JOINT CANADA-UNITED STATES
NATIONAL STANDARD

# ANSI/CAN/UL 144:2024A

# STANDARD FOR SAFETY

## LP-Gas Regulators and Regulator Systems



Approved American National Standard

ANSI/UL 144-2024

## SCC FOREWORD

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UL Standard for Safety for LP-Gas Regulators and Regulator Systems, ANSI/CAN/UL 144

Ninth Edition, Dated January 22, 2021

***Summary of Topics***

***This revision of ANSI/CAN/UL 144 dated August 5, 2024 has been issued to correct torque values under the column heading "(pound-inches)" in Table 20.1.***

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

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**ANSI/CAN/UL 144:2024A**

# Standard for LP-Gas Regulators and Regulator Systems

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# Preface

This is the Ninth Edition of ANSI/CAN/UL 144, Standard for LP-Gas Regulators and Regulator Systems.

ULSE is accredited by the American National Standards Institute (ANSI) and the Standards Council of Canada (SCC) as a Standards Development Organization (SDO).

This Standard has been developed in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization.

This ANSI/CAN/UL 144 Standard is under continuous maintenance, whereby each revision is approved in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization. In the event that no revisions are issued for a period of four years from the date of publication, action to revise, reaffirm, or withdraw the standard shall be initiated.

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

Comments or proposals for revisions on any part of the Standard may be submitted at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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This Edition of the Standard has been formally approved by the Technical Committee (TC) on LP-Gas Regulators, TC 144.

This list represents the TC 144 membership when the final text in this standard was balloted. Since that time, changes in the membership may have occurred.



**TC 144 Membership**

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This Standard is intended to be used for conformity assessment.

The intended primary application of this standard is stated in its scope. It is important to note that it remains the responsibility of the user of the standard to judge its suitability for this particular application.

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## INTRODUCTION

### 1 Scope

1.1 These requirements cover pressure regulators and pressure regulators with components that complete a pressure regulator system, for use with LP-Gas equipment. These components include, but are not limited to:

a) Changeover manifolds,

b) Check manifolds,

c) Service indicators,

d) LP-gas hose.

NOTE: For the purposes of this standard the terms “LP-Gas” and “Propane” are interchangeable.

1.2 Regulators covered by these requirements are intended to be installed and used in systems in accordance with the applicable Codes and Regulations as determined by the Authority Having Jurisdiction (AHJ), such as, but not limited to:

a) In the United States:

1) Liquefied Petroleum Gas Code, NFPA 58;

2) National Fuel Gas Code, NFPA 54;

3) Outdoor Cooking Gas Appliances, CSA/AM ANSI Z21.58/CSA 1.6; and

b) In Canada:

1) Natural gas and propane installation code, CSA B149.1;

2) Outdoor Cooking Gas Appliances, CSA/AM ANSI Z21.58/CSA 1.6;

3) CAN/CSA Z240 RV Series, Recreational Vehicles;

4) CAN/CSA Z241 Series, Park model trailers; and

5) Provincial or other Regulations.

1.3 These requirements do not cover:

a) Compressed gas regulators;

b) Gas appliance pressure regulators;

c) Regulators for use in chemical, petroleum, or utility power plants; pipeline or marine terminals; or related storage facilities at such plants or terminals;

d) Combination gas control valves for gas appliances;

e) Regulators for use in oxygen-fuel, gas-welding, and cutting operations; and

f) Regulators for use in engine fuel (automotive and/or marine) applications.

The requirements for (a) – (e) are covered in: the Standard for Compressed Gas Regulators, UL 252, or CGA E-4, Standard for Compressed Gas Regulators; and in the Standard for Gas Appliance Pressure Regulators, CSA/AM CSA/ANSI Z21.18/CSA 6.3, and in the Standard for Combination Gas Controls for Gas Appliances, CSA/AM CSA/ANSI Z21.78/CSA 6.20, respectively.

1.4 The assigning of flow ratings to regulators is not within the scope of these requirements

## 2 Units of Measurement

2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

## 3 Components

3.1 Except as indicated in 3.2, a component of a product covered by this standard shall comply with the requirements for that component.

3.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

3.3 A component shall be used in accordance with its rating established for the intended conditions of use.

3.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

## 4 Referenced Publications

4.1 The documents shown below are referenced in the text of this Standard. Any undated reference to a code or standard appearing in the requirements of this Standard shall be interpreted as referring to the latest edition of that code or standard.

### UL Standards

UL 252, *Standard for Compressed Gas Regulators*
UL 569, *Standard for Pigtails and Flexible Hose Connectors for LP-Gas*
UL 2061, *Standard for Adapters and Cylinder Connection Devices for Portable LP-Gas Cylinder Assemblies*

### Other Standards

ASME B1.20.1, *Pipe Threads, General Purpose*
ASME B16.26, *Cast Copper Alloy Fittings for Flared Copper Tubes*
ASME B36.10M, *Welded and Seamless Wrought Steel Pipe*
ASTM B16, *Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines*
ASTM B26/B26M, *Standard Specification for Aluminum-Alloy Sand Castings*
ASTM A47, *Standard Specification for Ferritic Malleable Iron Castings*
ASTM A48, *Standard Specification for Gray Iron Castings*

ASTM B61, *Standard Specification for Steam or Valve Bronze Castings*
ASTM B62, *Standard Specification for Composition Bronze or Ounce Metal Castings*
ASTM B85, *Standard Specification for Aluminum-Alloy Die Castings*
ASTM B86, *Standard Specification for Zinc-Alloy Die Castings*
ASTM B108, *Standard Specification for Aluminum-Alloy Permanent Mold Castings*
ASTM B124, *Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes*
ASTM B176, *Standard Specification for Copper-Alloy Die Castings*
ASTM B211, *Standard Specification for Aluminum or Aluminum-Alloy Bar, Rod, and Wire*
ASTM B283, *Standard Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed)*
ASTM A395, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*
ASTM D471, *Standard Test Method for Rubber Property-Effect of Liquids*
ASTM A536, *Standard Specification for Ductile Iron Castings*
ASTM B584, *Standard Specification for Copper Alloy Sand Castings for General Applications*
ASTM B858, *Standard Test Method for Ammonia Vapor Test for Determining Susceptibility to Stress Corrosion Cracking in Copper Alloys*
CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*
CGA E-4, *Standard for Gas Pressure Regulators*
CSA/AM ANSI Z21.58/CSA 1.6, *Outdoor Cooking Gas Appliances*
CSA/AM CSA/ANSI Z21.18/CSA 6.3, *Standard for Gas Appliance Pressure Regulators*
CSA/AM CSA/ANSI Z21.78/CSA 6.20, *Standard for Combination Gas Controls for Gas Appliances*
CSA 8.1, *Elastomeric composite hose and hose couplings for conducting propane and natural gas*
CSA 8.3, *Thermoplastic hose and hose couplings for conducting propane and natural gas*
CSA B149 Series, *Propane storage and handling code*
NFPA 54, *National Fuel Gas Code*
NFPA 58, *Liquefied Petroleum Gas Code*
SAE J512, *Automotive Tube Fittings*

**Abbreviations**

*ANSI – American National Standards Institute*
*ASME – American Society of Mechanical Engineers*
*ASTM – American Society for Testing and Materials*
*CGA – Compressed Gas Association*
*CSA – CSA Group*
*NFPA – National Fire Protection Association*
*SAE – Society of Automotive Engineers*

## 5 Terminology

5.1 The term "regulator" as used in this standard refers to a device placed in a gas line for reducing, controlling, and maintaining the pressure in that portion of the piping system downstream of the device.

## 6 Glossary

6.1 For the purpose of this standard the following definitions apply.

6.2 AUTHORITY HAVING JURISDICTION (AHJ) – The governmental body responsible for the enforcement of any part of this Standard or the official or agency designated by that body to exercise such a function.

6.3 FLOW CAPACITY – The maximum flow rate of a regulator at conditions as specified by the manufacturer, usually given in units of kW (BTU/h) and which is based upon factory setting of inlet and outlet (delivery) pressures.

6.4 LOCKUP PRESSURE – The outlet pressure of the regulator under no-flow conditions.

6.5 MANIFOLD:

a) AUTOMATIC CHANGEOVER MANIFOLD – A unit that combines two high-pressure regulators into a single unit that is intended to be connected to the inlet of a second-stage regulator. It incorporates two inlet connections with a single outlet connection, which is intended for use with dual or multiple cylinder installations. It incorporates a service-reserve indicator or provision for attachment of a service-reserve indicator. The manifold automatically changes the LP-Gas vapor withdrawal from the designated service cylinder to the designated reserve cylinder without interruption of service. A switching device is manually selected to alternate between the service and reserve cylinders.

b) CHECK MANIFOLD – A unit that incorporates two inlet connections with a single outlet connection, which is intended for use with dual cylinder installations for use in systems that require uninterrupted gas service during cylinder exchange. They serve to minimize discharge of gas to the atmosphere when the empty cylinder is being replaced.

6.6 OVERPRESSURE SHUTOFF (OPSO) FEATURE – A feature that shuts off the flow of LP-Gas vapor when the outlet pressure of the regulator reaches a predetermined maximum pressure.

6.6A PRESSURE REGULATOR SYSTEM – A pressure regulator and components provided with or installed on the regulator.

