type;
- Serial number;
- Year of manufacture;
- Nominal size DN and class rating;
- Allowable pressure P_{zul} ;
- Permissible inlet pressure P_{emax};
- Specific set range;
- Ambient temperature range;
- Valve seat diameter;
- Maximum component operating pressure p_{max} of chambers safeguarded (for "differential strength regulates" only);

The flow direction shall be marked clearly and permanently on the body by an arrow.
If a nameplate is used it shall be permanently legible and attached at a clearly visible place.
The technical details listed above shall be repeated in operating instructions.

7.2. Markings for the various connections

Each connection shall be marked in terms of:

- Function, e.g. breather line, exhaust line;
- Minimum nominal size for the pipe work concerned.

7.3. Marking of built – in safety devices

The safety devices shall be marked according to the relevant standard.
These inscriptions must be directly visible, easily legible and indelible under the normal condition of use of the regulator.

8 Packing and packaging

A- Each regulator shall be put in a plastic bag with all openings such as inlet, outlet covered, by plastic caps.

B- Each regulator in plastic bag shall be housed in wooden support.

C – The wooden supports shall be housed in wooden cases according to NIGC packing instructions under protection, packing, marking and dispatching.

9 Documentation

9.1 With technical quotation:

The manufacturer is required to complete, sign and submit the attached data sheet (s) and as well as 2 sets of the following documentation in English together with technical quotation.

All documentation should be dated.

9.1.1. A description of the regulator, giving the technical characteristics and the principle of its operation.

9.1.2. A perspective drawing or photograph of the regulator

9.1.3. A nomenclature of parts with a description of constituent materials of such parts.

9.1.4. An assembly drawing with identification of the component parts listed in the nomenclature.

9.1.5. A dimensioned drawing

9.1.6. A drawing showing the location of verification marks and seals

9.1.7. A dimensioned drawing of metrologically important components

9.1.8. A drawing of the data plate or face plate and of the arrangements for inscriptions

9.1.9 A drawing of any auxiliary devices

9.1.10. Instructions for installation, operation, periodic maintenance and trouble – shooting

9.1.11. Maintenance documentation including third – party drawings for any filed repairable components.

9.1.12. Documentation that the design and construction comply with applicable components safety codes and regulations

9.1.13. A list of the documents submitted

9.1.14. Recommended two years parts list

9.1.15. Manufacturer standard (informative)

9.2. After receipt of order

The manufacturer should furnish specific regulator outline drawings, including overall flange face – to – face dimensions, inside diameter.

The manufacturer should provide a recommended list of spare parts.

10 Guarantee:

10.1. Manufacturer shall guarantee the compliance of material and performance of the supplied equipments with this specification.

10.2. The guarantee period shall be one year after equipments goes on stream or 24 months from date of shipment, whichever occurs first.

10.3. Supplier should agree to repair on site or replace any part, equipment or unit which proves to be defective during the above mentioned period free of charge.

11 Appendix

DATA SHEET [(1)]

To be filled by purchaser	**To be filled by manufacturer / supplier**
Inquiry No:	Quotation No. :
Item No:	Item No:
Inquiry Date :	Quotation Date :
NIGC Standard : IGS-M-IN-202 (DRAFT) :2008	Catalogue No. :
The data sheet is provided by	Manufacturer ☐ supplier ☐

	Subject	**To be filled by purchaser**	**To be filled by manufacturer**
General	Tag No.	________	....
	Application	....	________
	Upstream / down stream Line size (IN)	....	________
	Model No.	________	....
	P&ID(Attached)	To be provided by purchaser	To be sent comment if any

Manufacturer signature and stamp:

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(1)This data sheet is an integrated part of STD.NO.IGS-M-IN -202 (0):2009 and should not be used separately.

	Subject	To be filled by purchaser	To be filled by manufacturer
Process data	Fluid	Natural Gas	________
	Max. capacity at min. inlet pressure and outlet set pressure (SCM/H)	Max. : ……………..	Max. : ……………..
	Operating pressure (barg)	…………….	
	Design pressure (barg)	________	…………….
	Gas inlet pressure (barg)	Min.: ……… Max. : ………...	Min. : ……… Max. : ………...
	Outlet pressure (barg)	…………….	…………….
	Set pressure (barg)	…………….	…………….
	Lock –up pressure at max. inlet pressure (barg)	…………….	…………….
	Gas inlet temperature (C^0)	Min.: -10 Max. : +45 Otherwise please specify	Min . : ……… Max. : ………...
	Design temperature (C^0)	________	…………….
	Ambient temperature (C^0)	Min.: -29 Max. : 60	Min.: ……… Max. : ………...
	Specific gravity	…………….	________
	Standard condition	1.01325 bara & 15.56 ^{0}C (14.696 PSIA& 60^{0}F)	Yes☐ No☐

