ANSI Z21.18-2007
CSA 6.3-2007

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

AMERICAN NATIONAL STANDARD
ANSI Z21.18-2007

CSA STANDARD
CSA 6.3-2007

Third Edition - 2007
This Standard is based on the Standard for
Gas Appliances Pressure Regulators
ANSI Z21.18-2000 • CSA 6.3-2000
and Addendas Z21.18a-2001 • CSA 6.3a-2001,
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Standard Developer

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For further information on CSA services, write to

Canadian Standards Association
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ANSI provides that the interests of the public may have appropriate participation and representation in standardization activity, and cooperates with departments and agencies of U.S. Federal, state and local governments in achieving compatibility between government codes and standards and the voluntary standards of industry and commerce.

ANSI represents the interests of the United States in international nontreaty organizations such as the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). The Institute maintains close ties with regional organizations such as the Pacific Area Standards Congress (PASC) and the Pan American Standards Commission (COPANT). As such, ANSI coordinates the activities involved in the U.S. participation in these groups.

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American National Standards Institute, Inc.
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10036

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, Missiaaauga, 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.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute, Inc., require that action be taken to reaffirm, revise or withdraw this standard no later than five (5) years from the date of approval. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute, Inc., 25 West 43rd Street, Fourth Floor, New York, N.Y. 10036, (212) 642-4900.

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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Contents

Page

Contents (Continued)

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 I0 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^3/hr (1.18 cm^3/s), or

   2. 0.50 ft^3/hr (3.93 cm^3/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 ± 10°F (25 ± 5.5°C). Regulators and vent limiters complying with the provisions of this standard shall be considered as having an ambient temperature range of 32°F (0°C) to 125°F (51.5°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 Ⓟ or ▽P 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 $^{1}/_{8}$ 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 $^1/_8$ 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, Ⓟ or ▽P, shall appear adjacent to the model number. Multistage regulators shall not display the Ⓟ or ▽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 indication 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 ± 10°F (25 ± 5.5°C), herein after referred to as room temperature.

For tests conducted at other than room temperature, the test temperature shall be within ± 3°F (± 1.5°C) of the specified value.

2.1.2
When the manufacturer's maximum specified ambient temperature is above 125°F (51.5°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°F (0°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^3 (37.3 MJ/m^3), 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^3 (93.1 MJ/m^3), 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 1$^1/_2$ 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^3/hr. This test shall be conducted at:

a. Room temperature if the specified ambient temperature range is 32°F (0°C) to 125°F (51.5°C);

b. Room temperature and the maximum specified ambient temperature if that temperature is above 125°F (51.5°C), (see 2.1.2);

c. Room temperature and the minimum specified ambient temperature if that temperature is below 32°F (0°C), (see 2.1.3); or

d. 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 $^1/_2$ 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 $^{1}/_{16}$ 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 $^{1}/_{8}$ in pipe, 2 $^{3}/_{4}$ 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 $^{1}/_{8}$ in pipe, 2 $^{3}/_{4}$ 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 ± 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 ± 0.1 in wc (24.9 Pa) for each 100/ft^3 (2.83 m^3) 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:

$$q_{sc} = KQ_1 \sqrt{\frac{P_t \times sp\ gr_t}{pd_t \times \theta_t}}$$

or, since

$$sp\ gr_t = \frac{sp\ gr_1\ (P_t - at)}{P_t} + \frac{at\ (sp\ gr_2)}{P_t}$$

then

$$q_{sc} = KQ_1 \sqrt{\frac{sp\ gr_1\ (P_t - at) + at\ (sp\ gr_2)}{pd_t \times \theta_t}}$$

where

K	=	5218 for U.S. customary units (345.543 for metric units).
q_{sc}	=	capacity with gas of 1000 Btu/ft^3 (37.3 MJ/m^3) 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^3/hr (m^3/hr).
sp gr_1	=	specific gravity of dry test gas (or air) referred to dry air as 1.0.

$sp\ gr_t$ = corrected or actual specific gravity of test gas (or air) as metered.

P_t = 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).

$sp\ gr_2$ = 0.62 = specific gravity of water vapor referred to dry air as 1.0.

pd_t = observed pressure drop (corrected for difference in velocity head, if any, due to change of area at points tappings are taken), inches water column (Pa).

θ_t = 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_1) or outlet tapping (hv_2) is found by the following formula:

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

and

C = 1.0335×10^{-5} for U.S. customary units (2.1923×10^{-10} for metric units).

Q_1 = quantity of test gas (or air) as metered, ft^3/hr (m^3/hr).

$sp\ gr_t$ = corrected or actual specific gravity of test gas (or air) as metered.

pd_o = pressure drop (may be negative) between inlet and outlet pressure tappings 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_t = 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^3/hr (1.18 cm^3/s) for regulators designated by the symbol Ⓟ and 0.50 ft^3/hr (3.93 cm^3/s) for regulators designated by the symbol ▽P.

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 ± 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.

The regulator and pilot flow line shall be installed as specified in 2.6, Mounting Regulator for Test, except that a manometer shall be installed at either point (1) or point (3) as shown in the appropriate section of Figure 2, Typical Arrangement of Test Apparatus.

With a flow rate through the regulator equivalent to the maximum specified regulation capacity and the pilot flow adjusted to 0.15 ft^3/hr (1.18 cm^3/s) for regulators designated by the symbol Ⓟ, or 0.50 ft^3/hr (3.93 cm^3/s) for regulators designated by the symbol ▽P, the settings specified below shall be made within the rated inlet pressure of the regulator and the minimum inlet test pressure specified in 2.9, Range of Regulation Capacity, . The main flow shall be cycled off and on to establish the reliability of the setting. The pilot line pressure at each of the established settings shall be recorded.

The regulator shall be mounted in Position B (as determined in 2.8, Outlet Pressure Range).

a. Adjust the regulator, if adjustable, 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). Then set the inlet pressure to produce the maximum outlet pressure.

b. Adjust the regulator, if adjustable, as described in "-a." Then set the inlet pressure to produce the minimum outlet pressure.

The regulator shall then be mounted in Position A (as determined in 2.8, Outlet Pressure Range).

c. Adjust the regulator, if adjustable, 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). Then set the inlet pressure to produce the maximum outlet pressure.

d. Adjust the regulator, if adjustable, as described in "-c." Then set the inlet pressure to produce the minimum outlet pressure.

At the end of the established settings, the instantaneous opening valve shall be closed and, without reopening the valve, the stabilized pilot line pressure shall again be noted. The pressure shall be within 1.5 in wc (373 Pa) or 20 percent, whichever is greater, of the previously recorded pilot line pressure.

2.10.2

The pressure in the pilot line resulting from changing the flow through the regulator from pilot rate to the maximum individual load capacity (see 1.2-1) shall not be less than 65 percent of the stabilized pilot line pressure at pilot rate when examined under the following Method of Test.

Method of Test

Convertible regulators shall be tested at each outlet pressure setting.

The regulator shall be installed as specified in 2.10.1, except the manometer shall be replaced by a pressure transducer coupled to a fast response recording voltmeter or other equivalent instrumentation to measure pilot line pressure, the vent limiter, if supplied, shall be in place.

The regulator shall be mounted in Position A (as determined in 2.8, Outlet Pressure Range).

a. The regulator, if adjustable, 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 inlet pressure shall then be adjusted to the minimum inlet test pressure specified 2.3.2, Table II, Inlet Test Pressure, at a flow rate equivalent to the maximum individual load capacity specified and the pilot flow adjusted to 0.15 ft^3/hr (1.18 cm^3/s) for regulators designated by the symbol Ⓟ, or 0.50 ft^3/hr (3.93 cm^3/s) for regulators designated by the symbol ▽P. The instantaneous opening valve shall be closed. The pressure in the pilot line shall be measured and recorded as the initial outlet pressure. With the inlet pressure held constant within ± 0.1 in wc (24.9 Pa), the instantaneous opening valve shall be opened and, starting at 0.25 second after flow has been initiated, the outlet pressure shall be noted until it has become stabilized. At least two more tests shall be conducted to definitely establish the minimum outlet pressure.

The minimum outlet pressure noted in the pilot line after 0.25 seconds of flow shall not be less than 65 percent of the initial outlet pressure.

b. The inlet pressure shall then be adjusted to the rated inlet pressure of the regulator. No change in any flow adjustment shall be made. The outlet pressure curve shall be developed and evaluated as specified in 2.10.2-a.

The regulator shall then be mounted in Position B (as determined in 2.8, Outlet Pressure Range).

c. The regulator, if adjustable, shall be 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 inlet test pressure shall then be adjusted to the minimum inlet test pressure specified in 2.3.2, Table II, Inlet Test Pressure, and flow rates adjusted as specified in 2.10.2-a. The outlet pressure curve shall be developed and evaluated as specified in 2.10.2-a.

d. The inlet pressure shall then be adjusted to the rated inlet pressure of the regulator. No change in any flow adjustment shall be made. The outlet pressure curve shall be developed and evaluated as specified in 2.10.2-a.

2.11 Regulators For Use On Domestic Gas Ranges

The provisions in this section apply only to regulators for use on domestic gas ranges.

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

2.11.1

The outlet pressure range of nonadjustable regulators for use on domestic gas ranges shall be evaluated as specified in 2.8.2 at a flow rate of 40,000 Btu/hr (11 723 W).

2.11.2

The lower limit of regulation for each outlet pressure setting of a Ⓟ pressure regulator shall be 0.15 ft^3/hr (1.18 cm^3/s) of 1000 Btu/ft^3 (37.3 MJ/m^3) 0.64 specific gravity gas.

2.11.3

The outlet pressure of convertible regulators for use on domestic gas ranges shall be evaluated at each outlet pressure setting as specified in the following Method of Test.

Method of Test

The regulators shall be tested in accordance with the procedure specified in 2.8.2 at a flow rate of 40,000 Btu/hr (11 723 W): (1) of 1000 Btu/ft^3 (37.3 MJ/m^3), 0.64 specific gravity gas, when the conversion means is positioned for natural gas, and (2) of 2500 Btu/ft^3 (93.1 MJ/m^3), 1.53 specific gravity gas, when the conversion means is positioned for liquefied petroleum gas.

The outlet pressure shall be observed and shall be within ± 0.3 in wc (74.7 Pa) of 4, 5 or 6 in wc (0.995, 1.24 or 1.49 kPa), as applicable, for natural gas, as specified by the manufacturer, and ± 0.5 in wc (124 Pa) for liquefied petroleum gas of the outlet pressure specified by the manufacturer.

2.11.4

The range of regulation capacity of convertible regulators for use on domestic gas ranges shall be evaluated at each outlet pressure setting including the lower and upper limits of the manufacturer's specified range of regulation capacity.

Method of Test

This test shall be conducted as specified in 2.9.1 with the flow rate established at a value less than the manufacturer's specified lower limit and the conversion means (1) positioned to deliver the natural gas outlet pressure, and (2) then positioned to deliver the liquefied petroleum gas outlet pressure.

After each series of tests ["(1)" and "(2)" above] the minimum and maximum obtainable outlet pressure readings on each orifice curve shall be joined as shown in Figure 6, Range of Regulation Curves for Convertible Regulators, (curves A, B and C for liquefied petroleum gas, and curves D, E and F for natural gas). The range of regulation capacity for each type gas shall be determined from points "a" and "b" or "c" and "d," respectively, in Figure 6.

2.11.5

The range of variable load capacity of a regulator for use on a domestic gas range shall include the upper and lower limits as specified by the manufacturer. The data and curves developed during the conduct of 2.9.1, 2.9.2 or 2.11.4 shall be used in determining the variable load capacity of the regulator. Figure 7, Range of Variable Load Capacity (Typical), illustrates how the curves shall be examined and the upper limit of the range of variable load capacity is determined.

a. Nonadjustable Regulators. Both the minimum obtainable outlet pressure curve (curve A, Figure 3, Range of Regulation Curves for Nonadjustable Regulators) and the maximum obtainable outlet pressure curve (curve B, Figure 3) shall be simultaneously examined to determine the flow rate (point b, Figure 7, Range of Variable Load Capacity (Typical), where the outlet pressure varies from the maximum outlet pressure recorded at a flow rate equal to the lower limit of the range of variable load capacity (point a, Figure 7) by 30 percent for natural, mixed, manufactured or LP gas-air applications and by 20 percent for liquefied petroleum gas applications, and shall include the upper limits of the range of variable load capacity specified by the manufacturer.

b. Adjustable Regulators. Both the minimum obtainable outlet pressure curve (curve A, Figure 3, Range of Regulation Curves for Nonadjustable Regulators) and the maximum obtainable outlet pressure curve (curve B, Figure 3) for the maximum pressure adjustment of the regulator shall be simultaneously examined to determine the flow rate (point b, Figure 7) where the outlet pressure varies from the maximum outlet pressure recorded at a flow rate equal to the lower limit of the range of variable load capacity (point a, figure 7) by 30 percent for natural, mixed, manufactured or LP gas-air applications and by 20 percent for liquefied petroleum gas applications.

   A similar examination shall be made of the pair of curves developed when examining the minimum outlet pressure adjustment of the regulator and the flow rate determined where the outlet pressure varies from the maximum outlet pressure recorded at a flow rate equal to the lower limit of the range of variable load capacity by 30 percent for natural, mixed, manufactured or LP gas-air applications and by 20 percent for liquefied petroleum gas applications.

   The lesser of the two maximum flow rates [the maximum flow rate determined by simultaneous examining of the curves developed during conduct of 2.9, Range of Regulation Capacity] shall be the upper limit of the range of variable load capacity for an adjustable regulator, and shall include the limits specified by the manufacturer.

c. Convertible Regulators. Both the minimum obtainable outlet pressure curves (curve D, Figure 6, Range of Regulation Curves for Convertible Regulators) and the maximum obtainable outlet pressure curve (curve E, Figure 6) for the natural gas position of the regulator shall be simultaneously examined to determine the flow rate where the outlet pressure varies from the maximum outlet pressure recorded at a flow rate equal to the lower limit of the range of variable load capacity by 30 percent for natural, mixed, manufactured or LP gas-air, as specified by the manufacturer.

A similar examination shall be made for both the minimum obtainable outlet pressure curve (curve A, Figure 6, Range of Regulation Curves for Convertible Regulators) and the maximum obtainable outlet pressure curve (curve B, Figure 6) to determine the flow rate where the outlet pressure varies from the maximum outlet pressure recorded at a flow rate equal to the lower limit of the range of variable load capacity by 20 percent and shall include the upper limit of the range of variable load capacity for liquefied petroleum gas as specified by the manufacturer.

2.11.6

For a Ⓟpressure regulator, the lowest stabilized pressure in the pilot line resulting from changing the flow through the regulator from pilot rate to the maximum individual load capacity as specified by the manufacturer shall not be less than 90 percent of the stabilized pilot line pressure at pilot rate. The appropriate curves developed during the conduct of 2.9.1, 2.9.2, 2.9.3 or 2.11.4 shall be used in determining compliance with this provision.

Figure 8, Typical Curves for Evaluations in 2.11.5, illustrates how special curves shall be established.

a. Nonadjustable Regulators. Both the minimum obtainable outlet pressure curve (curve A, Figure 3, Range of Regulation Curves for Nonadjustable Regulators) and the maximum obtainable outlet pressure curve (curve B, Figure 3) shall be individually examined to determine the flow rates at points "-c" and "-d," Figure 8, at which the outlet pressure is 90 percent of the outlet pressure recorded at a flow rate of 0.15 ft^3/hr (1.18 cm^3/s) (points "-a" and "-b," Figure 8). Neither of these flow rates shall be less than the individual load capacity specified for the regulator by the manufacturer.

b. Adjustable Regulators. The regulator shall be evaluated as in 2.11.6a using the curves in Figure 3, at both the maximum outlet pressure adjustment and the minimum outlet pressure adjustment of the regulator. The least of the four flow rates determined shall not be less than the individual load capacity specified for the regulator by the manufacturer.

c. Convertible Regulators. Convertible regulators shall be evaluated as specified in 2.11.6a using the curves in Figure 3 or Figure 6, , Range of Regulation Curves for Convertible Regulators, as applicable, at each outlet pressure setting. The "LP" setting shall be expressed in terms of a 2500 Btu/ft^3 (93.1 MJ/m^3), 1.53 specific gravity gas. The least of the four flow rates determined shall not be less than the individual load capacity specified for the regulator by the manufacturer.

2.11.7

Leakage Resistance to Excessive Pressure (Optional).

The following tests are applicable only to regulators rated at $^1/_2$ psi (3.5 kPa).

a. A regulator classified as leak resistant to excessive pressure shall not leak when subjected to a pressure of 60 psi (413.7 kPa) when tested as specified in the following Method of Test.

Method of Test

Air pressure at 60 psi (413.7 kPa) shall be admitted into both the inlet and the outlet of the regulator simultaneously and shall be maintained for 3 minutes at that pressure. During this time, the regulator shall not leak in excess of the equivalent of 1.0 ft^3/hr (7.86 cm3/s). Following this test, the regulator shall comply with 2.4.

b. A regulator classified as leak resistant to excessive pressure shall not allow more than 0.1 ft^3/hr (0.786 cm^3/s) of air to flow through it when subjected to an outlet back pressure of 14 in wc (3.48 kPa) and inlet pressures up to 60 psi (413.7 kPa) when subjected to the following Method of Test.

Method of Test

The inlet of the regulator shall be connected to a pressure controlled source of clean air followed by a flow measuring device, capable of accurately indicating flows up to 0.2 ft^3/hr (1.57 cm^3/s), and a suitable pressure gage between the flow measuring device and the inlet of the regulator. The outlet of the regulator shall be connected by means of a flexible tube to a glass tube at least 18 in (457 mm) in length and having an internal diameter of $^3/_{16}$ in (4.8 mm), extending vertically down 14 in (356 mm) below the surface of water in a large bottle, jar or standpipe.

With the regulator set to deliver its maximum rated outlet pressure, the inlet test pressure shall be gradually increased to 60 psi (414 kPa) with observations made of the flow rate and the air level in the vertical glass tube. If, at any time, air bubbles issue from the end of the tube, the inlet test pressure shall be maintained until the flow rate is recorded. The inlet test pressure shall then continue to be increased up to 60 psi (413.7 kPa). At no time shall the recorded flow rate exceed a flow equivalent to 0.1 ft^3/hr (0.786 cm^3/s).

