IS 15729 (2007): Natural gas pressure regulating and metering terminal - Code of practice [MED 17: Chemical Engineering Plants and Related Equipment]

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प्राकृतिक गैस दाब रेगुलेटिंग और मीटरिंग टर्मिनल — रीति संहिता

Indian Standard

NATURAL GAS PRESSURE REGULATING AND METERING TERMINAL — CODE OF PRACTICE

ICS 75.200

BUREAU OF INDIAN STANDARDS
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Price Group 8

Chemical Engineering Plants and Related Equipment Sectional Committee, ME 17

FOREWORD

This Code was adopted by the Bureau of Indian Standards, after the draft finalized by the Chemical Engineering Plants and Related Equipment Sectional Committee had been approved by the Mechanical Engineering Division Council.

The transportation and distribution of natural gas through cross-country pipelines are the major business of the oil and gas companies. It was felt that pipeline supplies were rapidly being laid to feed distribution systems for various users and that there was a need for a document embodying recommendations to ensure the utmost reliability and continuity of supply at pressures that are acceptable to and safe for the downstream pipeline or distribution system. Assistance has been derived from IGE/TD/13 'Pressure regulating installations for transmission and distribution systems' covering installation with inlet pressures between 0.7 to 10.0 MPa.

Considering the importance of metering, regulation, data acquisition and safety of gas transmission, this Code for regulating stations has been prepared.

This Code does not restrict the use of new and better techniques developed and proved in due course of time.

The composition of the Committee responsible for the formulation of this standard is given in Annex D.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be same as that of the specified value in this standard.

Indian Standard

NATURAL GAS PRESSURE REGULATING AND METERING TERMINAL — CODE OF PRACTICE

1 SCOPE

This Code covers the commissioning, operation and maintenance and safety aspects of natural gas pressure regulating and metering terminal.

This standard shall be used in conjunction with IS 15677.

2 REFERENCES

The standards listed in Annex A contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated at Annex A.

3 TERMINOLOGY

3.1 Cathodic Protection (CP) — A method of protecting a metallic pipeline/structure from corrosion by making it a cathode so that direct current flows on to the pipeline/structure from the surrounding electrolytic environment.

3.2 CP Related Terminology

3.2.1 *Insulating Flanges* — Flanges which permit mechanical continuity but break the electrical continuity.

3.2.2 *Isolating Joint* — Electrically insulating component such as monoblock insulating joint, insulating flange, isolating coupling, etc, inserted between two lengths of pipeline/structure to prevent electrical continuity between them.

3.3 Closing Time — The time taken by a slam-shut valve between commencing and completing the closing action of its internal valve element.

3.4 Creep (as Applied to Gas Control Equipment) — The minor leakage volume of gas which a regulator or other control unit may be unable to contain in its nominally closed state.

3.5 Creep (as Applied to Polymeric Material) — The phenomenon of growth or displacement of the material resulting from applied stress, aging or other factors.

3.6 Dead Time — The time taken by a slam-shut valve to sense a pressure signal.

3.7 Gas

3.7.1 *First Family Gas* — Gas of Wobbe number 24.4 to 28.8 MJ/m^3 commonly known as 'town gas'.

3.7.2 *Second Family Gas* — Gas of Wobbe number 48.2 to 53.2 MJ/m^3 commonly known as 'natural gas'.

3.8 Holiday — A flaw in the protective coating of a pipe or component which may expose the underlying surface.

3.9 Impulse — The pressure sensed at the selected point in the gas stream.

3.10 Lower Flammable Limit (LFL) — The concentralation of flammable gas, vapour of mist in air above which combustion can be sustained.

This term may be considered equivalent to the term 'Lower Explosive Limit' (LEL).

3.11 Non-destructive Testing (NDT) — Testing of pipework and components by methods, such as radiography, ultrasonic and magnetic crack detection etc, that are not destructive.

3.12 Pig — A device which can be propelled through a pipeline by fluid pressure, used for various purposes, for example, cleaning, swabbing, inspection, etc.

3.13 Pig Trap — A vessel connected to the end of a section of pipeline, having a breech loading/unloading arrangement for launching and receiving pigs.

3.14 Pressure Related Terminology

3.14.1 *Design Pressure* — The design pressure should be higher than the maximum pressure to which the system could be subjected during operation. The value selected as the design pressure should take account of any foreseeable overpressure condition, particularly where this is coincident with adverse temperature and/or fatigue conditions and of the performance of any overpressure protection devices in the system.

3.14.2 *Maximum Working Pressure (MWP)* — The maximum pressure to which a pipe or component may be subjected in normal operation.

3.14.3 *Test Pressure* — The pressure to which components or complete installations are subjected for acceptance purposes.

3.15 Regulator Related Terminology

3.15.1 *Regulator* — A device whose function is to automatically control pressure or volume flow at a selected point in a gas stream.

3.15.2 *Pressure Regulator* — A regulator which maintains a preset constant pressure at a point on its outlet.

3.15.3 *Volumetric (Constant Volume) Regulator* — A regulator which maintains a preset constant rate of volume flow irrespective of inlet pressures.

3.15.4 *Monitor/Active Regulation* — An arrangement of two regulators in series whose pressure settings are stepped so as to allow one regulator (active) normally to control the outlet pressure and the other (monitor) to assume control in the event of failure of the active unit towards the open position.

3.15.5 *Pilot Control* — A subsidiary regulating mechanism that generally employs the pressure upstream of the main regulator or other control unit as a power source to exert control over the main regulator.

3.15.6 *Size of a Regulator* — Size of the regulator is defined as the nominal diameter of the regulator's inlet connection.

3.15.7 *Capacity of a Regulator* — The maximum volume flow which a regulator will pass at given inlet and outlet pressure under specific gas measurement conditions for which the regulator is designed whilst maintaining stable control of that flow.

3.15.8 *Rangeability of a Regulator* — The ratio of the maximum capacity of regulator to the minimum capacity. The maximum capacity can usually be obtained from the manufacturer's catalogue, making due allowance for the specific gravity of the gas handled and the pressure recovery appropriate to the particular installation. The minimum capacity is that volume flow down to which the regulator is designed to maintain stable control.

3.15.9 *Repeatability of Actuation* — The limits of deviation from pressure set point within which a slam-shut valve is able, repeatedly without failure, to actuate closure from its normally open state.

3.15.10 *Dynamic Performance* — The transient behaviour of a regulator in controlling pressure or flow following deviation from set-point.

3.15.11 *Trim* — A term embracing the internal flow control elements within the body of a regulator, valve or other control unit.

3.15.12 *Lock-Up* — The act of closure of a regulator when gas demand falls to zero.

3.15.13 *Wicking* — A term used to describe the escape of gas within a pressurized, fabric-reinforced rubber diaphragm when the leakage path is along the fabric interstices.

