

**ANSI Z21.18-2007**  
**CSA 6.3-2007**

American National Standard/  
CSA Standard For  
**Gas Appliance Pressure  
Regulators**

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ANSI Z21.18-2007

CSA STANDARD  
CSA 6.3-2007

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Gas Appliances Pressure Regulators  
ANSI Z21.18-2000 • CSA 6.3-2000  
and Addendas Z21.18a-2001 • CSA 6.3a-2001,  
Z21.18b-2005 • CSA 6.3b-2005

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# Preface

This publication represents a basic standard for safe operation, substantial and durable construction, and acceptable performance of gas appliance pressure regulators. It is the result of years of experience in the manufacture, testing, installation, maintenance, inspection and research on gas appliance pressure regulators designed for utilization of gas. There are risks of injury to persons inherent in appliances that, if completely eliminated, would defeat the utility of the appliance. The provisions in this standard are intended to help reduce such risks while retaining the normal operation of the appliance.

Nothing in this standard is to be considered in any way as indicating a measure of quality beyond compliance with the provisions it contains. It is designed to allow compliance of gas appliance pressure regulators, the safety construction and performance of which may exceed the various provisions specified herein. In its preparation, full recognition has been given to possibilities of improvement through ingenuity of design. As progress takes place, revisions may become necessary. When they are believed desirable, recommendations or suggestions should be forwarded to the CSA America, 8501 East Pleasant Valley Road, Cleveland, Ohio 44131, or the Chairman of the CSA Technical Committee on Gas Appliances and Related Accessories, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, Canada L4W 5N6.

Safe and satisfactory operation of a gas appliance pressure regulator depends to a great extent upon its proper installation, use and maintenance. It should be installed, as applicable, in accordance with the *National Fuel Gas Code, ANSI Z223.1/NFPA 54*; or the *Natural Gas and Propane Installation Code, CSA B149.1*.

Users of this American National Standard/CSA Standard are advised that the devices, products and activities within its scope may be subject to regulation at the Federal, Territorial, Provincial, state or local level. Users are strongly urged to investigate this possibility through appropriate channels. In the event of a conflict with this standard, the Federal, Territorial, Provincial, state or local regulation should be followed.

THIS STANDARD IS INTENDED TO BE USED BY THE MANUFACTURING SECTOR AND BY THOSE APPLYING THE EQUIPMENT AND BY THOSE RESPONSIBLE FOR ITS PROPER INSTALLATION. IT IS THE RESPONSIBILITY OF THESE USERS TO DETERMINE THAT IN EACH CASE THIS STANDARD IS SUITABLE FOR AND APPLICABLE TO THE SPECIFIC USE THEY INTEND.

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**EFFECTIVE DATE:** An organization using this standard for product evaluation as a part of its certification program will normally establish the date by which all products certified by that organization should comply with this standard.

# ***History Of The Development Of Standard For Gas Appliance Pressure Regulators***

(This History is informative and is not part of the standard.)

With the onset of the Free Trade Agreement between the United States and Canada on January 2, 1988, significant attention was given to the harmonization of the United States and Canadian safety standards addressing gas-fired equipment for residential, commercial and industrial applications. It was believed that the elimination of the differences between the standards would remove potential trade barriers and provide an atmosphere in which North American manufacturers could market more freely in the United States and Canada. The harmonization of these standards was also seen as a step toward harmonization with international standards.

With the formation of joint subcommittees, a Canadian Gas Association Standards Steering Committee on Gas Burning Appliances and Related Accessories was established to parallel Accredited Standards Committees Z21 and Z83, and to support the formation of joint subcommittees. Operating procedures, in accordance with American National Standards Institute procedures, for joint subcommittees were developed and subsequently approved by ANSI on April 1, 1993.

At its July 14, 1993 meeting, the Joint Automatic Gas Controls Subcommittee adopted ANSI Z21.18 for distribution for review and comment as a harmonized standard, in that Z21.18 and CAN1-6.3 were identical in content. The first draft harmonized gas appliance pressure regulator standard was distributed for review and comment during March 1994.

Following reconsideration and modification of the proposed harmonized draft standard for gas appliance pressure regulators, in light of comments received, the joint automatic gas controls subcommittee, at its July 14, 1994 meeting, recommended the proposed standard to the Z21 Committee and the CGA Standards Steering Committee, for approval.

The proposed harmonized standard for gas appliance pressure regulators was approved by the Z21 Committee by letter ballot dated January 17, 1995. The CGA Standards Steering Committee approved the proposed harmonized standard for automatic gas valves by letter ballot dated April 13, 1995.

The first edition of the harmonized Z21/CGA Standard for Gas Appliance Pressure Regulators was approved by the Canadian Interprovincial Gas Advisory Council on October 18, 1995 and by the American National Standards Institute, Inc., on November 15, 1995.

The second edition of the harmonized Z21/CSA Standard for Gas Appliance Pressure Regulators was approved by the Canadian Interprovincial Gas Advisory Council on August 22, 2000, and by the American National Standards Institute, Inc., on September 27, 2000.

This the third edition of the harmonized Z21/CSA Standard for Gas Appliance Pressure Regulators was approved by the Canadian Interprovincial Gas Advisory Council on September 14, 2007, and by the American National Standards Institute, Inc., on July 19, 2007.

The previous editions of the gas appliance pressure regulator standard, and addenda thereto, approved by the American National Standards Institute, Inc. and the Interprovincial Gas Advisory Council, are as follows:

|                             |                                   |
|-----------------------------|-----------------------------------|
| Z21.18-1995 • CGA 6.3-M95   | ANSI Z21.18-2000 • CSA 6.3-2000   |
| Z21.18a-1998 • CGA 6.3a-M98 | ANSI Z21.18a-2001 • CSA 6.3a-2001 |
| Z21.18b-2000 • CGA 6.3b-M00 | ANSI Z21.18b-2005 • CSA 6.b-2005  |

The following identifies the designation and year of the harmonized standard:

ANSI Z21.18-2007 • CSA 6.3-2007

**NOTE:** *This edition of Z21.18 • CSA 6.3, incorporates changes to the 2000 edition and addenda thereto. Changes, other than editorial, are denoted by a vertical line in the margin.*

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(June, 2007)

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## NOTE

*This standard contains SI (Metric) equivalents to the yard/pound quantities, the purpose being to allow the standard to be used in SI (Metric) units. (Standard for use of the International System of Units (SI): The Modern Metric System, IEEE/ASTM SI 10 or Metric Practice Guide, CAN/CSA Z234.1 are used as a guide in making metric conversion from yard/pound quantities.) If a value for a measurement and an equivalent value in other units, the first stated is to be regarded as the requirement. The given 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.*

# ***American National Standard/CSA Standard For Gas Appliance Pressure Regulators***

## ***Part I: Construction***

### **1.1 Scope**

#### **1.1.1**

Types of Regulators. This standard applies to individual gas appliance pressure regulators, which are not a part of a combination control (see Part V, Definitions), constructed entirely of new, unused parts and materials, hereinafter referred to as regulators, intended for application on individual gas appliances.