2.12 Integrity Of Operation

2.12.1

A base curve(s) showing opening characteristics of the regulator shall be developed by recording outlet pressure versus time. A regulator with a separate vent limiter shall have curves developed with and without the vent limiter installed. If more than one vent limiter is used with the regulator, an additional curve shall be developed with each vent limiter in place. A convertible regulator shall have a curve developed for each operating pressure range. A multi-stage regulator shall have curves developed at the settings which deliver the maximum and minimum multi-stage outlet pressure, respectively.

Method of Test

This test shall be conducted at room temperature. The regulator shall be mounted for test in the manufacturer's specified upright position as specified by Figure 9, Arranegment for Integrity of Operation Test, and, where applicable, according to the equipment specifications under 2.6, Mounting Regulator For Test. Unless otherwise specified, all outlet pressure measurements shall be made at point (2) of Figure 9.

The inlet test pressure for each curve to be developed shall be set as indicated below:

Rated Inlet Pressure	Inlet Test Pressure
	(Manufacturer's specified minimum outlet pressure for each range plus the following increment:)
1/2 psi (3.5 kPa)	2 in wc (498 Pa)
2 psi (13.8 kPa)	1/2 psi (3.5 kPa)
5 psi (34.5 kPa)	1 psi (6.9 kPa)

For each operating pressure range, the pressure regulator shall be set to obtain the manufacturer's specified minimum outlet pressure at a flow rate equivalent to the midpoint of the specified range of regulation capacity. For purpose of this initial setting, the pressure tap at point (1) (see Figure 9) shall be used. After the initial setting, the pressure measuring device used at point (1) shall be isolated from the system for the remainder of these tests. The instantaneous opening valve shall then be closed.

The instantaneous opening valve shall be energized and the outlet pressure (Po) versus time (T) recorded until steady state outlet pressure is attained. The following points shall then be determined by examination of this curve:

P_1-1 = Outlet pressure at 1 second of gas flow.

P_1-2 = Outlet pressure at 2 seconds of gas flow.

P_1-3 = Outlet pressure at 3 seconds of gas flow.

P_1-4 = Outlet pressure at 4 seconds of gas flow.

P_1-SS = Steady state outlet pressure.

T_1 = Time at which the curve crosses either 90 percent P_1-SS or 110 percent P_1-SS and remains within these limits.

After 1 second of gas flow, the outlet pressure shall not exceed 120 percent of P_1-SS. After 4 seconds of gas flow, the outlet pressure shall be at least 0.2 iwc (50 Pa).

Figure 10, Integrity of Operation Curve, is an example of this curve when P_x-SS = P_1-SS and $T_x = T_1$.

2.12.2

For a regulator designed for operation in mounting positions other than the manufacturer's specified upright position as specified in 1.1.5, an additional base curve(s) shall be developed in the manner prescribed under 2.12.1 with no change in the flow rate adjustment and with the regulator mounted in the mounting position(s) which produces the extreme(s) of outlet pressure.

The following points shall then be determined by examination of this curve:

P_2-1 = Outlet pressure at 1 second of gas flow.

P_2-2 = Outlet pressure at 2 seconds of gas flow.

P_2-3 = Outlet pressure at 3 seconds of gas flow.

P_2-4 = Outlet pressure at 4 seconds of gas flow.

P_2-SS = Steady state outlet pressure.

T_2 = Time at which the curve crosses either 90 percent P_2-SS or 110 percent P_2-SS and remains within these limits.

After 1 second of gas flow, the outlet pressure shall not exceed 120 percent of P_2-SS. After 4 seconds of gas flow, the outlet pressure shall be at least 0.2 in wc (50 Pa).

Figure 10, Integrity of Operation Curve, is an example of this curve when P_x-SS = P_2-SS and $T_x = T_2$.

2.12.3

For a regulator designed for operation at temperatures above 125°F (51.5°C), the following curves shall be developed and shall be compared with the curves developed in 2.12.1 and 2.12.2, as applicable.

a. A curve(s) shall be developed as described under 2.12.1 with no change in the flow rate adjustment and with the ambient temperature equal to the manufacturer's specified maximum ambient temperature. (See 2.1.2.)

The following points shall then be determined by examination of the curve(s):

P_{1a}-1 = Outlet pressure at 1 second of gas flow.

P_{1a}-2 = Outlet pressure at 2 seconds of gas flow.

P_{1a}-3 = Outlet pressure at 3 seconds of gas flow.

P_{1a}-4 = Outlet pressure at 4 seconds of gas flow.

P_{1a}-SS = Steady state outlet pressure.

T_{1a} = Time at which the curve crosses either 75 percent P1-SS or 120 percent P1-SS and remains within these limits.

The outlet pressure readings for each second of time determined from this curve(s) shall be compared with the corresponding outlet pressure points determined from the curve(s) developed in 2.12.1 and shall comply with the following:

P_{1a}-1 shall be within ± 75 percent P_1-1.

P_{1a}-2 shall be within ± 70 percent P_1-2.

P_{1a}-3 shall be within ± 60 percent P_1-3.

P_{1a}-4 shall be within ± 50 percent P_1-4.

In addition, T_{1a} shall not be greater than T_1+1 minute. After 1 second of gas flow, the outlet pressure shall not exceed 120 percent of P_{1a}-SS. After 4 seconds of gas flow, the outlet pressure shall be at least 0.2 in wc (50 Pa).

Only the values determined from curves developed under similar test conditions (i.e., without a vent limiter or with the same vent limiter) shall be compared.

Figure 10, Integrity of Operation Curve, is an example of this curve when P_x-SS = P_1-SS and $T_y = T_{1a}$.

b. If the regulator is also designed for operation in a mounting position(s) other than the manufacturer's specified upright position, a curve(s) also shall be developed as described under 2.12.2 with no change in the flow rate adjustment and with the ambient temperature equal to the manufacturer's specified maximum ambient temperature, if greater than 125°F (51.5°C) (see 2.1.2).

The following points shall then be determined by examination of the curve:

P_{2a}-1	=	Outlet pressure at 1 second of gas flow.
P_{2a}-2	=	Outlet pressure at 2 seconds of gas flow.
P_{2a}-3	=	Outlet pressure at 3 seconds of gas flow.
P_{2a}-4	=	Outlet pressure at 4 seconds of gas flow.
P_{2a}-SS	=	Steady state outlet pressure.
T_{2a}	=	Time at which the curve crosses either 75 percent P_2-SS or 120 percent P_2-SS and remains within these limits.

The outlet pressure readings for each second of time determined from this curve(s) shall be compared with the corresponding outlet pressure points determined from the curve(s) developed in 2.12.2 and shall comply with the following:

P_{2a}-1 shall be within ± 75 percent P_2-1.

P_{2a}-2 shall be within ± 70 percent P_2-2.

P_{2a}-3 shall be within ± 60 percent P_2-3.

P_{2a}-4 shall be within ± 50 percent P_2-4.

In addition, T_{2a} shall not be greater than T_2+1 minute. After 1 second of gas flow, the outlet pressure shall not exceed 120 percent of P_{2a}-SS. After 4 seconds of gas flow, the outlet pressure shall be at least 0.2 in wc (50 Pa).

Only the values determined from curves developed under similar test conditions (i.e., without a vent limiter or with the same vent limiter) shall be compared.

Figure 10, Integrity of Operation Curve, is an example of this curve when P_x-SS = P_2-SS and $T_y = T_{2a}$.

2.12.4

For a regulator designed for operation at temperatures below 32°F (0°C), the following curves shall be developed and compared with the curves developed in 2.12.1 and 2.12.2, as applicable.

a. A curve(s) shall be developed as described under 2.12.1 with no change in the flow rate adjustment and with the ambient temperature equal to the manufacturer's specified minimum ambient temperature. (See 2.1.3.)

The following points shall then be determined by examination of this curve:

P_{1b}-1	=	Outlet pressure at 1 second of gas flow.
P_{1b}-2	=	Outlet pressure at 2 seconds of gas flow.

P_{1b}-3	=	Outlet pressure at 3 seconds of gas flow.
P_{1b}-4	=	Outlet pressure at 4 seconds of gas flow.
P_{1b}-SS	=	Steady state outlet pressure.
T_{1b}	=	Time at which the curve crosses either 75 percent P_1-SS or 120 percent P_1-SS and remains within these limits.

The outlet pressure readings for each second of time determined from this curve(s) shall be compared with the corresponding outlet pressure points determined from the curve(s) developed in 2.12.1 and shall comply with the following:

P_{1b}-1 shall be within ± 75 percent P_1-1.

P_{1b}-2 shall be within ± 70 percent P_1-2.

P_{1b}-3 shall be within ± 60 percent P_1-3.

P_{1b}-4 shall be within ± 50 percent P_1-4.

In addition, T_{1b} shall not be greater than T_1+1 minute. After 1 second of gas flow, the outlet pressure shall not exceed 120 percent of P_{1b}-SS. After 4 seconds of gas flow, the outlet pressure shall be at least 0.2 in wc (50 Pa).

Only the values determined from curves developed under similar test conditions (i.e., without a vent limiter or with the same vent limiter) shall be compared.

Figure 10, Integrity of Operation Curve, is an example of this curve when P_x-SS = P_1-SS and $T_y = T_{1b}$.

b. If the regulator is also designed for operation in a mounting position(s) other than the manufacturer's specified upright position, a curve(s) also shall be developed as described under 2.12.2 with no change in the flow rate adjustment and with the ambient temperature equal to the manufacturer's specified minimum ambient temperature, if less than 32°F (0°C) (see 2.1.3).

The following points shall then be determined by examination of this curve:

P_{2b}-1	=	Outlet pressure at 1 second of gas flow.
P_{2b}-2	=	Outlet pressure at 2 seconds of gas flow.
P_{2b}-3	=	Outlet pressure at 3 seconds of gas flow.
P_{2b}-4	=	Outlet pressure at 4 seconds of gas flow.
P_{2b}-SS	=	Steady state outlet pressure.
T_{2b}	=	Time at which the curve crosses either 75 percent P_2-SS or 120 percent P_2-SS and remains within these limits.

The outlet pressure readings for each second of time determined from this curve(s) shall be compared with the corresponding outlet pressure points determined from the curve(s) developed in 2.12.2 and shall comply with the following:

P_{2b}-1 shall be within ± 75 percent P_2-1.

P_{2b}-2 shall be within ± 70 percent P_2-2.

P_{2b}-3 shall be within ± 60 percent P_2-3.

P_{2b}-4 shall be within ± 50 percent P_2-4.

In addition, T_{2b} shall not be greater than T_2+1 minute. After 1 second of gas flow, the outlet pressure shall not exceed 120 percent of P_{2b}-SS. After 4 seconds of gas flow, the outlet pressure shall be at least 0.2 in wc (50 Pa).

Only the values determined from curves developed under similar test conditions (i.e., without a vent limiter or with the same vent limiter) shall be compared.

Figure 10, Integrity of Operation Curve, is an example of this curve when P_x-SS = P_2-SS and T_y = T_{2b}.

2.13 Continued Operation

2.13.1

Prior to conducting the continued operation test specified in 2.13.2, an additional curve(s) of outlet pressure versus time shall be developed. A convertible regulator shall have a curve developed for each operating pressure range of the device. A multistage regulator shall have curves developed at the settings which deliver the maximum and minimum outlet pressure, respectively. If separate vent limiting devices of other than a fixed orifice type are provided, a curve(s) shall be developed with the vent limiter in place.

Method of Test

This test shall be conducted at room temperature. The regulator shall be mounted for test in the manufacturer's specified upright position as specified in Figure 9, Arrangement for Integrity of Operation Test. The inlet test pressure for each curve to be developed shall be set as indicated in the table below:

Rated Inlet Pressure	Inlet Test Pressure
	(Manufacturer's specified minimum outlet pressure for each range plus the following increment:)
1/2 psi (3.5 kPa)	2" in wc (498 Pa)
2 psi (13.8 kPa)	1/2 psi (3.5 kPa)
5 psi (34.5 kPa)	1 psi (6.9 kPa)

For each operating range, the regulator shall be set to obtain the manufacturer's specified maximum outlet pressure at a flow rate equivalent to the midpoint of the specified range of regulation capacity. For this setting the pressure tap at point (1) of Figure 9 shall be used, after which the pressure measuring device used at point (1) shall be isolated from the system. The instantaneous opening valve shall then be closed.

The instantaneous opening valve shall be energized and the outlet pressure versus time recorded until steady state outlet pressure is attained. The following points shall then be determined by examination of this curve:

P_3-1 = Outlet pressure at 1 second of gas flow.

P_3-2	=	Outlet pressure at 2 seconds of gas flow.
P_3-3	=	Outlet pressure at 3 seconds of gas flow.
P_3-4	=	Outlet pressure at 4 seconds of gas flow.
P_3-SS	=	Steady state outlet pressure.
T_3	=	Time at which the curve crosses either 90 percent P3-SS or 110 percent P3-SS and remains within these limits.

After 1 second of gas flow, the outlet pressure shall not exceed 120 percent of P_3-SS. After 4 seconds of gas flow the outlet pressure shall be at least 0.2 in wc (50 Pa).

Figure 10, Integrity of Operation Curve, is an example of this curve when P_x-SS = P_3-SS and $T_x = T_3$.

2.13.2

The regulator(s) tested under 2.13.1 shall withstand 100,000 cycles of full opening and closing of the regulator valve, without any mechanical failure, impairment of operation, apparent damage, and without the development of leakage.

Method of Test

For this test, the highest setting of the regulator shall be used with no change in the adjustment(s) established in 2.13.1 (or 3.13.1).

The inlet of the regulator shall be connected to a clean gas or air supply which is controlled in such a manner that gas pressures of zero and the maximum inlet test pressure specified for its rated inlet pressure are alternately exerted at the inlet of the regulator which shall be installed in the manufacturer's specified upright position. The flow rate through the regulator shall be adjusted to a rate sufficient to assure full opening and closing of the valve. The outlet connection of the regulator shall be provided with a suitable mechanism which closes the outlet when the maximum inlet test pressure is applied at the inlet, and which permits access of the outlet to the atmosphere when no pressure is applied at the inlet. All piping and fittings shall be free from dirt, scale or other accumulations which would affect the operation of the regulator.

This test shall be conducted at a rate not greater than that specified by the manufacturer and in the following sequence according to the manufacturer's specified ambient temperatures(s):

a. 10,000 cycles at the minimum specified ambient temperature below 32°F (0°C) and 90,000 cycles at the maximum specified ambient temperature above 125°F (51.5°C);

b. 90,000 cycles at room temperature and 10,000 cycles at the minimum specified ambient temperature below 32°F (0°C);

c. 10,000 cycles at room temperature and 90,000 cycles at the maximum specified ambient temperature above 125°F (51.5°C); and

d. 100,000 cycles at room temperature if the specified ambient temperature range is 32 to 125°F (0 to 51.5°C).

e. At the completion of 100,000 cycles, the regulator shall comply with the following:

    1. The room temperature tests specified in 2.4, Leakage;

2. 2.13.3; and

3. 2.14, if equipped with a vent limiting device of other than the fixed orifice type.

2.13.3

After conducting the continued operation test specified in 2.13.2 (or 3.13.2), a curve(s) shall be developed as described in 2.13.1 (or 3.13.1), with no change in the regulator adjustments(s).

The following points shall then be determined by examination of this curve:

P_4-1 = Outlet pressure at 1 second of gas flow.

P_4-2 = Outlet pressure at 2 seconds of gas flow.

P_4-3 = Outlet pressure at 3 seconds of gas flow.

P_4-4 = Outlet pressure at 4 seconds of gas flow.

P_4-SS = Steady state outlet pressure.

T_4 = Time at which the curve crosses either 80 percent P_3-SS or 120 percent P_3-SS and remains within these limits.

The outlet pressure readings for each second of time determined from this curve(s) shall be compared with the corresponding outlet pressure points determined from the curve(s) developed in 2.13.1 (or 3.13.1) and shall comply with the following:

P_4-1 shall be within ± 75 percent P_3-1.

P_4-2 shall be within ± 70 percent P_3-2.

P_4-3 shall be within ± 60 percent P_3-3.

P_4-4 shall be within ± 50 percent P_3-4.

In addition, T_4 shall not be greater than T_3+1 minute. After 1second of gas flow the outlet pressure shall not exceed 120 percent of P_4-SS. After 4 seconds of gas flow the outlet pressure shall be at least 0.2 in wc (50 Pa).

Figure 10, Integrity of Operation Curve, is an example of this curve when P_x-SS = P_3-SS and T_y = T_4.

2.14 Resistance To Permanent Damage At Excessive Supply Pressure

A regulator rated at $^1/_2$ psi (3.5 kPa) shall operate as intended at normal inlet test pressure after being subjected to an excessive inlet pressure of $2^1/_2$ psi (17.2 kPa). If necessary, the regulator may be reset to restore operation after exposure to the $2^1/_2$ psi (17.2 kPa) test pressure.

a. A separate sample shall be used for this test. A base curve showing opening characteristics of the regulator shall be developed by recording the outlet pressure versus time. The pressure regulator shall be set to obtain the manufacturer's specified minimum outlet pressure at a flow rate equivalent to the midpoint of the specified range of regulation capacity and with an inlet pressure 2.0 in wc (498 Pa) above the minimum specified outlet pressure.

This curve shall be developed with the regulator at room temperature and mounted in the manufacturer's specified upright position.

The following points shall then be determined by examination of the curve:

P_5-1 = Outlet pressure at 1 second of gas flow.

P_5-2 = Outlet pressure at 2 seconds of gas flow.

P_5-3 = Outlet pressure at 3 seconds of gas flow.

P_5-4 = Outlet pressure at 4 seconds of gas flow.

P_5-ss = Steady state outlet pressure.

T_5 = Time at which the curve crosses either 90 percent of P_5-ss or 110 percent of P_5-ss and remains within these limits.

b. The regulator shall then be subjected to the manufacturer's minimum specified ambient temperature. With the outlet of the regulator blocked, an inlet pressure of $2^1/_2$ psi (17.2 kPa) shall be instantaneously applied to the regulator and held for one minute. The inlet test pressure shall then be lowered to zero psi.

c. Repeat the test with the regulator at the manufacturer's specified maximum ambient temperature.

d. The regulator shall be cooled to room temperature and the curve described in "-a" above shall be repeated. If a reset action is necessary to make the regulator operable, it shall be performed in accordance with the manufacturer's instructions.

The following points shall be determined by examination of the curve:

P_6-1 = Outlet pressure at 1 second of gas flow.

P_6-2 = Outlet pressure at 2 seconds of gas flow.

P_6-3 = Outlet pressure at 3 seconds of gas flow.

P_6-4 = Outlet pressure at 4 seconds of gas flow.