6.7 REGULATOR:

a) AUTOMATIC CHANGEOVER REGULATOR – An integral two-stage regulator that combines two high-pressure regulators and a second-stage regulator into a single unit. It incorporates two inlet connections that is designed for use with dual or multiple cylinder installations. The system automatically changes the LP-Gas vapor withdrawal from the designated service cylinder(s) to the designated reserve cylinder(s) without interruption of service. It incorporates a service-reserve indicator or provision for attachment of a service-reserve indicator. The service-reserve indicator gives a visual indication of the cylinder(s) that are supplying the system. A switching device is manually selected to alternate between the service and reserve cylinders.

b) FIRST-STAGE REGULATOR – A type of high-pressure regulator for LP-Gas vapor service designed to reduce pressure from the container to a nominal pressure of 13.7 – 68.7 kPa (2 – 10 psig).

c) HIGH-PRESSURE REGULATOR – A pressure regulator for LP-Gas liquid or vapor service designed to reduce pressure from the container to a lower pressure in excess of 6.9 kPa (1.0 psig).

d) INTEGRAL 13.8 KPA (2 PSIG) SERVICE REGULATOR – A pressure regulator that combines a high-pressure regulator and a 13.8 kPa (2 psig) 13.8 kPa (2 psig)service regulator into a single unit.

e) INTEGRAL TWO-STAGE REGULATOR – A pressure regulator that combines a high-pressure regulator and a second-stage regulator into a single unit.

f) MANUAL CHANGEOVER REGULATOR – A single-stage regulator with a manifold that contains two inlets that allow LP-Gas to flow from one inlet or the other using a handle or lever through the single-stage regulator to the gas consuming equipment. It is designed to be used with two LP-Gas containers. When the supply is exhausted from one container, the lever or handle must be manually moved to allow LP-Gas to flow from the second container.

g) SECOND-STAGE REGULATOR – A pressure regulator for LP-Gas vapor service designed to reduce first-stage regulator outlet pressure to a pressure equal to or less than 356 mm (14 in) water column [nominal 279 mm (11 in) water column].

h) SINGLE-STAGE REGULATOR – A pressure regulator for LP-Gas vapor service designed to reduce pressure from the container to a pressure of 6.9 kPa (1 psig) or less [nominal 279 mm (11 in) water column].

i) SPECIAL-PURPOSE HIGH-PRESSURE REGULATOR – A pressure regulator for LP-Gas designed to reduce the prevailing cylinder, tank or other pressure in excess of 6.9 kPa (1 psig) to a lower pressure. This regulator is not intended for installation in two-stage piping systems that serve 3.45 kPa (0.5 psi) appliance systems.

j) SPECIAL-PURPOSE LOW PRESSURE REGULATOR – A pressure regulator for LP-Gas vapor service designed to reduce high-pressure or first-stage regulator outlet pressure to a maximum pressure of 6.9 kPa (1 psig) or less. This regulator is not intended for installation in two-stage piping systems that serve 3.45 kPa (0.5 psi) appliance systems.

k) 13.8 KPA (2 PSIG) SERVICE REGULATOR – A type of regulator for LP-Gas vapor service designed to reduce first-stage regulator outlet pressure to a pressure of 17.2 kPa (2.5 psig) or less [nominal 13.8 kPa (2 psig)].

6.8 SERVICE-RESERVE INDICATOR – A device that gives a visual indication when the regulator system has switched from the designated “service” cylinder to the designated “reserve” cylinder.

6.8.1 UNDER PRESSURE SHUTOFF (UPSO) FEATURE – A feature that shuts off the flow of LP-Gas vapor when there is a lack of regulated pressure.

6.9 VALVE:

a) TYPE I RELIEF VALVE – A valve that is constructed to relieve pressure resulting from seat leakage due to the inability of the seat mechanism to achieve lock-up.

b) TYPE II RELIEF VALVE – A valve that has a start-to-discharge setting in accordance with Table 18.1 and is constructed to limit regulator outlet pressure to 13.8 kPa (2 psig) [for second-stage, integral two-stage and automatic changeover regulators when used as part of a two-stage regulator system] or 34.5 kPa (5 psig) [for 13.8 kPa (2 psig) service and integral 13.8 kPa (2 psig)13.8 kPa (2 psig)service regulators when used as part of a 13.8 kPa (2 psig) regulator system] when tested in accordance with the Type II Relief Valve Flow Capacity Test, Section 31.

## 7 Service Pressure and Temperature Ratings

7.1 The maximum inlet pressure rating of a single-stage regulator, first-stage regulator, high-pressure regulator, integral two-stage regulator, or integral 13.8 kPa (2 psig) service regulator shall not be less than 1723.7 kPa (250 psig).

7.2 The maximum inlet pressure rating for a second-stage regulator or 13.8 kPa (2 psig) service regulator shall be 68.9 kPa (10 psig), or as specified by the manufacturer, whichever is greater.

7.3 Regulators shall meet all of the requirements of this standard when exposed to ambient temperatures within the range of -40°C – +55°C (-40°F – +130°F).

## CONSTRUCTION

### 8 Assembly

8.1 A regulator, designed for field adjustment, shall be provided with convenient means of adjustment.

8.2 A screw, bolt, or lever-pin hole shall not extend through the outer wall of the regulator body into a gas-handling chamber unless closed by a threaded plug or the equivalent means to prevent leakage of gas.

8.3 A valve seat or disc shall be attached to its holder by a method that does not permit the disc to loosen and work out of position when tested in accordance with the requirements in Section 22, Leakage and Strength of Mechanism Test, and Section 33, Endurance Test.

8.4 A holder and disc assembly shall be constructed to preclude the trapping of air or gas behind the disc that may expand and force the disc out of its position in the holder.

8.5 A regulator having an external adjusting screw shall be constructed so that turning the screw clockwise will increase the regulator outlet pressure. See the Exception to 17.1.

8.6 A means to determine the outlet pressure of the high-pressure regulator portion in an integral two-stage or integral 13.8 kPa (2 psig) service regulator shall be provided.

8.7 Automatic changeover manifolds and automatic changeover regulators shall incorporate a service-reserve indicator, or a provision for the attachment of a service-reserve indicator.

### 9 Materials

9.1 A part of a regulator in contact with LP-Gas shall be resistant to the action of the gas under the service conditions to which it is subjected.

a) With reference to this requirement all elastomeric materials shall be subjected to:

1) Section 38, LP-Gas Compatibility Test;

2) Section 41, Accelerated-Aging Test; and

3) Section 42, Low Temperature Test.

b) With reference to this requirement all polymeric materials shall be subjected to:

1) Section 38, LP-Gas Compatibility Test; and

2) Section 41, Accelerated-Aging Test.

*Exception: Acetal polymers, chlorotrifluoroethylene polymers, tetrafluoroethylene, fluorinated ethylene propylene polymers, and polyamides of composition polyhexamethylene adipamide or polycaproamide polymers (nylon 6, 6/6, or 6/16) are only to be subjected to the requirements of Section 41, Accelerated-Aging Test.*

9.2 When an engineering analysis indicates that corrosion of a part interferes with the function of the regulator, or corrosion results in deterioration of performance, the part shall be of a corrosion-resistant material or shall be provided with a corrosion-resistant protective coating.

9.3 A protective coating shall provide resistance against corrosion to a degree not less than that provided by the protective coatings specified in 9.4.

9.4 Cadmium plating shall be minimum 0.0076 mm (0.0003 in) thick, and zinc plating shall be minimum 0.013 mm (0.0005 in) thick.

*Exception: When threads constitute the major portion of the area of a part, the thickness of the cadmium or zinc plating shall be minimum 0.0038 mm (0.00015 in) thick.*

9.5 The body and bonnet of a regulator shall be made of one of the materials specified in (a) – (g), or of a specification that has been determined to be the equivalent. A non-metallic material shall not be used for the body or bonnet of a regulator.

a) Aluminum alloys, as specified in Standard Specification for Aluminum-Alloy Sand Castings, ASTM B26/B26M; Standard Specification for Aluminum-Alloy Die Castings; ASTM B85, Standard Specification for Aluminum or Aluminum-Alloy Bar, Rod, and Wire; ASTM B211, or Standard Specification for Aluminum-Alloy Permanent Mold Castings, ASTM B108.

b) Ductile (nodular) iron as specified in the Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures, ASTM A395, or Grade 60-40-18 or 65-45-12 as specified in the Standard Specification for Ductile Iron Castings, ASTM A536.

c) Malleable iron as specified in the Standard Specification for Ferritic Malleable Iron Castings, ASTM A47.

d) High-strength Gray Iron Class 40B as specified in the Standard Specification for Gray Iron Castings, ASTM A48.

e) Copper alloys complying with Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes, ASTM B124; Standard Specification for Steam or Valve Bronze Castings, ASTM B61; Standard Specification for Composition Bronze or Ounce Metal Castings, ASTM B62; Standard Specification for Copper-Alloy Die Castings, ASTM B176; Standard Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed), ASTM B283; Standard Specification for Copper Alloy Sand Castings for General Applications, ASTM B584 or Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines; ASTM B16.

f) Steel.

g) Zinc alloys AG 40A, AG 40B, AC 41A, or AC 43A as specified in the Standard Specification for Zinc-Alloy Die Castings, ASTM B86.

9.6 A body of a service-reserve indicator shall comply with 9.5. A non pressurized service-reserve indicator housing or cap is permitted to be constructed of non-metallic materials.