This standard also applies to negative gas appliance pressure regulators (see Part V, Definitions). The performance of negative pressure regulators is covered under Part III of this standard.

Compliance of a device with this standard does not imply that such device is acceptable for use on gas appliances without supplemental tests with the device applied to the particular appliance design.

Components performing functions other than those of a gas appliance pressure regulator shall comply with the applicable American National Standards.

#### **1.1.2**

Types of Gases. This standard applies to regulators for operations with natural, manufactured and mixed gases, liquefied petroleum gases and LP gasair mixtures.

#### **1.1.3**

Regulators shall be classified in accordance with their intended application with reference to inlet pressures as follows:

Rated  
Inlet Pressure

1/2 psi (3.5 kPa)

2 psi (13.8 kPa)

5 psi (34.5 kPa)

#### **1.1.4**

Types of Application. This standard applies to regulators for the following general types of application:

- a. Main burner load application;
- b. Pilot burner load application;
- c. Main burner and pilot burner load application to control a minimum pilot flow rate of:
  1. 0.15 ft<sup>3</sup>/hr (1.18 cm<sup>3</sup>/s), or
  2. 0.50 ft<sup>3</sup>/hr (3.93 cm<sup>3</sup>/s); or

- d. Domestic range application (see 2.11, Regulators For Use on Domestic Gas Ranges).

### 1.1.5

Mounting Position(s). The manufacturer shall specify one or more of the following mounting classifications (see 1.12, Instructions).

Upright - single position on a horizontal axis with respect to the inlet connection, as specified by the manufacturer.

Horizontal - any position on a horizontal axis with respect to the inlet connection.

Vertical - any position on a vertical axis with respect to the inlet connection.

Limited Horizontal - any position from upright to 90 degrees (1.57 rad) from upright on a horizontal axis with respect to the inlet connection.

Multipoise - any position on a horizontal, vertical or intermediate axis with respect to the inlet connection.

The test specified herein shall be conducted with the regulator mounted in the manufacturer's specified upright position, unless otherwise specified herein.

If the manufacturer specifies more than one mounting position, the tests in 2.8, Outlet Pressure Range, or 3.8, Outlet Pressure Range, as applicable, shall be conducted in each mounting position. The data from these tests shall then be analyzed to determine the mounting position which produces the minimum outlet pressure with the minimum outlet pressure setting (if adjustable), and the mounting position which produces the maximum outlet pressure with the maximum outlet pressure setting (if adjustable). These two mounting positions shall be designated Position A and Position B, respectively.

- a. The tests in 2.9, Range of Regulation Capacity or 3.9, Range of Regulation Capacity, and 2.10, Regulators Designated to Operate at Pilot Flow Rate, as applicable, shall be conducted in Position A, as determined in 2.8, Outlet Pressure Range, or 3.8, Outlet Pressure Range.
- b. The tests in 2.9 or 3.9 and 2.10, as applicable, shall also be conducted in Position B, as determined in 2.8 or 3.8.

### 1.1.6

The tests specified herein shall be conducted at a room temperature of  $77 \pm 10^{\circ}\text{F}$  ( $25 \pm 5.5^{\circ}\text{C}$ ). Regulators and vent limiters complying with the provisions of this standard shall be considered as having an ambient temperature range of  $32^{\circ}\text{F}$  ( $0^{\circ}\text{C}$ ) to  $125^{\circ}\text{F}$  ( $51.5^{\circ}\text{C}$ ). At the option of the manufacturer, a greater ambient temperature range may be specified, in which case additional tests as outlined in 2.1.2 and 2.1.3 shall be conducted.

### 1.1.7

If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated value is to be regarded as the specification.

### 1.1.8

All references to "psi" throughout this standard are to be considered gage pressures, unless otherwise specified.

### 1.1.9

Exhibit A, Items Unique To One Country (Canada), contains provisions that are unique to Canada.

### 1.1.10

Exhibit B contains a list of standards referenced in this standard, and sources from which these reference standards may be obtained.

## 1.2 Data To Be Furnished By The Manufacturer

The manufacturer shall furnish the following data for the use of the testing agency in examining regulators under this standard:

- a. Drawings, blueprints, or photographs which describe each model, as specified by the testing agency;
- b. Rated inlet pressure of the regulator;
- c. Manufacturer's specified minimum inlet test pressure increments above the outlet pressure (see [Table II, Inlet Test Pressure](#));
- d. Outlet pressure adjustment range, related inlet pressure (in inch increments not to exceed the rated inlet pressure), and flow rate for adjustable regulators;
- e. Outlet pressure, related inlet pressure (in inch increments not to exceed the rated inlet pressure), and flow rate for nonadjustable regulators;
- f. Outlet pressure, related inlet pressure (in inch increments not to exceed the rated inlet pressure), and flow rate for each setting of a convertible regulator;
- g. Mounting classification (see [1.1.5](#));
- h. Ambient temperature range in which the control is intended to operate (see [1.1.6](#));
- i. Information as to the gases with which each vent limiter is to be used;
- j. Pressure drop capacity at 1.0 in wc (249 Pa);

This is not applicable to negative pressure regulators.