P_6-ss = Steady state outlet pressure.

T_6 = Time at which the curve crosses either 90 percent of P5-ss or 110 percent of P5-ss and remains within these limits.

P_6-1 Shall be within ± 50 percent of P_5-1.

P_6-2 Shall be within ± 40 percent of P_5-2.

P_6-3 Shall be within ± 30 percent of P_5-3.

P_6-4 Shall be within ± 20 percent of P_5-4.

In addition, T_6 shall not exceed the greater of 110 percent of T_5 or T_5 plus 5 seconds. After 1 second of gas flow, the outlet pressure shall not exceed 120 percent of P_6-ss and after 4 seconds of gas flow, the outlet pressure shall be at least 0.02 in wc (5 Pa).

The regulator shall then be checked for leaks as specified in 2.4, Leakage, at room temperature only.

2.15 Vent Limiter

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

Venting Rate. Vent limiters used with regulators shall limit the flow through the vent of the regulator as shown in Table VI, Maximum Allowable Vent Limiter Venting Rate.

Method of Test

Separate vent limiters shall be installed in an upright position in a gastight piping system so that the test medium passes through the vent limiter. It shall then be determined that there is no leakage at points other than through the vent limiter. The rate of flow through the test meter shall be determined at pressures from 2 in wc (498 Pa) up to and including the rated inlet pressure of the regulator, specified in 2.3, Test Pressures, or 3.3, Test Pressures, and corrected for 1.53 specific gravity for vent limiters for use with liquefied petroleum gases, and 0.64 specific gravity for vent limiters for use only with natural, manufactured, mixed gases and LP gas-air mixtures. The corrected flow rate shall not exceed the maximum allowable specified values. If the vent limiter is not a limiting orifice type and is designed for use in positions other than upright, additional tests to determine the rate of flow shall be conducted when the vent limiter is installed in other positions.

When the vent limiter is an integral part of the regulator, the regulator diaphragm shall be substantially removed to permit the test medium to flow freely through the vent limiter. With the regulator installed in a gastight piping system in the manufacturer's specified upright position, the flow rate through the integral vent limiter shall be determined as described for separate vent limiters. The corrected flow rate shall not exceed the maximum allowable specified values. Additional tests to determine the rate of flow shall be conducted with the regulator in any other position for which compliance with this standard is desired.

2.16 Marking Material Adhesion And Legibility

The adhesive quality of marking materials and the legibility of all marking materials shall not be adversely affected when the marking materials are exposed to heat and moisture as specified in the following Method of Test.

Method of Test

These tests shall be conducted on two devices as received and following the completion of the tests specified in 2.13, Continued Operation, or 3.13, Continued Operation, or equivalent periods of time and temperature. The manufacturer shall have applied the marking materials to the devices as they would be applied in production.

Each sample of marking material shall exhibit:

a. Good adhesion and no curling at edges, when labels are used;

b. No illegible or defaced printing by rubbing with thumb or finger pressure; and

c. Good adhesion when scraped across edges of the test sample plate with a metal blade (dulled knife blade or back of pocketknife blade) held at right angles to the test panel.

The manufacturer shall supply evidence that the marking materials and adhesives will not be adversely affected by water or corrosion.

Good adhesion qualities shall be obtained under all of the above test conditions.

Final acceptance of marking materials shall be based on the suitability of the application of the marking material to the device.

Part III: Negative Pressure Regulators Performance

3.1 General

The text of 2.1, General, shall apply.

3.2 Test and Reference Gases

The text of 2.2, Test and Reference Gases, shall apply.

3.3 Test Pressures

3.3.1

The text of 2.3.1 shall apply.

3.3.2

The text of 2.3.2 shall apply.

3.3.3

Vacuum Test Pressures for Negative Pressure Regulators

The vacuum test pressure for a negative pressure regulator is that pressure which is established 5 pipe diameters downstream of the outlet adjustment control valve (see Figure 11, Typical Arrangement of Test Apparatus for Negative Pressure Regulators, Section A).

The maximum and minimum vacuum test pressures shall be those specified by the manufacturer (see 1.2-o).

3.4 Leakage

The text of 2.4, Leakage, shall apply.

3.5 Strength And Deformation

The text of 2.5, Strength and Deformation, shall apply.

3.6 Mounting Regulator For Test

The text of 2.6, Mounting Regulator for Test, shall apply.

Two optional arrangements of the required test apparatus for testing negative pressure regulators are shown in Sections A and B of Figure 11, Typical Arrangement of Test Apparatus for Negative Pressure Regulators.

3.7 Pressure Drop Capacity

Negative pressure regulators are exempt from this test.

3.8 Outlet Pressure Range

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

3.8.1
Adjustable Negative Pressure 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 adjustment means shall not become disengaged.

Method of Test

The regulator shall be mounted in the upright position as specified in 2.6, Mounting Regulator for Test, and 1.1.5.

The cap provided for concealing the adjustment shall be in place. The inlet pressure, flow rate, and vacuum pressure specified by the manufacturer (see 1.2-d, 1.2-o and 3.6, Mounting Regulator for Test) shall be established for each regulator adjustment extreme and the observed outlet pressures shall be recorded. These observed pressures shall either equal or bracket the values specified by the manufacturer (see 1.2-d). For example, if the manufacturer's specified adjustment range is -0.2 in wc (-50 Pa) to 0.6 in wc (-149 Pa) then observed pressures of -0.1 in wc (-25 Pa) and -0.7 in wc (174 Pa) fulfill the requirement.

The above tests shall be repeated with the regulator mounted in each of the mounting positions specified by the manufacturer (see 1.1.5).

The data noted with the adjustment delivering the minimum absolute outlet pressure shall be examined to determine the regulator mounting position which produces the minimum absolute outlet pressure. The data noted with the adjustment delivering the maximum absolute outlet pressure shall be examined to determine the regulator mounting position which produces the maximum absolute outlet pressure. These two mounting positions shall be designated as Position A and Position B, respectively. (See 1.1.5-a and 1.1.5-b).

3.8.2
Nonadjustable Negative Pressure Regulators

The outlet pressure determined under the following Method of Test shall be within the tolerances specified by the manufacturer.

Method of Test

The regulator shall be mounted in the upright position as specified in 3.6, Mounting Regulator for Test, and 1.1.5.

The inlet pressure, flow rate, and vacuum pressure shall be established as specified by the manufacturer (see 1.2-d and 1.2-o and 3.6).

The outlet pressure shall be observed and shall be within the tolerances specified by the manufacturer.

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 absolute outlet pressure and the regulator mounting position which produces the maximum absolute outlet pressure. (See 1.1.5-a and 1.1.5-b.)

3.9 Range of Regulation Capacity

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

The range of regulation capacity as determined by test shall include the upper and lower limits specified by the manufacturer.

3.9.1
Nonadjustable Negative Pressure Regulators

Method of Test

The regulator shall be mounted for test as specified in 3.6, Mounting Regulator for Test, in Position A (as determined in 3.8, Outlet Pressure Range).

Either Test Method A or B shall be conducted at both the manufacturer's minimum and maximum specified vacuum pressures.

Test Method A Using Apparatus Described in Section A, Figure 11, Typical Arrangement of Test Apparatus for Negative Pressure Regulators.

Throughout this test the vacuum pressure shall be adjusted and maintained at the manufacturer's minimum specified vacuum pressure (see 1.2-o).

The inlet test pressure shall be adjusted to the appropriate minimum value determined according to Table II, 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 inlet test pressure shall be gradually increased to the rated inlet pressure. Over this range of inlet pressures, the minimum and maximum differential outlet pressures observed and their corresponding flow rates shall be recorded. The inlet test pressure shall then be increased to the maximum inlet test pressure (see Table II, Inlet Test Pressure) and the differential outlet pressure observed and corresponding flow rate shall be recorded. These observed values shall be used to construct a smooth orifice curve (see Part V, Definitions).

The 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 12, Range of Regulation Curves for Nonadjustable Negative Presure Regulators) when minimum differential outlet pressures are joined (Curve A), maximum differential outlet pressures are joined (Curve B), and differential outlet pressures obtained at the maximum inlet test pressure are joined (Curve C).

Differential outlet pressure variations and flow rates shall be examined along the orifice curves.

a. Curves A and B shall be examined to determine the minimum and maximum flow rates between which the differential outlet pressure variation does not exceed 20 percent of the minimum differential outlet pressure (see Figure 12) or 0.2 in wc (50 Pa) (whichever is greater).

b. Curve C shall be examined to determine the minimum and maximum flow rates between which the curve does not vary more than plus or minus 20 percent from the minimum differential outlet pressure (see Figure 12) or 0.2 in wc (50 Pa) (whichever is greater).

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.

The above procedure shall be repeated with the vacuum pressure adjusted and maintained at the manufacturer's maximum specified vacuum pressure (see 1.2-o).

The entire test shall be repeated with the regulator mounted in Position B (as determined in 3.8, Outlet Pressure Range).

Test Method B Using Apparatus Described in Section B, Figure 11, Typical Arrangement of Test Apparatus for Negative Pressure Regulators.

Throughout this test the side of the regulator diaphragm which communicates with the atmosphere shall be pressurized and maintained at a positive pressure (Pv) numerically equal to the manufacturer's specified minimum vacuum pressure (see 1.2-o).

The differential inlet test pressure shall be adjusted to the approximate minimum value specified in Table II. The initial flow rate shall be adjusted to a value less than the lower limit of the manufacturer's specified range of regulation capacity.

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

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 12, Range of Regulation Curves for Nonadjustable Negative Presure Regulators) when minimum differential outlet pressures are joined (Curve A), maximum differential outlet pressures are joined (Curve B), and differential outlet pressures obtained at the maximum differential inlet test pressure are joined (Curve C).

Differential outlet pressure variations and flow rates shall be examined along the orifice curves.

a. Curves A and B shall be examined to determine the minimum and maximum flow rates between which the differential outlet pressure variation does not exceed 20 percent of the minimum differential outlet pressure (see Figure 12) or 0.2 in wc (50 Pa) (whichever is greater).

b. Curve C shall be examined to determine the minimum and maximum flow rates between which the curve does not vary more than plus or minus 20 percent from the minimum differential outlet pressure (see Figure 12) or 0.2 in wc (50 Pa) (whichever is greater).

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.

The above procedure shall be repeated with the side of the regulator diaphragm which communicates with the atmosphere pressurized and maintained at a positive pressure (Pv) numerically equal to the manufacturer's maximum specified vacuum pressure (see 1.2-o).

The entire test shall then be repeated with the regulator mounted in Position B (as determined in 3.8, Outlet Pressure Range).

3.9.2
Adjustable Negative Pressure Regulators

Method of Test

The regulator shall be mounted for test as specified in 3.6, Mounting Regulator for Test.

Either Test Method A or B shall be conducted at both the manufacturer's minimum and maximum specified vacuum pressures.

Test Method A Using Apparatus Described in Section A, Figure 11, Typical Arrangement of Test Apparatus for Negative Pressure Regulators.

The regulator shall be mounted in Position A (as determined in 3.8, Outlet Pressure Range) 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 outline in Test Method A of 3.9.1 for Position A shall then be followed except the curves shall be designated D, E and F as shown in Figure 13, Range of Regulation Curves for Adjustable Negative Pressure Regulators.

The regulator shall then be mounted in Position B (as determined in 3.8) 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 Test Method A of 3.9.1 for Position B shall then be conducted to develop Curves A, B and C as shown in Figure 13.

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 manufacturer's specified range of regulation capacity (see Figure 13).

Test Method B Using Apparatus Described in Section B, Figure 11, Typical Arrangement of Test Apparatus for Negative Pressure Regulators.

The regulator shall be mounted in Position A (as determined in 3.8, Outlet Pressure Range) 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 Test Method B of 3.9.1 for Position A shall then be followed except the curves shall be designated D, E and F as shown in Figure 13.

The regulator shall then be mounted in Position B (as determined in 3.8) 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 Test Method B of 3.9.1 for Position B shall then be conducted to develop Curves A, B and C as shown in Figure 13.

The largest minimum flow rate and the smallest maximum flow rate as determined from all of the tests above shall include the lower and upper limits of the manufacturer's specified range of regulation capacity (see Figure 13).

3.10 Regulators Designated To Operate At Pilot Flow Rate

Not applicable to negative pressure regulators.

3.11 Regulators For Use On Domestic Gas Ranges

Not applicable to negative pressure regulators.

3.12 Integrity Of Operation

3.12.1

A base curve(s) showing opening characteristics of the regulator shall be developed recording differential outlet pressure versus time. A regulator with a separate vent limiter shall have curves developed both with and without the vent limiter installed. If more than one vent limiter is used with the regulator, an additional curve shall be developed with each vent limiter in place.

Method of Test

This test shall be conducted at room temperature. The regulator shall be mounted for test in the manufacturer's specified upright position as specified by either Section A or B of Figure 11, Typical Arrangement of Test Apparatus for Negative Pressure Regulators, with the addition of (1) a pressure tap 5 pipe diameters downstream from the regulator under test and (2) an instantaneous opening automatic valve 5 pipe diameters downstream from the new tap and according to the equipment specifications under 3.6, Mounting Regulator for Test, where applicable. Unless otherwise specified, all outlet pressure measurements shall be made at point 1 of Figure 11, Section A or B.

Test Method A Using Figure 11, Section A, Test Setup.

The manufacturer's specified minimum operating vacuum pressure shall be established and the pressure regulator adjustment means shall be set to obtain the manufacturer's specified minimum outlet pressure with the flow rate adjusted to the midpoint of the specified range of regulation. The inlet test pressure shall be set at either 2.0 in wc (498 Pa) greater than the outlet pressure or 3.0 in wc (747 Pa), whichever is greater. The instantaneous opening valve shall then be closed.

The instantaneous opening valve shall be energized and the differential outlet pressure (Pd) versus time (T) recorded until steady state differential outlet pressure is attained.

Test Method B Using Figure 11, Section B, Test Setup.

Throughout this test the side of the regulator diaphragm which communicates with atmosphere shall be pressurized and maintained at a positive pressure (Pv) numerically equal to the manufacturer's specified minimum operating vacuum pressure.

The pressure regulator adjustment means shall be set to deliver the manufacturer's specified minimum outlet pressure with the flow rate adjusted to the midpoint of the specified range of regulation. The differential inlet test pressure shall be set at either 2.0 in wc (498 Pa) greater than the differential outlet pressure or 3.0 in wc (747 Pa), whichever is greater. The instantaneous opening valve shall then be closed.

The instantaneous opening valve shall be energized and the differential outlet pressure (Pd) versus time (T) recorded until steady state differential outlet pressure is attained.

By examining the curve developed under either Method A or B, the following points shall then be determined:

P_1-1 = Differential outlet pressure at 1 second of gas flow.

P_1-2 = Differential outlet pressure at 2 seconds of gas flow.

P_1-3 = Differential outlet pressure at 3 seconds of gas flow.

P_1-4 = Differential outlet pressure at 4 seconds of gas flow.

P_1-SS = Steady state differential outlet pressure.

T_1 = Time at which the curve crosses either 90 percent P_1-SS or 110 percent P_1-SS and remains within these limits.

After 1 second of gas flow, the differential outlet pressure shall not exceed 120 percent of P_1-SS.

Figure 10, Integrity of Operation Curve, is an example of this curve when P_x-SS = P_1-SS and $T_x = T_1$.

3.12.2

For negative pressure regulators designed for operation in mounting positions other than the manufacturer's specified upright position, as specified in 1.1.5, an additional base curve(s) shall be developed in the manner prescribed under 3.12.1 with no change in the flow rate adjustment and with the regulator mounted in the one mounting position of all the alternative positions specified by the manufacturer, which has the greatest effect on the differential outlet pressure.

The following points shall then be determined by examination of this curve:

P_2-1 = Differential outlet pressure at 1 second of gas flow.

P_2-2 = Differential outlet pressure at 2 seconds of gas flow.

P_2-3 = Differential outlet pressure at 3 seconds of gas flow.

P_2-4 = Differential outlet pressure at 4 seconds of gas flow.

P_2-SS = Steady state differential outlet pressure.

T_2 = Time at which the curve crosses either 90 percent P_2-SS or 110 percent P_2-SS and remains within these limits.

After 1 second of gas flow, the differential outlet pressure shall not exceed 120 percent P_2SS.

Figure 10 is an example of this curve when P_x-SS = P_2-SS and $T_x = T_2$.

3.12.3

For negative pressure regulators designed for operation at temperatures above 125°F (51.5°C), the following curves shall be developed and compared with the curves developed in 3.12.1 and 3.12.2, as applicable.

a. A curve(s) shall be developed as described under 3.12.1 with no change in the flow rate adjustment and with the ambient temperature equal to the manufacturer's specified maximum ambient temperature. (See 2.1.2.)

The following points shall then be determined by examination of the curve(s):

P_{1a}-1 = Differential outlet pressure at 1 second of gas flow.

P_{1a}-2 = Differential outlet pressure at 2 seconds of gas flow.

P_{1a}-3 = Differential outlet pressure at 3 seconds of gas flow.

P_{1a}-4 = Differential outlet pressure at 4 seconds of gas flow.

P_{1a}-SS = Steady state differential outlet pressure.

T_{1a} = Time at which the curve crosses either 75 percent P_1-SS or 120 percent P_1-SS and remains within these limits.

The differential outlet pressure readings for each second of time determined from this curve shall be compared with the corresponding differential pressure points determined from the curve developed in 3.12.1 and shall comply with the following:

P_1a-1 shall be within ± 75 percent P_1-1.

P_1a-2 shall be within ± 70 percent P_1-2.

P_1a-3 shall be within ± 60 percent P_1-3.

P_1a-4 shall be within ± 50 percent P_1-4.

In addition, T_1a shall not be greater than T_1 + 1 minute. After 1 second of gas flow, the differential outlet pressure shall not exceed 120 percent of P_{1a}-SS.

Only the values determined from curves developed under similar test conditions (i.e., without a vent limiter or with the same vent limiter) shall be compared.

Figure 10, Integrity of Operation Curve, is an example of this curve when P_x-SS = P_1-SS and $T_y = T_{1a}$.

b. If the negative pressure regulator is also designed for operation in mounting positions other than the manufacturer's specified upright position, a curve(s) also shall be developed as described under 3.12.2 with no change in the flow rate adjustment and with the ambient temperature equal to the manufacturer's specified maximum ambient temperature. (See 2.1.2.)

The following points shall then be determined by examination of this curve:

P_{2a}-1 = Differential outlet pressure at 1 second of gas flow.

P_{2a}-2 = Differential outlet pressure at 2 seconds of gas flow.

P_{2a}-3 = Differential outlet pressure at 3 seconds of gas flow.

P_{2a}-4 = Differential outlet pressure at 4 seconds of gas flow.

P_{2a}-SS = Steady state differential outlet pressure.

T_{2a} = Time at which the curve crosses either 75 percent P2-SS or 120 percent P2-SS and remains within these limits.

The differential outlet pressure readings for each second of time determined from this curve shall be compared with the corresponding differential pressure points determined from the curve developed in 3.12.2 and shall comply with the following:

P_{2a}-1 shall be within ± 75 percent P_2-1.

P_{2a}-2 shall be within ± 70 percent P_2-2.

P_{2a}-3 shall be within ± 60 percent P_2-3.

P_{2a}-4 shall be within ± 50 percent P_2-4.

In addition, T_{2a} shall not be greater than T_2 + 1 minute. After 1 second of gas flow, the differential outlet pressure shall not exceed 120 percent of P_{2a}-SS.

Only the values determined from curves developed under similar test conditions (i.e., without a vent limiter or with the same vent limiter) shall be compared.

Figure 10, Integrity of Operation Curve, is an example of this curve when P_x-SS = P_2-SS and $T_y = T_{2a}$.

3.12.4

For a negative pressure regulator designed for operation at temperatures below 32°F (0°C), the following curves shall be developed and compared with the curves developed in 3.12.1 and 3.12.2, as applicable.

a. A curve(s) shall be developed as described under 3.12.1 with no change in the flow rate adjustment and with the ambient temperature equal to the manufacturer's specified minimum ambient temperature. (See 2.1.3.)

The following points shall then be determined by examination of this curve:

P_{1b}-1	=	Differential outlet pressure at 1 second of gas flow.
P_{1b}-2	=	Differential outlet pressure at 2 seconds of gas flow.
P_{1b}-3	=	Differential outlet pressure at 3 seconds of gas flow.
P_{1b}-4	=	Differential outlet pressure at 4 seconds of gas flow.
P_{1b}-SS	=	Steady state differential outlet pressure.
T_{1b}	=	Time at which the curve crosses either 75 percent P1-SS or 120 percent P1-SS and remains within these limits.

The differential outlet pressure readings for each second of time determined from this curve shall be compared with the corresponding differential pressure points determined from the curve(s) developed in 3.12.1 and shall comply with the following:

P_{1b}-1 shall be within ± 75 percent P_1-1.

P_{1b}-2 shall be within ± 70 percent P_1-2.

P_{1b}-3 shall be within ± 60 percent P_1-3.

P_{1b}-4 shall be within ± 50 percent P_1-4.

In addition, T1b shall not be greater than T_1 + 1 minute. After 1 second of gas flow, the differential outlet pressure shall not exceed 120 percent of P_{1b}-SS.

Only the values determined from curves developed under similar test conditions (i.e., without a vent limiter or with the same vent limiter) shall be compared.

Figure 10, Integrity of Operation Curve, is an example of this curve when P_x-SS = P_1-SS and $T_y = T_{1b}$.

b. If the negative pressure regulator is also designed for operation in mounting positions other than the manufacturer's specified upright position, a curve(s) also shall be developed as described under 3.12.2 with no change in the flow rate adjustment and with the ambient temperature equal to the manufacturer's specified minimum ambient temperature. (See 2.1.3.)

The following points shall then be determined by examination of this curve:

P_{2b}-1	=	Differential outlet pressure at 1 second of gas flow.
P_{2b}-2	=	Differential outlet pressure at 2 seconds of gas flow.
P_{2b}-3	=	Differential outlet pressure at 3 seconds of gas flow.
P_{2b}-4	=	Differential outlet pressure at 4 seconds of gas flow.
P_{2b}-SS	=	Steady state differential outlet pressure.
T_{2b}	=	Time at which the curve crosses either 75 percent P_2-SS or 120 percent P_2-SS and remains within these limits.

The differential outlet pressure readings for each second of time determined from this curve shall be compared with the corresponding differential pressure points determined from the curve(s) developed in 3.12.2 and shall comply with the following:

P_{2b}-1 shall be within ± 75 percent P_2-1.

P_{2b}-2 shall be within ± 70 percent P_2-2.

P_{2b}-3 shall be within ± 60 percent P_2-3.

P_{2b}-4 shall be within ± 50 percent P_2-4.

In addition, T_{2b} shall not be greater than T_2 + 1 minute. After 1 second of gas flow, the differential outlet pressure shall not exceed 120 percent of P_{2b}-SS.

Only the values determined from curves developed under similar test conditions (i.e., without a vent limiter or with the same vent limiter) shall be compared.

Figure 10, Integrity of Operation Curve, is an example of this curve when P_x-SS = P_2-SS and T_y = T_{2b}.

3.13 Continued Operation

3.13.1

Prior to conducting the continued operation test specified in 3.13.2, a curve of differential outlet pressure versus time shall be developed as specified in 3.12.1 with the exceptions that (1) the pressure regulator shall be set to obtain the manufacturer's specified outlet pressure (highest absolute pressure) with the flow rate set at the midpoint of the manufacturer's specified range of regulation and (2) the inlet pressure shall be set at the minimum inlet test pressure specified in Table II, Inlet Test Pressure.

The following points shall then be determined by examination of this curve:

P_3-1	=	Differential outlet pressure at 1 second of gas flow.
P_3-2	=	Differential outlet pressure at 2 seconds of gas flow.

P_3-3 = Differential outlet pressure at 3 seconds of gas flow.

P_3-4 = Differential outlet pressure at 4 seconds of gas flow.

P_3-SS = Steady state differential outlet pressure.

T_3 = Time at which the curve crosses either 90 percent P3-SS or 110 percent P3-SS and remains within these limits.

After 1 second of gas flow, the differential outlet pressure shall not exceed 120 percent of P_3-SS.

Figure 10, Integrity of Operation Curve, is an example of this curve when P_x-SS = P_3-SS and $T_x = T_3$.

3.13.2

The text of 2.13.2 shall apply, with the following modifications:

Negative pressure regulators shall be cycled using one of the following methods.

a. The regulator, if adjustable, shall be adjusted to deliver the manufacturer's specified maximum outlet pressure (highest absolute pressure). The inlet and outlet connections shall be provided with suitable mechanisms so the regulator is alternately subjected to the following conditions:

   1. The inlet of the regulator is opened to maximum inlet test pressure with the outlet closed.

   2. The outlet of the regulator is opened to the manufacturer's maximum specified vacuum pressure with the inlet closed.

   The timing shall be such as to provide for full opening and closing of the regulator valve.

b. The regulator, if adjustable, shall be adjusted to deliver the manufacturer's specified maximum outlet pressure (highest absolute pressure). The atmospheric side of the diaphragm shall be pressurized with a pressure numerically equal to the manufacturer's specified maximum vacuum pressure. The inlet and outlet connections shall be provided with suitable mechanisms so the regulator is alternately subjected to the following conditions:

   1. The inlet of the regulator is opened to a differential inlet test pressure equal to the maximum inlet test pressure with the outlet closed.

   2. The outlet of the regulator is opened to the atmosphere with the inlet closed.

   The timing shall be such as to provide for full opening and closing of the regulator valve.

c. At the completion of 100,000 cycles, the regulator shall comply with the following:

   1. The room temperature tests specified in 2.4, Leakage;

   2. 2.13.3; and

   3. 2.14, Resistance to Permanent Damage at Excessive Supply Pressure, if equipped with a vent limiting device of other than the fixed orifice type.

3.13.3

After conducting the continued operation test specified in 3.13.2, a curve shall be developed as described in 3.13.1, with no change in the regulator adjustment(s).

The following points shall then be determined by examination of this curve:

P_4-1	=	Differential outlet pressure at 1 second of gas flow.
P_4-2	=	Differential outlet pressure at 2 seconds of gas flow.
P_4-3	=	Differential outlet pressure at 3 seconds of gas flow.
P_4-4	=	Differential outlet pressure at 4 seconds of gas flow.
P_4-SS	=	Steady state differential outlet pressure.
T_4	=	Time at which the curve crosses either 80 percent P_3-SS or 120 percent P_3-SS and remains within these limits.

The differential outlet pressure readings for each second of time determined from this curve shall be compared with the corresponding differential pressure points determined from the curve(s) developed in 3.13.1 and shall comply with the following:

P_4-1 shall be within ± 75 percent P_3-1.

P_4-2 shall be within ± 70 percent P_3-2.

P_4-3 shall be within ± 60 percent P_3-3.

P_4-4 shall be within ± 50 percent P_3-4.

In addition, T_4 shall not be greater than T_3 + 1 minute. After 1 second of gas flow, the differential outlet pressure shall not exceed 120 percent of P_4-SS.

Only the values determined from curves developed under similar test conditions (i.e., without a vent limiter or with the same vent limiter) shall be compared.

Figure 10, Integrity of Operation Curve, is an example of this curve when P_x-SS = P_3-SS and $T_y = T_4$.

3.14 Vent Limiter

The text of 2.14, Resistance to Permanent Damage at Excessive Supply Pressure, shall apply.

3.15 Marking Material Adhesion And Legibility

The text of 2.15, Vent Limiter, shall apply.

Tables Referenced In Part I, Part II And Part III

Table I

Minimum Thread Length And Length To Shoulder

Nominal Pipe Size, Inches	Minimum Lengths, Inches (mm)		
	Length of Thread*	Length to Shoulder Male Thread**	Length to Shoulder Female Thread***
$^{1}/_{8}$	0.25 (6.4)	0.3924 (10.0)	0.3096 (7.9)
$^{1}/_{4}$	0.32 (8.1)	0.5946 (15.1)	0.4500 (11.4)
$^{3}/_{8}$	0.36 (9.1)	0.6006 (15.3)	0.4622 (11.7)
$^{1}/_{2}$	0.43 (10.9)	0.7815 (19.9)	0.6057 (15.4)
$^{3}/_{4}$	0.50 (12.7)	0.7935 (20.2)	0.6247 (15.9)
1	0.58 (14.7)	0.9845 (25.0)	0.7478 (19.0)
$1^{1}/_{4}$	0.67 (17.0)	1.0085 (25.6)	0.7678 (19.5)
$1^{1}/_{2}$	0.70 (17.8)	1.0252 (26.0)	0.7678 (19.5)
2	0.75 (19.1)	1.0582 (26.9)	0.7838 (19.9)
$2^{1}/_{2}$	0.92 (23.4)	1.5712 (39.9)	1.0570 (26.8)
3	0.98 (24.8)	1.6337 (41.5)	1.1410 (29.0)
4	1.08 (27.4)	1.7337 (44.0)	1.2190 (31.0)

* Use where threads are back relieved. (Reference: The Standard for MalleableIron Threaded Fittings, Class 150 and 300, ANSI/ASME B16.3.)

** Male threads = L4 (overall length of male thread).

*** Female Thread = L1 + L3 + 1 pitch.

(L1, L3 and L4 as specified in the Standard for Pipe Threads, General Purpose (Inch), ANSI/ASME B1.20.1.)

Table II

Inlet Test Pressure

Rated Inlet Pressure psi (kPa)	Maximum Inlet Pressure psi (kPa)	Minimum Inlet Pressure Inches w.c. (Pa)
1/2 (3.48)	3/4 (5.23)	Manufacturer's Specified Outlet Pressure (see 1.2, Data to be Furnished by the Manuafacturer) plus the Manufacturer's Specified Increment* of 0.3 to 1.0 in w.c. (75 to 249 Pa)
2 (13.8)	3 (20.7)	Manufacturer's Specified Outlet Pressure (see 1.2) plus the Manufacturer's Specified Increment* of 1.0 to 7.0 in w.c. (249 Pa to 1.74 kPa)
5 (34.5)	7.5 (51.7)	Manufacturer's Specified Outlet Pressure (see 1.2) plus the Manufacturer's Specified Increment* of 1.0 to 14.0 in w.c. (249 Pa to 3.48 kPa)

If the inlet test pressure determined by the table above is less than 3.0 iwc (747 Pa), the minimum inlet test pressure shall be 3.0 iwc (747 Pa).

* The inlet test pressure increment shall be as specified by the manufacturer and shall be within the range specified in the table. For nonadjustable regulators, the test pressure increment is added to the manufacturer's specified outlet pressure to determine the minimum inlet test pressure (see 2.9.2). For adjustable regulators, the test pressure increment is added to the manufacturer's specified maximum and minimum outlet pressure to determine the minimum inlet test pressure for each setting of the regulator (see 2.9.2).

Table III

Nominal Outlet Connection Size, Inches	Turning Effort, Inch-Pounds (N•m)	
1/8	170	(19.21)
1/4	220	(24.86)
3/8	280	(31.64)
1/2	375	(42.38)
3/4	560	(63.28)
1	750	(84.74)
1 1/4	875	(98.86)
1 1/2	940	(106.20)
2	1190	(134.45)
2 1/2	1310	(148.01)
3	1310	(148.01)
4	1500	(169.48)

Table IV

Nominal Pipe Size, Inches	Static Load, Lbs. (kg)	
1/8	14	(6.35)
1/4	16	(7.26)
3/8	18	(8.16)
1/2	20	(9.07)
3/4	22	(9.98)
1	25	(11.3)
1 1/4	30	(13.6)
1 1/2	35	(15.9)
2	45	(20.4)
2 1/2	70	(31.8)
3	100	(45.4)
4	125	(56.7)

Table V

Allowable Outlet Pressure Tolerances For Nonadjustable Regulators

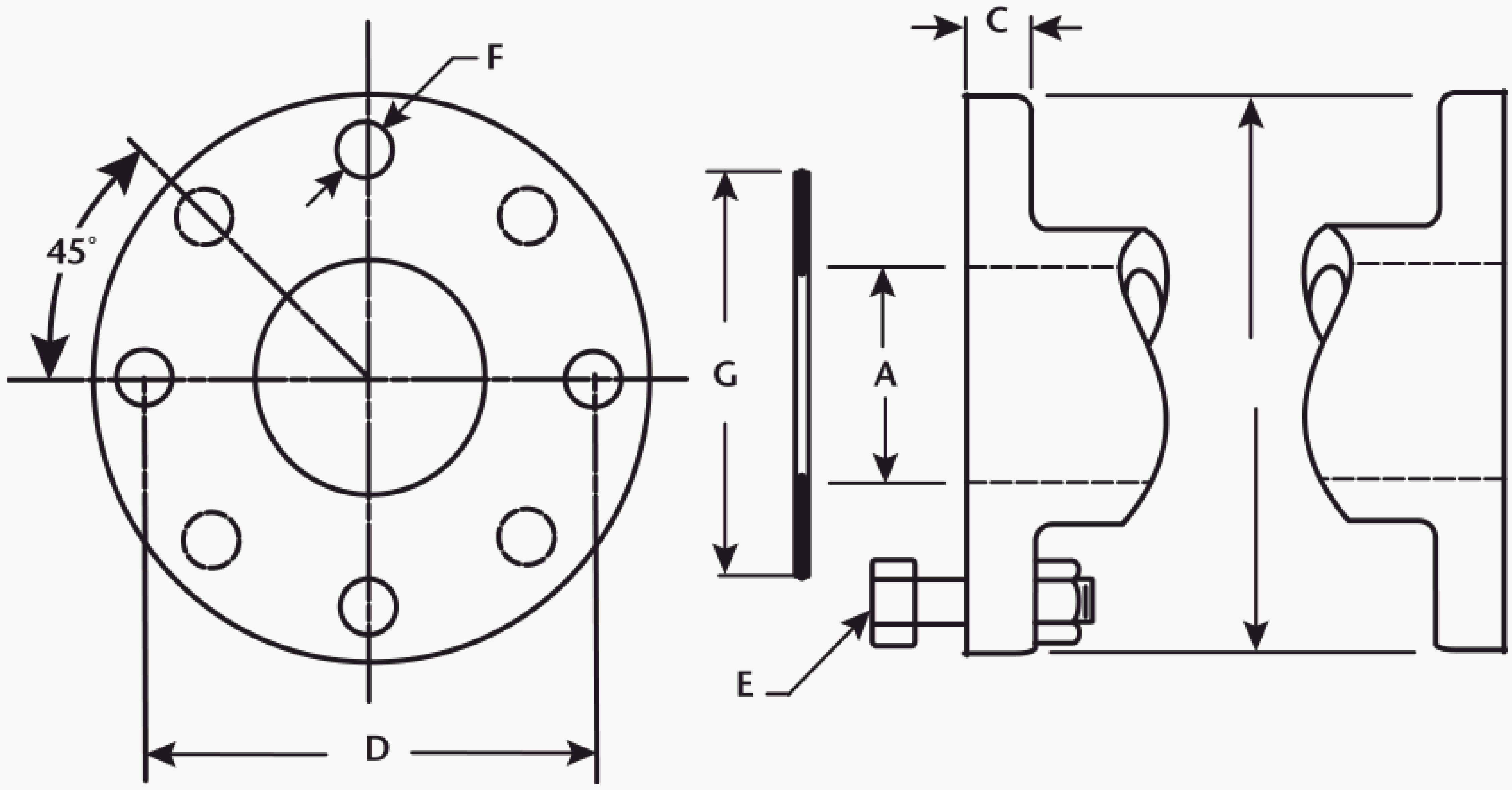
Manufacturers Specified Outlet Pressure, inches w.c. (kPa)	Tolerance	
	Pilot Burner Load Application Only, 3 cfh (23.6 cm^3/s) or less	All Others Regulators
Less than 1 (0.249)	Specified by manufacturer	Specified by manufacturer
1 to 6 (0.249 to 1.49)	± 0.5 inch (124 Pa)	± 0.3 inch (74.7 Pa)
More than 6 (1.49)	± 10 percent	± 5 percent

Table VI

Maximum Allowable Vent Limiter Venting Rate

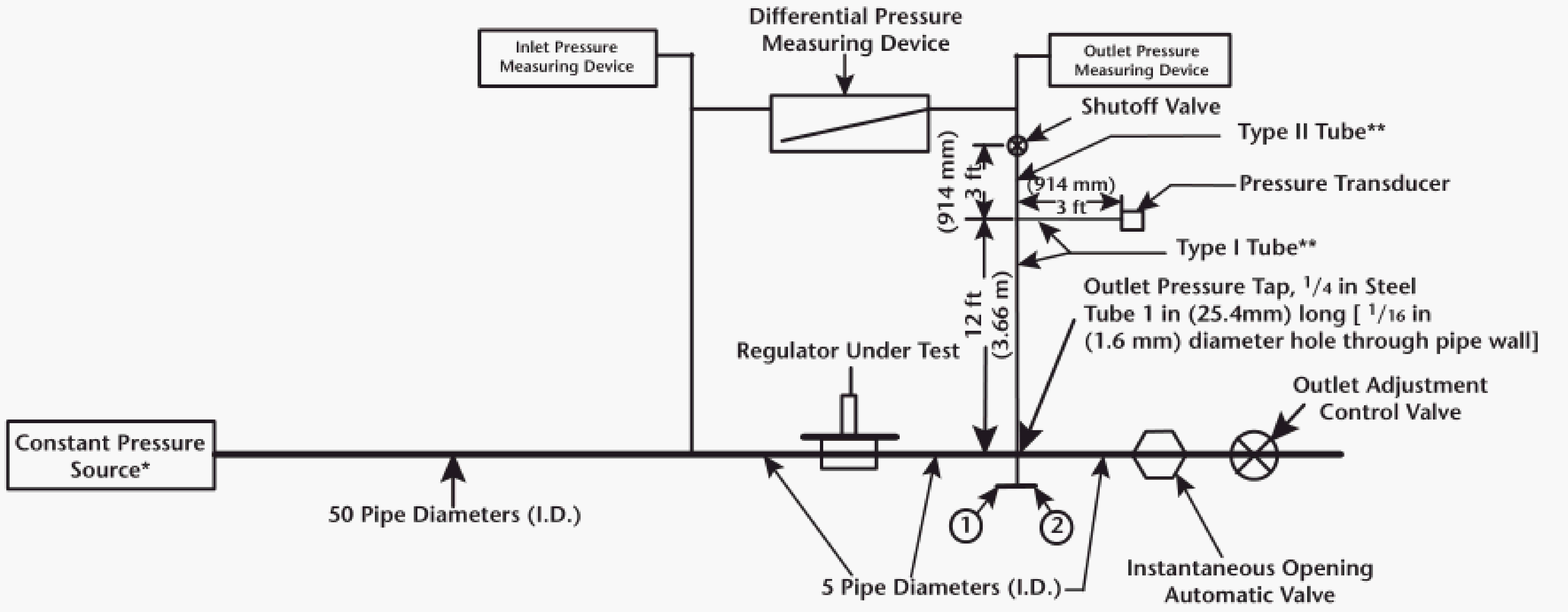
	Specific Gravity	Maximum Allowable Flow Rate Cubic Feet Per Hour (cm^3/s)
Vent Limiter for Use Only With Natural, Manufactured, Mixed gases and LP Gas-Air Mixtures	0.64	2.5 (19.7)
Vent Limiter for Use With Liquefied Petroleum Gas	1.53	1.0 (7.87)

Figures Referenced In Part I, Part II And Part III



Nominal Pipe Size, in.	Flange Diameter in. (mm)	Flange Thickness, in. (mm)	Bolt Circle Dia., in. (mm)	Bolts			Bolt Hole Dia., in. (mm)	Gasket Dia., in. (mm)
				No.	Size, in.	Length, in. (mm)		
A	B	C	D	E			F	G
1	4-1/4 (108)	7/16 (11.1)	3-1/8 (79.4)	4	1/2	1-3/4 (44.5)	5/8 (15.9)	2-5/8 (66.7)
1-1/4	4-5/8 (117)	1/2 (12.7)	3-1/2 (88.9)	4	1/2	2 (50.8)	5/8 (15.9)	3 (76.2)
1-1/2	5 (127)	9/16 (14.3)	3-7/8 (98.4)	4	1/2	2 (50.8)	5/8 (15.9)	3-3/8 (85.7)
2	6 (152)	5/8 (15.9)	4-3/4 (121)	4	5/8	2-1/4 (57.2)	3/4 (19.1)	4-1/8 (105)
2-1/2	7 (178)	11/16 (17.5)	5-1/2 (140)	4	5/8	2-1/2 (63.5)	3/4 (19.1)	4-7/8 (124)
3	7-1/2 (191)	3/4 (19.1)	6 (152)	4	5/8	2-1/2 (63.5)	3/4 (19.1)	5-3/8 (137)
4	9 (229)	15/16 (23.8)	7-1/2 (191)	8	5/8	3 (76.2)	3/4 (19.1)	6-7/8 (175)
6	11 (279)	1 (25.4)	9-1/2 (241)	8	3/4	3-1/4 (82.6)	7/8 (22.2)	8-3/4 (222)

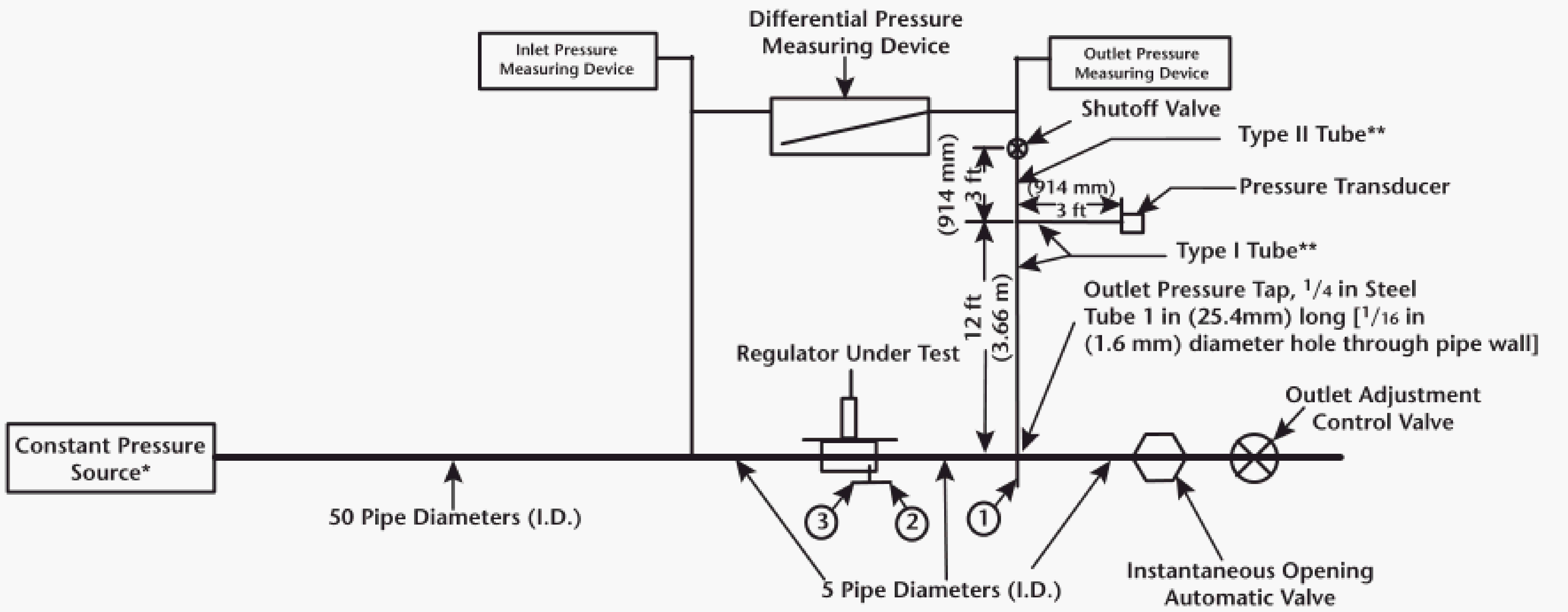
Figure 1. 125 Pound Cast Iron Pipe Flange Body Connections



① Optional Tap for Manometer or Pressure Transducer, 3 ft (914 mm) Type I Tube** (for Sections 2.10, Regulators Designated to Operate at Pilot Flow Rate, 2.11.5 and 2.12, Integrity of Operation) [1/16 (1.6 mm) diameter hole through pipe wall]

② Pilot Flow Line. 1/16 in pipe - 2 3/4 in (69.9 mm) long (for Sections 2.10, and 2.11.5)

Section A - Regulator Without Pilot Take-off



① Optional Tap for Pressure Transducer, 3 ft (914 mm) Type I Tube** (for Sections 2.11, Regulators for Use on Domestic Gas Ranges) [1/16 (1.6 mm) diameter hole through pipe wall]

② Pilot Flow Line. 1/8 in pipe - 2 3/4 in (69.9 mm) long (for Sections 2.10 and 2.11.5)

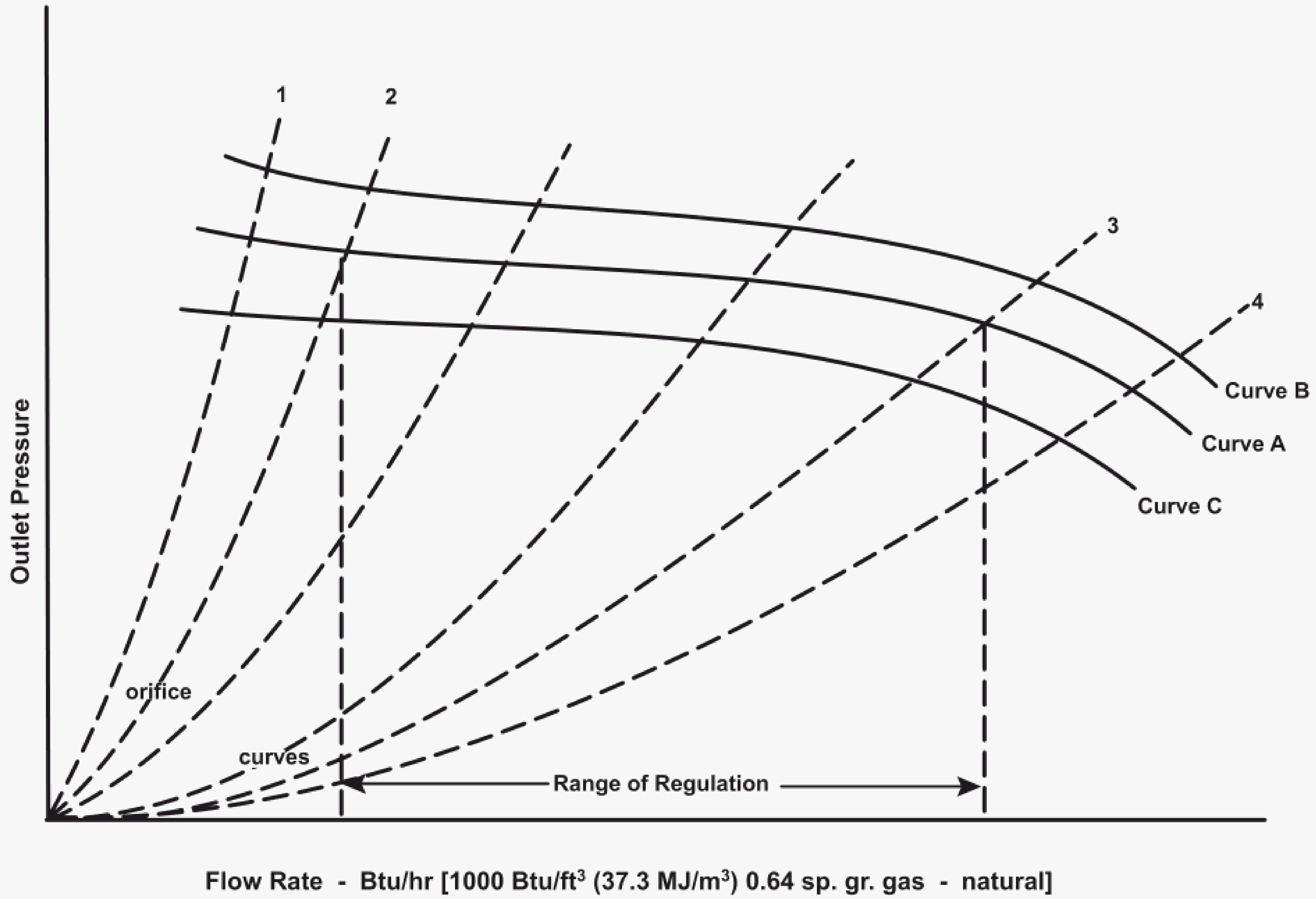
③ Tap for Manometer or Pressure Transducer, (for Sections 2.10 and 2.11.5) [1/16 in (1.6 mm) diameter hole through pipe wall]

Section B - Regulator With Pilot Take-off

Figure 2. Typical Arrangement of Test Apparatus

* The constant pressure source shall not permit a pressure variation from no flow to full flow, of more than ± 0.1 iwc (24.9 Pa) for each 100 ft^3 (2.83 m^3) of air flow at full flow.

** Type I Tube - Curtis Matheson Scientific Stock #203-414, Black Pure Gum Tubing $^3/_{16}$ in Bore, $^1/_{16}$ in Wall.
Type II Tube - Fisher Scientific Stock #14-167D or Curtis Matheson Scientific Stock #202-671, Red Thickwall Tubing, $^1/_4$ in Bore, $^3/_{32}$ in Wall.



Curves 1 and 3

Orifice curves at which maximum obtainable outlet pressure varies from minimum obtainable outlet pressure by 20%

Curves 2 and 4

Orifice curves at which outlet pressure at maximum inlet test pressure varies from minimum obtainable outlet pressure by 20%

Curve A

Minimum Obtainable Outlet Pressure Curve

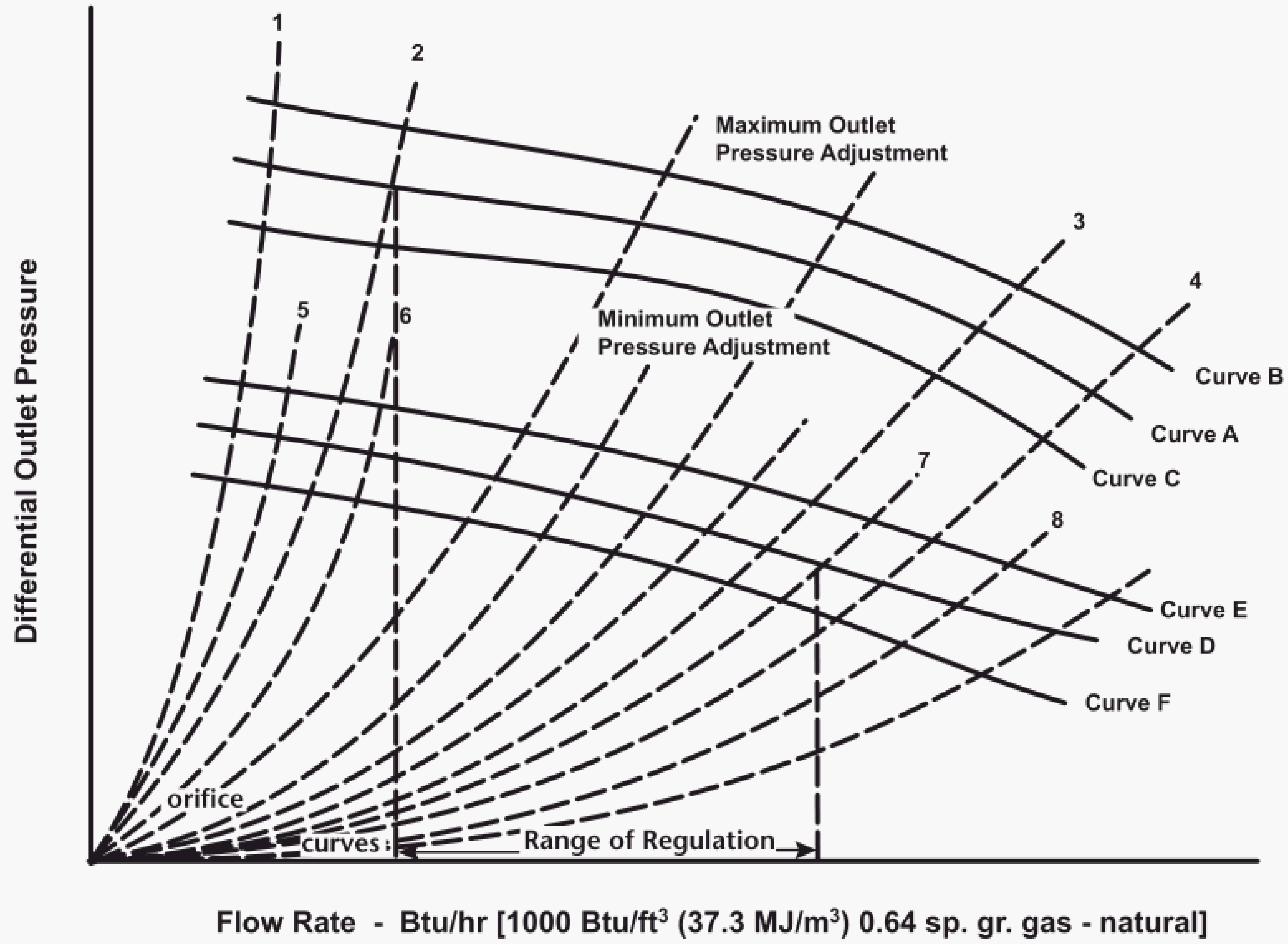
Curve B

Maximum Obtainable Outlet Pressure Curve

Curve C

Outlet Pressure Curve at Maximum Inlet Test Pressure

Figure 3. Range Of Regulation Curves For Nonadjustable Regulators



Maximum Outlet Pressure Adjustment

Curve 1 and 3

Orifice curves at which maximum obtainable outlet pressure varies from minimum obtainable outlet pressure by 20%

Curves 2 and 4

Orifice curves at which outlet pressure at maximum inlet test pressure varies from minimum obtainable outlet pressure by 20%

Minimum Outlet Pressure Adjustment

Curves 5 and 7

Orifice curves at which maximum obtainable outlet pressure varies from minimum obtainable outlet pressure by 20%

Curves 6 and 8

Orifice curves at which outlet pressure at maximum inlet test pressure varies from minimum obtainable outlet pressure by 20%