Manufacturer signature and stamp:

	Subject	To be filled by purchaser	To be filled by manufacturer
Regulator data	Type	Axial ☐	Yes☐ No ☐
		Conventional pilot operated ☐	Yes ☐ No☐
		Conventional spring loaded ☐	Yes ☐ No☐
		Others(*) ☐	Yes ☐ No☐
	Fail safe design	Regulator fail to open ☐	Yes ☐ No☐
		Regulator fail to close ☐	Yes ☐ No☐
	Built-in safety shut- off valve	Required ☐ Not required☐	Is equipped☐ not equipped ☐
	Size (IN)	_______	…………….
	Class rating	ANSI Class …..	ANSI Class ……..
	Connection type	Flanged end ☐	Yes ☐ No ☐
		Flangeless ☐	Yes☐ No ☐
	Valve body material	carbon steel according To ASTM A216 grade WCB☐ or	Yes ☐ No(*)☐
		Forged carbon steel according to ASTM A 105 ☐ or	Yes ☐ No(*)☐
		Seamless pipe according to API suitable for -29^0C to 60^0C ambient temperature ☐	Yes ☐ No(*)☐
	Internal metallic parts Material	Corrosion resistant material such as S.S ☐ or	Yes ☐ No(*) ☐
		Corrosion resistant plated steel ☐	Yes ☐ No(*) ☐
	Valve mechanism material	S.S type 316	Yes ☐ No(*) ☐
	Bolt & nut	According to ASTM A 194 and ASTM A 193	Yes ☐ No (*) ☐
	Pilot body material	Carbon steel according to ASTM A 216 grade WCB ☐ or	Yes ☐ No(*) ☐
		Forged carbon steel according to ASTM A 105☐or	Yes ☐ No(*) ☐
		Die cast aluminum according to ASTM B85 ☐or	Yes ☐ No(*) ☐
		Brass according to ASTM B 283 grade C 37700☐	Yes ☐ No(*) ☐

Manufacturer signature and stamp:

	Subject	To be filled by purchaser	To be filled by manufacturer
Regulator data	Internal non - metallic parts	Rubber or plastic material resistant to odorized natural gas	Yes ☐ No ☐
	Sensing line material	S.S Type 316	Yes ☐ No ☐
	Pilot type / model	________	…………….
	Pilot connection (sensing line)	________	Internal connection ☐ External connection ☐ Others ☐
	Pilot spring range (barg)	________	…………….
	Pilot setting (barg)	________	…………….
	Optional accessory	________	Filter ☐ Others (*) ☐

Manufacturer signature and stamp:

Supplier remarks on tests , certificates , guarantee acc. to section 5	Subject	To be filled by purchaser	To be filled by manufacturer
	Visual inspection	For the samples selected by inspector	Yes ☐ No ☐
	Dimensional checks	For the samples selected by inspector	Yes ☐ No ☐
	Materials check : - Valve body Regulator - Pilot body - Internal metallic parts - Valve mechanism - Rubber parts material diaphragm "O" ring, sleeve ….	Test certificate	Yes ☐ No ☐
	Spring range test	For the sample selected by NIGC inspector	Yes ☐ No ☐
	Hydrostatic test	Required for each regulator	Yes ☐ No ☐
	External leak test	Required for each regulator	Yes ☐ No ☐
	Outlet pressure range test	Required for each regulator	Yes ☐ No ☐
	Performance test	Type test (**)	Yes ☐ No ☐
	Accuracy class test	Type test (**)	Yes ☐ No ☐
	Ambient temperature test	Type test (**)	Yes ☐ No ☐
	Sound level limitation test	Type test (**)	Yes ☐ No ☐
	Salt spray test	Type test (**)	Yes ☐ No ☐
	Coating test	For the samples selected by NIGC inspector	Yes ☐ No ☐
	Guarantee	24 Months after shipment or one year after putting in service whichever occurs first	Yes ☐ No ☐

(*) Please specify

(**) Manufacturer shall submit test certificates verified by a national beaure of test and standard institute and NIGC inspector may select the samples for tests.

Manufacturer signature and stamp: