BSR B109.4
Revision Draft – June 2021

Self-Operated Diaphragm-Type Natural Gas Service Regulators

For Nominal Pipe Size 1¼ inches (32 mm) and smaller with outlet pressures of 2 psi (13.8 kPa) and less

ANSI PUBLIC REVIEW:
09 JULY – 23 AUGUST 2021

Secretariat

American Gas Association

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Washington, DC 20001
U.S.A.

Catalog No. XM####

First Edition–1998
Second Edition–2016
Third Edition–2021

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AMERICAN GAS ASSOCIATION (AGA)
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PREFACE

This publication presents a basic standard for the safe and reliable operation and the substantial and durable construction of self-operated diaphragm-type natural gas service regulators for nominal pipe size of 1¼ inches (32 mm) and smaller with outlet pressure of 2 psig (3.48 kPa) and less. This work is the result of years of experience that has been supplemented by extensive research. The standard is intended to meet the minimum design, material, performance and testing requirements for efficient use of service regulators.

It is recognized that during any transition period to the metric system, sizes and dimensions need to be expressed in either the metric system or the inch-pound system or both. In this document, both systems are used with the inch-pound units given preference. In most cases, a soft conversion from existing inch-pound values is shown. Soft conversion implies a change in nomenclature only. In this document, the alternative nomenclatures (metric and inch-pound) are shown by using parentheses and can be used interchangeably.

Nothing in this standard is to be considered as in any way indicating a measure of quality beyond compliance with the provisions it contains. It is designed to allow the construction and performance of service regulators that may exceed the various provisions specified in any respect. In this standard's preparation, recognition was intended to be given to the possibility of improvement, through the ingenuity of design or otherwise. As progress takes place, revisions may become necessary. Whenever such revisions are believed desirable, recommendations should be forwarded to the Chairman of ANSI B109 Committee, American Gas Association, 400 N. Capitol St., NW, Washington, DC 20001

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HISTORY OF DEVELOPMENT OF THE STANDARD FOR SELF-OPERATED DIAPHGRAM-TYPE GAS SERVICE REGULATORS

In December 1989 at an ad hoc meeting, representatives of the ANSI Z223.1 and Z21 committees, AGA, Gas Appliance Manufacturers Association (GAMA) and several other industry organizations recommended that an ANSI standard for service regulators be developed. It was recognized that a systems approach to pressure control and over-pressure protection was necessary to ensure consistency between the ANSI standards that cover the houseline and the utilization equipment. In April 1990, a revision that added service regulators to the scope of ANSI B109 ASC was approved.

The AGA Operating Section assembled a service regulator standard development task group with representatives from the AGA Distribution Measurement Committee, Customer Service and Utilization Committee, Distribution Engineering Committee and the major service regulator manufacturers. A representative from the Committee on Canadian Gas Service Regulator Standard was also included. Throughout the development, consideration was given to harmonizing the new standard with the Canadian standard. A first draft was completed in 1993. The draft was revised a number of times and was approved by the AGA Operating Section before it was presented to the ANSI B109 Accredited Standard Committee in January 1996.

The ANSI B109 Accredited Standard Committee requested comments on the proposed service regulator standard in May 1996. During a public meeting on Jan. 30, 1997, the committee addressed the comments and approved the standard for submittal to ANSI for endorsement as an American National Standard.

Add history to address the 2016 and 2021 versions.

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1.0 Scope

This standard shall apply to the minimum design, material, performance and testing requirements of 1¼ inches (32 mm) and smaller self-operated diaphragm-type natural gas service regulators operating at inlet pressures up to 125 psig (861.8 kPa). These regulators are used to control the gas delivery pressure (also referred to as set pressure or P_2) to pressures at 2 psig or less (13.8 kPa). This standard shall apply only to regulators manufactured after the approval date of this standard.

This standard includes overpressure protection options including internal relief valves (IRVs) and self-operated integral slam shut valves.

2.0 Definitions

Regulator Accuracy: The deviation in outlet pressure from the set point.

Slam-Shut Accuracy Group: The deviation in outlet pressure from the setpoint measured as a percentage.

Bypass: A device, usually internal to the slam shut, that allows the equalization of pressure across the slam shut valve in order to reset it from a closed position.

Casings: The casing is a pressure retaining part of the regulator which encloses either the spring and/or diaphragm assembly.

Diaphragm: A flexible element used to sense the outlet pressure and, in combination with the loading spring and linkage, to position the valve to control the downstream pressure.

Diaphragm Case or Casing: The housing for the diaphragm usually consists of an atmospheric or ambient casing and a gas or fuel casing. The gas or fuel casing and the diaphragm form the gas or fuel chamber. The atmospheric or ambient casing and the diaphragm form the atmospheric or ambient chamber. The diaphragm seals and separates the gas or fuel chamber from the atmospheric or ambient chamber. The atmospheric or ambient chamber houses the loading spring and vents into the atmosphere.

Diaphragm Plate: A rigid disk in contact with the diaphragm, which transmits the force of the loading mechanism (weights, springs, etc.) to the diaphragm.

Droop: The drop in outlet pressure from set point with respect to increasing gas flow rate.

Fixed-Factor Regulation: Regulator accuracy held to typically +/- 1% absolute (ABS) of set pressure or P_2, which will allow a utility to meter gas without doing pressure correction at the meter.

Hysteresis: Characteristic used to describe a deviation in the regulator performance based on internal friction, the diaphragm material and flow. This may also be referred to as regulator deadband.

Inlet Pressure, Rated: The highest inlet pressure allowed to be supplied to the regulator.

Inlet Pressure, Maximum: The highest inlet pressure to which tests have been conducted to determine that the regulator will control the outlet pressure within acceptable limits.

Integral Slam-shut: An independent mechanism sharing the same body of the pressure regulator shutting off the gas supply based upon high or low pressure at specified setpoint also called OPSO/UPSO.

Internal Relief Valve (IRV): A relief valve that relieves excessive outlet pressure through the diaphragm and vent assembly. The internal relief set point is a function of the regulator's set point and the maximum allowable build-up of downstream pressure.

Loading Spring: A spring placed on the diaphragm or diaphragm plate and contained in the atmospheric casing, which opposes the gas pressure exerted against the opposite side of the diaphragm. The outlet pressure of the regulator is set by the compression of this spring.

Lock-Up: The state of the regulator when inlet pressure is applied, and no gas is flowing.

Lock-Up Pressure: The rise in outlet pressure above set pressure when there is no flow through the regulator.

Maximum Capacity: The flow rate at maximum travel generally used for safety or relief valve sizing.

Orifice: The primary flow restrictor that is used to control the flow of gas. It is the position of the valve disk with respect to the seating surface of the orifice that determines the amount of gas flowing through the regulator.

Over-Pressure or Under-Pressure Shut-Off (OPSO/UPSO): A device designed to stop the flow of gas when the outlet pressure drops below or increases above a pre-determined pressure. Also called Over-Pressure Cut Off (OPCO) or slam shut valve. This device can be either standalone or integral within the regulator.

Pressure, Absolute: The gauge pressure plus the barometric or atmospheric pressure. Pounds per square inch absolute, abbreviated as psia.

Pressure, Atmospheric: The pressure due to the weight of the atmosphere (air and water vapor) on the Earth's surface. The average atmospheric pressure at sea level has been defined as 14.696 psia (101.33 kPa).

Pressure Differential: The difference in pressure between two points in a gas system.

Pressure Drop: The loss in pressure between two points in a system in which gas is flowing.

Pressure, Gauge: Pressure measured relative to the atmospheric pressure (atmospheric pressure being defined as zero). Abbreviated psig.

Pulsation, Hunting or Chattering: An unstable state in which there is oscillation of the regulator diaphragm, linkage and/or mechanisms that causes noise and/or fluctuating outlet pressure.

Rated Capacity: The rate of flow obtainable through a regulator, for specified inlet and outlet conditions, at a specified droop or accuracy of regulation.

Room Temperature: A temperature of from 59 °F to 77 °F (15 °C to 25 °C), which is suitable for human occupancy and at which laboratory experiments are usually performed.

Standard Cubic Feet per Hour (scf/h): Standard cubic feet per hour rate of flow. For the purpose of this standard, a cubic foot is defined as a volume of one cubic foot (0.0283 cubic meters) of gas at a temperature of 60 °F (15.6 °C) and at an absolute pressure of 14.73 psia (101.56 kPa). All published material shall be based on gas with a 0.60 specific gravity.

Seal Cap: The cap serving as a weather seal and external closure for the loading spring and spring adjustment screw.

Set Flow: The flow rate used for the initial setting of the regulator at a specified inlet pressure and outlet set pressure.

Service Regulator: The device on a service line that controls the pressure of gas delivered from a higher pressure to the pressure provided to the customer.

Set Pressure, Setting Pressure, Set Point or $\underline{P}_2$: The initial setting of the regulator outlet pressure at a specified set flow and inlet pressure.

Spring Adjustment Mechanism: Usually a threaded part by which the loading spring is adjusted to set the outlet pressure.

Tripping Pressure: The pressure at which a slam shut trips either on a condition of high or low pressure.

Valve: A valve consists of the valve orifice and valve disk, and it is used to control gas flow through the regulator.

Valve Body: That part of the regulator that consists of inlet and outlet piping connections and the orifice.

Valve Disk or Valve Seat: A resilient disk or similar device that is positioned with respect to the regulator valve orifice to control and shut off the flow of gas.

Valve Linkage: A lever or mechanism connecting the diaphragm to the valve disk.

Vent: The opening to the atmospheric side of the diaphragm casing through which the regulator breathes. This may be the point of connection for a vent pipe or vent cap and could also be the opening for the relief of excess downstream gas pressure.

Vent Cap or Vent Screen: A cap that is inserted into the vent of the regulator to keep insects and water from getting into the regulator's atmospheric or ambient casing. It may also act as a restrictor in the vent to prevent pulsation or chattering.

Water Column (w.c.): The pressure required to support a column of water measured in inches. It would take 27.68 inches of water column to equal 1 pound per square inch (psi).

3.0 General

a) Regulators shall operate without objectionable noise, malfunction, hunting, pulsation or chattering over an ambient temperature range of -20 °F to 150 °F (-28.9 °C to 65.6 °C) unless a lower temperature of -40 °F (-40 °C) is specified by the manufacturer and at inlet pressures ranging up to a maximum of 125 psig (861.8 kPa).

b) All materials in the regulator and component parts shall be suitable for the intended use and shall be chemically resistant to constituents normally found in natural, manufactured and liquefied petroleum (LP) gasses.

c) Copper parts shall not be permitted. Copper alloy parts shall contain no more than 70% copper.

d) All surfaces in contact with the atmosphere shall be constructed or provided with a finish to prevent deterioration by normal exposure to the elements (refer to Section 4.7.2 and ASTM B117).

e) Regulators shall bear a permanent and legible marking as per Section 4.9, “Markings.”

f) An internal relief valve may be used to limit downstream pressure for the given orifice and inlet pressure rating in the event of a wide-open failure. Performance is based on a regulator without vent piping. Attachments to the vent, such as pipe fittings, piping, etc., affect relief capacity and downstream pressure build-up. If such material must be used, contact the manufacturer for recommendations concerning size, length and relief performance issues.

g) The OPSO/UPSO may be used to stop the flow of gas in the event of an overpressure/underpressure condition. The operating mechanism shall be independent from that of the service regulator. All slam shut valves shall be manually reset.

h) This standard contains SI (metric) equivalents to the English units of measure. If a value for a measurement given in this standard is followed by an equivalent value in other units, the first value given is to be regarded as the requirement. The equivalent value may be approximate. If a value for a measurement and an equivalent value in other units are both specified as a quoted marking requirement, the first stated unit, or both, shall be provided.

i) Slam shuts within the scope of this document shall function in any mounting orientation.

j) If equipped with a bypass for the purpose of equalization of pressure for resetting, the slam shut shall retain the bubble tight shutoff of the main valve.

k) A visual indication may be provided to indicate the open or closed position of the slam shut.

4.0 Design Requirements

Regulators shall be constructed of materials (including lubricants and/or sealants) and component parts suitable for the intended use and shall be chemically resistant to constituents normally found in natural, manufactured and LP gasses. Alternative materials to those specified in sub-parts of this section may be used when manufacturers prove by testing that the minimum requirements of the standard are met.

4.1 Valve Body

4.1.1 The valve body, as a minimum, shall be constructed of materials meeting the following specifications in Table I below:

TABLE I

MATERIAL	SPECIFICATION
Grey Iron	ASTM A126 Classes A, B or C, ASTM A48 of Class 30 or higher
Ductile Iron	ASTM A395
Steel	ASTM A216
Aluminum	ASTM B85 or ASTM B211

4.1.2 The valve body shall conform to the dimensions and pressure requirements of the current edition of the ANSI/ASME B16.4, "Grey Iron Threaded Fittings." The direction of gas flow shall be marked in accordance with Section 4.9, "Markings," of this standard.

4.1.3 All pipe threads shall conform to ANSI/ASME B1.20.1, "Pipe Threads, (Inch) General Purpose" specifications and chamfered or countersunk as set forth in ANSI B16.3, "Fitting, Malleable Iron Threaded."

4.1.4 The body shall be of materials with a melting point of not less than 800 °F (427 °C).

4.1.5 The valve body shall meet the strength, casting integrity and leakage-performance testing requirements of this standard.

4.2 Diaphragm Casing Assembly

4.2.1 The atmospheric and gas diaphragm cases shall be constructed of materials meeting the following specifications in Table II below:

TABLE II

MATERIAL	SPECIFICATION
Grey Iron	ASTM A126 Class A and B ASTM A48 Class 30 or higher
Ductile Iron	ASTM A395
Steel	ASTM A216
Aluminum	ASTM B85 UNS S12A A14130 S12B A04130 SC102A A03830 SC84B A03800

4.2.2 The diaphragm casing shall be free of flash, cores, pits and burrs.

4.2.3 Assembled regulators/slam-shuts shall withstand an outlet pressure of 5 psig (34.5 kPa) without leakage (vents shall be blocked closed) or permanent deformation of any component. (See test procedures under Section 5.3.)

4.2.4 The regulator/slam-shut shall withstand a cantilevered load in accordance with Section 5.3.1, "Cantilever Load Test," of this standard, without affecting performance or causing leakage, fracture or permanent deformation of any component.

4.2.5 The upper cover of the diaphragm case shall have a vent connection as detailed in Section 4.8.1.

4.2.6 The diaphragm case, which contains the natural gas under normal operation, shall withstand a pressure of 10 psig (68.9 kPa) without rupture. [Refer to Section 5.3.11 "Shell Pressure Test."]

4.2.7 All fasteners and fastening components shall be corrosion-resistant. Screws, bolts and nuts shall conform to ANSI Bl.l.

4.2.8 The diaphragm case shall be of materials with a melting point of not less than 800 °F (427 °C).

4.3 Diaphragm

4.3.1 The diaphragm shall be constructed with materials that meet the tests described in this standard.

4.3.2 No parts coming in contact with the diaphragm shall have sharp edges, burrs, projections or similar conditions, which might chafe or abrade the diaphragm.

4.3.3 Adequate means shall be provided to prevent the diaphragm and diaphragm plate from restricting the vent.

4.3.4 The diaphragm shall withstand a differential pressure of at least 5 psig (34.5 kPa) without leakage or rupture.

4.4 Loading Spring

4.4.1 The loading spring shall be protected against corrosion.

4.4.2 The loading-spring mechanism shall be adjustable. The adjustment mechanism shall be constructed so that it may be adjusted using a common slotted screwdriver.

4.4.3 The adjustment mechanism seal-cap or cover shall be provided with a means for sealing that discourages unauthorized adjustments. The spring adjustment seal-cap or cover shall be of a gas-tight, weather-resistant construction that prevents the entry of water into the diaphragm chamber and contains the gas in the event of a regulator/slam-shut failure. This will direct discharge or relieve gas to the regulator vent.

4.4.4 The regulator shall be designed so that, through the full range of movement of the spring adjustment screw, the adjustment mechanism will not cause the regulator/slam-shut to bind or malfunction.

4.4.5 The loading springs shall be designed for the optimum set point pressure to minimize droop characteristics due to spring-compression effects. The spring range should allow for an adjustment above and below the optimum set point pressure.

4.4.6 The design shall include a provision to prevent the spring from being fully compressed. The spring shall be adjustable with a torque no greater than two foot-pounds (2.71 Nm).

4.5 Valve Linkage and Disk

4.5.1 The valve linkage shall be constructed of a corrosion-resistant material or be protected from corrosion.

4.5.2 Levers and linkages, when used, shall be held in place with a pivot designed in a way that cannot work loose in normal operation and handling.

4.5.3 If a toggle-type linkage is used, there shall be a travel stop to prevent the linkage from reaching a dead-center position.

4.5.4 The valve disk shall be made of resilient material designed to withstand abrasion by the gas or by impurities in the gas as well as cutting by the valve orifice. It shall also resist permanent deformation when pressed against the valve orifice.

4.5.5 The valve disk shall be securely fastened to its actuator so that it cannot become separated during shipping, handling or operation. It shall be removable for inspection and replacement.

4.5.6 For internal relief regulators, a travel stop shall be incorporated to ensure relief-valve operation.

4.6 Orifice

4.6.1 The valve orifice shall be constructed of materials that meet the tests described in this standard.

4.6.2 The valve orifice shall be removable. The valve orifice threads, if used, shall be gas-tight. If a thread sealant is used, it shall be of a permanent non-drying type. Sealants shall withstand 250 °F (121 °C) without affecting the gas tightness of the thread.

4.6.3 The orifice seat gasket, if used, shall be made of a pressure-containing, non-galling, corrosion-resistant material.

4.7 Exterior Surface

The external components of the regulator shall either be made of or protected by materials resistant to attack by the atmosphere, weather or sunlight. The components shall also be resistant to agents used in regulator repair and cleaning. Exteriors shall be capable of meeting or exceeding the following tests:

4.7.1 Accelerated weathering test:

Samples of the regulator casings or other specific external parts of the regulator that are to be tested shall be prepared and protected using the same methods and materials employed in manufacturing the regulators. Samples shall be exposed to the following weathering tests, with reference to ASTM D822, ASTM D6695 (Daylight Filter) or ASTM D4587 (UVA-340) for 2,000 hours. The exposure cycle shall consist of the periods of ultraviolet light radiation and fresh water spray shown in Table III. Following this 2,000 hour test, there shall be no appreciable progressive corrosion, electrolytic action, or any appreciable discoloration or deleterious reaction.

TABLE III

EXPOSURE CYCLE

Portion of Exposure Cycle	Time Period
Direct Ultraviolet Radiation Light Only:	102 minutes
Fresh Water Spray Light and Spray:	18 minutes
Total Length of Each Exposure Cycle	120 minutes

4.7.2 Salt spray test: Samples, as in Section 4.7.1, shall be mounted in the salt-spray chamber in their normal operating position. They shall be subjected to a 1,000-hour salt-spray test in accordance with ASTM Method B-117, "Salt Spray (Fog) Testing." At the conclusion of the test, the coating will meet or exceed the following acceptance criteria:

a) Ferrous-based materials shall be evaluated using ASTM D-610 and have a score of Grade 4 or greater.

b) Non-ferrous metal materials shall be evaluated using ASTM D-714 and exhibit blister size No. 4 or greater with no more than a medium density.

4.8 Vent

4.8.1 The atmospheric side of the diaphragm case shall have a female threaded vent connection and shall conform to the NPT standards of ANSI/ASME B1.20.1. The threads shall be countersunk or chamfered as set forth in ANSI B16.3 to prevent damage to the threads when making a threaded connection.

4.8.2 The vent connection shall have a removable non-corrosive vent screen or the equivalent. The vent opening shall be designed to resist blockage by ice, sleet, snow and insects, and it shall be resistant to the formation of corrosion residue on the surfaces of screen ports.

NOTE: Historically, if a screen is used, a 16- to 20-mesh screen has been shown to be effective. The vent opening shall be designed to meet the environmental test requirements as detailed in Section 5.3.12, "Environmental Tests."

4.9 Markings

4.9.1 The following information shall appear in a permanent and legible form on the regulator.

a) orifice size
b) pressure adjusting spring range
c) month and year of manufacture or serial number
d) manufacturer's name or trademark
e) type or model

4.9.2 The following information shall appear in a permanent and legible form on the slam-shut.

a) pressure adjusting spring ranges
b) month and year of manufacture or serial number
c) max pressure rating
d) manufacturer's name or trademark
e) type or model

4.9.3 The above marking are the minimum requirement of this standard. Additional optional information may appear on the regulators/slam-shut according to the user's specific requirements, such as:

a) IRV type, if appropriate for pressure regulator
b) maximum recommended inlet pressure for the orifice
c) the regulator/slam-shut set point
d) serial number for regulator or slam shut
e) accuracy group

4.9.4 Direction of the gas flow shall be clearly and permanently marked on the regulator body as prescribed in MSS Standard Practice SP-25.

4.9.5 The vent outlet shall be clearly and permanently marked "VENT."

5.0 Qualification Test for Service Regulator Performance

5.1 General

The purpose of the testing is to evaluate the regulator design for compliance with this standard. Designs shall be subjected to testing for regulator capacity, relief-valve capacity, set point, lock-up performance, material strength and other factors influencing the performance to the regulator.

5.1.1 A careful inspection of the regulator shall be made prior to testing to ensure that there is no foreign material present in the regulator.

5.1.2 The regulator shall be tested in the following orientation (See Figure 1):

a) The regulator shall be installed in a vertical run of pipe.
b) The diaphragm shall be in a vertical position.
c) The vent shall be pointed downwards with unrestricted air flow.

5.1.3 The regulator shall have an orifice selected for the appropriate operating conditions.

5.1.4 All tests shall be conducted with air at room temperature unless specified otherwise.

5.1.5 All tests shall be conducted under known and controlled conditions, wherein the accuracy of the containers, tapes, scales and other "state-of-the-art" measurement devices are traceable to the National Institute of Standards and Technology (NIST).

5.1.6 The inlet air temperature shall be measured to an error not exceeding ± 2 °F (± 1 °C) of actual value. The inlet air temperature shall remain constant within ±5 °F (±3 °C) during the test run to record data for each specific test point.

5.2 Test Equipment

5.2.1 Pressure Measurement

Pressure gauges: Bourdon tube pressure gauges should have a dial face not less than four inches (10.2 cm) in diameter. The smallest graduation and uncertainty of the middle half of the scale should be in accordance with ANSI B40.100 Grade B, "Dial Type, Elastic Element Gauges." The gauge should be selected to provide readings in the middle half of its scale. Calibration of the gauge should be in accordance with ASME Power Test Code (PTC) 19.2.

Manometers: A manometer should have scale graduations not greater than 0.1 inch (2.5 mm).

Digital pressure transducers: A pressure transducer should have uncertainty of better than ±0.25% of full scale, taking into account linearity, repeatability and hysteresis. A digital display used in conjunction with the transducer should be updated a minimum of twice per second. It should have traceable calibration or be calibrated in accordance with ASME PTC 19.2.

5.2.2 Pressure Sensing

Positions: All pressure-sensing positions and connections should be as shown in Figure 1.

Piezometer tubes: Body-sized piezometer tubes should be used to sense the inlet and the outlet pressures immediately upstream and downstream of the unit. Tubes larger or smaller than the pipe size of the regulator body should not be used. Their dimensions should correspond to the following ratios:

a) Tube inlet: 5 Five pipe I.D. upstream of ring holes

b) Tube outlet: Five pipe I.D. downstream of ring holes

c) Ring holes: Up through one-inch NPT pipe: Six 1/16-inch holes equally spaced around the pipe, Greater than one-inch NPT: Eight 3/32-inch holes equally spaced around the pipe

d) Gauge connection: 1/4-NPT registering through an 1/8-inch hole into the piezometer ring

5.2.3 Flow Measurement

Flow meters: Orifice meters, rotary meters or equivalents may be used to measure the flow of the regulator. The flow result given by the meter should be accurate to within ± 1.0% of flow rate.

5.3 Regulator Test Procedures

The following design-qualification test procedures shall be performed for each regulator configuration and orifice size specified by the manufacturer. For consistent proof of regulator performance, each regulator of the manufacturer's sample lot (a minimum of two regulators) shall be subjected to each test procedure except for destructive tests. Each sample tested shall pass all of the following tests to demonstrate compliance with this standard. The test sequence shall be at the manufacturer's discretion.

5.3.1 Cantilever Load Test

The regulator body and diaphragm casing assembly, when tested to the specified cantilever load test, shall not show evidence of fracture permanent deformation, external leakage or impaired performance. The test shall be conducted as follows:

a) Mount the regulator in a vertical pipe stand with the diaphragm oriented horizontally. Set the regulator according to section 5.3.3.

b) Apply a load of 250 lbs. (113.4 kg) at the point of the regulator case that is farthest from the centerline of the pipe. The load shall be maintained for 10 minutes and then removed while the regulator is pressurized to a lock- up condition. During the loading cycle, the regulator shall not leak.

c) After the load has been removed, examine the regulator to ensure that the load has not affected performance or caused leakage, fracture or permanent deformation of any component by carrying out the applicable performance tests listed in Sections 5.3.2, "Leakage;" 5.3.3, "Set Point"' 5.3.5, "Lock-Up;" 5.3.8, "Relief Set Point;" and 5.3.9, "Relief Valve Performance Test."

d) If the regulator incorporates an auxiliary device such as an over-pressure cut-off (OPCO) device, repeat the testing with the auxiliary device at the farthest distance from the centerline of the pipe.

5.3.2 <u>External Leakage</u>

The leakage shall not exceed the requirements set forth below when the regulator is subjected to a back pressure of 5 psig (34.5kPa) through the regulator outlet with the vent and body inlet connection blocked or plugged for regulators with internal relief valves. For non-internal relief regulators, the vent shall be piped to downstream pressure supply and body inlet connection blocked or plugged. Leaks to the atmosphere may be detected, by water immersion or other acceptable means of measuring stated leakage rate. When using the immersion method, submerge the complete regulator under water [at a depth not greater than two inches (5.1 cm)] and watch for a continuous stream of bubbles. There shall be no stream of bubbles greater than one bubble per second, regardless of the size of the bubbles. The leakage rate from the regulator shall not exceed 200 cc/hr. The leak test should last for a minimum of 60 seconds.

5.3.3 <u>Set Point</u>.

For the purposes of developing a uniform testing procedure and comparison, the set point shall be established with the following parameters:

a) Inlet Pressure: 40 psig (276 kPa) or the maximum allowable inlet pressure per the manufacturer's specification if less than 40 psig (276 kPa).

b) Outlet Pressure Ranges:

TABLE IV

Outlet Pressure Range	Set Point Tolerance
X ≤ 14 inches w.c. gauge (3.48 kPa gauge)	+/- 0.1 inches w.c. gauge (0.025 kPa gauge)
14 inches w.c. gauge (3.48 kPa gauge) < X ≤ 1 psig (6.89 kPa gauge)	+/- 0.2 inches w.c.gauge (0.050 kPa gauge)
1 psig (6.89 kPa gauge) < X ≤ 2 psig (13.8 kPa gauge)	+/- 0.03 psig (0.2 kPa gauge)

c) Flow Rate: 39 scf/h (1.1 m^3/h) of air to be set by slowly increasing the flow rate from zero for a period of five seconds.

During tests to check the set point, the regulator should be stable with no evidence of hunting or chattering. Other pressures and flow rates may be used to demonstrate compliance with this standard for alternative requirements.

NOTE: Inlet and outlet conditions other than those specified above will affect the performance of the regulator and could produce varying results.

5.3.4 <u>Hysteresis</u>

The regulator hysteresis shall be checked by the following test:

a) Mount the regulator in a vertical pipe mount with the diaphragm oriented vertically. Set regulator as described in Section 5.3.3, "Set Point."

b) Close the downstream valve with a consistent closing speed over a period of five seconds, keep the valve closed for five seconds, and then reopen the valve over a period of five seconds to a flow of 39 scf/h (1.1 m3/h) of air for a period of five seconds.

c) Record the outlet pressure while at 39 scf/h (1.1 m3/h). Repeat this step three times.

d) Open the downstream valve with a consistent opening speed over a period of five seconds to a flow of 200 scf/h (5.67 m3/h) of air. Keep the valve in this position for five seconds, and then close the valve over a period of five seconds to a flow rate of 39 scf/h (1.1 m3/h) of air for a period of five seconds.

e) Record the outlet pressure while at 39 scf/h (1.1 m3/h). Repeat this step three times.

f) The recorded readings shall be within ±0.5 inch w.c. (0.124 kPa) of the established set point.

5.3.5 Lock-Up

When the demand for flow from the regulator is shut off, the flow of gas should be stopped against the maximum inlet pressure recommended by the manufacturer for the applicable orifice. The outlet pressure under no-flow conditions, or "lock-up pressure," shall be checked using the following test method:

a) Set the regulator as described in section 5.3.3.

b) Close the outlet valve at a constant speed over five seconds. Allow outlet pressure to stabilize and record lock-up pressure. Wait an additional 30 seconds and ensure the reads are comparable within the measurement system accuracy.

c) Ensure that the lock-up pressure is no greater than 3 inches w.c. (0.75 kPa) above the original set pressure for set points of 14 inches w.c. or less (3.48 kPa). For set points greater than 14 inches w.c. (3.48 kPa), lock-up pressure shall be not be greater than 115% of set point. See Section 5.3.3.

5.3.6 Inlet Pressure Sensitivity

With the regulator set point adjusted as per 5.3.3, "Set Point," the outlet pressure shall be recorded for varying inlet pressure conditions from a minimum of 5 psig (34.5 kPa) to a maximum of 125 psig (861.8 kPa) or to the maximum inlet pressure, limited by either the body rating or orifice, as recommended by the manufacturer. This requirement shall be demonstrated by maintaining the inlet pressure of 5 psig (34.5 kPa) for a minimum of 10 seconds while observing the outlet pressure. Record the inlet and outlet pressures. Increase the inlet pressure in 10 psig (68.9 kPa) increments. Record the inlet and outlet pressures after each adjustment. Continue the process until the 125 psig (861.8 kPa) or the maximum inlet pressure — limited by either the body rating or the orifice as recommended by the manufacturer — has been reached. Then reverse the procedure by decreasing the inlet pressure in 10 psig (68.9 kPa) increments, recording the inlet and outlet pressures for each step until the minimum inlet pressure of 5 psig (34.5 kPa) is reached. The data may be made available by the manufacturer upon request.

5.3.7 Flow Capacity

The regulator flow capacity for each orifice specified by the manufacturer shall be determined by the following procedure. The actual test sequence may be determined by the manufacturer.

a) Set outlet pressure as described in Section 5.3.3, "Set Point."

b) Slowly increase the flow rate until the outlet pressure exceeds the upper or lower limits, whichever occurs first, of the accuracy range as listed in Table V.

c) Log the flow rate when item "b" is met. Results are to be expressed in scf/h of 0.6 specific gravity gas.

TABLE V

Additional capacities may be established for alternative inlet pressures using the procedure described above.

Set Point	Regulator Accuracy Range
X ≤ 14 inches w.c. gauge (3.48 kPa gauge)	+2 inch w.c. / - 1 inch w.c.
14 inches w.c. gauge (3.48 kPa gauge) < X < 1 psig (6.89 kPa gauge)	+2 inch w.c. / - 2 inch w.c.
1 psig (6.89 kPa gauge) ≤ X ≤ 2 psig (13.8 kPa gauge)	± 1% Absolute Pressure

5.3.8 Relief Set Point

TABLE VI

Set Point	IRV – Start-to-Discharge Range (Over Set-Point)	Minimum IRV Reseat Above Lock-Up
Set ≤ 14 inches w.c. gauge (3.48 kPa	6 – 12 inches w.c.	2 inches w.c.
14 inches w.c. gauge (3.48 kPa gauge) < Set < 1 psig	7 – 21 inches w.c.	2 inches w.c.
1 psig ≤ Set ≤ 2 psig	2.0 psi max	0.1 psi

For regulators equipped with an internal relief valve, the following design verification test shall be performed for each orifice size available:

a) Set outlet pressure as described in Section 5.3.3, “Set Point.”

b) Once outlet pressure stabilizes, close the downstream valve allowing the regulator to go into lockup.

c) Slowly apply a controlled backpressure of air into the outlet side of the regulator to yield a flow rate of approximately one cubic foot an hour.

d) The relief valve should begin to relieve as downstream pressure rises above the lock-up point of the regulator. After the regulator has been pressurized, the start-to- relieve point can be detected by:
   - applying a leak-detection solution to the regulator vent,
   - placing the vent discharge into a maximum water seal of one inch w.c. (0.25 kPa),
   - or other acceptable means.

e) To determine the relief-valve reseat point, remove the backpressure on the outlet side of the regulator and observe the pressure at which the relief valve ceases to release pressure. The relief valve shall reseat according to the values in the Table VI. The reseat pressure should be checked to see that it remains constant for a minimum of 10 seconds.

5.3.9 Internal Relief-Valve Performance Test

This section is only for regulators equipped with an internal relief valve. The internal relief-valve capacity for each orifice size available shall be tested as follows:

a) Cause the regulator to fail by disconnecting the linkage between the diaphragm and valve mechanism or the most severe failure condition that yields the highest build-up pressure.

b) Disconnect any vent piping to allow the regulator to vent the flow of gas freely and unrestricted to the atmosphere.

c) Close the valve downstream of the regulator so that there is no flow of gas through the regulator.

d) Note the outlet pressure while slowly increasing the inlet pressure from 0 psig to the maximum inlet pressure recommended by the manufacturer for the orifice installed. Record the outlet pressure at the maximum inlet pressure after the system reaches a steady-state condition. Refer to the Appendix A for how to display the result.

TABLE VII

Set Point	Maximum Outlet Buildup
Set ≤ 14 inches w.c. gauge (3.48 kPa gauge)	2 psi
14 inches w.c. gauge (3.48 kPa gauge) < Set < 1 psig	5 psi
1 psig ≤ Set ≤ 2 psig	5 psi

The user shall evaluate all downstream equipment limits and design considerations when selecting the relief performance. The maximum outlet pressure shall not exceed those guidelines established by governing standards and regulations. Table VIII shows typical equipment allowable limits. However applicable codes and standards shall be additionally considered.

5.3.10 Endurance Test

A regulator shall withstand 100,000 cycles of opening and closing of the valve under the following test method:

a) Mount the regulator in a vertical pipe stand with the diaphragm oriented vertically.

b) Set the regulator as described in Section 5.3.3, “Set Point.”

c) Slowly increase the inlet pressure to the regulator to the maximum inlet pressure recommended by the manufacturer.

d) The inlet and outlet piping of the regulator shall be connected to a mechanism that will open the outlet piping to the atmosphere and close the inlet air supply when the maximum inlet test pressure is applied and close the outlet piping and open the inlet air supply when no inlet pressure is applied. This mechanism will establish an open/close cycling of the regulator valve.

   NOTE: A cycling rate of 20 to 30 cycles per minute shall be used. The number of cycles shall be accurately determined by a counter linked to the pressure control mechanism or by other suitable means.

e) After each 25,000 cycles of operation, the regulator shall be checked for set point and lock-up in accordance with Section 5.3.3, “Set Point,” and Section 5.3.5, “Lock-Up,” not to exceed the guidelines from Table VIII:

TABLE VIII

Set Point	Set Point Deviation	Lock-Up Above Set Point
Set ≤ 14 inches w.c. gauge (3.48 kPa gauge	+/-1.0 inches wc	3 inches wc
14 inches w.c. gauge (3.48 kPa gauge) < Set < 1 psig	+/-3.0 inches wc	15%
1 psig ≤ Set ≤ 2 psig	+/-1% absolute	15%

5.3.11 <u>Shell Pressure Test</u>

Each regulator type shall be tested to establish that it is able to withstand an internal pressure in excess of that which it may be subjected to in actual service. A pressure test shall be performed on all regulator pressure retaining shells to a minimum pressure of 10 psig or at 1.5 times the maximum allowable operating pressure (MAOP), whichever is greater, for cast steel, cast aluminum and wrought aluminum shells, and at 2.0 times MAOP for cast and ductile iron shells. (Reference Section VIII, ASME Boiler and Pressure Vessel Code and FCI/ANSI 791.

5.3.12 Environmental Tests

The regulator vent opening shall be designed to resist a complete vent blockage due to water deposited on the bug screen at or below 32 °F (0 °C). The test is intended to simulate water from freezing rain or from water dripping directly onto the regulator. The regulator vent opening or any additional device attached to the relief vent shall be subjected to the Freezing Rain Test below.

Freezing Rain Test:
The resistance of the regulator to vent blockage from freezing rain or water dripping onto a regulator shall be tested in accordance with the following:

Test Environment

a) The test shall be performed in a room with a controllable room temperature range of 50 °F (10 °C) to 14 °F (-10 °C).

b) A water source and a device to maintain the water temperature close to 32 °F (0 °C) shall be available inside the test room. The water temperature shall be less than 41 °F (5 °C).

Test Apparatus:
The test apparatus shall contain four major components: a simulated wall, a wind fan, the regulator assembly and the water spraying equipment. The simulated wall is constructed with a 4′ x 8′ x 3/4″ wood panel and a self- supported wood frame. The regulator assembly shall be installed eight inches (203 mm) from the wall and 24 inches (609 mm) from the floor. The piping arrangement and the test regulator shall be constructed as indicated in Figure 2. The wind fan shall be able to deliver a wind velocity of 14 mph (23 km/h) measured at three feet (0.91 m) in front of the test regulator. The water spraying nozzle shall be a VeeJet nozzle model H1/4U1515 with a 15-degree spraying angle (or equivalent). The nozzle shall be able to provide a droplet size of approximately 0.04 inches (1 mm). The water flow rate through the nozzle shall be one U.S. gallon per minute (3.7 L/min) at a water pressure of 20 psig (138 kPa).

Method of Test:

a) Install the test regulator as indicated in Figure 2. Thoroughly clean the regulator to remove surface grease.

b) Set pressures and flow rates in accordance with Section 5.3.3, “Set Point.”

c) Check lock-up pressure of the regulator in accordance with Section 5.3.5, “Lock-Up.”

d) Lower the room temperature to 35° F (2 °C) and allow it to stabilize for a minimum of two hours.

e) Turn on the outlet flow control valve to allow the regulator to operate at the set conditions defined in step “b” above.

f) Spray water onto the regulator by using the nozzle. The water spray pattern shall be in a form of a vertical parabola. Water shall be sprayed vertically upward from the nozzle so that it falls straight down on top of the test regulator. The distance from the spraying location to the test regulator shall be approximately 13 feet (four meters).

g) Turn on the wind fan. The wind fan shall be located 10 feet (3 meters) from the test regulator and blow horizontally at the regulator at a 45-degree angle to the simulated wall.

h) Maintain a direct spray on the regulator for 30 seconds at one-minute intervals. Repeat this process five times.

i) Reduce the room temperature to 23 °F (-5 °C) and continue the spraying process described in step “h” above for three hours.

j) Allow the ice formed on the regulator to age for 15 minutes.

k) Repeat the lock-up test as specified in step “c” above.

l) Use dry air at a temperature of approximately 32 °F (0 °C) to apply back-pressure to the regulator through the outlet valve from 0 psig to 2 psig (0 to 13.8 kPa) at 0.5 psig (3.4 kPa) intervals. Maintain the back-pressure at each interval for one minute. The regulator has failed the test if the regulator vent relieves less than 40 scf/h (1.13 m^3/h) of air during the 2 psig (13.8 kPa) back-pressure situation. Otherwise, the regulator has passed the test.

5.4 Slam-Shut Test Procedures

5.4.1 External Leakage

a) The leakage shall not exceed the requirements set forth below when the slam shut is subjected to a back pressure of 5 psig (34.5kPa) through the outlet with the vent and body inlet connection blocked or plugged. Leaks to the atmosphere may be detected, by water immersion or other acceptable means of measuring stated leakage rate. When using the immersion method, submerge the complete slam shut under water [at a depth not greater than two inches (5.1 cm)] and watch for a continuous stream of bubbles. There shall be no stream of bubbles greater than one bubble per second, regardless of the size of the bubbles. The leakage rate from the slam shut shall not exceed 200 cc/hr. The leak test should last for a minimum of 60 seconds.

5.1.2 Seat leakage test

a) The slam-shut should have a shut off classification of FCI/ANSI 70-3 Class VIII or better.

5.1.3 Slam Shut Set Point

a) For OPSO setting, starting at lock-up pressure, increase the downstream pressure at 1" wc increments every 5 seconds until the slam shut trips and closes. Record the downstream pressure and this will be considered the slam shut set point. The slam shut shall trip within one second. Repeat test 25 times and record the tripping pressure.

b) While flowing at 50% of the regulator's rated capacity, increase the outlet pressure to ensure that the tripping pressure under flowing conditions is the same as the static tripping pressure.

c) Determine accuracy group from Table IX and state in the manufacturer's literature.

d) For UPSO setting, starting at lock-up pressure, decrease the downstream pressure at 1" wc increments every 5 seconds until the slam shut trips and closes. Record the downstream pressure and this will be considered the slam shut set point. The slam shut shall trip within one second. Repeat test 25 times and record the tripping pressure.

e) While flowing at 50% of the regulator's rated capacity, decrease the outlet pressure to ensure that the tripping pressure under flowing conditions is the same as the static tripping pressure.

f) Determine accuracy group from Table IX and state in the manufacturer's literature.

g) With the slam shut closed after reaching UPSO setpoint, reduce the outlet pressure to atmospheric and wait one minute. Connect the outlet of the regulator/slam shut to a bubble bottle to check for seat leakage. Use ANSI/FCI 70-3 Class VIII as the criteria for passing this seat leakage test.

h) Repeat the test above at the OPSO setpoint. Reduce the outlet pressure to atmospheric and wait one minute. Connect the outlet of the regulator/slam shut to a bubble bottle to check for seat leakage. Use ANSI/FCI 70-3 Class VIII as the criteria for passing this seat leakage test.