- k. Range of regulation capacity for main burner load application (a separate range of regulation may be furnished for both the high- and low-pressure settings of a convertible regulator);
- l. Regulation capacity and maximum individual load capacity for main burner and pilot burner load application (see 2.10, Regulators Designated to Operate at Pilot Flow Rate, and [2.11.6](#)), and whether for  $\textcircled{P}$  or  $\nabla$  application (see [1.1.4-c](#));
- m. Range of variable load capacity for regulators for use on domestic gas ranges (see [2.11.5](#));
- n. Range of regulation capacity for pilot burner load application;
- o. For negative pressure regulators, the manufacturer's specified minimum and maximum vacuum pressure. These specifications may be expressed as pressures to be added algebraically to the regulator's outlet pressure setting(s);
- p. The fuel gas(es) for which it is intended;
- q. Supporting documentation relative to the suitability of materials (see [1.11.1](#));

- r. A description of the operating principle;
- s. Maximum cycling rate(s) for continued operation testing; and
- t. For a regulator which has more than one main burner gas outlet, the data required per “-k” and “-l” above shall be provided for each outlet (see 2.1.7). The highest manufacturer’s specified regulation capacity for any of the outlets shall be considered as the limiting value for the regulator as a whole.

## 1.3 Assembly

### 1.3.1

Air movement (breathing) from the atmospheric side of the regulator diaphragm shall take place only through the vent opening(s).

### 1.3.2

The construction of parts not covered by this standard shall be in accordance with reasonable concepts of safety, substantiality, durability and interchangeability.

All specifications as to construction set forth herein may be satisfied by the construction actually prescribed or such other construction as will provide at least equivalent performance.

## 1.4 Connections

### 1.4.1

When for connection to pipe, connections shall be provided with cleanly cut taper pipe threads in accordance with the Standard for Pipe Threads, General Purpose (Inch), ANSI/ASME B1.20.1.

### 1.4.2

When a pressure test gage connection is provided as a part of the regulator, this pressure test gage connection shall be:

- a. A tapping sealed by a minimum  $\frac{1}{8}$  in NPT plug or cap with cleanly cut taper pipe threads in accordance with the Standard for Pipe Threads, General Purpose (Inch), ANSI ASME B1.20.1. If the plug is of the slotted type, it shall also incorporate square or hex flats.
- b. A hose fitting with a minimum length of 0.355 in (9.02 mm) and a 0.355 in (9.02 mm) maximum/0.335 in (8.50 mm) minimum outside diameter and which incorporates a sealing means. The construction of the hose fitting shall incorporate an internal restriction not greater than 0.0394 in (1.0 mm) in diameter.

### 1.4.3

Pipe thread length and length to shoulder dimensions shall not be less than shown in Table I, Minimum Thread Length and Length to Shoulder.

### 1.4.4

A regulator equipped with pipe or tubing threads shall be designed to accept a wrench for use in assembly and disassembly to piping.

### 1.4.5

When for connection to semirigid tubing, the connection, together with the fittings used thereon shall be in accordance with or be interchangeable with the fittings described in Volume I- Materials, SAE Handbooks, or equivalent.

### **1.4.6**

Standard flange connections, when provided, shall be constructed in accordance with the dimensional specifications for 125 lb cast-iron flanges of the *Standard for Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, ANSI/ASME B16.1*. (See Figure 1, 125 Pound Cast Iron Pipe Flange Body Connections.)

## **1.5 Bolts And Screws**

The threads of all bolts, nuts and screws used in the assembly shall be in accordance with the *Standard for Unified Inch Screw Threads (UN and UNR Thread Form), ANSI/ASME B1.1*.

## **1.6 Adjustments**

### **1.6.1**

Adjustable type regulators and the adjustable stages of multi-stage regulators shall be provided with means for making any necessary adjustment of outlet pressure. Full physical adjustment of the adjustment means shall not limit the valve movement. The adjusting means of spring-type regulators shall be concealed.

### **1.6.2**

Suitable means for maintaining the positions of all adjustments shall be provided. Locknuts or adjusting nuts held by springs or compression will be considered satisfactory, except when their adjustment can be accidentally disturbed.

### **1.6.3**

Construction of the regulator assembly shall be such that in all operating positions of the diaphragm or adjustment means correct alignment will be maintained.

### **1.6.4**

A convertible regulator shall be designed so that it can be changed from one predetermined outlet pressure setting to another predetermined outlet pressure setting with no intermediate pressure settings and without addition, deletion or substitution of parts.

Changing from one predetermined outlet pressure setting to another shall require the use of a tool.

### **1.6.5**

When the regulator cap or adjusting stack of a convertible regulator is used as both the gas sealing means and an integral part of the means providing a predetermined pressure setting, the internal adjusting mechanism shall be retained in the stack or the seal cap assembly.

### **1.6.6**

Factory adjustment means not intended for field adjustment shall be sealed by means suitable for both continuous and intermittent exposure at the manufacturer's specified minimum and maximum ambient temperatures. Suitability of the sealing means shall be judged before and after completion of all tests specified in this standard. Mechanical sealing means shall require the use of special tools.

## **1.7 Strength**

The strength of all parts and joints of the body of the regulator shall be such that no evidence of leakage or permanent deformation will develop as a result of the tests specified herein.

## 1.8 Vent Connections And Vent Limiters

### 1.8.1

Vent connections of regulators not incorporating integral vent limiters shall be substantially bossed and tapped for a connection not less than  $\frac{1}{8}$  inch nominal size taper pipe thread in accordance with the Standard for *Pipe Threads, General Purpose (Inch)*, ANSI/ASME B1.20.1, or shall have suitable internal threads for tubing connections.

### 1.8.2

The orifice of a vent limiter shall be protected from foreign particles.

### 1.8.3

A vent limiter shall be constructed so as to perform satisfactorily within the temperature range specified for the regulator on which the device is employed.

### 1.8.4

The flow rate through vent limiters employed on convertible gas pressure regulators shall not exceed that specified in Table VI, Maximum Allowable Vent Limiter Venting Rate, for vent limiters for use with the gas having the highest heating value.

## 1.9 Springs

Springs actuating the diaphragm and valve shall be constructed of corrosion-resistant material or have a corrosion-resistant finish.

## 1.10 Finish

The body and other external parts shall be of corrosion-resistant material or have a corrosion resistant finish or coating. Steel housings shall have a galvanized, plated, baked enamel or equivalent corrosion-resistant finish.