## 10 Bodies and Bonnets

10.1 T body and a bonnet of a regulator or a manifold shall withstand the stresses of connecting the regulator or manifold to piping, as well as other stresses imposed by service conditions, without developing leakage at joints, permanent deformation, or other damage which impairs the serviceability of the regulator or manifold. See Section 20, Deformation Test, Section 26, Strength of Body Test, and Section 33, Endurance Test.

10.2 A body of a service indicator shall withstand the stresses of connecting the indicator to piping or tubing. See Section 20, Deformation Test, and Section 35, Service-Reserve Indicator Endurance Test.

10.3 Any flanges of a body and a bonnet of a regulator or manifold constructed to be clamped together shall withstand the stresses imposed by normal tightening of the clamping screws or bolts. Clamping screws or bolts shall be spaced sufficiently close together so as to preclude the necessity of using excessive force in tightening to obtain joints that are tight against leakage. See Section 22, Leakage and Strength of Mechanism Test, and Section 26, Strength of Body Test.

10.4 When warping of a casting-affects the tightness of gas -confining joints or the required fit of parts, the part shall be stress-relieved to reduce the risk of warping. See Section 22 Leakage and Strength of Mechanism Test.

10.5 The inlet of a regulator shall conform to one of the following:

a) CGA No. 510 or 600 fitting in accordance with the Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections, CGA V-1;

b) Standard for Pipe Threads, General Purpose, ANSI/ASME B1.20.1;

c) Automotive Tube Fittings, SAE J512;

d) Cast Copper Alloy Fittings for Flared Copper Tubes, ANSI/ASME B16.26; or

e) A CGA No. 791, 793, or 810 appliance portion of the cylinder connection device in accordance with the Standard for Adapters and Cylinder Connection Devices for Portable LP-Gas Cylinder Assemblies, UL 2061 or the Standard for Cylinder Connection Devices, ANSI Z21.81 and described in CGA V-1, Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections. If the Type CGA 791 or CGA 793 inlet connection is integral with the regulator body so that the connection cannot be removed in service, the flow limiting device as required by UL 2061 is allowed to be part of the regulator construction, complying with material requirements of this standard. The performance of the inlet connection-regulator combination shall be in accordance with UL 2061 and this standard.

*Exception: The regulator is not prohibited from being provided with an inlet connection other than those previously described, when it is marked in accordance with 44.1(i).*

10.6 The outlet of a regulator shall comply with 10.5 (b), (c), or (d), or the Exception to 10.5.

10.7 The opening in the body of an automatic changeover regulator or automatic changeover manifold that communicates with the service indicator component shall not exceed that of a No. 54 drill orifice [1.4 mm (0.055 in)].

## 11 Bonnet Vent Openings

11.1 A regulator shall be provided with a vent opening in the bonnet to permit the displacement of air due to any intended movement or breathing of the diaphragm.

11.2 When a regulator is constructed with an integral pressure relief valve, the vent opening shall also serve as the pressure-relief discharge opening.

11.3 The vent opening shall be of such size and located or protected so as to reduce the risk of clogging under service conditions.

11.4 The vent opening in a single-stage regulator, the second stage of an integral two-stage regulator, an automatic changeover regulator, a second-stage regulator, a 13.8 kPa (2 psig) service regulator, or the 13.8 kPa (2 psig) stage of an integral 13.8 kPa (2 psig) service regulator shall be provided with a drip lip having an inside diameter not less than 17.5 mm (11/16 in) and an outside diameter of not less than 19.1

mm (3/4 in), and having a screened opening recessed at least 1.6 mm (1/16 in) from the opening face. See Figure 11.1 for a typical construction. Such regulators shall be marked as specified in 44.1(d).

*Exception: The vent opening is not required to be constructed as described above when:*

*a) The regulator is marked as specified in 44.1(e) or*

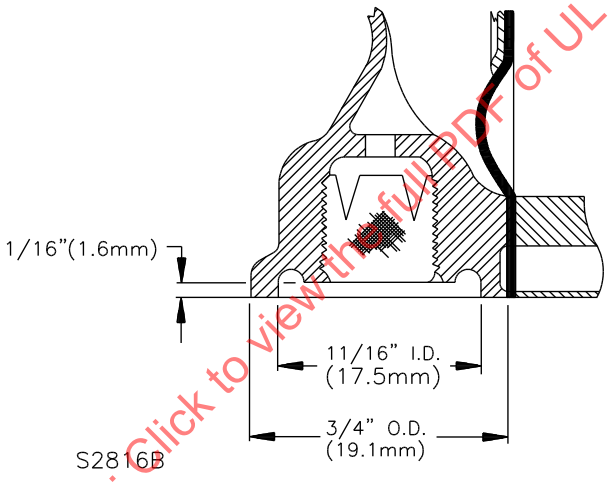
*b) The regulator is:*

*1) Marked as specified in 44.1(f) and*

*2) The construction, as determined by test, is such that the vent opening is not subject to blockage when exposed to the effects of freezing rain. See Section 36, Freezing Rain Test.*

**Figure 11.1**

**Typical Drip Lip Vent Construction**






11.5 A regulator having a vent opening for connection of vent piping shall have such connection tapped with tapered pipe threads, unless otherwise arranged to permit connection of vent piping or tubing.

11.6 A second-stage or 13.8 kPa (2 psig) service regulator shall be provided with a tapped vent opening or other means for connection to vent piping.

11.7 A regulator shall be constructed to provide drainage of all condensate from the entire regulator bonnet cavity when the vent is directed vertically down.

*Exception: For integral two-stage regulators, automatic changeover regulators, and integral 13.8 kPa (2 psig) service regulators this requirement applies to the second-stage bonnet cavity and vent opening.*

## 12 Bonnet Caps

12.1 A spring-adjusting screw opening in a bonnet shall be closed by a cap, or shall be constructed so as to exclude the entrance of water, dirt, and other contaminants. For single-stage regulators having a capacity not greater than 29.3 kW (100,000 BTU/h), a hole in the cap is acceptable, if the regulator is marked in accordance with 44.1(e).

12.2 An unthreaded bonnet cap shall be mechanically secured in place.

12.3 A bonnet cap of a regulator intended for connection of vent piping shall provide means for the making of a tight joint.

## 13 Springs

13.1 A spring shall be of such construction and material that its function is not impaired by abrasion or the stresses imposed by the intended use.

13.2 A spring shall be guided and arranged to prevent buckling, binding, or other interference with its free movement to the degree where it interferes with the operation of the regulator.

## 14 Diaphragms

14.1 A diaphragm shall be guarded or enclosed to reduce the risk of damage.

14.2 A part in contact with a diaphragm shall have no sharp edges, burrs, projections, or other surfaces, that chafe or abrade the diaphragm.

## 15 Linkage Mechanisms

15.1 The construction and arrangement of the linkage shall allow for wear of bearing parts and for wear or indentation of the valve seat or disc without impairing the linkage function.

15.2 Bearing or fulcrum pins and screws used in the linkage assembly shall be secured to prevent them from loosening or working out of position.

## 16 Hose Assemblies

16.1 An integral hose assembly on a regulator shall comply with the applicable construction and performance requirements in the Standard for Pigtails and Flexible Hose Connectors for LP-Gas, UL 569, CSA 8.1, Elastomeric composite hose and hose couplings for conducting propane and natural gas or CSA 8.3, Thermoplastic hose and hose couplings for conducting propane and natural gas.

## 17 Pressure-Regulating Adjustments

17.1 An adjustable regulator shall be provided with a convenient means for adjustment within the limits of minimum and maximum regulator outlet pressures. The means for adjustment shall be enclosed or shielded to discourage tampering after adjustment has been made.

*Exception: For a high-pressure regulator, the means of adjustment is not required to be enclosed or shielded.*

17.2 A regulator shall not be able to attain an operating (not lock-up) outlet pressure greater than that indicated in Table 17.1 for each type of regulator tested in accordance with Section 21, Regulating Adjustment Test.

**Table 17.1**
**Maximum Outlet Pressure for Regulator Type**

| Regulator type | Maximum outlet pressure, kPa | (psig) |
|---|---|---|
| single-stage, special-purpose low pressure | 6.9 | (1.0) |
| 13.8 kPa (2 psig) service | 17.2 | (2.5) |
| first-stage | 103.4 | (15.0) |
| second-stage | 4.0 [16-in water column] | (0.577) |
| integral two-stage | | |
| first-stage | 103.4 | (15.0) |
| second-stage | 4.0 [16-in water column] | (0.577) |
| high-pressure, special-purpose high-pressure | As specified by the manufacturer | |
| automatic changeover | | |
| high-pressure stage | 138 | (20.0) |
| second-stage | 4.0 [16-in water column] | (0.577) |
| integral 13.8 kPa (2 psig) service | | |
| high pressure stage | 103.4 | (15.0) |
| 13.8 kPa (2 psig) stage | 17.2 | (2.5) |

17.3 A pressure-regulating spring adjustment shall not be able to compress the spring to its compressed solid height, or otherwise interfere with lockup.

## 18 Regulator Overpressure Protection

18.1 A single-stage regulator, first-stage regulator, or special-purpose low pressure regulator shall incorporate in its assembly one of the methods specified in (a) or (b) below to reduce the risk of a build-up of an excessive outlet pressure.

a) A Type I relief valve having a start-to-discharge (s-t-d) pressure setting within the limits specified in Table 18.1. See Section 30, Type I Relief Valve Flow Capacity Test.

b) An overpressure shutoff (OPSO) feature that operates to shut off the flow of gas when the regulator outlet pressure reaches the limits specified in Table 18.1. Such a feature shall remain closed until it has been manually reset. The OPSO feature shall comply with Section 32, Overpressure Shutoff (OPSO) Feature Tests.