Curves A and D

Minimum Obtainable Outlet Pressure Curve

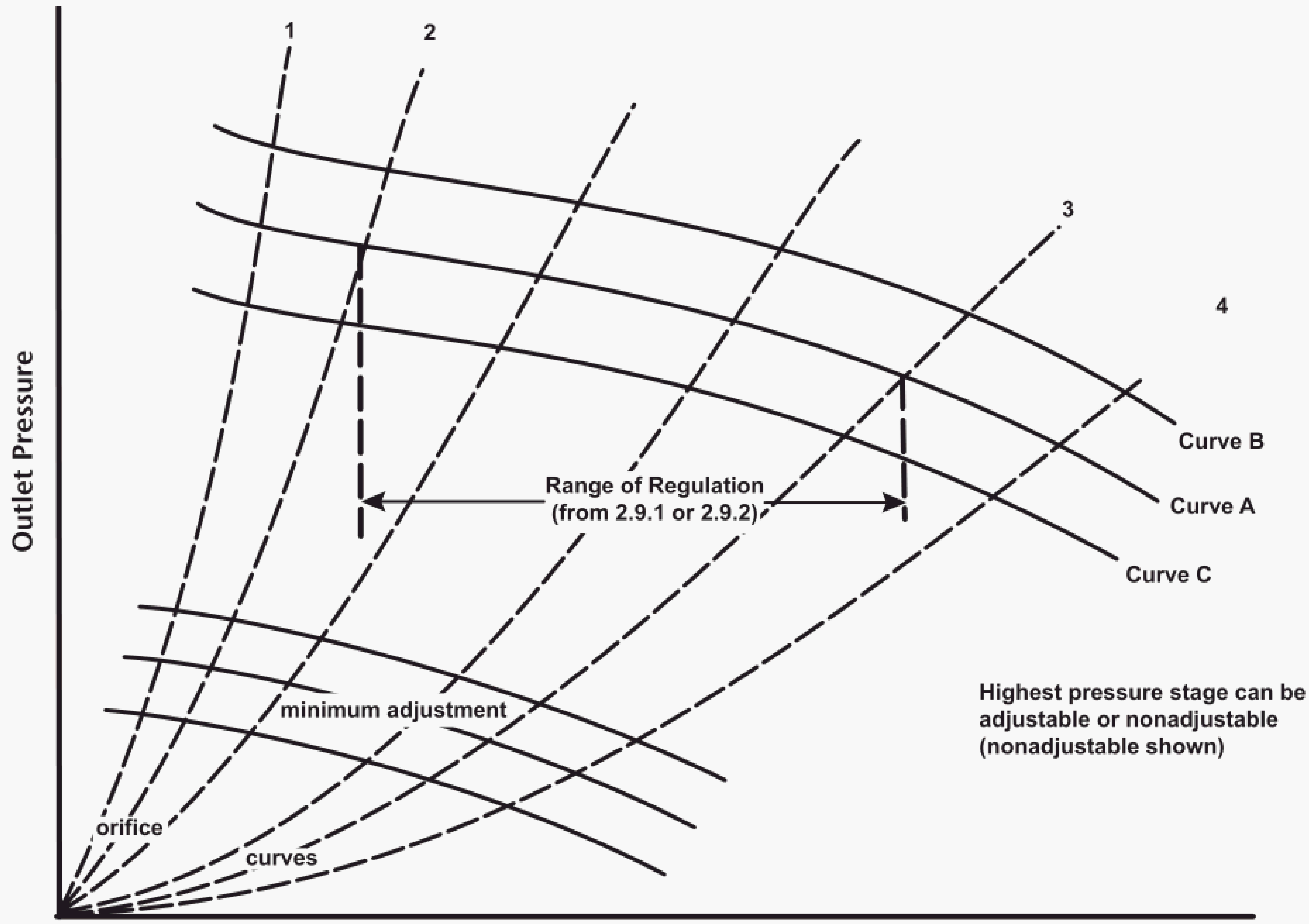
Curves B and E

Maximum Obtainable Outlet Pressure Curve

Curves C and F

Outlet Pressure Curve at Maximum Inlet Test Pressure

Figure 4. Range of Regulation Curves for Adjustable Regulators



Curves 1 and 3

Orifice curves at which maximum obtainable outlet pressure varies from minimum obtainable outlet pressure by 20%

Curves 2 and 4

Orifice curves at which outlet pressure at maximum inlet test pressure varies from minimum obtainable outlet pressure by 20%

Curve A

Minimum Obtainable Outlet Pressure Curve

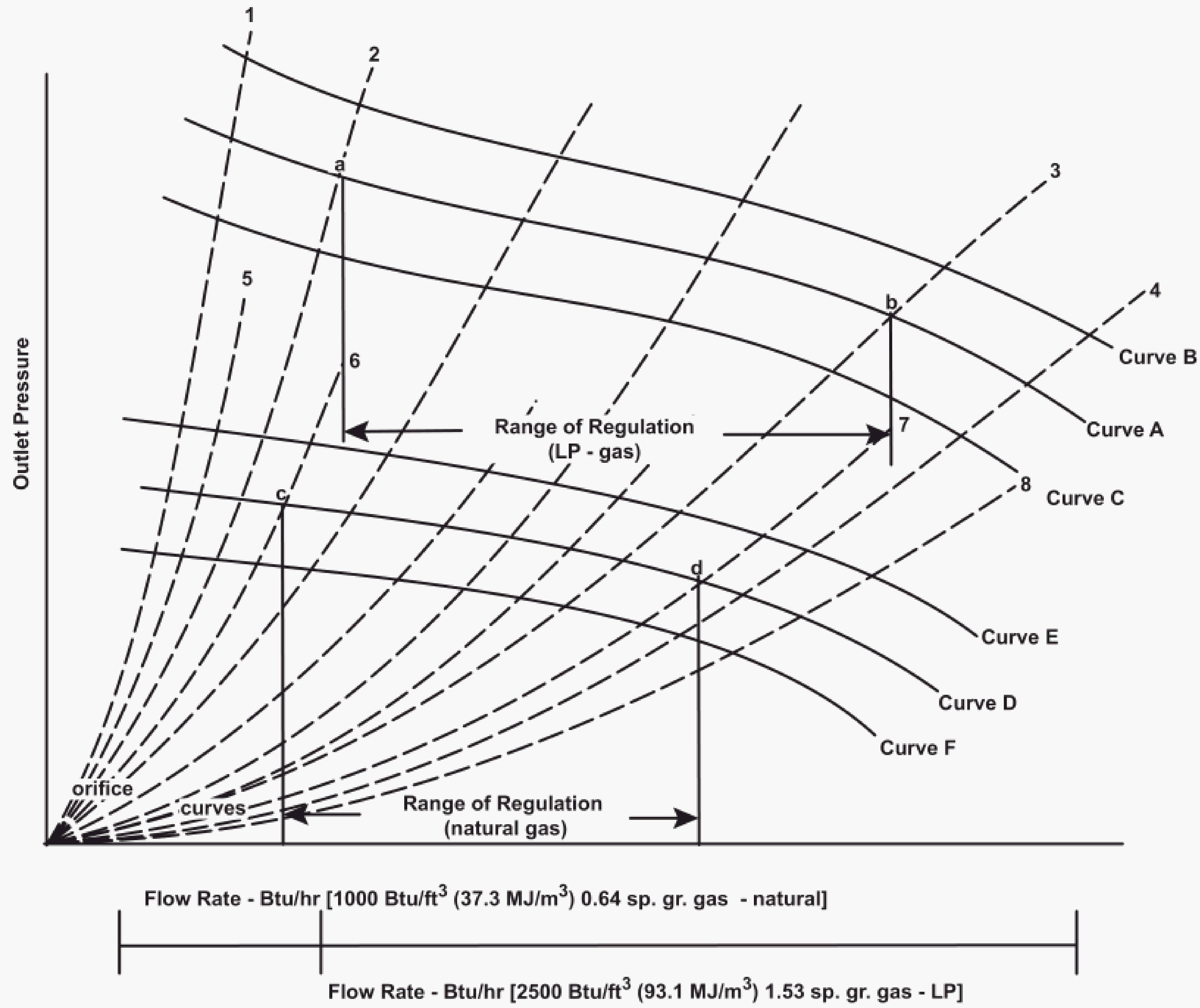
Curve B

Maximum Obtainable Outlet Pressure Curve

Curve C

Outlet Pressure Curve at Maximum Inlet Test Pressure

Figure 5. Range of Regulation Curves for Multi-Stage Regulators



LP - Gas Setting

Curves 1 and 3 - Orifice curves at which maximum obtainable outlet pressure varies from minimum obtainable outlet pressure by 20%

Curves 2 and 4 - Orifice curves at which outlet pressure at maximum inlet test pressure varies from minimum obtainable outlet pressure by 20%

Natural Gas Setting

Curves 5 and 7 - Orifice curves at which maximum obtainable outlet pressure varies from minimum obtainable outlet pressure by 20%

Curves 6 and 8 - Orifice Curves at which outlet pressure at maximum inlet test pressure varies from minimum obtainable outlet pressure by 20%

Curves A and D

Minimum Obtainable Outlet Pressure Curves

Curves B and E

Maximum Obtainable Outlet Pressure Curves

Curves C and F

Outlet Pressure Curves at Maximum inlet Test Pressure

Figure 6. Range of Regulation Curves for Convertible Regulators

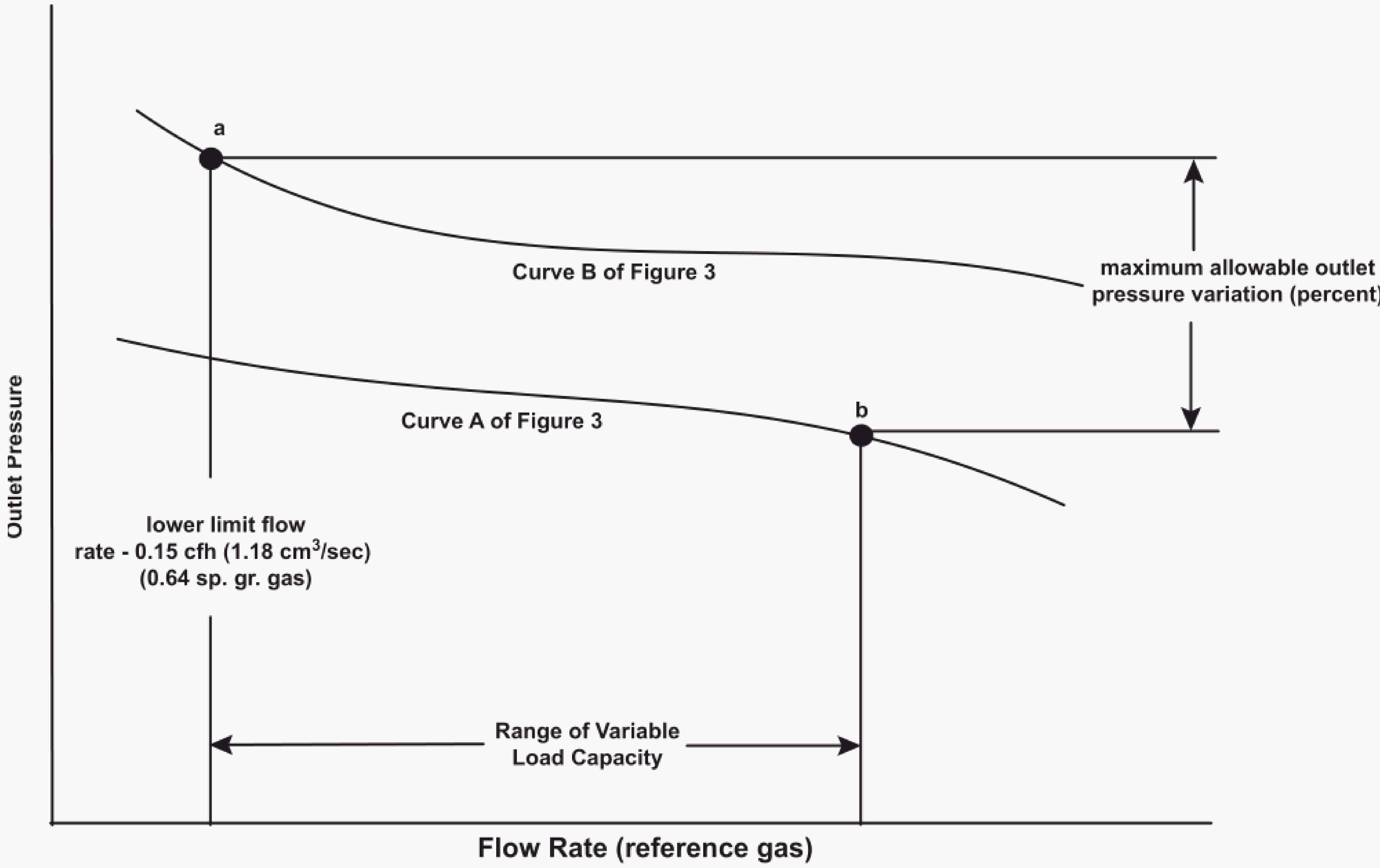


Figure 7. Range of Variable Load Capacity (Typical)