## 1.11 Materials

### 1.11.1

The manufacturer shall supply evidence acceptable to the testing agency that all materials have been evaluated and found to be suitable for their intended usage. Test data based on ASTM or other appropriate test procedures, certifications or historical data may be submitted for this purpose. The evidence shall show that the materials have been evaluated, as appropriate, for resistance to moisture, corrosion and the effects of fuel gases, including the sulfur compounds therein, and that nonmetallic diaphragm and seal materials are suitably resistant to the effects of ozone.

### 1.11.2

Materials shall be suitable for use throughout the ambient temperature range of the regulator (see 1.2h).

### 1.11.3

Valve bodies and casings shall be of materials having melting points of not less than 800°F (427°C).

### 1.11.4

Vent limiters shall be of materials having melting points of not less than 800°F (427°C).

## 1.12 Instructions

The manufacturer shall provide printed instructions and diagrams adequate for the proper field installation of the regulator.

These instructions shall include information, as applicable.

- a. Diagrams to illustrate the specified mounting positions(s).
- b. Method of adjusting the regulator pressure setting.
- c. Method of converting a convertible regulator.
- d. Method of adjusting a multistage regulator.
- e. Method of venting the regulator.
- f. Maximum and minimum ambient temperatures in which the regulator is intended to operate.
- g. The type(s) of fuel gas for which the regulator is intended.
- h. For negative pressure regulators, the manufacturer's specified minimum and maximum vacuum pressure.

## 1.13 Marking

The suitability of markings shall be determined as specified in 2.16, Marking Material Adhesion and Legibility.

### 1.13.1

Regulators shall be marked to indicate the following:

- a. Manufacturer's name, trademark or symbol.
- b. Model designation, and one of the following, if applicable,
  1. Outlet pressure setting for a non-adjustable or factory-set adjustable regulator, or
  2. Outlet pressure adjustment range.
- c. Rated inlet pressure.
- d. The outlet pressure and the gas the regulator is intended to control for both positions of a convertible regulator, for example, Nat4"; LP10". (Also see [1.13.5](#).)
- e. When the range of regulation capacity includes the pilot flow, the appropriate symbol,  $\textcircled{P}$  or  $\nabla P$ , shall appear adjacent to the model number. Multistage regulators shall not display the  $\textcircled{P}$  or  $\nabla P$  symbol.
- f. Symbol of the organization making tests for compliance with this standard.

### 1.13.2

The direction of gas flow shall be clearly marked.

### 1.13.3

Separate vent limiters shall be marked so as to be individually identifiable.

### 1.13.4

Regulators not incorporating an integral vent limiter shall be marked "Vent" adjacent to the vent opening.

### 1.13.5

Convertible gas pressure regulators shall be clearly marked for each convertible position to indicate the gas which the regulator is to control. Abbreviations may be used: for example, "Nat" for natural gas and "LP" for liquefied petroleum gases. This marking shall be visible during the act of conversion.

### 1.13.6

Regulators leak resistant to excessive pressure shall be marked with the symbol, EP. (See 2.11.7.)

### 1.13.7

Each regulator shall bear a separate marking indicating the date of manufacture. This marking shall be as specified in "-a", "-b" or "-c" below.

a. The date in the form of:

1. The month, day and year; or
2. The day, month and year.

The abbreviation of the month shall be at least the first three letters of the month. The day may be the Monday of the week and the year must be at least the last two digits of the year.

b. A four digit date code consisting of:

1. The first and second digits indicating the calendar year in which the regulator was manufactured (e.g., 07 for 2007).
2. The third and fourth digits indicating the week in which the regulator was manufactured (e.g., 03 for the third week of the year). For purposes of this marking, a week shall begin at 0001 hours on Sunday and end at 2400 hours on Saturday.

A four digit code may be used for more than one week; however, it shall not be used for more than four consecutive weeks, nor more than two weeks into the next calendar year.

Additional numbers, letters or symbols may follow the four digit number specified in "-a" and "-b." If additional numbers are used, they must be separated from the date code.

c. A five digit code consisting of:

1. The first and second digits indicating the calendar year in which the regulator was manufactured (e.g., 07 for 2007); and
2. The third, fourth and fifth digits indicating the day of the year in which the regulator was manufactured (e.g., 183 for the one hundred and eighty third day in the year 2007, which is July 2, 2007).

Additional numbers, letters or symbols may follow the five digit code. If additional numbers are used, they shall be separated from the five digit code.

## ***Part II: Performance***

### **2.1 General**

#### **2.1.1**

Unless otherwise specified, tests for compliance with this standard shall be conducted at  $77 \pm 10^{\circ}\text{F}$  ( $25 \pm 5.5^{\circ}\text{C}$ ), herein after referred to as room temperature.

For tests conducted at other than room temperature, the test temperature shall be within  $\pm 3^{\circ}\text{F}$  ( $\pm 1.5^{\circ}\text{C}$ ) of the specified value.

#### **2.1.2**

When the manufacturer's maximum specified ambient temperature is above  $125^{\circ}\text{F}$  ( $51.5^{\circ}\text{C}$ ), the regulator shall also comply with [2.4, Leakage](#), [2.12.3](#) (or [3.12.3](#)) and [2.13, Continued Operation](#), or [3.13, Continued Operation](#), when operated at the maximum temperature specified. (See [1.1.6](#).)

#### **2.1.3**

When the manufacturer's minimum specified ambient temperature is below  $32^{\circ}\text{F}$  ( $0^{\circ}\text{C}$ ), the regulator shall also comply with [2.4, Leakage](#), [2.12.4](#) (or [3.12.4](#)) and [2.13, Continued Operation](#), or [3.13, Continued Operation](#), when operated at the minimum temperature specified. (See [1.1.6](#).)

#### **2.1.4**

Multistage regulators shall have all tests conducted with the regulator at the setting which will deliver the maximum outlet pressure. Additional tests, as specified in [2.8, Outlet Pressure Range](#), [2.9, Range of Regulation Capacity](#), and [2.12, Integrity of Operation](#), shall be conducted with the regulator at the setting which will deliver the minimum outlet pressure. Maximum and minimum adjustment, when specified in the various provisions, are in reference to each particular setting for this type of regulator.

#### **2.1.5**

Convertible regulators shall have all tests conducted with the regulator at the setting which will deliver the maximum outlet pressure. Additional tests, as specified in [2.8, Outlet Pressure Range](#), through [2.12, Integrity of Operation](#), shall be conducted at the setting which will deliver the minimum outlet pressure.