## Table 18.1
## Regulator Relief Valve and Overpressure Shutoff (OPSO) Feature Performance Limits (Notes 1 and 2)

| Regulator type | Regulator outlet pressure setting (Note 2) | Type I & Type II relief valve S-T-D (outlet) pressure limits (Note 3) | | Type II relief valve limit (regulator outlet pressure) (Note 4) | Overpressure shutoff feature activation limit (regulator outlet pressure) (Note 5) | |
|---|---|---|---|---|---|---|
| | | Minimum | Maximum | Maximum | Minimum (Notes 3) | Maximum |
| First-stage | Above 6.9 kPa (1 psig) and not over 34.5 kPa (5 psig) | 140% | 250% | Not required | 200% | 34.5 kPa (5 psig) above minimum |
| | Above 34.5 kPa (5 psig) but not over 69 kPa (10 psig) | 140% | 200% | Not required | 200% | 34.5 kPa (5 psig) above minimum |
| High pressure, | Above 6.9 kPa (1 psig) and not over 34.5 kPa (5 psig) (as specified by mfr.) | 140% | 250% | Not required | 200% | 34.5 kPa (5 psig) above minimum |
| | Above 34.5 kPa (5 psig ) but not over 103.5 kPa (15 psig) (as specified by mfr.) | 140% | 200% | Not required | 200% | 34.5 kPa (5 psig) above minimum |
| | Above 103.5 kPa (15 psig) (as specified by mfr.) | 140% | 200% | Not required | 69 kPa (10 psig) above outlet pressure | 69 kPa (10 psig) above minimum |
| Special-purpose high pressure | Above 6.9 kPa (1 psig) and not over 34.5 kPa (5 psig) (as specified by mfr.) | 140% | 250% | Not required | 200% | 34.5 kPa (5 psig) above minimum |
| | Above 34.5 kPa (5 psig) but not over 103.5 kPa 7(15 psig) (as specified by mfr. | 140% | 200% | Not required | 200% | 34.5 kPa (5 psig) above minimum |
| | Above 103.5 kPa (15 psig) (as specified by mfr.) | 140% | 200% | Not required | 69 kPa (10 psig) above outlet pressure | 69 kPa (10 psig) above minimum |
| Two-psig service | 13.8 kPa (2.0 psig) | 140% | 250% | 34.5 kPa (5 psig) | 27.6 kPa (4 psig) | 34.5 kPa (5 psig) |
| Integral two-psig service | 13.8 kPa (2.0 psig) | 140% | 250% | 34.5 kPa (5 psig) | 27.6 kPa (4 psig) | 34.5 kPa (5 psig) |

Table 18.1 Continued on Next Page

## Table 18.1 Continued

| Regulator type | Regulator outlet pressure setting (Note 2) | Type I & Type II relief valve S-T-D (outlet) pressure limits (Note 3) | | Type II relief valve limit (regulator outlet pressure) (Note 4) | Overpressure shutoff feature activation limit (regulator outlet pressure) (Note 5) | |
|---|---|---|---|---|---|---|
| | | Minimum | Maximum | Maximum | Minimum (Notes 3) | Maximum |
| Second-stage | 2.7 kPa (11 in WC) | 170% | 300% | 13.8 kPa (2 psig) | 350% | 13.8 kPa (2 psig) |
| Integral two-stage | 2.7 kPa (11 in WC) | 170% | 300% | 13.8 kPa (2 psig) | 350% | 13.8 kPa (2 psig) |
| Automatic changeover regulator | 2.7 kPa (11 in WC) | 170% | 300% | 13.8 kPa (2 psig) | 350% | 13.8 kPa (2 psig) |
| Special-purpose low pressure | Less than 6.9 kPa (1 psig) | 170% | 300% | Not required | 350% | 13.8 kPa (2 psig) |
| Single stage | 2.7 kPa (11 in WC) | 170% | 300% | Not required | 350% or as specified by mfr. (Note 6) | 13.8 kPa (2 psig) or as specified by mfr. (Note 6) |

**NOTES**

1 – 18.1, 18.2, and 18.3 indicate what type of overpressure protection is required (or prohibited) for the various types of regulators. This table indicates the activation limits when such features are provided.

2 – Regulator outlet pressure settings as specified in Table 28.1.

3 – Limits are expressed as a percentage of regulator outlet pressure setting as specified in Table 28.1.

4 – When tested in accordance with Type II Relief Valve Flow Capacity Test, Section 31.

5 – Limits shown only apply if the shutoff feature is provided, in accordance with 18.1(b) or 18.3(b) and when tested in accordance with Overpressure Shutoff (OPSO) Feature Tests, Section 32.

6 – When activation is not within the limits shown but is as specified by the manufacturer, the maximum limit shall be marked on the regulator in accordance with 44.1(j).

18.2 The use of a Type I relief valve or overpressure shutoff (OPSO) feature with a high-pressure regulator shall not be required. A relief valve shall not be used in the high-pressure regulators of an automatic changeover manifold, the high-pressure stages of an automatic changeover regulator, the first stage of an integral two-stage regulator, or the first stage of an integral 13.8 kPa (2 psig) service regulator.

18.3 A second-stage regulator, a 13.8 kPa (2 psig) service regulator, the second stage of an integral two-stage regulator, the second stage of an integral 13.8 kPa (2 psig) service regulator, or the second stage of an automatic changeover regulator shall incorporate in its assembly one of the following as specified below in (a) or (b) to reduce the risk of a build-up of excessive outlet pressure.

a) A Type II pressure relief valve having a start-to-discharge (s-t-d) pressure setting within the limits specified in Table 18.1, and which will limit the downstream delivery pressure to 13.8 kPa (2 psig) for a second-stage regulator and the second-stage of an integral two-stage or automatic changeover regulator, and 34.5 kPa (5 psig) for 13.8 kPa (2 psig) service regulators and the second-stage of an integral 13.8 kPa (2 psig) service regulator under specified test conditions. See the Type II Relief Valve Flow Capacity Test, Section 31.

b) An overpressure shutoff (OPSO) feature in accordance with 18.1(b).

18.4 The means of adjustment for a pressure-relief valve or an overpressure shutoff (OPSO) feature shall reduce the risk of any unintentional change in the setting and discourage tampering with such a setting.

18.5 An overpressure shutoff feature incorporated in the assembly of a regulator shall not be rendered inoperative in the event of malfunction of the regulator valve seat. See 33.1.2 and Section 32, Overpressure Shutoff (OPSO) Feature Tests,. For an integral 13.8 kPa (2 psig) service regulator, integral two-stage regulator or automatic changeover regulator, malfunction for this test applies to the second-stage valve seat of the regulator.

18.6 An overpressure shutoff (OPSO) feature that is activated by the regulator linkage mechanism shall close upon failure, or upon separation of the regulator linkage.

18.7 The overpressure shutoff (OPSO) feature incorporated in the assembly of a regulator shall be independent of the regulator linkage assembly after activation of the shutoff feature. The regulator linkage shall not be permitted to maintain the overpressure shutoff (OPSO) feature in the closed position.

## 18A Regulators With Under-Pressure Shut Off (UPSO) Protection

18A.1 An underpressure shutoff (UPSO) feature shall operate to shut off the flow of gas when the regulator outlet pressure reaches the limits specified in Table 18A.1. Such a feature shall remain closed until it has been manually reset. The UPSO feature shall comply with Underpressure Shutoff (UPSO) Feature Test, Section 32A.

18A.2 The shut off device closing mechanism, measuring device and external impulse tube if any, shall be independent of the regulating mechanism.

18A.3 The shut-off device shall shut off the gas flow only when the outlet pressure is within the limits specified in Table 18A.1.

**Table 18A.1**
**Regulator Underpressure Shutoff (UPSO) Feature Performance Limits**

| Regulator type | Regulator outlet pressure setting[a] | Underpressure shutoff feature activation limit (regulator outlet pressure)[a,b] | |
|---|---|---|---|
| | | Minimum | Maximum |
| First-stage | Above 1 psig (6.9) and not over 5 psig (34.5) | 7 in WC (1.74) | 13 in WC (3.2) |
| | Above 5 psig (34.5) but not over 10 psig (69) | 32 in WC (7.96) | 52 in WC (12.94) |
| Mnh High pressure | Above 1 psig (6.9) and not over 5 psig (34.5) (as specified by mfr.) | 7 in WC (1.74) | 13 in WC (3.2) |
| | Above 5 psig (34.5) but not over 15 psig (103.5) (as specified by mfr.) | 32 in WC (7.96) | 52 in WC (12.94) |
| | Above 15 psig (103.5) (as specified by mfr.) | specified by mfr. | Specified by mfr. |
| Special-purpose high pressure | Above 1 psig (6.9) and not over 5 psig (34.5) (as specified by mfr.) | 7 in WC (1.74) | 13 in WC (3.2) |
| | Above 5 psig (34.5) but not over 15 psig (103.5) (as specified by mfr.) | 32 in WC (7.96) | 52 in WC (12.94) |
| | Above 15 psig (103.5) (as specified by mfr.) | specified by mfr. | specified by mfr. |
| Two-psig service | 2.0 psig (34.5) | 7 in WC (1.74) | 13 in WC (3.2) |
| Integral two-psig service | 2.0 psig (34.5) | 7 in WC (1.74) | 13 in WC (3.2) |
| Second-stage | 11 inch WC (2.7) | 3 in WC (0.75) | 7 in WC (1.74) |
| Integral two-stage | 11 inch WC (2.7) | 3 in WC (0.75) | 7 in WC (1.74) |
| Automatic changeover regulator | 11 inch WC (2.7) | 3 in WC (0.75) | 7 in WC (1.74) |
| Special-purpose low pressure | Less than 1 psig (6.9) | 3 in WC (0.75) | 13 in WC (3.2) |
| Single stage | 11 inch WC (2.7) | 3 in WC (0.75) | 7 in WC (1.74) |

[a] Numbers in parenthesis are pressure values in kilopascal gauge (kPag) units.