3.15.14 *Relief Valve (Relief Regulator)* — A valve or regulator incorporated to protect a system, or a component part thereof, against excessive pressure. Its function is to vent, usually to atmosphere, when a pre-determined pressure is attained.

3.16 Slam-Shut Valve — A valve that is designed to close quickly in the event of an abnormal (usually excess) pressure being detected at a selected point in a gas stream.

3.17 Thermowell — A metal pocket protruding into the gas stream to house a temperature-measuring device.

4 PLANNING, LAYOUT AND SECURITY

Any natural gas pressure regulating and metering terminal must be designed, located, constructed and operated taking into consideration the safety and environmental requirements of applicable legislation.

4.1 Planning

Consideration should be given to the layout and other uses of the station, for example, gas storage, the need for security of the station and any housing for the natural gas pressure regulating and metering.

Consideration should be given to the possibility of flooding and, in the case of an underground installation, the likelihood of a rising water table.

4.2 Station Location

When selecting the location for a natural gas pressure regulating and metering, care should be taken to avoid the following:

a) Proximity to residential properties or areas that may be subject to residential development;
b) Proximity to tall buildings where eddy currents around the building may cause problems with gas dispersal;
c) Positioning the natural gas pressure regulating and metering beneath or close to overhead power lines; and
d) Vulnerable sites where traffic accidents, etc, could result in damage to the natural gas pressure regulating and metering.

4.3 Station Layout

4.3.1 The area of the station should be adequate to accommodate the equipment and provide access for maintenance purposes and/or the location of emergency facilities, for example, fire extinguishers.

NOTE — It is desirable to provide hard access up to and within the station to accommodate maintenance and emergency service vehicles.

4.3.2 An emergency exit should be provided, if appropriate.

4.3.3 Vulnerable pipework or equipment should be protected, where necessary.

4.3.4 Any hazardous area should be taken into account when determining the station boundary.

4.3.5 The combustion air intake of any gas heater or other burner equipment should be located so as to minimize any hazard arising from any source of gas leakage or emission, for example, from a filter, relief valve vent, etc.

4.3.6 Consideration should be given to:

a) access for pigging operation and equipment,
b) minimizing noise,
c) access for maintenance activities,
d) excess for fire fighting, and
e) gas detection.

NOTE — Where gas is not odorized, enhanced arrangements may be needed, such as prominent notices and/or additional detection equipment.

4.4 Station Security

4.4.1 Any station should be secured against entry by unauthorized persons.

4.4.2 If a station security fence is used, equipment should be sited at a sufficient distance from the fence to prevent interference from outside.

4.4.3 Consideration should be given to the provision of a locking device for valves, including auxiliary valves located external to a natural gas pressure regulating and metering housing.

4.4.4 Consideration should be given to installing intruder detection devices.

4.4.5 Where the presence of vehicular traffic could cause a hazard, the use of safety barriers should be considered.

4.4.6 Prominent signs should be displayed, prohibiting smoking and other ignition sources.

4.4.7 A permanent notice should be displayed clearly, showing an emergency telephone number which may be used by the public or others.

5 COMPONENTS OF NATURAL GAS DESPATCH TERMINAL

The natural gas terminal shall generally include:

a) Two or more high pressure inlet filters with suitable valves and connections to permit design throughput to be maintained with one unit out of action.

b) Means to avoid the entrapment of liquids in the gas entering a pressure regulator and if necessary, suitable provision made for their removal.

   It is particularly important that the gas supply to valve control instruments should be free of liquids and dust and suitable filters/separators shall be installed as appropriate.

c) Two or more streams of pressure regulators, each stream to contain at least one pressure regulator. For critical installation, consideration may be given for one monitor and one active regulator in each stream. Where the installation is not a big gas despatch terminal, consideration may be given to the provision of a single stream of pressure regulators only.

d) Upstream slam-shut valves shall be fitted on all streams of pressure regulators.

e) Installations should be designed to withstand maximum inlet pressure conditions to be at metering station. Where this is not reasonably practicable, the design should include inter-stage relief valves in each stream where more than one stage, if pressure reduction is involved. Such relief valves should be at least of sufficient capacity to offset the effects of gas passing due to failure of regulators to 'lock-up' at times of no flow.

   Protection may also be afforded by providing an auxiliary trip switch for the slam-shut valve referred to in (d) above.

f) In certain circumstances failure of a pressure reduction installation to 'lock-up' at periods of low flow may cause the normal working pressure of the system into which it delivers to be exceeded, the use of a relief valve and vent of sufficient capacity to offset this failure to lock-up may be considered, if the operation of the slam-shut system is unacceptable.

g) It is necessary to consider whether pre-heating of the gas is required to avoid unacceptably low temperature in the downstream pipe network and auxiliary systems due to pressure reduction. If heaters are installed then they shall be controlled in such a way as to avoid high gas temperature which may damage any seal, diaphragm or valve seat in equipments like regulators, meters, relief valves, etc.

To meet the above requirement the main components of natural gas terminals are as follows:

a) Gas filtration system;
b) Gas heating system;
c) Pressure regulators;
d) Pressure relief valves, vent and drains;
e) Valves and actuators;
f) Slam shut valves;
g) Thermowell;
h) Meter and associated piping;
j) Electrical system; and
k) Supervisory control and data acquisition system.

NOTE — The applicable aspects of EN 12186 may be used as reference for functional requirements of gas pressure regulating stations and their operation, maintenance and safety recommendations.

5.1 Gas Filtration System

Filters, scrubbers and separators or composite units should be installed on the inlet of gas Despatch terminal to clean the gas to a standard required for satisfactory operation of the downstream equipments.

Certain filter elements shall withstand high differential pressures which could be sufficient to shut off the supply of gas through the installation. In some cases such conditions could not be tolerated and alternative types of filters with internal components designed to collapse and/or relieve high differential pressures may be preferred; the selection of downstream equipment should therefore take account of the choice made.

The filter shall be so designed that the desired degree of filtration is achieved in the normal operating conditions. Maximum pressure loss across the inlet/outlet flanges of filter shall not be more than that specified in process parameters of product data sheet.

The filter element shall be suitable for any reverse flow of gas. Filter design shall be such that only the element itself shall require replacement when blocked/chocked.

The end closure should be such that filter element could be accessed.

5.1.1 The design of the filter assembly shall take into account the following:

a) Ease of replacement of basket (for example the baskets should be bolted to a support ring).
b) If welded to the pressure shell, the basket support ring shall be of such a design as to avoid shrinkage stress (for example, segment construction), with a suitable gasket arrangement to prevent bypass.
c) Horizontally positioned baskets shall be adequately supported. Baskets of cantilever design are not acceptable.
d) All baskets/elements shall be designed to withstand the effects of any vibration under all operating conditions.