TABLE IX

Accuracy Group	**Allowed Tripping Pressure Deviation** [a]
AG 1	**+/ 1%**[b]
AG 2.5	**+/- 2.5%**[b]
AG 5	**+/- 5%**
AG 10	**+/- 10%**
AG 20	**+/- 20%**

AG 30	**+/- 30%**
[a] setpoint deviation from gauge pressure **[b] or 0.5” wc whichever is greater**	

5.1.4 Endurance Test

A slam shut shall withstand 150 cycles of opening and closing of the valve under the following test method:

a) Set the slam shut as described in Section 5.5.3, “Set Point.”

b) The cycle test shall include 75 cycles at room temperature, 50 cycles at the lowest temperature in the specified range and 25 cycles at the highest temperature in the specified range. With the product stabilized, the product temperature shall be within 2 degrees F of the test temperature.

c) Slowly increase the downstream pressure until the slam shut trips. When the cycles at a given temperature are complete check for set point and seat leakage in accordance with Section 5.5.3, “Set Point,” and Section 5.5.2, “Seat Leakage test,” not to exceed the setpoint deviation for designated accuracy group in Table IX.

d) After 150 cycles of operation, the slam shut shall be checked for set point and seat leakage in accordance with Section 5.5.3, “Set Point,” and Section 5.5.2, “Seat Leakage test,” not to exceed the setpoint deviation in Table VIV.

5.1.5 Shell Pressure Test

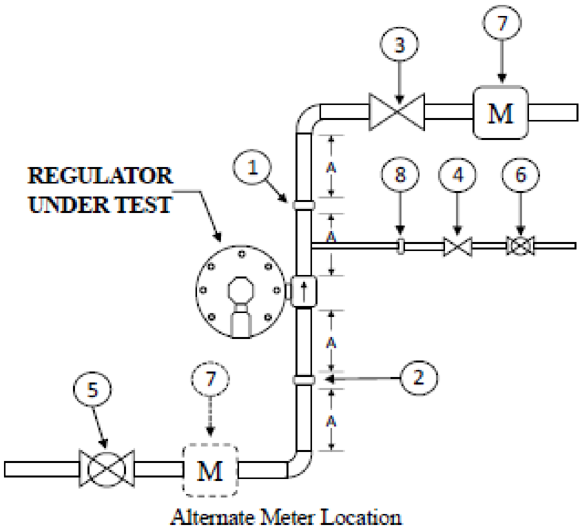
a) Each slam shut type shall be tested to establish that it is able to withstand an internal pressure in excess of that which it may be subjected to in actual service. A pressure test shall be performed on all slam shut pressure retaining shells to a minimum pressure of 10 psig or at 1.5 times the maximum allowable operating pressure (MAOP), whichever is greater, for cast steel, cast aluminum and wrought aluminum shells, and at 2.0 times MAOP for cast and ductile iron shells. (Reference Section VIII, ASME Boiler and Pressure Vessel Code and FCI/ANSI 79-1.)

5.1.6 Response Time

a) The slam shut shall respond in ≤ 1 seconds to a fully closed position when tripped.

5.1.7 Vibration Resistance

a) Impact load test shall be carried out per EN 14382.

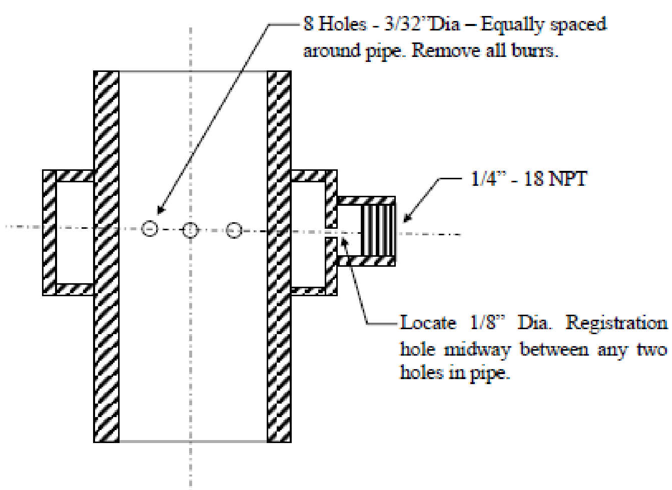


1 Outlet Pressure gauge
2 Inlet Pressure gauge
3 Flow Control valve
4 Relief Test Valve
5 Constant Pressure Source
6 Relief Test Supply Source
7 Flow Meter
8 Orifice – 0.013”

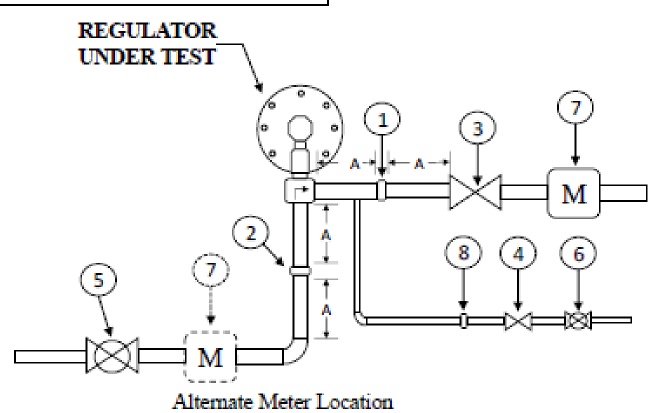
A= Minimum of 5 times the inside pipe diameter

STRAIGHT BODY CONFIGURATION

FIGURE 1 – TEST SETUP FOR PERFORMANCE TEST



CROSS-SECTIONAL DETAIL OF PIEZOMETER RING



ANGLE BODY CONFIGURATION

NOTES:
Inlet and outlet piping size to match regulator connections.
Inlet of regulator to be facing vertically down.
The instrument used for testing must comply with traceability requirement of section 5.1.5.

FIGURE 1 – TEST SETUP FOR PERFORMANCE TEST

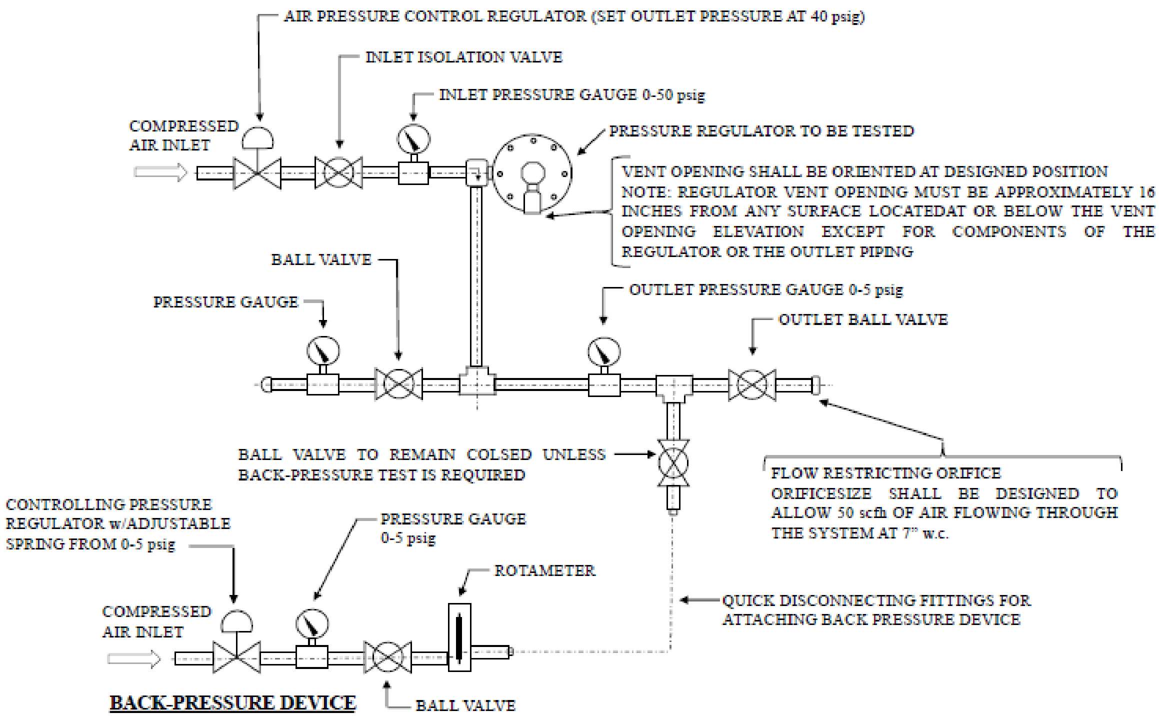


FIGURE 2 – TEST SETUP FOR FREEZING RAIN TEST

APPENDIX A

GUIDELINES FOR PRESENTATION OF REGULATOR PERFORMANCE DATA

The following guidelines shall be used for the presentation of the regulator performance and data. Standardized reporting shall be based on the set point criteria outlined in Section 5.3.3 of this standard, except that the flow rate shall be set to 50 scf/h (1.42 m^3/h) for a 0.60 specific gravity gas. All flow-rate data generated using air shall be converted for reporting to that of a 0.60 specific gravity gas as outlined in A.1.2.f below.