[b] Regulator outlet pressure settings as specified in Table 28.1.



18A.4 The UPSO feature shall be designed in such a way that, without manual intervention, it can only be in the fully open position or fully closed position. If the resetting device also acts as a manual closing valve using a rotating handle, the sense of shutting off the gas shall be clockwise. If the resetting device has no other function and if it is accessible, it shall be protected against any intervention which could impair the regulating device's normal operation when it is reset.

## PERFORMANCE

### 19 General

19.1 Representative samples of a regulator shall be subjected to the tests specified in Sections 20 – 38. Additional samples of parts constructed of nonmetallic materials, such as diaphragms and valve seat discs, are required for physical and chemical tests.

19.2 The manufacturer shall provide the LP-Gas regulators rated capacity prior to conducting the Flow Test, 28.1.1 and 28.1.2. The tests in these clauses shall verify the outlet pressure stability characteristics are within the manufacturer's rated capacity.

19.3 Leakage tests shall use a source of aerostatic pressure such as air, nitrogen, or carbon-dioxide gas. Regulator and pressure-relief valve flow tests shall use air as the test medium. Water shall be used for developing the required pressure in Section 26, Strength of Body Test. All aerostatic and hydrostatic pressures shall be maintained for 5 min and 1 min, respectively.

19.4 Test requirements for no leakage refer to no observable leakage over the period of the test with the sample submerged in water or when all joints and body casting surfaces are brushed with a soap and water solution, or equivalent leak-detection solution.

19.5 Piping and fittings used in the testing of a regulator shall be free from dirt, scale, and other foreign particles that affect the operation of the regulator. When required, an air filter shall be installed in the supply piping ahead of the regulator.

19.6 For the purpose of these requirements, standard conditions are considered to be at a base pressure of 102 kPa (760 mm Hg) (14.696 psia) and base temperature of 15.6°C (60°F).

19.7 For the purpose of these requirements, the initial air-flow rate setting shall be calculated as follows:

$$Flow\ Rate = 0.268 \times D$$

in which:

*Flow Rate* is the numerical value being expressed in $m^3/h$ and

*D* is diameter of the regulator orifice in mm

$$Flow\ Rate = 240 \times D$$

in which:

*Flow Rate* is the numerical value being expressed in $ft^3/h$ and

*D* is diameter of the regulator orifice in inches).

To determine the initial air-flow setting for integral two-stage, integral 13.8 kPa (2 psig) service, and automatic changeover regulators, the diameter of the second stage orifice shall be used.

*Exception: At the manufacturer's option, a different initial air flow rate setting may be used, but it shall not be less than that calculated above.*

19.8 Pressure-measuring devices shall be calibrated over the range that they are used. The test pressure measured shall be not less than 20% or more than 80% of the full-scale reading of the device used.

*Exception: The test pressure is allowed to be less than 20% and more than 80% of the full-scale reading of the measuring device, when calibration indicates that there is no loss of accuracy in the measured value.*

## 20 Deformation Test

20.1 Joints in a regulator shall not leak, nor shall there be evidence of distortion or other damage resulting from the stresses imposed on pipe-threaded sections on the body, when tested as described in this section. See Section 19, Performance, General.

20.2 Four regulator samples of each type shall be used in this test. After this test is completed, the samples shall be used in the following tests:

a) One sample shall be used for Section 21, Regulating Adjustment Test, and Section 22, Leakage and Strength of Mechanism Test;

b) One sample shall be used for Section 25, Excess Pressure Test;

c) One sample shall be used for Section 26, Strength of Body Test; and

d) One sample shall be used for Section 27, Lock-Up Test, Section 28, Flow Test, and Section 33, Endurance Test.

20.3 A tool that fits snugly about the body of the regulator, or to a section of the shank shaped for a wrench, when such section is provided, shall be used to apply the turning force. The turning force shall be applied to the hex of the fitting adjacent to where it is attached to piping, or, when no hex is provided in this position, to the body of the regulator. The measured torque specified in Table 20.1 shall be applied to the completely assembled regulator to screw it onto an extra-heavy pipe or into a pipe fitting of appropriate size. The male threads shall have pipe joint sealing compound or polytetrafluoroethylene (PTFE) tape applied to them first or be coated as specified by the manufacturer.

**Table 20.1**
**Torque Requirements for Pipe Connections**

| Pipe size, ANSI/ASME B1.20.1, | | Torque, | |
|---|---|---|---|
| mm | (Nominal inches) | N·m | (pound-inches) |
| 3.2 | (1/8) | 15.3 | (135) |
| 6.4 | (1/4) | 28.2 | (250) |
| 9.5 | (3/8) | 50.8 | (450) |
| 12.7 | (1/2) | 90.4 | (800) |
| 19.1 | (3/4) | 113.0 | (1000) |
| 25.4 | (1) | 135.0 | (1200) |
| 31.8 | (1-1/4) | 164.0 | (1450) |
| 38.1 | (1-1/2) | 175.0 | (1550) |
| 50.8 | (2) | 186.0 | (1650) |



## 21 Regulating Adjustment Test

21.1 Single-stage, first-stage, second-stage, 13.8 kPa (2 psig) service, integral two-stage, integral 13.8 kPa (2 psig) service and automatic changeover regulators, shall comply with Table 17.1 following application of the test as described in 21.2 and 21.3.

21.2 One sample of each type of regulator shall be tested. When more than one main spring is used with a type of regulator, the spring with the highest outlet pressure shall be used.

21.3 Each sample shall be connected to an air supply of adequate capacity and pressure incorporating a flowmeter. A pipe tee and flow control valve shall be connected to the outlet of the sample. A pressure-indicating device shall be connected to the pipe tee. For integral two-stage and integral 13.8 kPa (2 psig) service regulators, a second pressure-indicating device shall be connected to the sample, at the location provided, to determine outlet pressure of the high-pressure stage. With the initial inlet pressure of 690 kPa (100 psig) applied to the sample, the flow control valve shall be adjusted to a flow rate in accordance with 19.6. For adjustable regulators, the outlet pressure shall be adjusted for an outlet pressure as specified in

Table 28.1. The inlet pressure is then to be increased to 250 psig (1725 kPa) and the adjustment set to maximum (when of the regulator design provides for adjustment).

*Exception: For a second-stage regulator or 13.8 kPa (2 psig) service regulator the initial inlet pressure shall be 69 kPa (10 psig) and maximum pressure applied shall be 103.4 kPa (15 psig), or the manufacturer's inlet pressure rating, whichever is greater.*

## 22 Leakage and Strength of Mechanism Test

22.1 A regulator shall withstand for at least 5 min, without leakage at joints, an internal aerostatic pressure of 1.5 times the maximum obtainable outlet pressure, and not less than 41.4 kPa (6 psig). See Section 21, Regulating Adjustment Test.

*Exception: For a second-stage regulator, and the second stage of integral two-stage and automatic changeover regulators incorporating Type II relief valves, the maximum test pressure shall be 20.7 kPa (3 psig).*

22.2 If a regulator incorporates a static seal that is subjected to inlet pressure, those portions of a sample shall be subjected to an aerostatic pressure of 2585.5 kPa (375 psig) or 1.5 times rated pressure if less than 1723 kPa (250 psig) for 1 min without any signs of external leakage at the static seal joint.

22.3 A regulator shall withstand for 5 min, without deformation of the valve-to-diaphragm linkage mechanism and without evidence of porosity in castings, an internal aerostatic pressure of 2.5 times the maximum obtainable outlet pressure, and not less than 41.4 kPa (6 psig) or more than 1723.7 kPa (250 psig).

22.4 The regulator samples to be used in these tests shall be those previously subjected to the requirements of Section 20, Deformation Test, and Section 21, Regulating Adjustment Test. When the regulator incorporates a relief valve, a specially prepared sample shall be submitted with the relief valve blocked or otherwise rendered inoperable.

22.5 The inlet opening of the regulator shall be closed and the aerostatic pressure shall be applied through the outlet opening.

22.6 The regulator shall be first subjected to the aerostatic leakage test pressure. The internal pressure is then to be increased to that specified in 22.2. Following the application of increased pressure, the regulator shall be dismantled and the internal linkage mechanism shall be examined for evidence of distortion or fracture.

## 23 Changeover Leakage Test

23.1 One sample of each model of manual changeover regulator or automatic changeover regulator or automatic changeover manifold shall be subjected to this test. Prior to this test the sample shall meet the requirements of Section 21, Regulating Adjustment Test, The sample shall show no signs of leakage past each open inlet, at the changeover lever mechanism, or at the service indicator, if provided, when tested as described in 23.2 – 23.3.