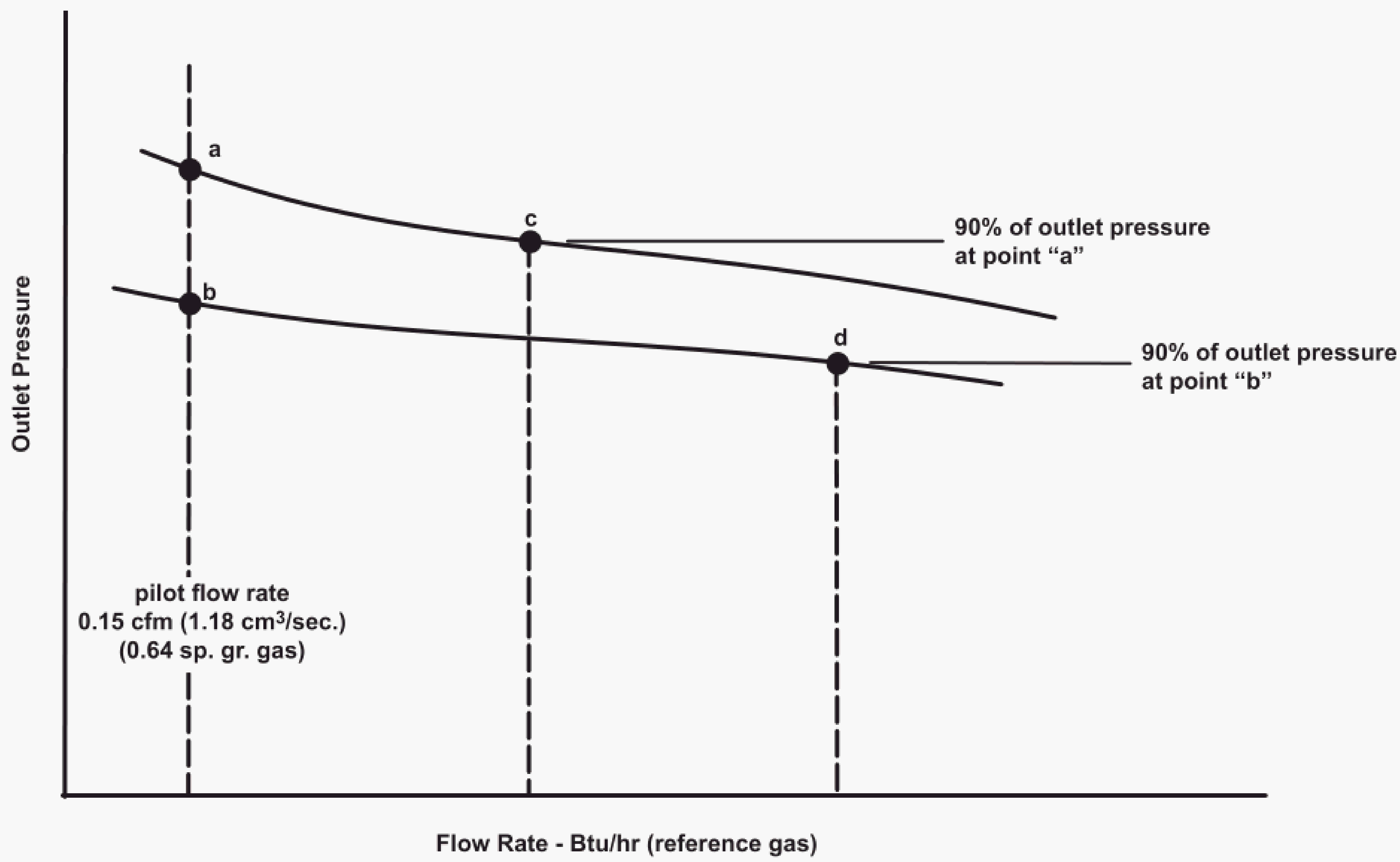


Figure 8. Typical Curves for Evaluations in 2.11.5

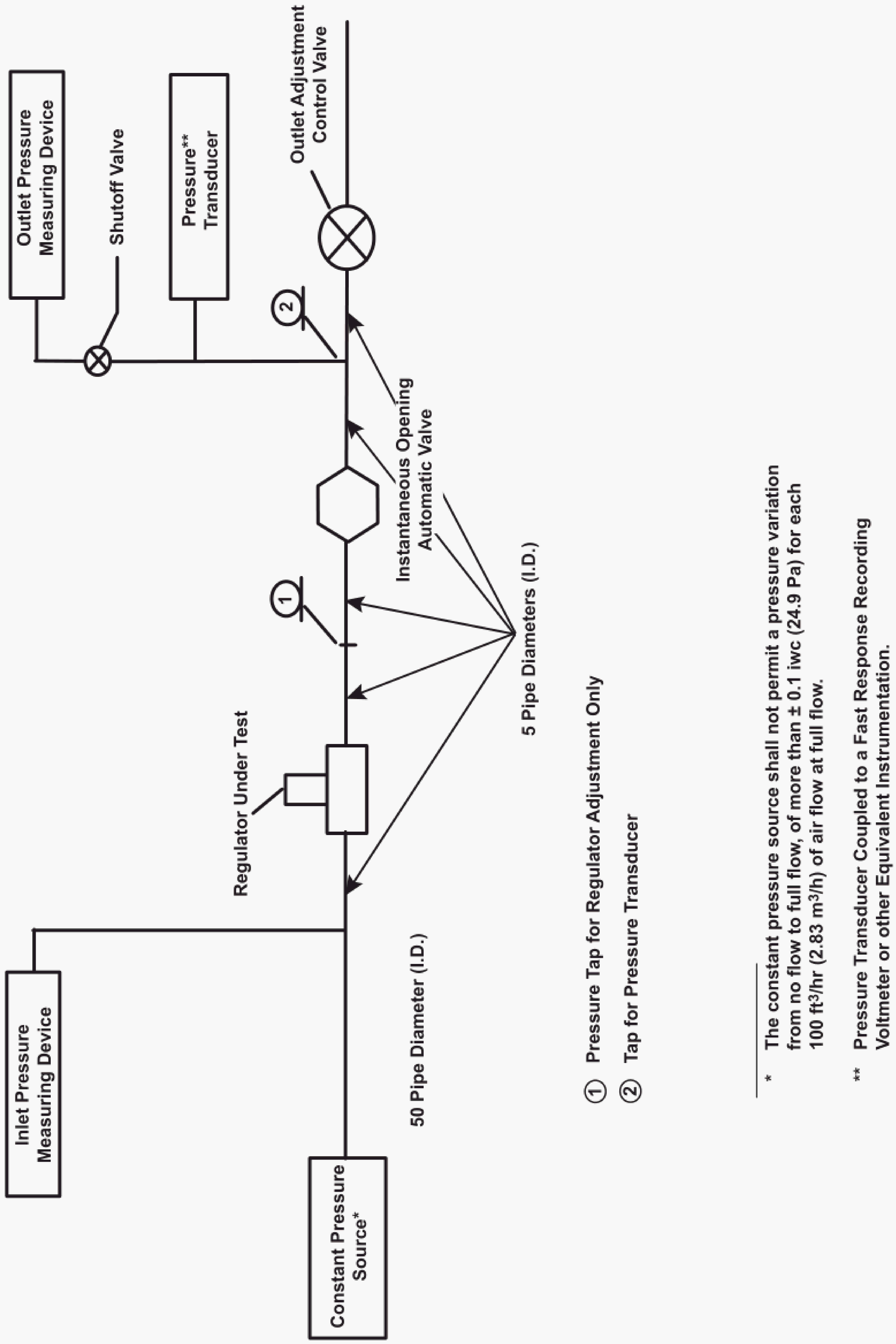


Figure 9. Arrangement for Integrity of Operation Test

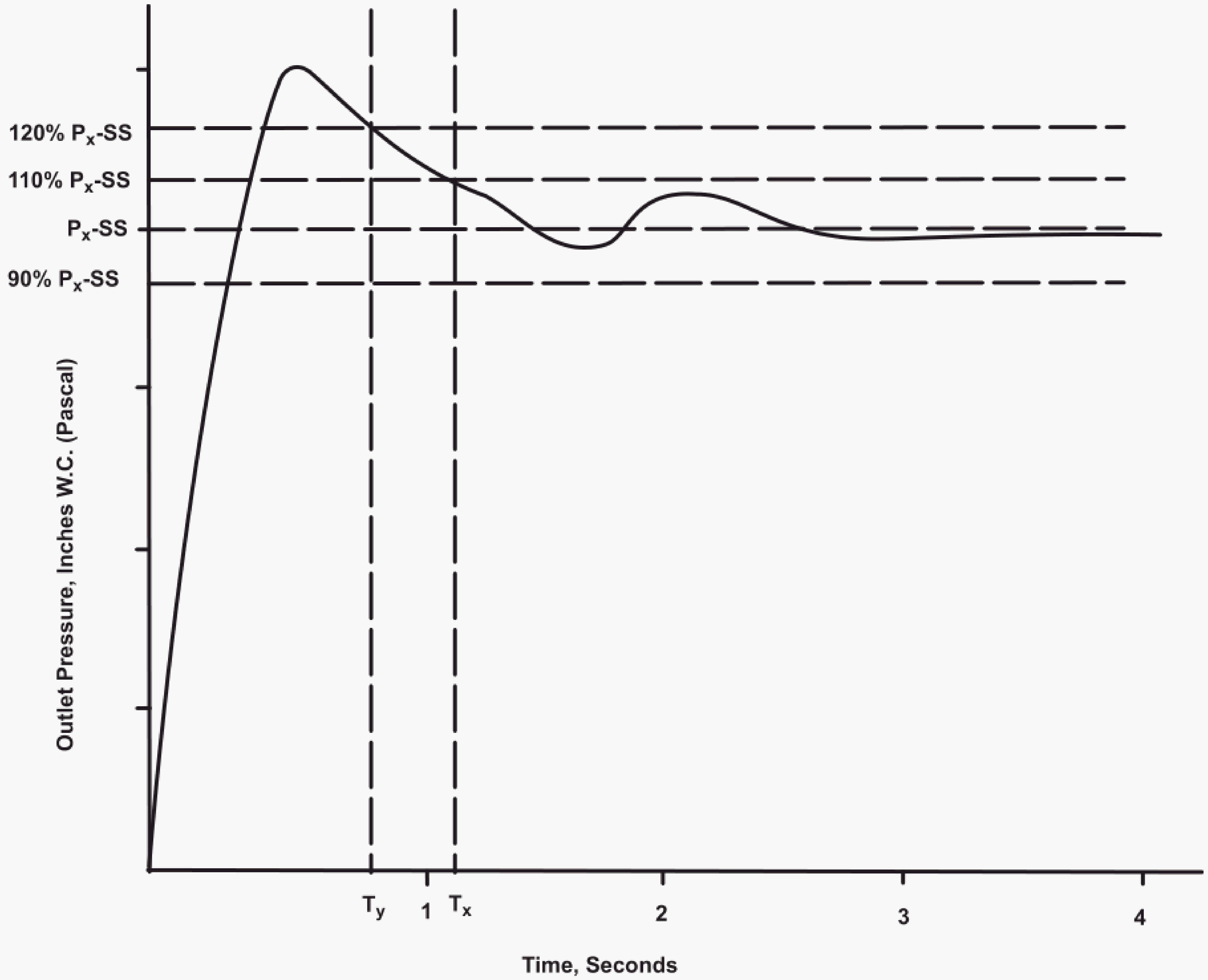
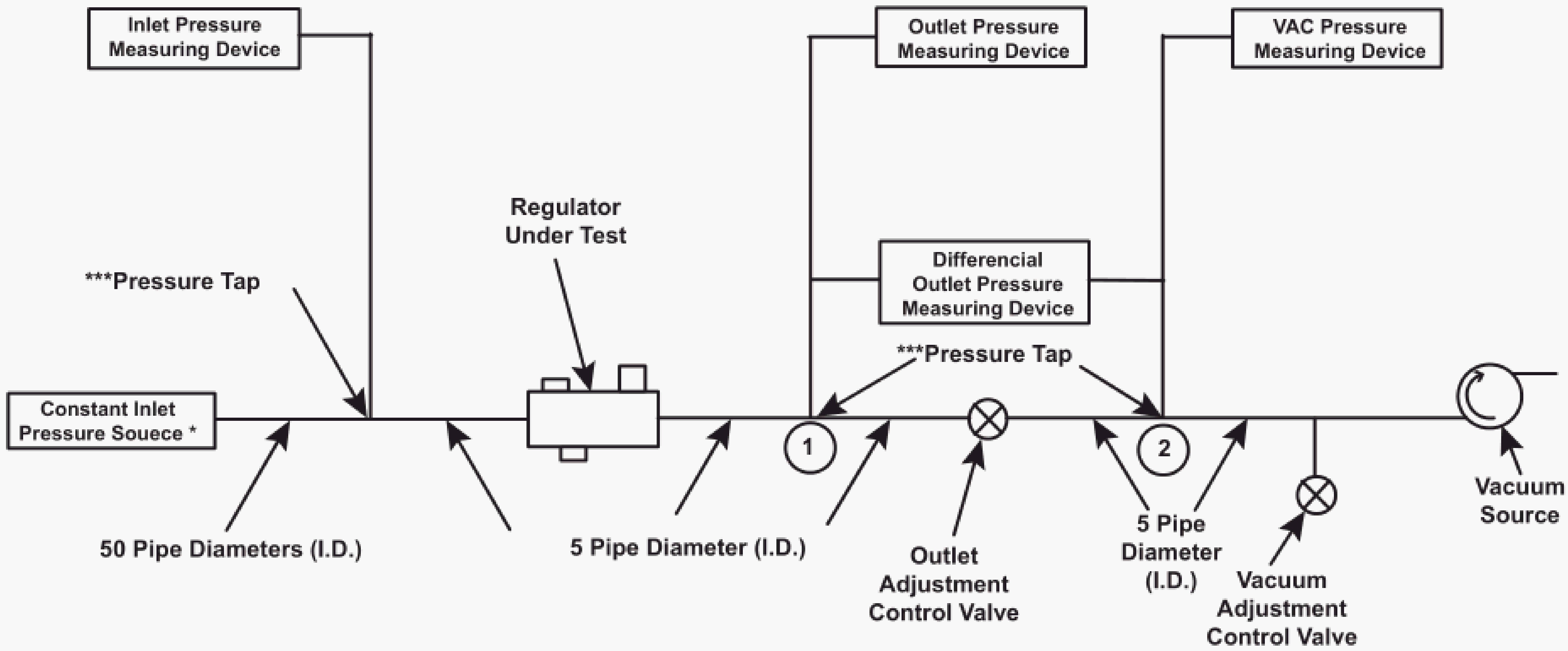


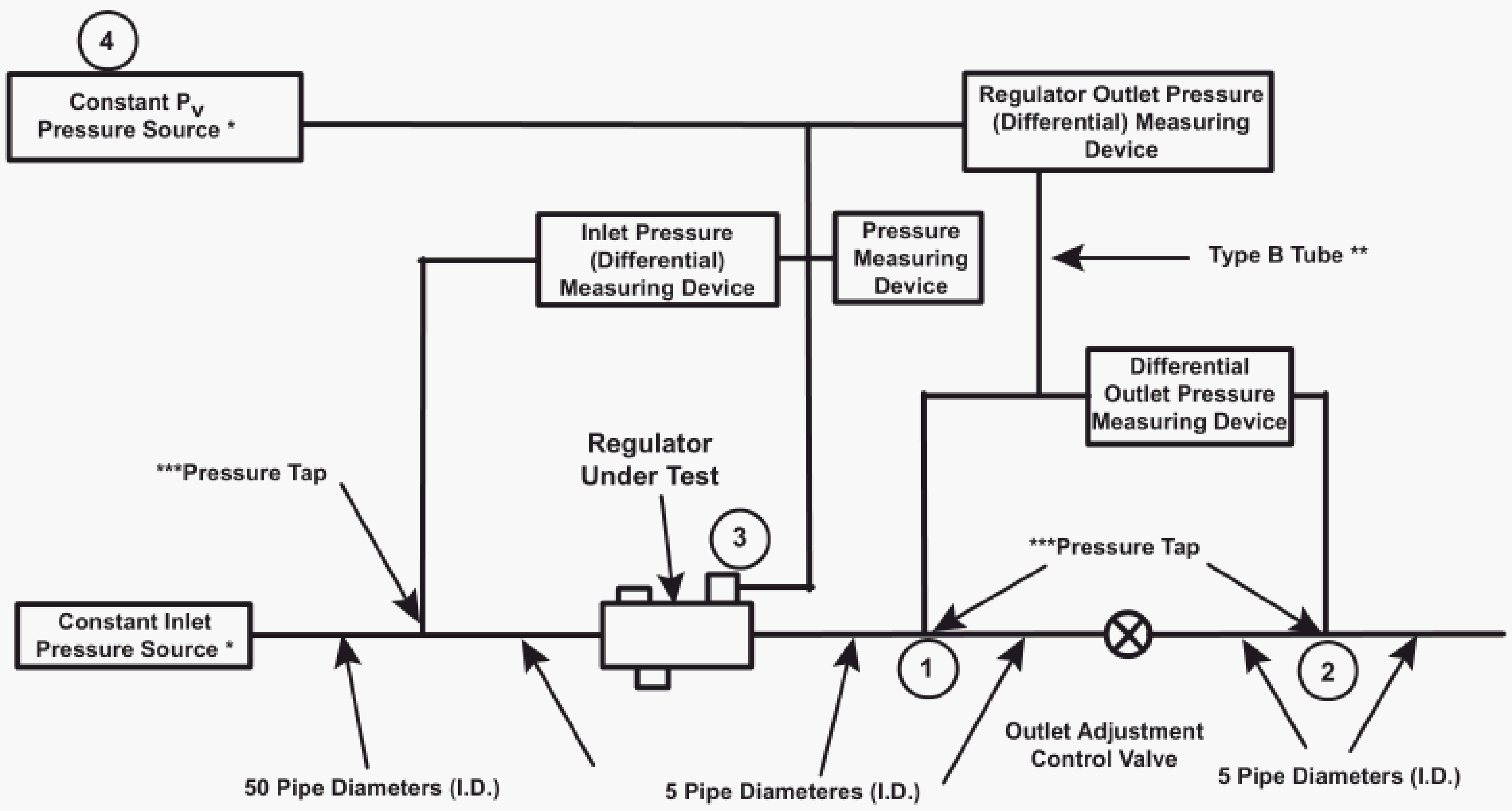
Figure 10. Integrity of Operation Curve



(1) Tap for differencial outlet pressure measuring devices, 3 ft (914 mm) Type 1 Tube** (for Section 3.12)

(2) Tap for vacuum pressure Measuring device.

SECTION A. NEGATIVE PRESSURE REGULATOR USING VACUUM SOURCE



(1), (2) Tape for differencial outlet pressure measuring device.

(3) Pressurize atmospheric side of regulator diaphragm through vent.

(4) P_v = Positive numerically equal to the vacuum pressure specified by the manufacturer

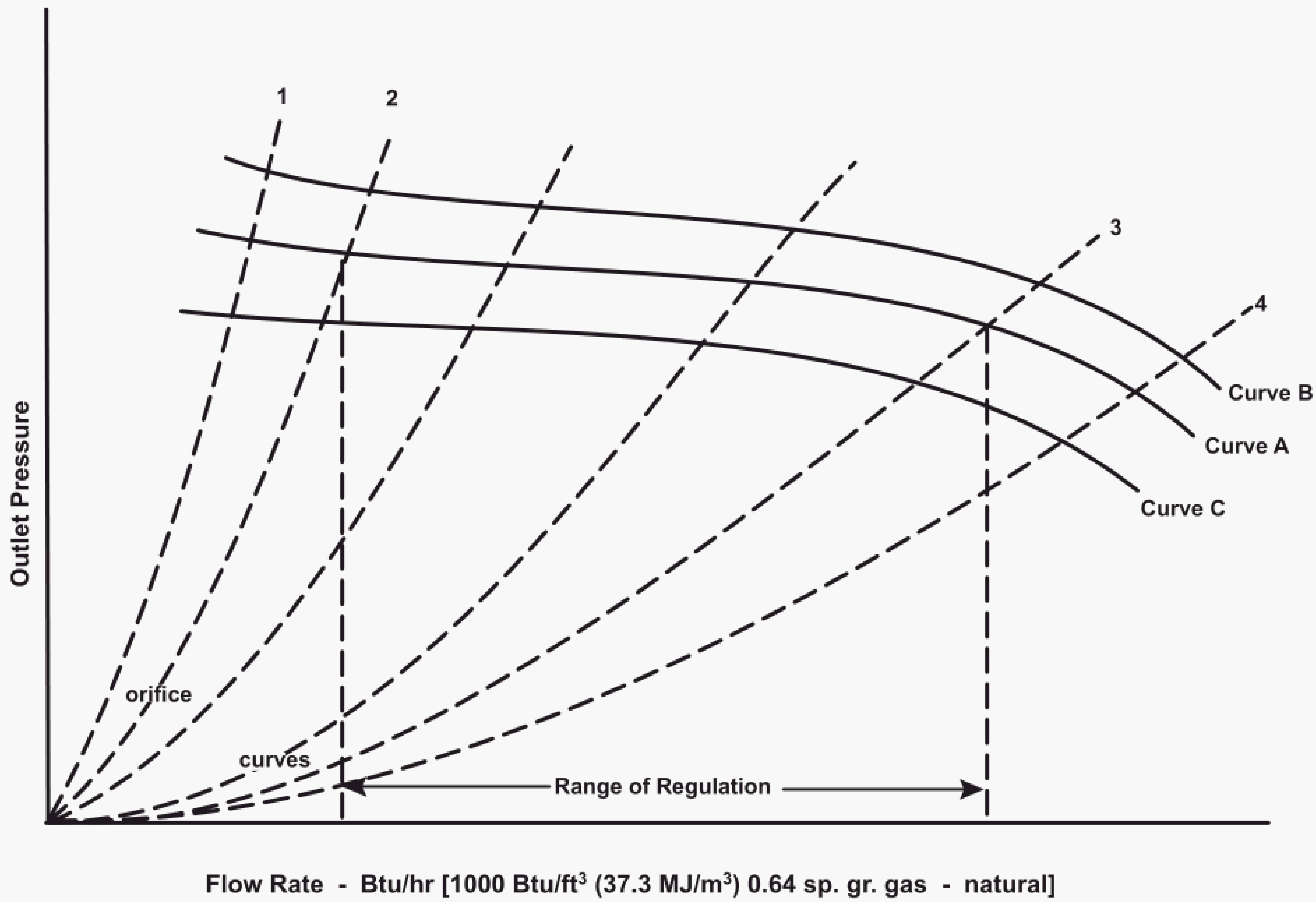
SECTION B. NEGATIVE PRESSURE REGULATORS USING POSITIVE PRESSURE ON ATMOSPHERIC SIDE OF REGULATOR DIAPHRAGM

Figure 11. Typical Arrangement of Test Apparatus for Negative Pressure Regulators

* The constant pressure source shall not permit a pressure variation from no flow to full flow, of more than ± 0.1 iwc (24.9 Pa) for each 100 ft^3 (2.83 m^3) of air flow at full flow.

** Type I Tube - Curtis Matheson Scientific Stock #203-414, Black Pure Gum Tubing $^3/_{16}$ in Bore, $^1/_{16}$ in Wall. Type II Tube - Fisher Scientific Stock #14-167D or Curtis Matheson Scientific Stock #202-671, Red Thickwall Tubing, $^1/_4$ in Bore, $^3/_{32}$ in Wall.