5.1.1.1 The recommended differential pressure before cleaning or changing and the maximum differential pressure which the element can withstand before collapse shall be specified by the filter manufacturer in the data sheet.

5.1.1.2 The filter body shall be provided with supports when specified in the data sheet. In case saddle type supports are provided, these shall be either welded to the body or of the loose clamp type. Supports shall make designed displacement in either direction in addition to full axial movement to allow for movement of the pipework.

5.1.1.3 Vent and drain connections shall be provided on the body of the filter. Unless otherwise specified, different pressure tappings shall also be provided on the body.

5.1.1.4 All flanges shall be fitted so that their bolt holes are off the vertical and horizontal centre line.

5.1.2 *Mechanical Design*

5.1.2.1 The design pressure for the filter shall be as desired by the buyer and same shall be stated in the data sheet.

5.1.2.2 For the ambient temperature range of –20° to 50°C, the lower design temperature for the determination of impact properties of metallic materials shall be taken as –10°C. For other operating temperature ranges, the lower design temperature shall be as stated by the buyer.

5.1.2.3 The design pressure shall be such that during the hydrostatic pressure test, the design stress shall not exceed 90 percent of the specified yield stress.

5.1.3 *Manufacturing, Inspection and Tests*

5.1.3.1 All flanges left for connection by others shall be square to the centre line of the vessel within 0.25 mm/100 mm of flange outside diameter.

5.1.3.2 The peripheries of the flanges shall be machined within the following tolerances:

a) Up to and including 200 mm nominal size : ±0.5 mm
b) Greater than 200 mm nominal size : ±1.0 mm

5.1.3.3 The completed vessel, including the end closure, shall be pressure tested hydrostatically.

5.2 Gas Heating System

Due to reduction in pressure across the control valve/ regulator, the temperature of gas reduces, it may be necessary to install pre-heaters to avoid unacceptable low temperatures on the outlet of pressure reduction equipment. Generally it is not necessary to provide pre-heater where differential pressure across the installation is less than 1.5 Mpa.

In establishing a requirement for the provision of pre-heating of gas, the aspects to be seen are as under.

The ability of the downstream pipe material to retain satisfactory physical characteristics at any reduced temperature of operation.

The possibilities of hydrate or liquid formation which may influence the operation of the equipments.

The possibility of frost formation due to frozen ground around buried outlet pipe.

The effective operation of any gas conditioning process.

The number of heaters and their capacity should be determined having regard to the probability of failure of unit occurring simultaneously with a period of extreme demand. If this possibility is low then the provision of standby heater capacity to meet the extreme condition may not be necessary.

Consideration should be given to the reliability of the heating system in operation, taking into account its dependence of other services. It may be necessary to provide standby water and electricity supplies where continuous operation under all fault conditions is essential.

Any polymeric and elastomeric materials used in the installation should be capable of withstanding the maximum temperature that the preheat source can attain. To avoid exceeding the safe operating temperature of these materials in meters or regulator valve seats it may well be necessary to limit the maximum temperature of the preheat source.

The heater installation should be equipped with a meter and control system which minimizes the energy consumed by the preheaters. This is normally achieved by carefully sensing the temperature of the gas downstream of the regulators to control the operation of heaters.

The chosen set-point should be as low as possible and this equipment and control system should be designed to maintain a minimum variation from this set-point.

The determination of the heat input required should be carefully considered to meet a particular duty. The complete calculation shall be undertaken having regard to the composition of the gas to be heated and the influence of pressure on the specific heats of the various constituents.

Heating of the gas may be achieved by the use of heater units located in the installation on the inlet side of the regulators.

The following forms of gas heaters may be used:

a) *Water bath heaters* — These consist of tubular elements, carrying the gas, immersed in a water bath, which is maintained at the required constant temperature by the use of a burner fitted with standard controls and safety devices to maintain the desired exit temperature in the gas stream.
b) *Indirect heaters* — These consist of tube-in-shell heat exchangers located in the gas stream, heated by steam from an external source, or by hot water circulated from an adjacent boiler or modular boiler unit.

The pressure-containing parts of all heating installations subject to gas pressure shall be constructed and tested in accordance with the requirements of IS 2825. Due allowance for corrosion shall be made where it is necessary.

5.3 Pressure Regulators

5.3.1 *Design*

Regulator bodies, diaphragm chambers and bolting shall be designed to withstand the maximum pressure and temperature variations under fault conditions. Parts of the regulator normally subject to outlet pressure only should where practicable, also be designed to the same standard unless provided with integral pressure relief of adequate capacity.

For inlet pressure up to 10 MPa and size up to DN 400, pressure regulators, the applicable aspects of EN 334 may be used as reference for the constructional, functional and testing requirements.

Regulators should be sized on the basis of maximum design flow rate coefficient with demand at minimum differential pressure and inlet and outlet pressure range capability. The type selected should have a dynamic performance compatible with the characteristics of the system to be supplied; taking into account any associated metering arrangements.

Wherever it is known that stream capacity is likely to change, consideration should be given to the installation of regulators with adjustable rangeability.

It is desirable that a port opening indicator and scale be incorporated in all main regulators.

A schematic line diagram of natural gas pressure regulating and metering terminal is shown in Fig. 1.

5.3.2 *Pressure Testing*

Hydrostatic testing shall be carried out at the pressure shown in Table 1. The test pressure shall be maintained for the test duration shown in Table 2 without any leakage.

Manufacturer of regulator shall provide the hydrostatic and pneumatic test certificates.

Table 1 Hydrostatic Test Pressure

(*Clause* 5.3.2)

Material (1)	Pressure Rating of Regulator Body (2)	Hydrostatic Test Pressure (3)
Material shall be as specified in the purchase order	2.0 MPa (Class 150) 5.0 MPa (Class 300) 10.0 MPa (Class 600)	1.5 times of rated pressure

NOTE — 1 bar = 1 000 mbar = 10^5 N/m^2 = 10^5Pa = 0.10 MPa.