23.2 With the outlet plugged, and one inlet open, the other inlet shall be subjected to an increasing aerostatic pressure from 103.4 to 2585.5 kPa (15 to 375 psig), with the changeover initially set to the pressurized inlet. Then the pressure shall be reduced to 0 kPa (0 psig) and the changeover moved toward the open inlet. The pressure source shall then be connected to the open inlet. Pressure shall then be increased from 103.4 to 2585.5 kPa (15 to 375 psig).

23.3 The test sequence shall be repeated for the second inlet by using the same procedure as described in 23.2.

## 23A Check Manifold Leakage Test

23A.1 One sample of each check manifold shall be subjected to this test. The sample shall show no signs of leakage past each open inlet when tested as described in 23A.2.

23A.2 With the outlet plugged, and one inlet open, the other inlet shall be subjected to an increasing aerostatic pressure from 104 to 2586 kPa (15 to 375 psig). The test sequence shall be repeated for the second inlet.

## 24 Swivel Coupling Leakage Test

24.1 One sample of each model of regulator or manifold that incorporates a swivel assembly permanently attached to the inlet or outlet, following upon testing to the requirements of Section 20, Deformation Test, shall be subjected to this test. The sample shall show no signs of external leakage at the swivel joints when tested in accordance with 24.2. Regulators that incorporate a relief valve shall have the relief valve plugged or blocked.

24.2 With pipe fittings attached to each swivel connection, the swivel shall be rotated 180 degrees and back to that starting position for 20 cycles without pressure applied. Then aerostatic pressure of 375 psig applied to the inlet swivel for 1 minute and 1-1/2 times maximum outlet pressure applied to the outlet swivel, but not less than 6 psig for 5 minutes.

## 25 Excess Pressure Test

25.1 A regulator body or bonnet shall not rupture or throw parts (for example, separation of body and bonnet), and the diaphragm shall not rupture or pull out from its means of securement following application of the test as described in 25.2 and 25.3.

25.2 One sample of each type of regulator that has been previously subjected to the requirements of Section 20, Deformation Test, and Section 21, Regulating Adjustment Test, is to be used. A sample that has been modified to remove the seat disks from the poppet assembly shall be used. The inlet of the regulator shall be connected to the air side of a piston-type hydraulic accumulator using not more than 3.05 m (10 ft) of 6.35-mm (0.25 in) outside diameter metal tubing having a minimum inside diameter of 4.82 mm (0.190 in). The accumulator shall have a volume of approximately 9.83 L (600 $in^3$) and be provided with a 1/4-turn full-open valve at the air-inlet port. The air-inlet port shall be charged with air or nitrogen and compressed to a pressure of 1723.7 kPa (250 psig) by applying hydrostatic pressure at the hydraulic-inlet port. With the outlet of the regulator closed, the 1/4-turn valve to the regulator is then to be opened as quickly as possible. Alternately, at the manufacturer's option, the pressure shall be applied to the outlet with the inlet of the regulator closed.

*Exception No. 1: For second-stage, 13.8 kPa (2 psig) service regulators, integral 13.8 kPa (2 psig) service regulators, integral two-stage regulators and automatic changeover regulators, the test pressure shall be 413.8 kPa (60 psig).*

*Exception No. 2: For special-purpose low pressure regulators and special-purpose high-pressure regulators, the test pressure shall be 6 times the rated inlet pressure, but not less than 413.8 kPa (60 psig) or greater than 1723.7 kPa (250 psig).*

25.3 Adjustable regulators shall be adjusted at midrange prior to the start of the test.

## 26 Strength of Body Test

26.1 All portions of a regulator body subjected to inlet pressure shall withstand, for 1 min without rupture, an internal hydrostatic pressure of 8618.4 kPa (1250 psig).

26.2 The regulator samples to be used in this test shall be those previously subjected to the requirements of Section 20, Deformation Test.

26.3 The hydrostatic pressure shall be applied to the inlet connection of the regulator. Since this is a test for strength of the inlet portion of the body, leakage at joints shall be disregarded.

## 27 Lock-Up Test

27.1 Each type of regulator shall have a lock-up pressure not greater than the limits specified in Table 27.1, following application of the test as described in 27.1 and 27.3.

27.2 One sample of each type of regulator that has been subjected to the requirements of Section 20, Deformation Test,, shall be used. When more than one main spring is used in the assembly, the spring with the highest outlet pressure shall be used. The sample shall connected to a piping system in accordance with 28.2.5 and 28.2.6.

27.3 The sample shall be adjusted using the initial inlet and outlet pressures specified in Table 27.1 at an air flow in accordance with 19.6 and the lock-up pressure shall be recorded. The inlet pressure is then to be increased to maximum inlet pressure noted and the lock-up pressure shall be recorded again.

*Exception: For nonadjustable regulators, the initial outlet pressure setting shall be the outlet pressure at the initial inlet pressure at the flow rate specified in 19.6.*

**Table 27.1**
**Regulator Lock-up Pressure Limits**

| Type of regulator | Initial inlet pressure | Initial outlet pressure setting (adjustable type) | Lock-up pressure limit | Maximum inlet pressure | Lock-up pressure limit at maximum inlet pressure |
|---|---|---|---|---|---|
| Single-stage | 689 kPa (100 psig) | 2.7 kPa (11 in WC) | 120% | 1724 kPa (250 psig) | 160 % |
| Integral two-stage, automatic changeover | 689 kPa (100 psig) | 2.7 kPa (11 in WC) | 120% | 1724 kPa (250 psig) | 160 % |
| High-pressure | 689 kPa (100 psig) | As specified by manufacturer | 130% | 1724 kPa (250 psig) | 150 % |
| First-stage | 689 kPa (100 psig) | 13.8 – 69 kPa (2 – 10 psig) | 130% | 1724 kPa (250 psig) | 150 % |
| Second-stage | 69 kPa (10 psig) | 2.7 kPa (11 in WC) | 120% | 103 kPa (15 psig) or the manufacturer's inlet pressure rating, whichever is greater | 160 % |
| 13.8 kPa (2 psig) service | 69 kPa (10 psig) | 13.8 kPa (2 psig) | 130% | 103 kPa (15 psig) or the manufacturer's inlet pressure rating, whichever is greater | 150 % |
| Integral 13.8 kPa (2 psig) service | 689 kPa (100 psig) | 13.8 kPa (2 psig) | 130% | 1724 kPa (250 psig) | 150 % |
| Special-purpose | High-pressure type = 689 kPa (100 psig) Low pressure type – specified by manufacturer | As specified by manufacturer | 130% | 2.5 times the initial inlet pressure | 150 % |
| NOTE – Lock-up pressure limits are expressed as a percentage of the initial outlet pressure setting. | | | | | |



## 28 Flow Test

### 28.1 General

28.1.1 During a flow test, there shall be no evidence of humming or chattering or outlet pressure instability of a regulator at the inlet pressures specified in 28.2.7 and 28.2.8 and at flows within its capacity. See 19.2 regarding manufacturer's input. For the purpose of these requirements, outlet pressure instability is defined as outlet pressure fluctuation of more than 13 mm (0.5 in) water column for outlet pressures equal to or less than 6.9 kPa (1.0 psig), and a fluctuation of more than 3% of the outlet pressure initially established for outlet pressures greater than 6.9 kPa (1.0 psig) at a constant inlet pressure and at any adjusted flow within its capacity.

28.1.2 For single-stage regulators, second-stage regulators, integral two-stage regulators, automatic changeover regulators, and special-purpose low pressure regulators with a delivery pressure range of 6.9 kPa (1 psig) or less, the outlet pressure shall be within ±51 mm (±2 in) water column from the initial setting at any flow within the manufacturer's rated flow capacity for each specified inlet pressure. See 28.2.7 and 28.2.8.

*Exception: For single-stage regulators, the outlet pressure shall be within +3 in water column at inlet pressure of 1723.7 kPa (250 psig).*

28.1.3 For high-pressure regulators, first-stage regulators, 13.8 kPa (2 psig) service regulators, integral 13.8 kPa (2 psig) service regulators and special-purpose high-pressure regulators with a delivery pressure more than 6.9 kPa (1 psig), the outlet pressure shall be within ±20% from the initial setting at any flow within the manufacturer's rated flow capacity for each specified inlet pressure. See 28.2.8 and Table 28.1.

**Table 28.1**
**Regulator Adjustments for Flow Test**

| Type | Inlet pressure, kPa | (psig) | Outlet pressure before flow test |
|---|---|---|---|
| Single-stage, integral two-stage and automatic changeover regulator | 689.5 | (100) | 279 mm (11 in) water column |
| First-stage regulators | 689.5 | (100) | 69 kPa (10 psig), or at the pressure specified by the manufacturer, whichever is less |
| Second-stage regulators | 69 | (10) | 279 mm (11 in) water column |
| 13.8 kPa (2 psig) service | 69 | (10) | 13.8 kPa (2 psig) |
| Integral 13.8 kPa (2 psig) service | 689.5 | (100) | 13.8 kPa (2 psig) |
| High-pressure regulator | 689.5 | (100) | As specified by manufacturer |
| Special-purpose regulator | 690 (100) or 69 (10), or as specified by manufacturer | | As specified by manufacturer |

## 28.2 Test method

28.2.1 One sample of each type of regulator that has been subjected to the requirements of Section 20, Deformation Test, and Section 27, Lock-Up Test, shall be used. When more than one main spring or orifice is used, representative samples shall include the spring and orifice combination that results in the highest and lowest outlet pressure ranges.