A.1 Regulator flow capacity data shall be presented graphically for each orifice size to be used. For uniformity of reporting performance, the following series of inlet pressures shall be shown: 5, 10, 20, 40, 60, 100 and 125 psig (or as limited by manufacturer recommendations). Curves shall be extended to the capacity determined by section 5.3.7, “Flow Capacity,” of this standard (i.e., where the outlet pressure decrease falls 1.0 inch w.c. below the original set point).

A.1.1 The following minimum details shall be documented for each graph:

a) regulator orifice size

b) set point criteria (i.e., 7.0 inches w.c. at an inlet pressure of 40 psig and a 50 scf/h rate of flow for a 0.60 specific gravity gas)

c) regulator type or model number

d) regulator inlet connection size

e) regulator outlet connection size

f) manufacturer of the regulator

g) spring range

A.1.2 The graph shall adhere to the following units and scale (see Figure A1 for a sample graph).

a) The abscissa (x-axis) units shall represent the rate of flow in standard cubic feet per hour (scf/h) of a 0.60 specific gravity gas reported at the standard pressure and temperature of 14.7 psia and 60 °F, respectively. The scale shall begin at 0 scf/h and increase in steps of 50 scf/h, with every 100 scf/h increment labeled.

b) For set points 14 inches water column or less, the ordinate (y-axis) units shall represent the outlet pressure in inches of water column (inches w.c.). The scale units shall be scaled to one-half or whole inches of water column with the whole inch units labeled. The scale shall neither be greater than 1 inch of w.c. above the highest recorded data point to be plotted nor less than 1 inch of w.c. below the lowest recorded data point to be plotted.

c) For set points greater than 14 inches water column and 2 psig or less, the ordinate (y-axis) units shall represent the outlet pressure in psi. The scale units shall be scaled to 0.1 psi with the whole units labeled. The scale shall neither be greater than 0.1 psi above the highest recorded data point to be plotted nor less than 0.1 psi below the lowest recorded data point to be plotted.

d) Both the abscissa and ordinate scales shall be represented with linear scales.

e) The set point on which the graph is based shall be marked with a small square.

f) Capacity curves shall be plotted for each of the following inlet pressures: 5, 10, 20, 40, 60, 100 and 125 psig limited only by the manufacturer's recommended highest inlet pressure for the orifice being shown. All curves shall be based on the original set point as marked by item "d" above. The set point is not to be reset for the various inlet pressures to be shown.

g) Conversion factor to be used to report volumes at 0.60 specific gravity is as follows:

$$V_{cfh(0.6)} = V_{cfh(G)} \times \sqrt{\frac{G}{0.6}}$$

h) Calculate the square root of a ratio of the specific gravity "*G*" of the test gas divided by 0.6. Multiply this value by the quantity in *cfh* of the test gas to obtain the 0.6 gravity volume in cfh. For air, the ratio is 1.29 (square root of the specific gravity of 1.0 divided by the square root of 0.6).

A.2 Regulator relief-valve performance data shall be presented graphically for each orifice size to be used. For uniformity of reporting performance, curves shall be shown relating the effect of inlet pressure to the regulator versus the regulator's outlet pressure. Each curve shall represent build-up of the regulator's outlet pressure for each orifice size to be used. The curves are to extend to the 2 psig or 5 psig limits defined in Section 5.3.9, "Relief-Valve Performance Test," of this standard.

The following minimum details shall be documented for each graph:

a) regulator orifice size

b) set point criteria (i.e., 7.0 inches w.c. at an inlet pressure of 40 psig and a 50 scf/h rate of flow for a 0.60 specific gravity gas)

c) start-to-relieve point as determined by Section 5.3.8

d) regulator type or model number

e) regulator inlet connection size

f) regulator outlet connection size

g) manufacturer of regulator

h) spring range

The graph shall adhere to the following units and scale (see Figure A2 for a sample graph):

a) The abscissa (x-axis) units shall represent the inlet pressure in psig. The scale shall begin at 0 psig and increase in steps of 5 psig, with every 10 psig step labeled.

b) The ordinate (y-axis) units shall represent the outlet pressure in inches of water column. The scale units shall begin at 0 psig and increase in steps of 1/4 psig with each 1/2 psig step labeled.

c) Both the abscissa and ordinate scales shall be represented with linear scales.

d) The start-to-relieve point on which the graph is based shall be marked with a small square.

e) Outlet pressure curves shall be plotted for each orifice size to be supplied by the manufacturer. Each curve shall be labeled with the orifice size for which the curve is shown.

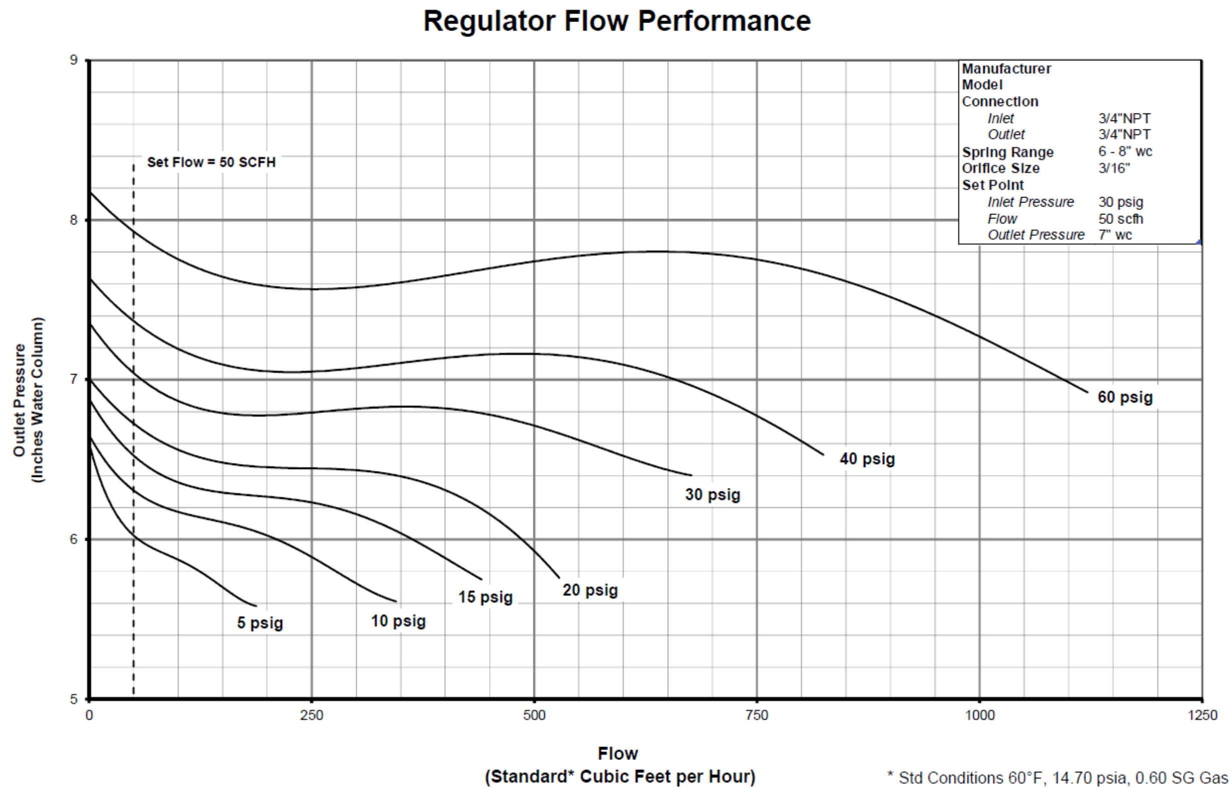
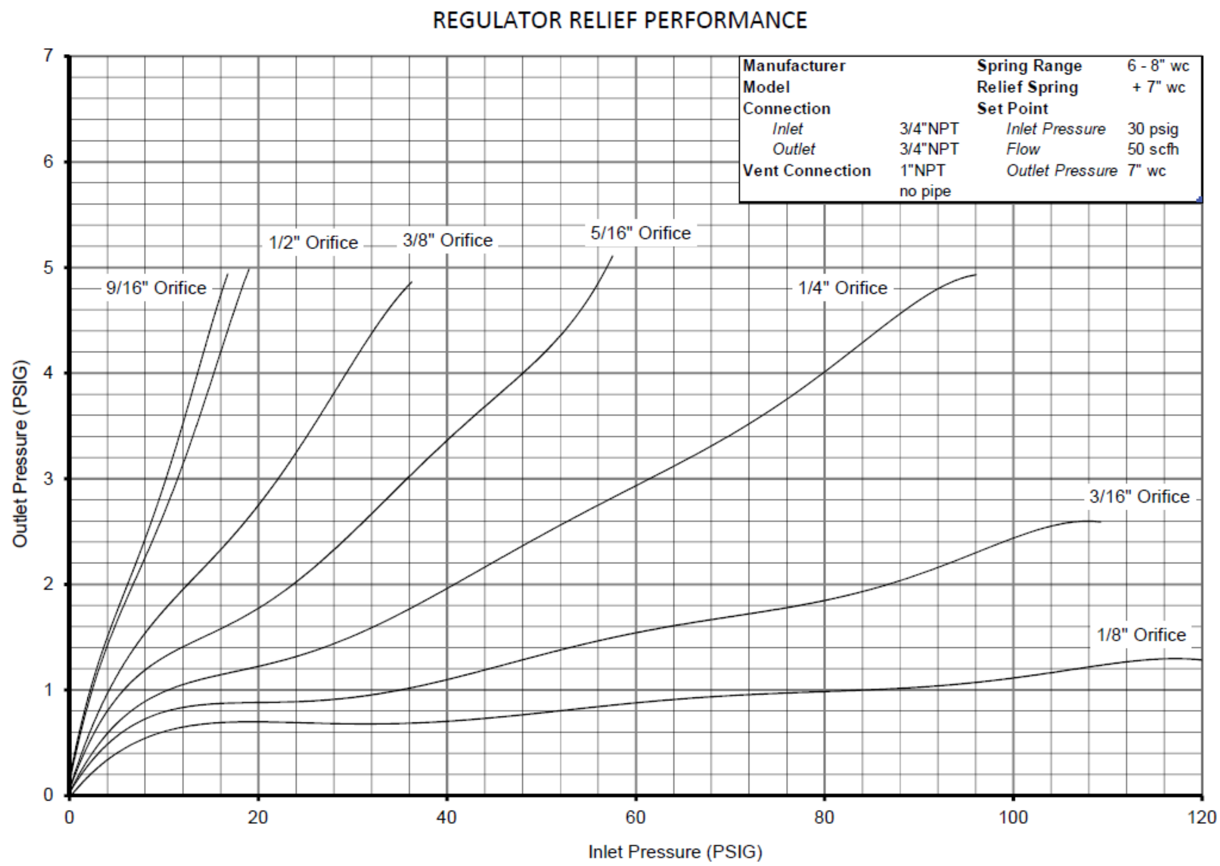