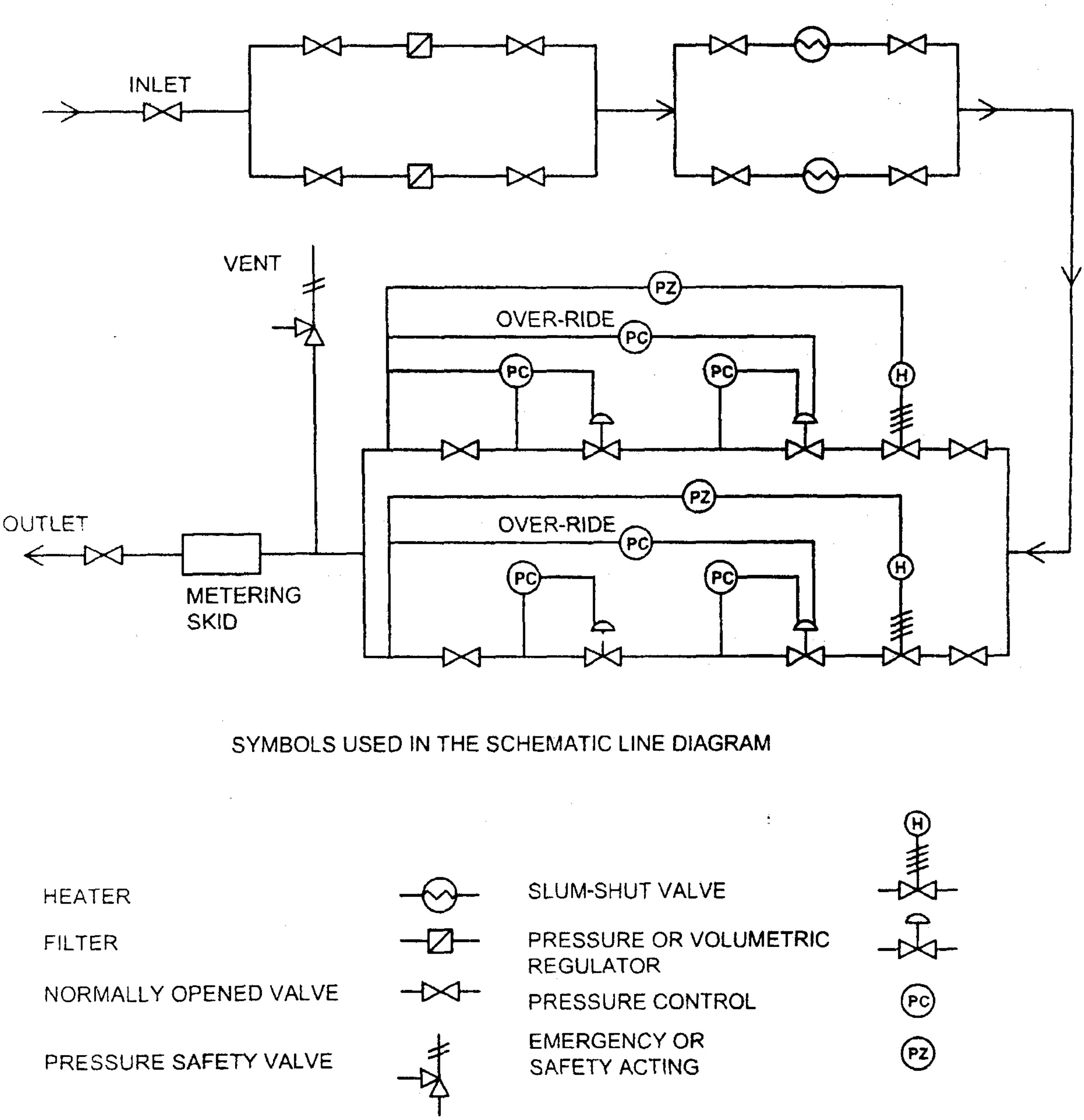


FIG. 1 TYPICAL NATURAL GAS PRESSURE REGULATING AND METERING TERMINAL WITH TWO STAGE PRESSURE REDUCTION AND MONITOR OVER-RIDE

Table 2 Duration of Hydrostatic Test
(*Clause* 5.3.2)

Sl No.	Body Size mm	Minimum Time Duration of Test min
(1)	(2)	(3)
i)	Up to 80	2
ii)	100 to 150	3
iii)	200 to 250	5
iv)	300 to 450	7
v)	500 and above	8

5.3.3 *Performance*

Adequate test or design data on capacity, rangeability, lock-up, minimum and maximum operating pressure differentials, dynamic performance characteristic and predicted noise level emission should be obtained from the manufacturer in order to determine the performance of regulators under various operating conditions. Results of any tests carried out by the manufacturer to determine operational performance and thereby confirm these design data should also be made available.

In order to derive the capacity of a regulator with reduced or modified trim, the manufacturer should provide on request all relevant data which is reasonably obtainable.

5.3.4 *Elastomeric and Polymeric Components*

All flexible elastomer diaphragms used for operating the gas regulator, its pilot controls and its additional safety features should be fabric — reinforced. They should be resistant to delamination and 'wicking' under all working conditions.

Diaphragm assemblies should be designed in such a way that the operating differential pressure rating should not exceed the maximum working pressure differential rating of diaphragm. The burst pressure of diaphragm should be at least three times the maximum working differential pressure.

The securing of diaphragms, sleeves or liners with regulators and other control units should be designed in such a way that the damage is avoided which may cause due to the components overstressing or other actions which could unreasonably reduce their effective working life.

Flexible elastomer sleeves and liners which are positioned directly in the main gas stream and function as control membranes should be resistant to abrasion and effects of long-term deformation. They should be capable of operating for long periods high differential pressure and low temperature with undue degradation of performance.

All elastomeric and polymeric components including gaskets regularly subjected to a gas environment should be fabricated from materials that are resistant to any constituent of gas under normal or abnormal condition, for example, methanol. Additionally polymeric component including so-called 'engineering plastics' shall be chosen discreetly and only after careful research of their stress-bearing, 'creep'-resisting and gas/ moisture absorbing properties.

Elastomeric components including seals should be from the prescribed fit and perform properly. They should bear an identification number related to their manufacturing specification and the date.

5.4 Pressure Relief Valves, Vent and Drains

Provision should be made for venting, purging and draining all sections of pipe network and equipment that may have to be isolated during construction or maintenance.

Due consideration should be given to the environment and so far as reasonably practicable to safety.

All relief valves should preferably be fitted upstream of customers' premises. Extreme care should be taken in choosing the location of relief valves so that the vented gas will not interfere with industrial processes and the chances of ignition are minimized.

To ensure that gas is dispersed safely the vent stack should discharge vertically. The vent tip should be at least 3 m above the ground level. The location of a stack close to features such as cliffs, quarry walls etc, should be avoided.

A weather cap should be fitted which allows unimpeded vertical discharge of gas. Weather caps should be designed as far as reasonably practicable to be non-sparking.

Particular care should be taken to avoid sitting a stack near to furnaces, gas turbine inlets etc, where dangers might arise from the ingress of combustible gases.

The capacity of pressure-relief valves and vents should be designed to limit pressure in the system to the extent as specified for various sub-systems. The relief valve shall be capable to pass maximum one percent of the full stream flow at full fault condition.

Relief valves, whether direct-acting or pilot controlled should be fully automatic in operation.

The outlet of vent should terminate with a weather cap. The upstream connection of the relief valve should not impose any restraint on free gas flow.