28.2.2 Pressure-measuring devices shall be in accordance with 19.7.

28.2.3 A manometer for low-pressure readings shall be of a type having scale graduations of not greater than 2.5 mm (0.1 in).

28.2.4 The adjustments or settings for inlet and outlet pressures for test purposes shall be within ±2% of the specified values.

28.2.5 The flow test system shall consist of an air supply of the required capacity and pressure control valve or valves, a flow measuring device, test sample or samples, and a piping system as described in 28.2.6. The flow measuring device shall be a device that determines true time average flow rate and shall be located upstream or downstream of the test sample. Aerostatic flow medium other than air shall not be used unless additional correction factors are used.

28.2.6 The test sample piping system shall incorporate piezometer tubes of the same size as the inlet and outlet of the sample. The piezometer tubes shall be made of ANSI/ASME B36.10M Schedule 40 pipe and shall have a length 20 times of the internal diameter of the pipe. The ring holes shall be in the center of the tubes. For 1 inch NPT and smaller pipe size there shall be six ring holes 1.6 mm (1/16 in) in diameter equally spaced around the pipe. For pipe size larger than 1 inch NPT, there shall be eight ring holes 2.4 mm (3/32 in) in diameter equally spaced around the pipe. The pressure measurement connection shall be 1/4 inch – 18 NPT registering through a 4.8 mm (3/16 in) hole into the piezometer ring. Liquid manometers, pressure gauges, or transducers shall be connected to the piezometer tubes to record upstream and downstream pressures during the test.

28.2.7 Prior the flow tests, an adjustable regulator shall be adjusted for outlet pressure and inlet pressure as specified in Table 28.1, and at an air flow in accordance with 19.6. When the regulator is nonadjustable, the outlet pressure at this flow rate and inlet pressure shall be recorded as the initial setting. The setting shall remain unchanged during the flow test.

28.2.8 Single-stage regulators, first-stage regulators, integral two-stage regulators, integral 13.8 kPa (2 psig) service regulators, automatic changeover regulators, high-pressure regulators, and special-purpose (with 689.5 kPa (100 psig) inlet pressure for setting delivery pressure) regulators shall then be subjected to flow tests at constant inlet pressures of 172.3, 344.7, 689.5, and 1723.7 kPa (25, 50, 100, and 250 psig). Second-stage regulators, 13.8 kPa (2 psig) service regulators and special-purpose (with 10 psig inlet pressure for setting delivery pressure) regulators shall be subjected to flow tests at constant inlet pressures of 34.5, 69, and 103.4 kPa (5, 10, and 15 psig), and the manufacturer's inlet pressure rating if greater than 15 psig (104 kPa). The air flow through the regulator shall be varied in steps from the initial air flow rate setting (see 19.6) to the manufacturer's maximum rated capacity for that inlet pressure.

## 29 Pressure Relief Test

29.1 The initial start-to-discharge pressure of a Type I or Type II relief valve incorporated in the assembly of a regulator shall be within the limits specified in Table 18.1, based on the operating outlet pressure for which the regulator is designed.

29.2 The reseating pressure of a Type I or Type II relief valve shall not be less than the minimum required start-to-discharge pressure specified in Table 18.1.

29.3 Three sample regulators of each type, and for each type including one which has been subjected to the requirements of Section 28, Flow Test, shall be used. All three samples of each type shall be adjusted as required in Section 28, Flow Test. Each sample, in turn, shall be connected in the reverse position to a piping system, identical to that used in Section 28, Flow Test, so that the sample is subjected to internal pressure through the outlet.

29.4 The pressure shall then be increased until the first evidence of discharge from the pressure-relief valve is detected. This pressure shall be recorded as the start-to-discharge pressure of the relief valve. After obtaining the start-to-discharge pressure of the relief valve, the pressure shall be increased above the start-to-discharge pressure to result in unseating of the relief valve. The shutoff valve shall then be closed. The pressure at which the discharge through the relief valve ceases shall be recorded as the reseating pressure. The start-to-discharge and reseating pressures shall be observed through a water seal not over 25.4 mm (1 in) in depth. When the construction of the regulator is such that this is not workable, a soapy-water solution or other similar leak detection solution shall be used.

## 30 Type I Relief Flow Valve Capacity Test

30.1 The air-discharge capacity of a Type I relief valve at any inlet pressure between 6.9 and 34.5 kPa (1 and 5 psig) above the start-to-discharge pressure setting of the relief valve shall not be less than that calculated by the formula indicated below, and in no case shall the discharge of the relief valve be less than that calculated for a regulator having a 3.2 mm (1/8 in) diameter regulator valve orifice.

$$Q = 0.00646 \times D \times P$$

in which:

$Q$ is the pressure-relief valve discharge rate in $m^3/h$ of air;

*0.00646* is a constant;

*D* is the diameter of regulator orifice in mm; and

*P* is the inlet pressure to the relief valve in kPa above the start-to-discharge pressure setting of the relief valve

$$Q = 40 \times D \times P$$

in which:

*Q* is the pressure-relief valve discharge rate in $ft^3/h$ of air;

*40* is a constant;

*D* is the diameter of regulator orifice in inches; and

*P* is the inlet pressure to the relief valve in psig above the start-to-discharge pressure setting of the relief valve).

30.2 One of the three sample regulators that was subjected to the requirements of Section 29, Pressure Relief Test, shall be used. The flow equipment and test setup described for the test in 29.3 and 29.4 shall be used.

30.3 The sample shall be subjected to internal pressures between 6.9 to 34.5 kPa (1 and 5 psig) above the start-to-discharge pressure of the pressure-relief valve. The pressure shall be increased in 6.9 kPa (1 psig) increments. The flow through the pressure-relief valve at each 6.9 kPa (1 psig) increment shall be recorded.

## 31 Type II Relief Valve Flow Capacity Test

31.1 The air-discharge flow rate from a Type II relief valve in a second-stage, 13.8 kPa (2 psig) service regulator, integral two-stage regulator, integral 13.8 kPa (2 psig) service regulator, or automatic changeover regulator shall limit the downstream delivery pressure in accordance with 18.3(a) when tested as described in 31.2 – 31.4. At no time shall the outlet delivery pressure from the sample exceed 13.8 kPa (2.0 psig) for second stage and automatic changeover regulators or 34.5 kPa (5.0 psig) for 13.8 kPa (2 psig) service regulators and integral 13.8 kPa (2 psig) service regulators.

31.2 One sample of the regulator that has been modified to remove the valve seat disc(s) from the poppet assembly shall be used. The regulator adjustment means on the regulator shall be in the same position as on the three regulator samples used during the tests described in Section 29, Pressure Relief Test,. A pressure gauge or other pressure indicating device shall be installed into the outlet of the sample. The inlet shall be connected to a regulated source of aerostatic pressure using piping of the same pipe size as the inlet.

31.3 With the sample mounted as intended in service, the inlet shall be subjected to slowly increasing aerostatic pressure from 0 to 103.4 kPa (0 to 15 psig) or the manufacturer's inlet pressure rating, whichever is greater. At the 103.4 kPa (15 psig) inlet pressure or the manufacturer's inlet pressure rating, whichever is greater, the maximum outlet pressure shall be recorded.

31.4 An additional sample of a second-stage regulator without the valve seat disc removed, and of an integral two-stage integral 13.8 kPa (2 psig) service regulator, and automatic changeover regulator with only the high-pressure stage valve seat disc removed shall be subjected to a slowly increasing aerostatic pressure from 0 to 1723.7 kPa (0 to 250 psig). At the 1723.7 kPa (250 psig) inlet pressure, the maximum outlet pressure shall be recorded.

## 32 Overpressure Shutoff (OPSO) Feature Tests

### 32.1 General

32.1.1 A regulator that incorporates an overpressure shutoff (OPSO) feature shall have the samples subjected to the specific tests as described in Table 32.1.

**Table 32.1**
**Samples to be Provided and Tests to be Conducted[a]**

| Overpressure shutoff (OPSO) feature seat disc location | Description of samples to be provided | Number of samples | Tests to be conducted[a] |
|---|---|---|---|
| Upstream of regulator seating orifice[b] | Normal production samples, | 3 | All tests in Section 32 |
| At a point downstream from regulator seating orifice[b] | Normal production samples | 3 | Activation Test, OPSO Feature Endurance Test, Repeat Activation Test |
| | Samples with regulator seat disc removed | 3 | Leakage and Strength Test, OPSO Feature Endurance Test, Repeat Leakage and Strength Test |
| | Sample with regulator seat disc in place but with OPSO feature seat disc removed, or modified as described in 32.3.2 | 1 | Leakage and Strength Test, and Flow Capacity Test |

[a] If the regulator design also includes a relief valve, and the relief valve will open before, or at the same point as the OPSO feature, the relief valve shall be sealed or disabled so that no gas escapes from the regulator vent on the samples to be tested.

[b] For an integral two-stage regulator, integral 13.8 kPa (2 psig) service regulator, or an automatic changeover regulator, seating orifice shall mean the controlling orifice for the second stage portion of the regulator.