Regulator Flow Performance
Manufacturer
Model
Connection
Inlet 3/4"NPT
Outlet 3/4"NPT
Spring Range 6 - 8" wc
Orifice Size 3/16"
Set Point
Inlet Pressure 30 psig
Flow 50 scfh
Outlet Pressure 7" wc
Set Flow = 50 SCFH
60 psig
40 psig
30 psig
20 psig
15 psig
10 psig
5 psig
Outlet Pressure
(Inches Water Column)
9
8
7
6
5
0
250
500
750
1000
1250
Flow
(Standard* Cubic Feet per Hour)
* Std Conditions 60°F, 14.70 psia, 0.60 SG Gas

Figure A1



REGULATOR RELIEF PERFORMANCE
Manufacturer
Model
Connection
Inlet 3/4"NPT
Outlet 3/4"NPT
Vent Connection 1"NPT
no pipe
Spring Range 6 - 8" wc
Relief Spring + 7" wc
Set Point
Inlet Pressure 30 psig
Flow 50 scfh
Outlet Pressure 7" wc
9/16" Orifice
1/2" Orifice
3/8" Orifice
5/16" Orifice
1/4" Orifice
3/16" Orifice
1/8" Orifice
Outlet Pressure (PSIG)
Inlet Pressure (PSIG)
0
1
2
3
4
5
6
7
0
20
40
60
80
100
120

Figure A2

APPENDIX B

SI /METRIC SYMBOLS AND ABBREVIATIONS

°C	degrees Celsius
cc	cubic centimeter
g	gram
kg	kilogram
h	hour
Hz	hertz
kPa	kilopascal
min	minute
mL	milliliter
mm	millimeter
Nm	Newton meter
V	volt
cm	centimeter
m	meter
N	Newton
m^3/h	cubic meters per hour
cc/h	cubic centimeters per hour
km/h	kilometers per hour
L/min	liters per minute

APPENDIX C

U.S. (INCH-POUND) SYMBOLS AND ABBREVIATIONS

°F	degrees Fahrenheit
lbs	pounds
psia	pounds per square inch, absolute
psig	pounds per square inch, gauge
NPS	nominal pipe size
NPT	National Pipe Thread
scf/h	standard cubic feet per hour
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
FCI	Fluid Controls Institute
CSA	Canadian Standards Association
ASTM	American Society of Testing and Materials
CEN	European Committee for Standardization
gal/min	gallons per minute
fl.oz.	fluid ounce
mph	miles per hour
I.D.	inside diameter
Inch w.c.	inches water column
MSS	Manufacturers Standardization Society

APPENDIX D

REFERENCED STANDARDS

Standard Number	Description
ASTM	
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A126	Standard Specification for Gray Cast Iron Fittings
ASTM A395	Standard Specification for Ductile Iron Pressure Containing Castings for Use at Elevated Temperature
ASTM A216	Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
ASTM B85/B85M	Standard Specification for Aluminum-Alloy Die Castings
ASTM B117	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B211/B211M	Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod and Wire
ASTM D610	Standard Practice For Evaluating Degree Of Rusting On Painted Steel Surfaces
ASTM D714	Standard Test Method for Evaluating Degree of Blistering of Paints
ASTM D822/D822M	Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
ASTM D6695	Standard Practice for Xenon-Arc Exposures of Paint and Related Coatings
ASTM D4587	Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
ANSI / AMSE	
ASME B1.1	Unified Inch Screw Threads, UN and UNR Thread Form
ASME B1.20.1	Pipe Threads, General Purpose, Inch
ASME B16.3	Malleable Iron Threaded Fittings Classes 150 and 300
ASME B40.100	Pressure Gauges and Gauge Attachments
ASME PTC 19.2	Pressure Measurement
FCI	
ANSI/FCI 79-1	Proof of Pressure Ratings For Pressure Regulators
ANSI FCI 70-3	Regulator Seat Leakage
ANSI/FCI 99-2	Pressure Reducing Regulator Capacity
European Standard CEN	
EN 14382	Gas safety shut-off devices for inlet pressure up to 100 bar

FORM FOR PROPOSALS ON ANSI B109.4

Send to: **Operating Section**
American Gas Association
400 N. Capital St., NW
Washington, DC 20001
U.S.A.
Email: publications@aga.org

Name ____

Company ____

Address ____

Tel. No. ____

Fax No. ____

Please Indicate Organization Represented (if any)

____

1. Section/Paragraph

____

2. Proposal Recommends: (check one)

☐ **New Text**
☐ **Revised Text**
☐ **Deleted Text**

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted, use separate sheet if needed): [Proposed text should be in legislative format; i.e., use underscore to denote wording to be inserted (<u>inserted wording</u>) and strike-through to denote wording to be deleted (~~deleted word~~).

4. Statement of problem and substantiation for proposal (use separate sheet if needed): (State the problem that will be resolved by your recommendation. Give the specific reason for your proposal including copies of tests, research papers, etc.)

5. ☐ **This proposal is original material.** (Note: Original material is considered to be the submitter's own idea based on or as a result of his/her own experience, thought or research and, to the best of his/her knowledge, is not copied from another source.)

6. ☐ **This proposal is not original material. The source (if known) is as follows:**

____

Type or print legibly. If supplementary material (photographs, diagrams, reports, etc.) is included, you may be required to submit sufficient copies for all members of reviewing committees or task forces.

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