The vent system should have adequate support and anchorage to minimize induced stresses in the relief valve and its associated piping.

5.5 Valves and Actuators

The design and construction of valves shall meet the requirements of ISO 14313.

All valves should be fitted with a device to indicate accurately the position of the plug, ball, gate or disc. Consideration should be given to the need to vent the body of the valve. Where it is necessary to lubricate a valve for continued satisfactory operation seals should be provided to minimize the amount of excess lubricant passing into the gas stream. This is especially important, if metering is directly associated with the installation.

The dimensions of the flanged ends of valves shall meet the requirements of IS 13159 (Part 1). Requirements for preparation of the end of valves to be welded in-line should be specified to the manufacturer.

Valve bodies should be hydrostatically tested under the conditions stated in the standard relevant to the type and pressure rating selected in accordance with **5.3.2** and test certificates provided by the manufacturer.

Hydrostatic and pneumatic seat leakage tests should be applied to all valves under the conditions stated in the relevant standards.

Care should be taken to ensure the correct matching of an actuator to a valve both in terms of required torque and mechanical attachment. The conditions under which the valve is required to operate including speed of action should be specified to the manufacturer.

Where valves are ordered with actuators stem extensions gear-boxes, etc, the valve manufacturer should be responsible for matching and fitting them and ensuring that each assembly functions correctly. Removal of the actuator should not affect the pressure-tightness of the valve.

Actuators should be fully weatherproof. All electrical equipment should be housed in a flameproof enclosure. Mechanically independent hand-operated drive should be provided as part of any actuator and it should be designed that it can be operated easily by a operator/ engineer. Interlocks should be provided to prevent local or remote automatic operation whilst the hand-operated drive is engaged.

5.6 Slam-Shut Valves

A slam-shut valve may be an independent special purpose unit, a composite unit incorporating a quick closing valve or a unit comprising a conventional valve and an actuator with the latter type care must be taken to match the valve and actuator torque characteristics especially on closing. Each actuator should include its own adjustable control stops which prevent excessive stresses being imposed by the momentum of the actuator being transmitted to the valve stops and body. Wherever appropriate the direction of gas flow should be clearly marked on the valve body.

The applicable aspects of EN 14382 for inlet pressure up to 10 MPa and size up to DN 400, Slam-Shut Valves may be used as reference for the constructional, functional and testing requirements.

The selection of a particular type of slam-shut valve should take into account calculations to determine a maximum acceptable safe closing time. The factors involved in these calculations shall include:

a) Maximum working pressures,
b) Volume of associated downstream piping,
c) Fail-open characteristics of the regulator(s),
d) Capacities of the relief valves and vents, and
e) Flow rate through the working regulator under fault conditions.

The greatest temporary flow rate and pressure accumulation in the downstream system shall occur when a regulator or system of regulators suddenly fails to open while the installation is operating at maximum differential pressure. In no case should the temporary pressure accumulation be allowed to exceed the maximum pressure which can safely be tolerated by the downstream system.

Data on closing time and repeatability of activation of valves should be obtained from the manufacturer.

5.7 Thermowells

Thermowells should be designed in accordance with the provisions of BS EN 61152.

Thermowells should be of non-welded construction and preferably forged and manufactured from stainless steel as per IS 11714 (Parts 1 to 5).

Thermowells should be so designed as to minimize stress concentrations at the root of the stem and to prevent resonant vibrations. These may be caused by a combination of gas velocity, the design features of the individual thermowells and their configuration in multiple unit arrays.

The control of gas heating equipment and the correction to standard conditions of meter readings may necessitate the measurement of the gas stream temperature. This may be achieved by the installation of thermowells.

When using pipe wall temperature measurements, care must be taken to ensure good thermal contact between the sensor and the pipe wall and adequate insulation and protection should be applied around the sensor to prevent ambient conditions affecting the pipe wall temperature (Insulation is adequate when further application does not affect the indicated temperature).

Thermowell shall be positioned in straight pipe at meter downstream and generally away from bends. To ensure good temperature measurement, in general thermowells should protrude into the pipework to approximately two thirds of the bore. However, on large bore pipes above 300 mm when resonant vibration of thermowell stems is known to present a problem, the depth of immersion may have to be limited. In this case adequate measurement accuracy can be obtained provided the thermowell protrudes at least 75 mm into the pipe bore.

It is not advisable to fit two or more thermowells in close proximity but where this is unavoidable they should not be fitted in-line but arranged radially. The design and spacing of thermowells should take account of the maximum gas velocities.

The position of thermowell associated with flow meter shall be as per IS 15677.

5.8 Meters and Associated Piping

This part shall comply with the requirements of IS 15677.

5.9 Electrical System

5.9.1 *General*

All electrical equipment should be designed, manufactured installed and maintained in accordance with IEC 60079-14 and other relevant *Indian Electricity Act*, 2003. Any relevant local or statutory requirements should also be adhered to.

5.9.2 *Hazardous Areas*

Areas which may become hazardous as the result of the presence of flammable gas are classified as Zone 0, 1 and 2 (*see* IS 5572).

5.9.2.1 *Zone* 0

An area in which an explosive gas atmosphere is present continuously or is present for long periods.

5.9.2.2 *Zone* 1

An area in which an explosive gas atmosphere is likely to occur in normal operation.

5.9.2.3 *Zone* 2

An area in which an explosive gas atmosphere is likely to occur in normal operation and if it occurs it will exist for a short period only.

The selection, installation, testing and maintenance of equipments within such specified zones should comply with the requirements of IS 5571.

A zone diagram should be produced and maintained as a permanent record to enable the correct selection of electrical equipment for the site and other potential sources of ignition to be undertaken for both initial installation and future modifications.

To avoid proliferation of types of electrical equipment in small installations it may be desirable to install Zone 1 equipment in both Zone 1 and Zone 2 areas.

The degree and extent of a hazard will depend on the overall factors and should be determined by the prospective operation including, where applicable an electrical engineer, other persons familiar with the nature of the risk. Attention should be given to the effects of any future expansions to the plant or other plant in its vicinity.

5.9.3 *Lighting System*

All plant areas and buildings should be provided with lighting adequate to ensure safe access and movement to enable work therein to be accomplished safely.

Continuous illumination may be unnecessary in plant areas, but consideration should be given to installation of permanent fixed lighting points, separate switching at positions where light is frequently required to carry out routine maintenance.

The need for flameproof lighting can in many cases be avoided by the provision of floodlighting equipment outside the hazardous area or mounted at sufficient height to eliminate the possibility of the flammable gas approaching the fittings.

All lighting switches should preferably be located in safe areas and be readily accessible in order that unnecessary use of light can be avoided.

In 'classified safe' areas, supplementary lighting for occasional use can be provided by portable equipment.