A convertible regulator may have a different range of regulation, variable load capacity and pressure rating for each of its outlet pressure settings.

#### **2.1.6**

Regulators for use on domestic gas ranges shall also comply with [2.11, Regulation For Use On Domestic Gas Ranges](#).

#### **2.1.7**

A regulator which has more than one main burner gas outlet shall be tested under [2.5, Strength and Deformation](#), and [2.9, Range of Regulation Capacity](#), or [3.9, Range of Regulation Capacity](#), for each outlet in turn with the other outlet(s) plugged. All other tests shall be conducted using the outlet with the highest manufacturer's specified regulation capacity and with the other outlet(s) plugged (also see [1.2-t](#)).

### **2.2 Test And Reference Gases**

#### **2.2.1**

Unless otherwise specified herein, either gas or air may be used for the tests. The term "test gas" as used herein shall mean either gas or air.

### 2.2.2

The temperature of the test gas for low temperature operation tests shall be at the manufacturer's specified minimum ambient temperature.

### 2.2.3

The test results shall be expressed in terms of a 1000 Btu/ft<sup>3</sup> (37.3 MJ/m<sup>3</sup>), 0.64 specific gravity gas at standard conditions [saturated with water at 60°F (15.5°C) and 30 inches mercury column (101.3 kPa) pressure]. For convertible regulators intended for use with liquefied petroleum gases, the test results for the LP position shall be expressed in terms of a 2500 Btu/ft<sup>3</sup> (93.1 MJ/m<sup>3</sup>), 1.53 specific gravity gas at standard conditions.

## 2.3 Test Pressures

### 2.3.1

#### Maximum Inlet Test Pressure

Unless otherwise specified, the maximum inlet test pressure shall be 1½ times the rated inlet pressure (see [1.1.3](#)).

### 2.3.2

#### Minimum Inlet Test Pressure

The minimum inlet test pressure for each regulator adjustment extreme shall be that obtained by adding an increment to each manufacturers specified outlet pressure.

This increment shall be specified by the manufacturer and shall be within the limits shown in [Table II, Inlet Test Pressure](#).

## 2.4 Leakage

Gas pressure regulators when subjected to the maximum inlet test pressure, shall not leak externally at a rate in excess of 200 cm<sup>3</sup>/hr. This test shall be conducted at:

- Room temperature if the specified ambient temperature range is 32°F (0°C) to 125°F (51.5°C);
- Room temperature and the maximum specified ambient temperature if that temperature is above 125°F (51.5°C), (see [2.1.2](#));
- Room temperature and the minimum specified ambient temperature if that temperature is below 32°F (0°C), (see [2.1.3](#)); or
- Both the minimum and maximum specified ambient temperatures if the ambient temperature range extends below 32°F (0°C) and above 125°F (51.5°C), (see [2.1.2](#) and [2.1.3](#)).

### Method of Test

The inlet and outlet of the regulator shall be connected to a pneumatic system capable of supplying clean air. Air shall be admitted slowly and maintained at the specified maximum inlet test pressure. Leakage, corrected to standard conditions of 30 inches mercury column (101.3 kPa) pressure and 60°F (15.5°C), shall be determined by a flowmeter capable of accurately indicating the allowable flow located at the inlet of the air supply, and shall not be in excess of 200 cubic centimeters per hour.

## 2.5 Strength And Deformation

### 2.5.1

Regulators shall be capable of withstanding, without deformation, breakage or leakage, the turning effort shown in [Table III](#), exerted by assembling to piping or tubing.

This test shall not apply to regulators having flange connections.

#### Method of Test

A wrench of suitable size shall be used to apply the turning force. SAE 10 viscosity machine oil shall be applied to the taper threads of steel pipe nipples, which shall be inserted in the inlet and outlet of the regulator and turned up handtight. With the inlet nipple secured in a vise, the specified turning effort shall be applied to the outlet nipple. For other than straight through type regulators, the tests shall be repeated as outlined above except with the outlet nipple inserted in the vise and the turning effort applied to the inlet nipple. There shall be no evidence of deformation or breakage, or impairment of operation or capacity as a result of making up inlet and outlet connections.

Regulators designed for connection to tubing shall be tested as specified above except that the torque shall be applied to opposite ends of the regulator body through wrench flats or bosses and not to the tubing fittings.

After relaxation of the applied torque, the tests specified in [2.4, Leakage](#), shall be performed.

*NOTE: Any leakage due to dry threads shall be disregarded.*

### 2.5.2

A regulator shall be capable of withstanding the bending moment generated where subjected to the applicable static loads specified in [Table IV](#), .

This test shall not apply to regulators having tubing connections.

#### Method of Test

The regulator under test and suitable lengths of standard weight pipe of the same size as the connections shall be made up into a pressure tight assembly. The inlet and outlet pipe shall be connected to an air pressure system capable of applying the test pressures as specified in [2.4, Leakage](#).

With the regulator in the upright position, the outlet pipe shall be clamped as close to the regulator as possible in a vise or other suitable rigid support. The appropriate static load specified in [Table IV](#), shall then be applied to the inlet pipe as close to the regulator as possible at a 90 degree (1.57 rad) angle from the direction of the outlet tapping. If the inlet and outlet connections are of different sizes, the static load for the larger size shall be applied.

While subjected to this load, the regulator shall be checked for external leakage in the manner prescribed in [2.4](#) and shall not exceed the allowable leakage rate specified.

### 2.5.3

For regulators rated in excess of  $\frac{1}{2}$  psi (3.5 kPa), the body, atmospheric diaphragm chamber and sealing means of the regulator, except the diaphragm, shall withstand, without rupture, a static pressure of 5 times the rated inlet pressure.

## Method of Test

A separate regulator, not to be used for the conduct of other tests, shall be tested.

The diaphragm employed in the regulator shall be substantially removed to permit the test medium to flow freely to both sides of the diaphragm.

The inlet and outlet of the regulator shall be connected to a suitable hydraulic system. The pressure shall be raised slowly to 5 times the rated inlet pressure of the regulator, or 7.5 psi (51.7 kPa), whichever is greater, and held at that pressure for 1 minute.