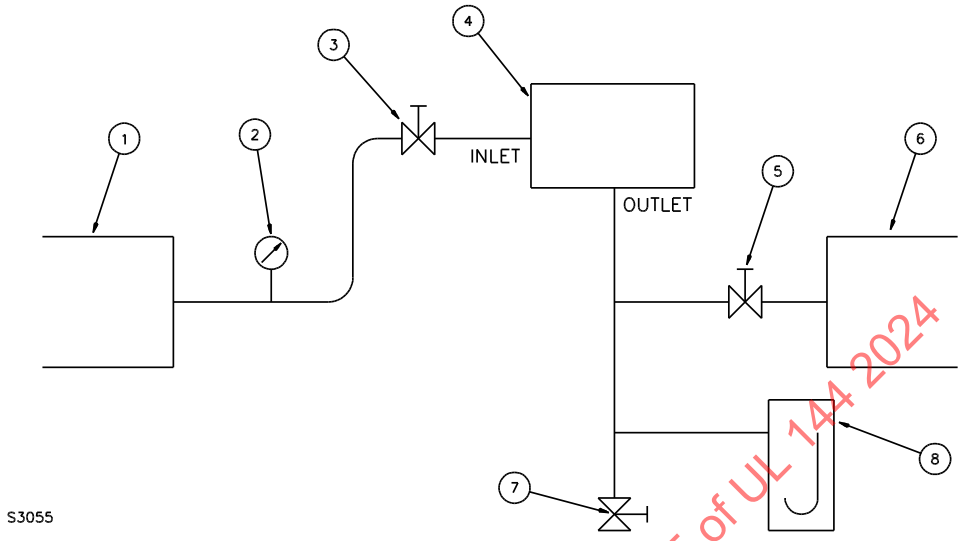
### 32.2 Activation test

32.2.1 The sample regulators as outlined in Table 32.1 shall be subjected to this test. The activation pressure measured for the overpressure shutoff feature shall be within the limits specified in Table 18.1.

32.2.2 Each sample shall be connected to a piping system incorporating regulated sources of aerostatic pressure, two pressure indicating devices, and three shutoff valves as shown in Figure 32.1. The piping system shall be of the same pipe size as the inlet and outlet of sample.

**Figure 32.1**

**OPSO Feature Activation Test Setup**




NOTES –

1) Pressure source number 1
2) Pressure gauge
3) Shutoff valve number 1
4) Regulator test sample
5) Shutoff valve number 3
6) Pressure source number 2
7) Shutoff valve number 2
8) Water or mercury manometer or pressure gauge, as appropriate.

32.2.3 Aerostatic pressure as specified in Table 32.2 shall be applied from pressure source number 1 with shutoff valves numbers 1, 2, and 3 closed. Shutoff valve number 1 is then to be slowly opened. The regulator will then be in a lock-up condition. Shutoff valve number 3 shall then also be opened, slowly, so as to increase the outlet pressure. When the overpressure shutoff feature incorporated in the regulator operates, the output pressure shall be recorded as the activation pressure of the feature.

**Table 32.2**
**Aerostatic Pressure for Overpressure Shutoff (OPSO) Feature Tests**

| Test | Aerostatic pressure | | | |
|---|---|---|---|---|
| | Second-stage regulator, 13.8 kPa (2 psig) service regulator, or special-purpose low pressure [with 69 kPa (10 psig) inlet rating] regulator, | | All other regulators, | |
| | kPa | (psig) | kPa | (psig) |
| Activation test | 138 or the manufacturer's inlet pressure rating, whichever is greater | (20 or the manufacturer's inlet pressure rating, whichever is greater) | 689.5 | (100) |
| Leakage and strength test | 172.5 or the manufacturer's inlet pressure rating, whichever is greater | (25 or the manufacturer's inlet pressure rating, whichever is greater) | 2585.5 | (375) |
| Endurance test using normal production samples | 69 or the manufacturer's inlet pressure rating, whichever is greater | (10 or the manufacturer's inlet pressure rating, whichever is greater) | 689.5 | (100) |

## 32.3 Leakage and strength test

### 32.3.1 General

32.3.1.1 The samples outlined in Table 32.1 shall be tested in accordance with 32.3.2 or 32.3.3 as indicated by the location of the OPSO feature and shall meet the requirements of the applicable clause.

### 32.3.2 Overpressure shutoff (OPSO) feature at a point upstream of regulator seating orifice

32.3.2.1 Each sample shall be removed from the piping system that was used for the activation test when the overpressure shutoff feature is in the closed position. With the regulator outlet open, aerostatic pressure in accordance with Table 32.2 shall be slowly applied to the regulator inlet and held at the test pressure for 1 min. The sample shall show no signs of seat or external leakage during this test.

### 32.3.3 Overpressure shutoff (OPSO) feature at a point downstream from regulator seating orifice

32.3.3.1 Each of the three samples, that have been modified to remove the regulator seat disc, shall be installed into a piping system and aerostatic pressure shall be slowly applied in the normal flow direction until activation of the OPSO occurs. The value of activation shall be recorded for informational purposes, and the OPSO shall remain in the closed position. Then, with the regulator outlet open, aerostatic pressure in accordance with Table 32.2 shall be slowly applied to the regulator inlet and held at the test pressure for 1 min. The samples shall show no signs of seat leakage; no signs of external leakage; the diaphragm shall not pull out from its securement means; and rupture of the body shall not occur. Regulator operating levers or diaphragm heads shall not bend. Two of the three samples shall be disassembled and the parts examined for damage. The third sample shall then be subjected to the OPSO feature endurance test, 32.4.

32.3.3.2 The sample that has the regulator seat disc in place but does not have an OPSO seat disc shall be subjected to the test pressure as indicated by Table 32.2 but the pressure shall be slowly applied in the

reverse flow direction, through the outlet, and held at the test pressure for 1 min. The sample shall then be subjected to the Flow test and shall meet the requirements for that test.

### 32.4 OPSO feature endurance test

32.4.1 The sample regulators as outlined in Table 32.1 shall be subjected to this endurance test. There shall not be malfunction or breakdown of the overpressure shutoff (OPSO) feature in any of the samples tested. The test method shall be in accordance with 32.4.2 or 32.4.6 as indicated by the modifications made to the samples.

32.4.2 Normal production samples shall be tested as indicated in 32.4.3 – 32.4.5.

32.4.3 Each sample shall be connected to a piping system incorporating regulated sources of aerostatic pressure, two pressure indicating devices, and a three-way valve as shown in Figure 32.2. The piping system shall be of the same size as the inlet and outlet of the sample.

32.4.4 During the test, an aerostatic pressure as specified in Table 32.1 shall be maintained at the outlet of pressure source number 1. See Figure 32.1.

32.4.5 The test shall be conducted for 100 cycles of operation. Each cycle shall consist of the following:

a) The three-way valve shall be adjusted so that it is opened to the atmosphere allowing flow through the regulator;

b) The three-way valve shall then to be adjusted so that the aerostatic pressure of 1.25 times the operation pressure, as determined in 32.2.3, is applied resulting in back pressure that operates the shutoff feature;

c) The three-way valve is again to be opened to the atmosphere; and

d) The shutoff feature shall be manually reset.

32.4.6 Samples that have been modified to remove the normal regulator seat disc shall be tested as indicated in 32.4.7.

32.4.7 One hundred cycles of operation shall be conducted using the following procedure:

a) Each sample shall be connected to a piping system as shown in Figure 32.2 but without items 4 and 5. The piping system shall be of the same size as the inlet and outlet of the sample. Initially each sample shall not be pressurized.

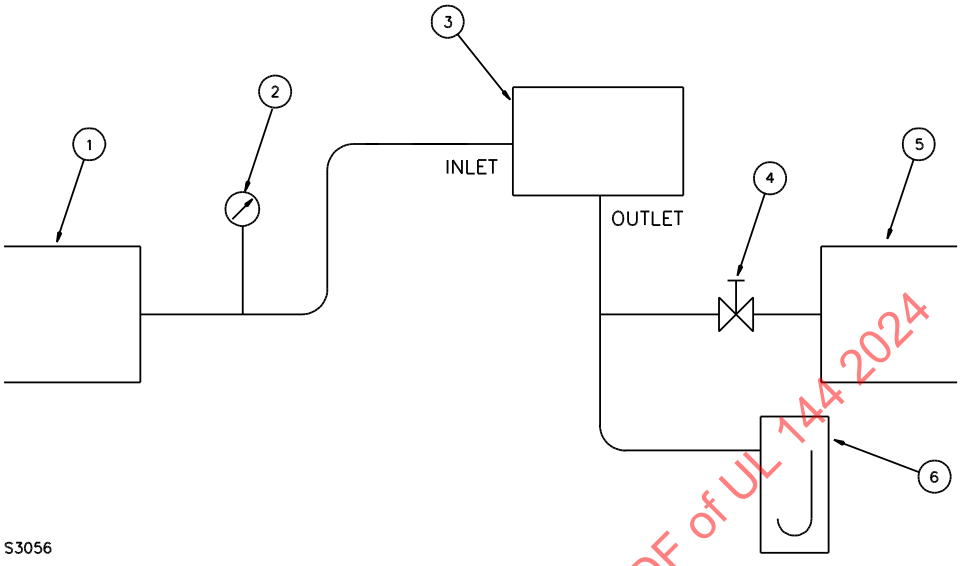
b) Aerostatic pressure of 1.25 times the activation pressure as determined in 32.2.3 shall be applied in the normal flow direction, which should result in activation of the OPSO feature.

c) The inlet pressure shall be reduced to 0 kPa (0 psig).

d) The OPSO feature shall be manually reset.

**Figure 32.2**

**OPSO Feature Endurance Test Setup**




NOTES –

1) Pressure source number 1
2) Pressure gauge
3) Regulator test sample
4) Three-way valve
5) Pressure source number 2
6) Water or mercury manometer or pressure gauge, as appropriate.