In hazardous areas the use of portable lighting equipment is avoided. Wherever its use is essential, it shall correctly be certified for the position of use and supplied through the operation of a permit work system.

5.9.4 *Electrical Isolation*

Requirements for electrical isolation shall be as per IEC 60079-14.

It is essential that adequate means of isolation should be provided to disconnect electricity supplies from certain sections of the plant, for normal and emergency purpose. Provision should be made for the isolation of incoming power supplies, certified circuits and electrical circuits.

The position and duty of isolating switches shall be provided clearly identifiable on site.

It is essential particularly in hazardous areas that isolators should disconnect the neutrals as well as the phases.

All motors actuators and similar equipment that are under automatic or remote control should be provided with immediately adjacent stay-put-stop buttons or equivalent safeguards, including arrangements for padlocking in order to prevent accidental starting during maintenance or inspection. Where isolation is required for long periods main isolating switches should be used and padlocked. Isolators should interrupt all control and monitoring circuits main phase and neutral connections.

It is recommended that fuses should be of the high-rupturing-capacity type.

5.9.5 *Earthing System*

The whole of the electrical installation must be adequately and effectively earthed.

Where the supply is taken directly from the local distribution system, at medium voltage by means of an overhead line, it may be necessary for the user's earthing conductor to the sheath of that cable.

Where the supply is taken directly from the local distribution system at medium voltage by means of an overhead line, it may be necessary for the user to provide his own earth.

Where the supply is taken from a local transformer, the user's earth connection will usually be made at the same electrode as that to which the transformer secondary neutral is connected.

Care should be taken to avoid interactions between the electrical earthing, instrumentation earthing and cathodic protection systems.

The design and site of electrical earthing electrodes will require special attention. Such electrodes should be manufactured from stainless steel, austenitic steel or other cathodic protection compatible materials. Copper or any other incompatible electrodes should not be used as the buried steel pipework may corrode preferentially with respect to the electrode.

Under no circumstance should coke or other carbonaceous materials be used as part of the electrical earth systems.

Consideration should be given to installing lightning protection as per IS 2309.

5.10 Supervisory Control and Data Acquisition (SCADA) System

The various parameters of terminals like pressure, temperature, gas flow rate, gas composition, etc, should be made available through SCADA system to main control room. Also the position status of actuated valves, heater status, etc, should be available in main control room for better monitoring and control. The various analog signals and digital signals should be interfaced through remote transmission unit. There should be optical/galvanic isolation between the signal of remote transmission unit and control room. This isolation should be created through Zener barriers. This is provided to restrict the fault to one side only. This does affect the other side of equipments. The details of SCADA system for oil and gas pipeline is given in IS 15654.

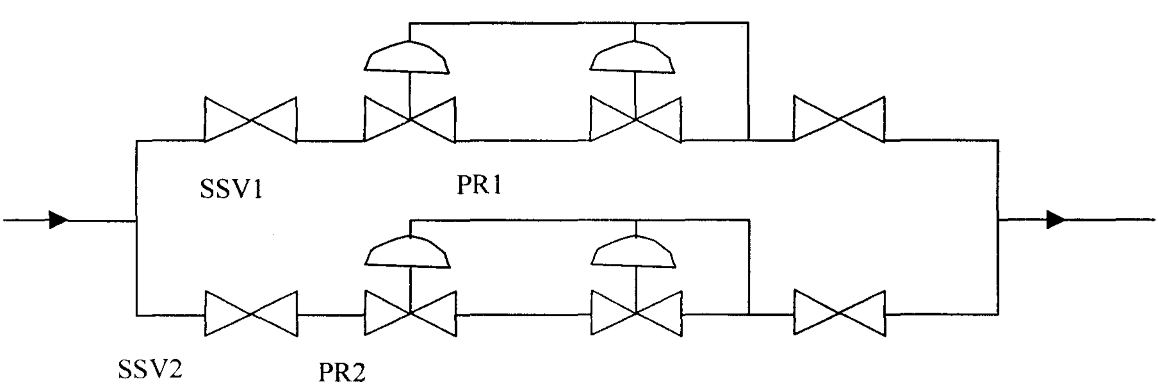
All vents, drains, pressure safety valve, temperature safety valve and other valves shall be accessible for the operation and accordingly the valve location shall be determined and adequate valve operation platforms shall be provided.

6 OPERATION AND MAINTENANCE

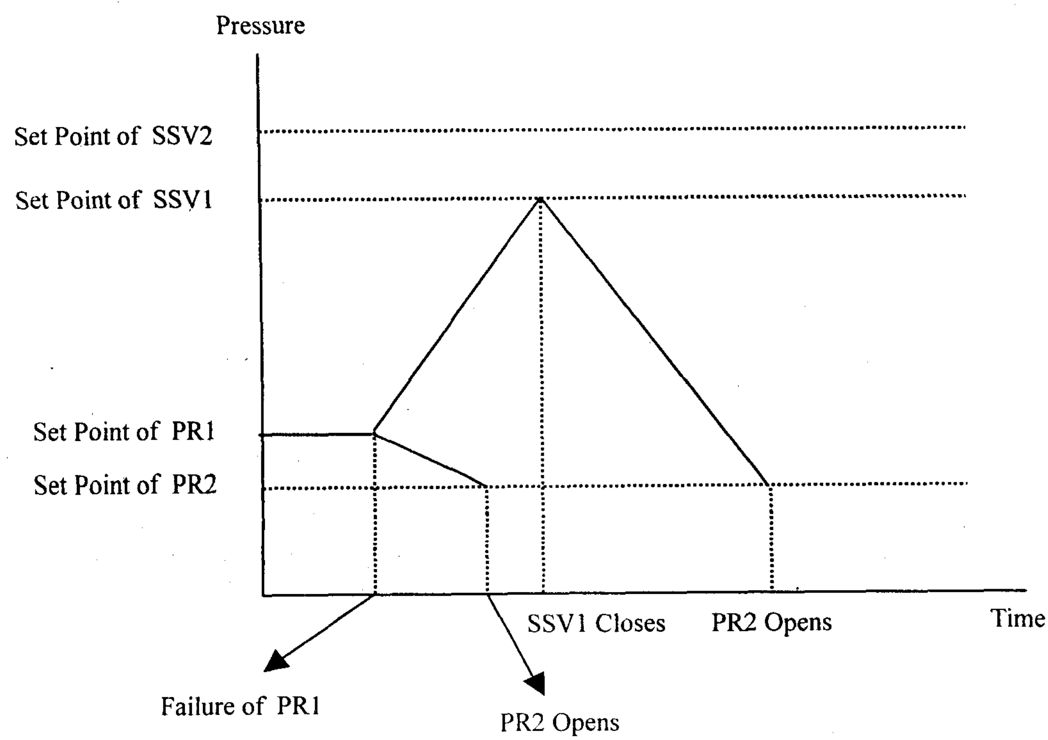
6.1 General

6.1.1 Operation of natural gas pressure regulating and metering terminal follows automatic logic based on the philosophy of uninterrupted supply of natural gas to the customers.