### 2.6 Mounting Regulator For Test

Standard weight pipe (Schedule 40, API 5 L Grade B) of proper size, reamed to remove burrs caused by cutting, shall be properly fitted to the inlet and outlet connections of the regulator. When a regulator is provided with semirigid tubing connections, fittings and semirigid tubing of the proper size reamed to remove burrs caused by cutting shall be used instead of standard weight pipe.

The length of straight run of pipe before the inlet pressure tap shall not be less than 50 pipe diameters (I.D.), or in accordance with the principles established for pipe tap connections as presented in Gas Measurement Committee Report No. 3, Edition, for the Orifice Metering of Natural Gas. The length of straight run of pipe between the regulator and any downstream controlling means shall be 10 pipe diameters (I.D.).

Three short lengths of pipe or metal tubing having a small diameter shall be soldered to the pipe or semi-rigid tubing, one before the inlet and the other two after the outlet connection. The pressure tap before the inlet shall be located 5 pipe diameters from the discharge end of the inlet pipe or tubing. The two pressure taps after the outlet connection shall be located 180 degrees (3.14 rad) apart and 5 pipe diameters from the inlet end of the discharge pipe or tubing. A  $\frac{1}{16}$  in (1.6 mm) diameter drill shall be inserted in each short length of pipe or metal tubing and a hole drilled through the wall of the larger pipe or semi-rigid tubing, care being taken to remove any burrs caused thereby.

The pilot takeoff, if provided, of regulators to be tested under [2.10, Regulators Designated To Operate At Pilot Flow Rate](#), and [2.11.6](#), shall be equipped with a pipe tee of suitable size. A pilot flow line consisting of  $\frac{1}{8}$  in pipe, 2  $\frac{3}{4}$  in (69.9 mm) long, shall be attached to one end of the tee. If a pilot takeoff is not provided and the tests specified in 2.10 and [2.11.6](#) are to be conducted, a pilot flow line also consisting of  $\frac{1}{8}$  in pipe, 2  $\frac{3}{4}$  in (69.9 mm) long, shall be attached to the side of one of the two pressure taps on the discharge side of the regulator under test.

The regulator shall be placed in the mounting position specified in [1.1.5](#) for the particular test to be conducted. The pressure tap on the inlet side and one of the pressure taps on the outlet side shall be connected to independent pressure measuring devices having an accuracy of 1 percent at the observed value as well as to a differential gage (one tap being connected to each side) which has an accuracy of 1 percent at the observed value. An adjustment control valve system of the same size as the regulator under test, permitting precise control, shall be installed not less than the above specified number of pipe or tubing diameters from the regulator under test. To permit the interruption of gas flow through the regulator without changing the adjustment control system, an automatic valve having an opening time of 0.1 second or less from initial flow to a capacity greater than the maximum regulation capacity of the regulator being tested shall be provided downstream from the regulator under test.

Typical arrangements of the required test apparatus are shown in sections A and B of Figure 2, Typical Arrangement of Test Apparatus, (or sections A and B of Figure 11, Typical Arrangement of Test Apparatus for Negative Pressure Regulators).

The flow of test gas shall be measured by means which will provide a reading of volumetric accuracy within  $\pm 1$  percent at the rated flow. If fuel gas is used for the test gas, it shall be vented or burned as far away from the apparatus and the regulator under test as will preclude the heating of such equipment.

The constant pressure source shall not permit a pressure variation, from no flow to full flow, of more than  $\pm 0.1$  in wc (24.9 Pa) for each 100/ft<sup>3</sup> (2.83 m<sup>3</sup>) of air flow at full flow.

## 2.7 Pressure Drop Capacity

The pressure drop capacity shall not be less than that specified by the manufacturer (see 1.2-j).

### Method of Test

The regulator shall be mounted in the upright position as specified in 2.6, Mounting Regulator for Test.

The regulator, if adjustable, shall be adjusted to deliver its maximum outlet pressure. The inlet pressure shall be established at the rated inlet pressure of the regulator as specified in 2.3, Test Pressures, at an equivalent flow rate of the manufacturer's specified pressure drop capacity at 1.0 in wc (249 Pa). The observed outlet pressure shall be recorded.

The inlet pressure shall then be reduced to and held constant at 80 percent of the outlet pressure observed above. Beginning at approximately 10 percent of the manufacturer's specified pressure drop capacity, the flow rate shall be observed at intervals of approximately 20 percent. This procedure shall be continued until the pressure drop exceeds 1.0 in wc (249 Pa). The results of these observations shall be recorded.

The capacity of the valve shall be calculated using the following formula:

$$q_{sc} = KQ_1 \sqrt{\frac{P_t \times \text{sp gr}_t}{\text{pd}_t \times \theta_t}}$$

or, since

$$\text{sp gr}_t = \frac{\text{sp gr}_1 (P_t - \text{at})}{P_t} + \frac{\text{at} (\text{sp gr}_2)}{P_t}$$

then

$$q_{sc} = KQ_1 \sqrt{\frac{\text{sp gr}_1 (P_t - \text{at}) + \text{at} (\text{sp gr}_2)}{\text{pd}_t \times \theta_t}}$$

where

- K = 5218 for U.S. customary units (345.543 for metric units).
- $q_{sc}$  = capacity with gas of 1000 Btu/ft<sup>3</sup> (37.3 MJ/m<sup>3</sup>) and 0.64 sp. gr. [saturated with water at 60°F (15.5°C) and 30 in. mercury column (101.3 kPa)] at which a pressure drop of 1.0 inch equivalent water column (249 Pa) occurs, Btu/hr (kW).
- $Q_1$  = quantity of test gas (or air) as metered, ft<sup>3</sup>/hr (m<sup>3</sup>/hr).
- $\text{sp gr}_1$  = specific gravity of dry test gas (or air) referred to dry air as 1.0.

|                    |   |                                                                                                                                                          |
|--------------------|---|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| sp gr <sub>t</sub> | = | corrected or actual specific gravity of test gas (or air) as metered.                                                                                    |
| P <sub>t</sub>     | = | absolute pressure of test gas (or air) as metered, in. mercury column (kPa).                                                                             |
| at                 | = | aqueous tension of water vapor in test gas (or air), in. mercury column (Pa).                                                                            |
| sp gr <sub>2</sub> | = | 0.62 = specific gravity of water vapor referred to dry air as 1.0.                                                                                       |
| pd <sub>t</sub>    | = | observed pressure drop (corrected for difference in velocity head, if any, due to change of area at points tapings are taken), inches water column (Pa). |
| θ <sub>t</sub>     | = | temperature of test gas (or air) as metered, °F absolute (°C).                                                                                           |