Generally there are two streams of Pressure Regulator (PR) and Slam Shut-Valve (SSV) as per sketch given below:



In case of failure of Pressure Regulator (PR) and Slam Shut-Valve (SSV) of one stream, it changes over to other stream automatically. The auto changeover is achieved as follows:



6.1.2 An approved emergency action plan shall be prepared and kept at the terminal stations for handling of emergencies at natural gas pressure regulating and metering terminal.

6.1.3 A log register shall be maintained at terminal to record/communicate various general and miscellaneous information.

6.1.4 Wherever on-line gas chromatograph is installed, it shall be ensured that the standard gas being used is having the valid compositional stability. The frequency of gas sampling should be on hourly basis.

6.1.5 The terminal inlet valve shall be tested for remote operation (functional/actual as per site conditions) annually, if applicable.

6.2 Preventive Maintenance

6.2.1 There shall be an annual preventive maintenance schedule for all the equipments of natural gas pressure regulating and metering terminal.

6.2.2 Preventive maintenance activities shall be carried out as per schedule.

6.2.3 All the relevant safety precautions shall be taken prior to any maintenance activity.

6.2.4 After completion of major maintenance activities, the equipment shall be put on-line.

6.3 Maintenance Schedule

The maintenance frequency of various equipments may be as per the table given below:

Instruments	*Frequency*
Terminal inlet valve	Once in a year
Filter	Once in a year
Pressure control valve	Once in a year
Slam shut-valve	Once in a year
Fire alarm system	Quarterly
Pressure transmitter	Quarterly
Temperature transmitter	Quarterly
Turbine flow meter	Once in 2 years

To ensure that the metering system continues to perform to its design accuracy, routine inspections and calibration should be based on the required system accuracy, the meter performance and any changes to the process parameters. A record of all calibration results and equipment changes should be kept. The maintenance of record filter and pressure regulator shall be as per format given in Annex B and Annex C.

Regular inspection and maintenance of certified electrical equipment shall be carried out in accordance with the certification requirements and should take account of the manufacturer's instructions and any relevant standards. Documentation and records should be kept to enable explosion-protected electrical and electronic equipment to be maintained in accordance with its type of protection.

The operation of the meter run and bypass valves should be checked to ensure that they are capable of being fully opened and fully closed and that any status indication is correct. The valves should be tested to ensure that they do not leak. Any leaks, wire seals, etc, used to indicate closure of bypass valves should be checked regularly for integrity.

Relevant safety procedures concerning positive isolation of high pressure gas should be followed when removing meters, orifice plates or other fittings form the line.

The pressure differential across filters should be checked at predetermined intervals and filters cleaned/changed when necessary.

The maintenance practices for flow meters should be followed as per their manufacturers' recommendations.

The secondary equipments like pressure, temperature transmitter, etc, of metering system shall be calibrated at regular intervals to ensure the correct functioning of transmitters. The calibrations should be carried out using a certified dead-weight tester traceable to national standards. Calibration can be achieved directly using a deadweight tester or indirectly using a secondary standard of known repeatability that has been verified against a certified device.

The instructions for operation and maintenance of filter shall include a description of the elements (including the number and type) and the method for detecting and removing clogged elements.

At periodic intervals the analog inputs of flow computers should be calibrated. Also the data entered in the flow computer should be verified at regular interval and proper documentation should be maintained.

Prior to the start of the tests, the constants entered in the flow computer should be recorded and checked. Checks should be carried out on the following:

a) Analogue to digital conversion;
b) Frequency inputs;
c) RTD temperature input;
d) Digital to analogue conversion;
e) Calculation of density, relative density and calorific value of the gas;
f) Composition;
g) Calculation of flow rate;
h) Integration of flow rate; and
j) Check alarm functions.

When checking the calculation and integration of flow rate, using keypad values, all keypad inputs should be returned to live inputs on completion of tests and all constants recorded and checked.

Regular inspection and checking of electrical system should take place in accordance with the requirements of IEC 60079-14. Adequate records of all maintenance activities should be kept.

The use of portable electrical equipment including standard generators should be restricted to zoned areas for which they are certified.

Electrical maintenance personnel carrying out work in hazardous areas should receive special training and certified to show that they have received such training and are competent to carry out such work.

7 SAFETY ASPECTS OF THE SYSTEM

7.1 General

Safety procedures should conform to appropriate national statutory requirements such as those given in Factories Acts, Oil Industries Safety Directorate Guidelines, etc, Relevant Codes and Specifications such as the welding instructions, health and safety in welding should also be followed.

Wherever radiation sources are used or stored, proper provision for the safety of the public and persons employed in the vicinity should be made in accordance with the safety requirement of ISO 17636.

The safety aspect is divided into two parts — one is safety related with the process and another one is safety related with the equipments. The gas despatch terminals should have following safety features:

a) Appropriate fire detection system may also be provided.
b) Fire alarm system may be provided at gas despatch terminal. The actuation of the fire alarm should be through break glass system.
c) The main inlet valve of the terminal should be actuated type and it should have provision to close during emergency conditions either from master control room or from the local control room. Also it should be closed in case of actuation of fire alarm system.
d) All the pressure vessels should have suitable pressure relief valves as per the requirement of pressured vessel system.
e) Heater should have provision to trip at higher temperature.
f) In the downstream of pressure reduction system there should be suitable pressure relief valve to take care of failed situation of pressure control valve/pressure regulator.

g) To take care of lightening a suitable lightening arrester should be provided.

h) The pressure set-points of regulators and slam shut-valves shall be selected in such a way that in case of hot standby operation, the failure of one pressure reduction stream should not affect the continuous supply of gas to the customer.

j) To avoid the failure of filter element a differential pressure measurement should be provided in the filters.

k) Terminal should be equipped with suitable fire fighting equipments like extinguishers, fire hydrant, etc. Appropriate fire protection system should be installed at discretion of asset operator depending upon size of gas despatch terminal and risk involved.

m) While doing maintenance of the equipments a suitable work permit system should be followed considering the following points:

   1) A regular gas leak check shall be conducted.

   2) Smoking, naked lights or sources of ignition should not be allowed in the area, and notices should be displayed accordingly.

   3) No entry should be made to pits, buildings, or other confined spaces until the space is ventilated and the atmosphere is checked in accordance with factory rules.

   4) Appropriate Personal Protective Equipments (PPE) shall be provided for all personnel on site and worn when necessary.

   5) Remotely operated valves may need to be isolated prior to any work taking place.

   6) On completion of the maintenance work a leakage check should be made before leaving the site.

7.2 Preparedness and Arrangements for Emergency Situation

Clear and effective emergency procedures and operating instructions should be established for the guidance of all personnel connected with the operation and maintenance of pressure-regulating installations. The procedures should cover the possibility of emergency situations arising in the supply of gas to or from the system, or resulting from leakage. In dealing with any emergency situation the primary objectives are to:

a) ensure the safety of the public and personnel,

b) prevent damage to property and installations, and

c) minimize the extent of environmental hazards and the effects of the emergency.

The organization of routine work and the provision of communications should be such that sufficient supervisory and maintenance personnel can be immediately alerted and despatched to the installations concerned, wherever the installations are located. In order to cater for emergencies which arise outside normal working hours, the procedures should include the action to be taken for calling out maintenance teams, supervisors and engineers in the order of priority.

Periodic exercises should be carried out to conform the effectiveness of the emergency procedures.

8 COMMISSIONING OF THE TERMINAL

After fulfilling the requirements of this document the installation can be commissioned. Before starting the commissioning activities, a written commissioning procedure should be prepared and issued to maintenance personnel for each type of installation. The prepared commissioning procedure should cover all the equipment installed at the terminal. In the preparation of commissioning procedure the operation and maintenance manual of equipments should be referred. The procedure should be carried out whenever an installation is commissioned, wholly or in part. It is essential that regulators are shown to be in full control of the inlet pressure before installation outlet valves are opened. The set-points of all pilots, controllers and regulators should be checked for each stream on load, preferably under high and low flow conditions.

The first step of commissioning is to identify/segregate the whole installation in different sections with isolation and vent/drain provisions. Then the leak test is to be carried out. The details of leak test are given below.

The leak test medium should either be air or nitrogen. The test should be applied to the assembled installation and should include all equipment and the associated small bore pipelines.

The responsible engineer/supervisor should confirm that all main, bypass and impulse valves are open. The installation should be pressurized slowly up to the recommended test pressure.

All joints, flanges and glands on valves and fittings should be tested for leakage with a suitable foaming fluid. Any leakage should be made good by adjustment or the remaking of joints where necessary.

The duration of a pneumatic test should be adequate to ensure that the installation can be thoroughly inspected. The pneumatic test pressure should start from minimum of 0.7 MPa but consideration should be given to progressively raising this minimum to a higher level up to the maximum working pressure. This test may be combined with the nitrogen purge prior to commissioning.

After leak test the procedure for commissioning described below should be followed.

On satisfactory completion of the leakage test, the test media should be safely vented to near atmospheric pressure prior to testing for freedom from oxygen using suitable test equipment. If necessary, a purge should be carried out until the installation is shown to be oxygen-free by the use of suitable test equipment. Then vent valves should be closed.

Where nitrogen has been used as a test media it should be fully purged out using gas. When tests by suitable equipment show the installation to be completely full of gas, all valves used for purging should be closed.

Vent and purge points should be carefully positioned to ensure all pipeline is purged.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

Indian/International Standard	*Title*
2309 : 1989	Code of practice for the protection of buildings and allied structures against lightning (*second revision*)
2825 : 1969	Code for unfired pressure vessels
5571 : 2000	Guide for selection of electrical equipment for hazardous areas
5572 : 2004	Classification of hazardous areas (other than mines) having flammable gases and vapours for electrical installation (*second revision*)
11714 (Parts 1 to 5) : 1986	Specification for steel tubes for heat exchangers
13159 (Part 1) : 1993	Pipe flanges and flanged fittings — Specification: Part 1 Dimensions
15654 : 2006	Supervisory control and data acquisition for oil and gas pipeline system
15677 : 2006	Flow measuring of natural gas — Code of practice
ISO 14313 : 1999	Specification for pipe line valves
ISO 17636 : 2003	Non-destructive testing of welds — Radiographic testing of fusion welded joints
IEC 60079-14 (1996)	Electrical apparatus for explosive gas atmospheres — Part 14: Electrical installations in hazardous areas
BSEN 61152 : 1994	Specification for dimensions of temperature detecting elements and corresponding pockets
EN 334 : 2005	Gas pressure regulators for inlet pressures up to 100 bar
EN 12186 : 2000	Gas pressure regulating stations for transmission and distribution — Functional requirements
EN 14382 : 2005	Safety devices for gas pressure regulating stations and installations — Gas safety shut-off devices for inlet pressures up to 100 bar

ANNEX B

(*Clause* 6.3)

MAINTENANCE FORMAT OF FILTER

Site		Job No.	
Unit No.			
Date			

Sl No.	Activities to be Undertaken	REMARKS
i)	Perform the following before starting the work:	
	a) Place the fire extinguisher and fire hoses near the metering skid filter.	
	b) Isolate the filter, close all instrumentation tubings and open the equalizing valve of differential pressure gauge/transmeter.	
	c) Depressurize the filter.	
ii)	Remove the filter cover and inspect the 'o'-ring.	
iii)	Disengage the filter retainer and remove the filter element(s).	
iv)	Clean the filter housing thoroughly before inserting the new/cleaned filter element(s).	
v)	Clean the inside cover and place the 'o'-ring after applying a thin layer of grease.	
vi)	Place the cover back and tighten as per the standard practice.	
vii)	Charge the stream in steps after proper purging and checking for leakages.	
viii)	Open the upstream valve and keep the stream as standby.	
ix)	Close the equalizing valve of differential pressure gauge/ transmeter.	

Spares/Consumables Used

Sl No.	Code No.	Part No.	Item Name	Quantity	Remarks

REMARKS (if any):

SIGNATURE

NOTE — Vendor manual to be referred before undertaking activities.

ANNEX C

(*Clause* 6.3)

MAINTENANCE FORMAT OF PRESSURE REGULATOR

Site			Job No.	
Unit No.			Date	

Sl No.	Activities to be Undertaken	REMARKS
i)	Perform the following before starting the work:	
	a) Place the fire extinguisher and fire hoses near PR.	
	b) Changeover the flow through standby PR.	
	c) Isolate and depressurize the stream and disconnect all instrument tube and connections.	
	d) Dismantle the pilot assembly and accessories.	
ii)	Dismantle/Remove Position indicator assembly and clean/service the same. Check the 'o'-ring and change, if necessary.	
iii)	Dismantle the PR,.clean and check the condition of all internal parts and change, if necessary.	
iv)	Lubricate all the matching surface.	
v)	Assemble and reinstall the PR on the stream.	

Spares/Consumables Used

Sl No.	Code No.	Part No.	Item Name	Quantity	Remarks

REMARKS (if any):

SIGNATURE

NOTE — Vendor manual to be referred before undertaking activities.

ANNEX D

(Foreword)

COMMITTEE COMPOSITION

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Scientist 'E' (MED), BIS

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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