When the inlet and outlet connections of a regulator differ in size, the observed pressure drop shall be corrected for the change in velocity pressure using the following formula:

$$pd_t = pd_o + hv_1 - hv_2$$

where:

The velocity head, inches water column (Pa), at the inlet tapping (hv<sub>1</sub>) or outlet tapping (hv<sub>2</sub>) is found by the following formula:

$$h_v = \frac{C \times Q_1^2 \times P \times \text{sp gr}_t}{D^4 \theta_t}$$

and

|                    |   |                                                                                                                              |
|--------------------|---|------------------------------------------------------------------------------------------------------------------------------|
| C                  | = | 1.0335 x 10 <sup>-5</sup> for U.S. customary units (2.1923 x 10 <sup>-10</sup> for metric units).                            |
| Q <sub>1</sub>     | = | quantity of test gas (or air) as metered, ft <sup>3</sup> /hr (m <sup>3</sup> /hr).                                          |
| sp gr <sub>t</sub> | = | corrected or actual specific gravity of test gas (or air) as metered.                                                        |
| pd <sub>o</sub>    | = | pressure drop (may be negative) between inlet and outlet pressure tapings on manifold as observed, inches water column (Pa). |
| D                  | = | inside diameter of pipe at inlet or outlet pressure tapping, in (mm).                                                        |
| P                  | = | absolute pressure of test gas (or air) at inlet or outlet pressure tapping, inches mercury column (kPa).                     |
| θ <sub>t</sub>     | = | temperature of test gas (or air) as metered, °F absolute (°C).                                                               |

The data obtained shall then be resolved and a graph plotted of pressure drop versus flow rate. The flow rate at a pressure drop of 1.0 in wc (249 Pa) shall then be recorded, in terms of the reference gas specified in 2.2.3, as the pressure drop capacity.

This capacity shall be equal to or more than the 1.0 in wc (249 Pa) pressure drop capacity specified by the manufacturer.

## 2.8 Outlet Pressure Range

These tests shall be conducted at room temperature. (See [2.1.1](#).)

### 2.8.1 Adjustable Regulators.

The highest obtainable outlet pressure shall not be less than that specified by the manufacturer. The lowest obtainable outlet pressure shall not be more than that specified by the manufacturer. During the test to determine the limits of the adjustment range, the spring of the spring adjusting means shall not become disengaged.

### Method of Test

The regulator shall be mounted as specified in 2.6, Mounting Regulator for Test, in the upright position (see [1.1.5](#)).

The regulator shall be adjusted to deliver its minimum outlet pressure. The cap provided for concealing the adjustment means shall be in place. The inlet pressure and flow rate specified by the manufacturer (see 1.2-d) shall be established. The observed outlet pressure shall be noted in each mounting position specified by the manufacturer (see [1.1.5](#)), and shall not be more than that specified by the manufacturer.

The regulator shall be adjusted to deliver its maximum outlet pressure. The inlet pressure and flow rate specified by the manufacturer (see 1.2-d) shall be established. The observed outlet pressure shall be noted in each mounting position specified by the manufacturer (see [1.1.5](#)), and shall not be less than that specified by the manufacturer.

The data noted with the minimum outlet pressure adjustment shall be examined to determine the regulator mounting position which produces the minimum outlet pressure. This mounting position shall be designated Position A. The data noted with the maximum outlet pressure adjustment shall be examined to determine the regulator mounting position which produces the maximum outlet pressure. This mounting position shall be designated Position B. (See [1.1.5-a](#) and [1.1.5-b](#).) These two mounting positions are to be used for conduct of 2.9, Range of Regulation Capacity, and 2.10, Regulators Designated to Operate at Pilot Flow Rate, as applicable.

### 2.8.2 Nonadjustable Regulators

This provision applies to regulators for use other than on domestic gas ranges. (Nonadjustable regulators for use on domestic gas ranges shall be evaluated under [2.11.1](#).)

The outlet pressure determined under the following Method of Test shall be within the tolerances specified in Table V, Allowable Outlet Pressure Tolerances for Nonadjustable Regulators, for the outlet pressure specified by the manufacturer.

### Method of Test

The regulator shall be mounted as specified in 2.6, Mounting Regulator for Test, in the upright position (see [1.1.5](#)).

The inlet pressure and flow rate shall be established as specified by the manufacturer (see 1.2-e).

The outlet pressure shall be observed and shall be within the tolerances specified in Table V.

The above test shall be repeated with the regulator mounted in each mounting position specified by the manufacturer (see [1.1.5](#)).

The data shall be examined to determine the regulator mounting position which produces the minimum outlet pressure and the regulator mounting position which produces the maximum outlet pressure. (See [1.1.5a](#) and [1.1.5b](#).) These two mounting positions are to be used for conduct of [2.9](#), Range of Regulation Capacity, and [2.10](#), Regulators Designated to Operate at Pilot Flow Rate.

### **2.8.3 Convertible Regulators**

This provision applies to regulators for use other than on domestic gas ranges. (Convertible regulators for use on domestic gas ranges shall be evaluated as specified in [2.11.3](#).)

The outlet pressure, at each outlet pressure setting, of convertible regulators for use other than on domestic gas ranges shall be within the tolerances specified in Table V, Allowable Outlet Pressure Tolerances for Nonadjustable Regulators, of the outlet pressure specified by the manufacturer.

## **Method of Test**

This test shall be conducted in accordance with the Method of Test specified in [2.8.2](#).

## **2.9 Range Of Regulation Capacity**

The range of regulation capacity as determined by test shall include the upper and lower limits specified by the manufacturer. The applicable tests are to be conducted at room temperature. (See [2.1.1](#).)

### **2.9.1**

Nonadjustable Regulators

## **Method of Test**

The regulator shall be mounted for test as specified in [2.6](#), [Mounting Regulator For Test](#), in Position A (as determined in [2.8](#), [Outlet Pressure Range](#)).

The inlet test pressure shall be adjusted to the appropriate minimum value specified in [Table II](#), [Inlet Test Pressure](#). If this minimum value exceeds the rated inlet pressure, the rated inlet pressure shall be used as the minimum inlet test pressure. The initial flow rate shall be set at a value less than the lower limit of the manufacturer's specified range of regulation capacity. The lower limit of the range of regulation capacity shall be 0.15 ft<sup>3</sup>/hr (1.18 cm<sup>3</sup>/s) for regulators designated by the symbol  $\textcircled{P}$  and 0.50 ft<sup>3</sup>/hr (3.93 cm<sup>3</sup>/s) for regulators designated by the symbol  $\nabla$ .

The inlet test pressure shall be gradually increased to the rated inlet pressure. Over this range of inlet pressures, the minimum and maximum obtainable outlet pressures observed and their corresponding flow rates shall be recorded and used to construct a smooth orifice curve (see Part V, Definitions).

The inlet test pressure shall then be increased to the maximum inlet test pressure (see [Table II](#), [Inlet Test Pressure](#)) and the outlet pressure observed shall be recorded.

This procedure shall be repeated for increased flow rates to a flow rate exceeding the upper limit of the manufacturer's specified range of regulation capacity. Sufficient readings shall be recorded to establish smooth curves (see Figure 3, Range of Regulation Curves for Nonadjustable Regulators) when minimum obtainable outlet pressures are joined (Curve A), maximum obtainable outlet pressures are joined (Curve B), and outlet pressures obtained at the maximum inlet test pressure are joined (Curve C).

Pressure variations and flow rates shall be examined along the orifice curves.

- a. The minimum and maximum obtainable outlet pressure curves shall be examined to determine the minimum and maximum flow rates between which the outlet pressure variation does not exceed 20 percent of the minimum obtainable outlet pressure. (See Figure 3, Range of Regulation Curves for Nonadjustable Regulators.)
- b. A curve constructed from the outlet pressures obtained at the maximum inlet test pressure shall be examined to determine the minimum and maximum flow rates between which the curve does not vary more than  $\pm 20$  percent from the minimum obtainable outlet pressure. (See Figure 3.)

The largest minimum flow rate and the smallest maximum flow rate determined from “-a” and “-b” above shall include the lower and upper limits of the manufacturer’s specified range of regulation capacity.

This entire test shall be repeated with the regulator mounted in Position B (as determined in [2.8, Outlet Pressure Range](#)).

## 2.9.2

### Adjustable Regulators

#### Method of Test

The regulator shall be mounted for test as specified in 2.6, Mounting Regulator for Test, in Position B (as determined in [2.8, Outlet Pressure Range](#)) and adjusted to deliver the manufacturer’s specified maximum outlet pressure with the related inlet pressure and flow rate established as specified by the manufacturer (see 1.2-d). The procedure outlined in [2.9.1](#) shall then be followed to develop Curves A, B and C as shown in Figure 4, Range of Regulation Curves for Adjustable Regulators.

The regulator shall then be mounted in Position A (as determined in 2.8) and adjusted to deliver the manufacturer’s specified minimum outlet pressure with the related inlet pressure and flow rate established as specified by the manufacturer (see 1.2-d). The procedure outlined in [2.9.1](#) shall then be repeated to develop Curves D, E and F as shown in Figure 4, Range of Regulation Curves for Adjustable Regulators.

The largest minimum flow rate and the smallest maximum flow rate determined from all of the tests above shall include the lower and upper limits of the manufacturers specified range of regulation capacity. (See Figure 4.)

## 2.9.3

### Convertible Regulators

This provision applies to regulators for use other than on domestic gas ranges. (Convertible regulators for use on domestic gas ranges shall be evaluated as specified in [2.11.4](#).)

Convertible regulators for use other than on domestic gas ranges shall be evaluated at each outlet pressure setting as a nonadjustable regulator.

#### Method of Test

This test shall be conducted in accordance with the Method of Test specified in [2.9.1](#).

The range of regulation capacity at each outlet pressure setting shall be determined independently.

## 2.9.4

### Multi-Stage Regulators

Multi-stage regulators shall be tested at the highest and lowest stages.

These stages may be adjustable or nonadjustable. The minimum inlet test pressure for the lowest stage shall be the minimum inlet test pressure determined for the highest stage.

### Method of Test

a. The highest pressure stage shall be examined first. If the highest pressure stage is nonadjustable, it shall be tested following the procedure specified in [2.9.1](#).

If the highest pressure stage is adjustable, it shall be tested following the procedure specified in [2.9.2](#).

b. The regulator shall then be mounted in Position A (as determined in [2.8, Outlet Pressure Range](#)) and manually or automatically energized to provide the lowest pressure stage.

If the lowest pressure stage is nonadjustable, it shall be tested following the procedure specified in [2.9.1](#), except with the regulator mounted only in Position A.

If the lowest pressure stage is adjustable, it shall be adjusted to deliver the manufacturer's specified minimum outlet pressure, with the related inlet pressure and flow rate established as specified by the manufacturer (see 1.2-d). The test shall then be conducted following the procedure specified in [2.9.1](#), except with the regulator mounted only in Position A.

Curves A, B and C shall be developed as specified in [2.9.1](#) except that the maximum flow rate need not exceed the flow rate on the orifice curve for the maximum regulation capacity determined in 2.9.4a (see Figure 5, Range of Regulation Curves for Multi-Stage Regulators).

Within the limits of the flow rates obtained from the orifice curves at the lower and upper limits of the manufacturer's specified range of regulation capacity, the observed outlet pressure shall not vary by more than 20 percent of the lower outlet pressure reading or 0.3 iwc (74.7 Pa), whichever is greater. In no case shall the observed outlet pressure be less than 0.2 iwc (50 Pa).

## 2.10 Regulators Designated To Operate At Pilot Flow Rate

These tests shall be conducted at room temperature. (See [2.1.1](#).)

### 2.10.1

This provision applies to regulators for use other than on domestic gas ranges. An alternative evaluation applicable to regulators for use on domestic gas ranges is specified in [2.11.5](#).

The specified maximum regulation capacity for main burner and pilot load application shall not be greater than the specified maximum regulation capacity for main burner load only. The pressure variation in the pilot line, resulting from the change of flow rate through the regulator from the specified regulation capacity for main burner and pilot load to a pilot flow rate, shall not exceed the value specified in the following Method of Test.

### Method of Test

Convertible regulators shall be tested at each outlet pressure setting.