*** Pressure tap shall be $^1/_4$ in steel tube 1 in long, $^1/_{16}$ in (1.6 mm) diameter hole through pipe wall.



Curves 1 and 3

Orifice curves at which maximum obtainable outlet pressure varies from minimum obtainable outlet pressure by 20%

Curves 2 and 4

Orifice curves at which outlet pressure at maximum inlet test pressure varies from minimum obtainable outlet pressure by 20%

Curve A

Minimum Obtainable Outlet Pressure Curve

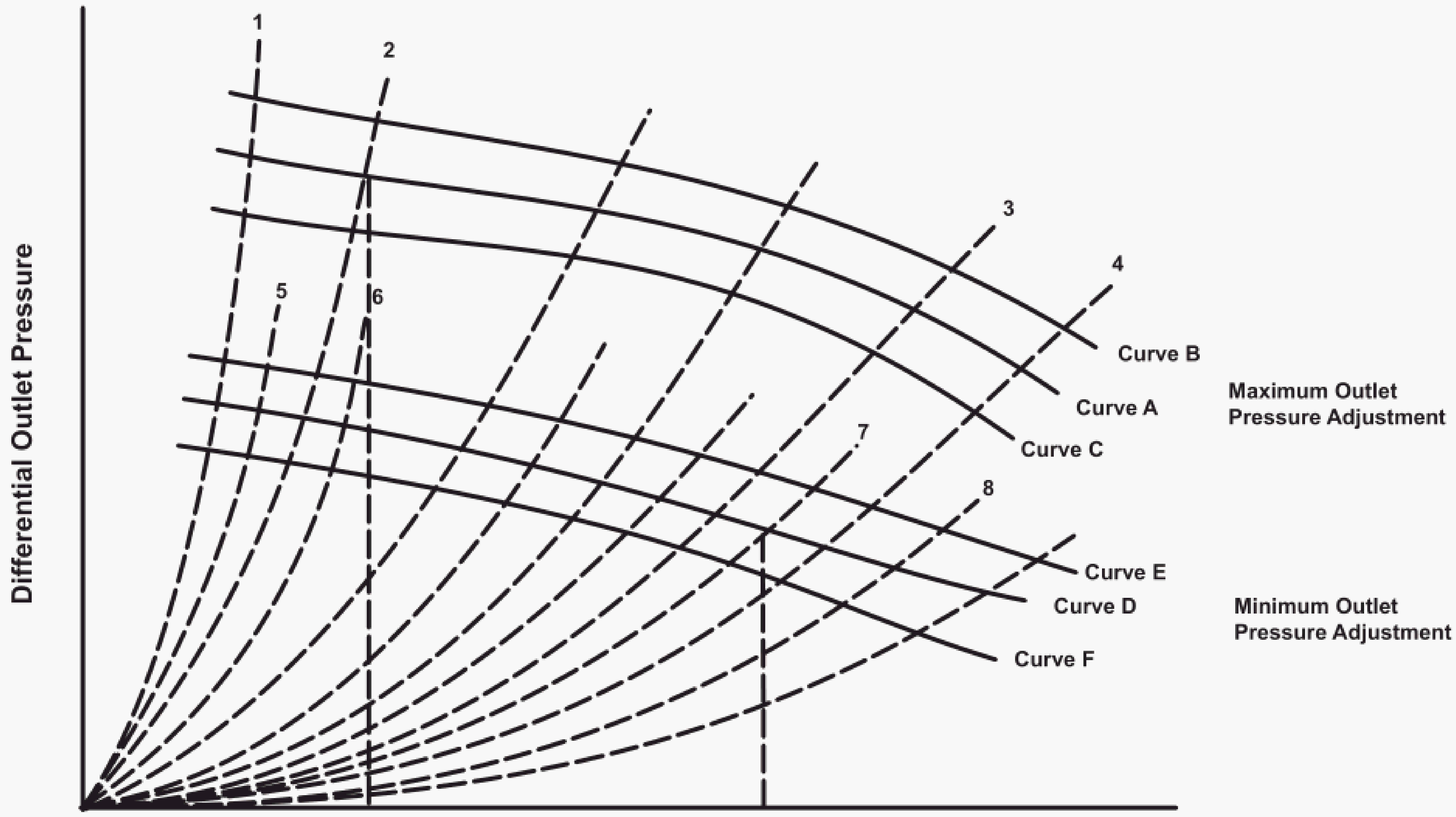
Curve B

Maximum Obtainable Outlet Pressure Curve

Curve C

Outlet Pressure Curve at Maximum Inlet Test Pressure

Figure 12. Range of Regulation Curves for Nonadjustable Negative Pressure Regulators



Maximum Outlet Pressure Adjustment

Curve 1 and 3

Orifice curves at which maximum differential outlet pressure varies from minimum differential outlet pressure by 20%

Curves 2 and 4

Orifice curves at which differential outlet pressure at maximum inlet test pressure varies from minimum differential outlet pressure by 20%

Minimum Outlet Pressure Adjustment

Curves 5 and 7

Orifice curves at which maximum differential outlet pressure varies from minimum differential outlet pressure by 20%

Curves 6 and 8

Orifice curves at which differential outlet pressure at maximum inlet test pressure varies from minimum differential outlet pressure by 20%

Curves A and D

Minimum Differential Outlet Pressure Curve

Curves B and E

Maximum Differential Outlet Pressure Curve

Curves C and F

Differential Outlet Pressure Curve at Maximum Inlet Test Pressure

Figure 13. Range of Regulation Curves for Adjustable Negative Pressure Regulators

Exhibit A
Items Unique To Canada

Exhibit A does not apply to ANSI Z21.18

A.1
All installation and marking provisions specified in this standard are required to be in a form easily understood in both English and French.

A.2
Units of measurement required on printed instructions and markings shall include the SI (metric) values as a minimum.

Exhibit B
List Of Reference Standards

AMERICAN GAS ASSOCIATION,
400 N. Capitol Street NW, Washington, D.C., U.S.A. 20001.

Gas Measurement Committee Report No. 3, Edition, for the Orifice Metering of Natural Gas

ANSI Z223.1-2006/NFPA 54-2006, National Fuel Gas Code

AMERICAN PETROLEUM INSTITUTE
Dept. of Publications and Distribution
Section 1220 L. St. NW, Washington DC, U.S.A. 20005

API SPEC 5L-2004, Specifications for Line Pipe Forty-Second Edition

ASME
United Engineering Center,
345 East 47th Street, New York, New York, U.S.A. 10017.

ANSI/ASME B1.1-2003, Unified Inch Screw Threads (UN and UNR Thread Form)

ANSI/ASME B1.20.1-1983 (R2006), Pipe Threads, General Purpose (Inch)

ANSI/ASME B16.1-2005, Gray Iron Pipe Flanges and Flanged Fittings, (Class 25, 125 and , 250)

ANSI/ASME B16.3-1998 (R2006), Malleable-Iron Threaded Fittings, Classes 150 and 300

ASTM
100 Barr Harbor Dr., West Conshohocken, Pennsylvania, U.S.A. 19428-2959.

IEEE/ASTM SI-10-2002 Standard for Use of the International System of Units (SI) (The Modern Metric System)

CSA
5060 Spectrum Way, Suite 100, Mississauga, Ontario Canada L4W 5N6.

B149.1-M05, Natural Gas and Propane Installation Code

CAN/CSA Z234.1-2000, Metric Practice Guide

NATIONAL FIRE PROTECTION ASSOCIATION
Batterymarch Park, Quincy, Massachusetts, U.S.A. 02269.

ANSI Z223.1-2006/NFPA 54-2006, National Fuel Gas Code

SOCIETY OF AUTOMOTIVE ENGINEERS
400 Commonwealth Drive, Warrendale, PA, U.S.A. 15096.

SAE Handbooks-1993, Volume I - Materials

SAE 10 2000, Automotive and Off-Highway Air Brake Reservoir Performance and Identification Requirements

Part IV: Manufacturing And Production Tests

The manufacturer shall submit to the certifying agency a plan which is mutually acceptable to the manufacturer and the certifying agency, that describes the programs and test procedures specified in 4.1, 4.2, 4.3 and the records which are to be kept by the manufacturer.

4.1

The manufacturer shall use a program to qualify raw materials, parts, assemblies and purchased components.

4.2

The manufacturer shall test each regulator at room temperature for:

a. Leakage (2.4); and

b. Outlet pressure setting or corresponding flow rate;

4.3

The manufacturer shall use a program which includes a mutually acceptable schedule(s) to conduct the following tests:

a. Continued operation (2.13 or 3.13);

b. Outlet pressure adjustment range (2.8 or 3.8);

c. Range of regulation capacity (2.9 or 3.9);

d. Integrity of operation (2.12 or 3.12);

e. Strength (2.5.1 and 2.5.2); and

f. Leakage (2.4).

4.4

The manufacturer's test method(s) used shall be capable of relating back to the test(s) specified in the standard. The section numbers of tests in the standard are provided in parenthesis for ease of reference.

Part V: Definitions

ADJUSTMENT MEANS. A means for loading the diaphragm and thus regulating the outlet pressure.

ADJUSTMENT, OUTLET PRESSURE (SETTING). The outlet pressure to which the regulator is adjusted.

BODY. The principal structure of the device which contains and supports the actuating mechanism and constitutes the primary gas passage.

CAPACITY, PRESSURE DROP. The equivalent flow rate for a loss in pressure equal to 1.0 inches water column (249 Pa) with the regulator valve, if applicable, in a nominally wide open position.

COMBINATION CONTROL. An assembly of two or more different functions at least one of which conveys gas, in a single unit without the use of pipe nipples, including the following:

1. Manually Operated Gas Valves;
2. Gas Appliance Pressure Regulator;
3. Automatic Valve;
4. Thermostat Other than Electric Type;
5. Ignition System Components; and
6. Automatic Gas Shutoff Device.

CUBIC FOOT OF GAS. The amount of gas which would occupy 1 ft^3 (0.03 m^3) when at a temperature of 60°F (15.5°C) saturated with water vapor and under an absolute pressure of 30 inches mercury column (101.3 kPa).

DIAPHRAGM. A flexible member upon which gas pressure acts to perform a mechanical function

DIAPHRAGM PLATE. A rigid disc in contact with the diaphragm, which transmits the force of fixed weight, fixed springs or adjustable springs to the diaphragm.

DIFFERENTIAL OUTLET PRESSURE. Observed pressure drop across outlet adjustment control valve.

INLET PRESSURE, RATED. The highest inlet pressure for which the regulator is intended to be used.

INLET TEST PRESSURE, MAXIMUM. The highest inlet pressure at which tests have been conducted to determine that the regulator will control the outlet pressure within acceptable limits.

MAIN BURNER LOAD APPLICATION, REGULATOR FOR. A regulator designed to control the flow of gas to main burners only.

MAIN BURNER AND PILOT LOAD APPLICATION, REGULATOR FOR. A regulator designed to control the flow of gas to main and pilot burners.

MAXIMUM INDIVIDUAL LOAD CAPACITY. The maximum capacity or flow at which the regulator will control pilot line pressure within acceptable limits.

NEGATIVE PRESSURE REGULATOR. A gas appliance pressure regulator intended primarily for use in conjunction with a downstream vacuum producing system.

ORIFICE CURVE. A plot showing the relationship between flow rate and orifice pressure as the pressure is varied immediately upstream of a fixed orifice.

PROPANE HD-5. A special grade of liquefied petroleum gas composed of a minimum of 90 percent liquid volume of propane (C_3H_8) and a maximum of 5 percent liquid volume propylene (C_3H_6).

REGULATION RANGE. The high and low limits of flow between which is found acceptable regulating characteristics. For regulators designed to control pilot flow, the minimum regulation capacity is 0.15 ft^3/hr (1.18 cm^3/s) of 1000 Btu/ft^3 (37.3 MJ/m^3) 0.64 specific gravity gas for a regulator designated by the symbol Ⓟ, or 0.50 ft^3/hr (3.93 cm^3/s) of 1000 Btu/ft^3 (37.3 MJ/m^3) 0.64 specific gravity gas for a regulator designated by the symbol ▽P.

REGULATOR, GAS PRESSURE. A device for controlling a selected outlet gas pressure.

1. Adjustable.

   a. Spring Type, Standard Adjustment. A regulator in which the regulating force acting upon the diaphragm is derived principally from a spring, the loading of which is adjustable. The adjustment means shall be concealed.

   b. Spring Type, Limited Adjustment. A regulator in which the regulating force acting upon the diaphragm is derived principally from a spring, the loading of which is adjustable over a range of not more than ± 15 percent or ± 0.3 inches water column, whichever is greater, of the outlet pressure at the midpoint of the adjustment range.

2. Nonadjustable.

   a. Spring Type, Nonadjustable. A regulator in which the regulating force acting upon the diaphragm is derived principally from a spring, the loading of which is not field adjustable.

   b. Weight Type. A regulator in which the regulating force acting upon the diaphragm is derived from a weight or combination of weights.

3. Convertible.

   A nonadjustable regulator for conversion between gases having different heating values whose converting mechanism can be changed from one predetermined outlet pressure setting for one gas to another predetermined outlet pressure setting for the other gas with no intermediate pressure settings and without addition, deletion or substitution of parts.

4. Multi-Stage Regulator.

   A regulator for use with a single gas whose adjustment means can be positioned manually or automatically to two or more predetermined outlet pressure settings. Each of these settings may be either adjustable or nonadjustable. The regulator may modulate outlet pressures automatically between its maximum and minimum predetermined outlet pressure settings.

RESPONSE CURVE. The characteristic curves which show the pressure at the outlet of a regulator with respect to time following a change from no flow to flow conditions.

SPECIFIC GRAVITY. The ratio of the weight of a given volume of gas to that of the same volume of air, both measured at the same temperature and pressure.

TOOLS, SPECIAL. Those tools which are not available on the open retail market.

VALVE. The movable member which, in conjunction with the valve seat, control flow.

VALVE SEAT. The stationary portion of an assembly which, in conjunction with the valve, controls the outlet pressure.

VALVE STEM. A rod which positions the valve relative to the diaphragm and seat, directly or through linkage.

VARIABLE LOAD CAPACITY RANGE. The high and low limits of flow between which is found an acceptable constant outlet pressure. For regulators designed to control pilot flow, the minimum variable load capacity is 0.15 ft^3/hr (1.18 cm^3/s) of 1000 Btu/ft^3 (37.3 MJ/m^3), 0.64 specific gravity gas for a regulator designated by the symbol Ⓟ, or 0.50 ft^3/hr (3.93 cm^3/s) of 1000 Btu/ft^3 (37.3 MJ/m^3), 0.64 specific gravity gas for a regulator designated by the symbol ▽P.

VENT LIMITER. A means which limits the flow of gas from the atmospheric diaphragm chamber to the atmosphere in the event of a diaphragm rupture. This may be either a limiting orifice or a limiting device.

Limiting Orifice Type. A vent limiter where the flow through the limiter is the same in both directions.

Appendix A
Table Of Conversion Factors

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

Quantity	U. S. Unit		Multiplying Factor		SI Units*	
	Name	Symbol	U.S. to SI	SI to U.S.	Symbol	Name
TORQUE	ounce-force-inch	ozf-in	7.061×10^{-3}	141.62	N•m	newton-meter
	pound-force-inch	lbf-in	1.129×10^{-1}	8.85	N•m	newton-meter
	pound-force-foot	lbf-ft	1.355	7.38×10^{-1}	N•m	newton-meter
LENGTH	inch	in	2.540×10^{-2}	39.37	m	meter
	inch	in	2.540×10	39.37×10^{-3}	mm	millimeter
	foot	ft	3.048×10^{-1}	3.281	m	meter
AREA	square inch	in^2	6.452×10^{-4}	1550	m^2	square meter
	square inch	in^2	6.452×10^{2}	1550×10^{-6}	mm^2	square millimeter
	square foot	ft^2	9.290×10^{-2}	10.76	m^2	square meter
VOLUME	cubic inch	in^3	1.639×10^{-5}	61.02×10^{3}	m^3	cubic meter
	cubic foot	ft^3	2.832×10^{-2}	35.31	m^3	cubic meter
	cubic foot	ft^3	2.832×10	35.31×10^{-3}	l	liter
	gallon	gal	3.785×10^{-3}	264.1	m^3	cubic meter
	gallon	gal	3.785	264.1×10^{-3}	l	liter
VELOCITY	foot/second	ft/s	3.048×10^{-1}	3.281	m/s	meter/second
	foot/minute	ft/min	5.080×10^{-3}	196.8	m/s	meter/second
	mile/hour	m/hr	4.470×10^{-1}	2.236	m/s	meter/second
ACCELERATION	foot/second^2	ft/s^2	3.048×10^{-1}	3.281	m/s^2	meter/second^2
FREQUENCY	cycle/second	c/s	1	1	Hz	hertz
MASS	ounce	oz	2.835×10^{-2}	35.27	kg	kilogram
	ounce	oz	2.835×10	35.27×10^{-3}	g	gram
	pound	lb	4.536×10^{-1}	2.204	kg	kilogram
	grain	gr	6.480×10^{-5}	15.43×10^{-3}	kg	kilogram
MASS PER UNIT AREA	pound/foot^2	lb/ft^2	4.882	2.048×10^{-1}	kg/m^2	kilogram/meter^2
MASS PER UNIT VOLUME	pound/foot^3	lb/ft^3	1.602×10	6.243×10^{-2}	kg/m^3	kilogram/meter^3
SPECIFIC VOLUME	foot^3/pound	ft^3/lb	6.243×10^{-2}	1.602×10	m^3/kg	meter^3/kilogram
MASS FLOW RATE	pound/hour	lb/hr	1.260×10^{-4}	7.936×10^{3}	kg/s	kilogram/second
	pound/foot^2•hour	lb/ft^2•hr	1.356×10^{-3}	7.374×10^{2}	kg/m^{2}s	kilogram/meter^2•second
	pound/inch^2•hour	lb/in^2•hr	1.953×10^{-1}	5.120	kg/m^{2}s	kilogram/meter^2•second
VOLUME FLOW RATE	foot^3/second	ft^3/s	2.832×10^{-2}	35.31	m^3/s	meter^3/second
	foot^3/second	ft^3/s	2.832×10	35.31×10^{-3}	l/s	liter/second
	foot^3/minute	ft^3/min.	4.719×10^{-4}	2.119×10^{-3}	m^3/s	meter^3/second
	foot^3/minute	ft^3/min.	4.719×10^{-1}	2.119×10	l/s	liter/second
	gallon/minute	gal/min.	6.309×10^{-5}	1.585×10^{4}	m^3/s	meter^3/second
	gallon/minute	gal/min.	6.309×10^{-2}	1.585×10	l/s	liter/second
	gallon/hour	gal/hr	1.052×10^{-6}	9.505×10^{5}	m^3/s	meter^3/second
	gallon/hour	gal/hr	1.052×10^{-3}	9.505×10^{2}	l/s	liter/second
PRESSURE	pound force/inch^2	lbf/in^2	6.895×10^{3}	1.450×10^{-4}	Pa	pascal
	pound force/foot^2	lbf/ft^2	4.788×10	2.088×10^{-2}	Pa	pascal
		inch H_2O (4°C)	2.491×10^{2}	4.014×10^{-3}	Pa	pascal
	atmosphere	inch Hg (0°C)	3.386×10^{3}	2.953×10^{-4}	Pa	pascal
		atm (std)	1.013×10^{5}	9.871×10^{-6}	Pa	pascal
ENERGY, WORK, QUANTITY OF HEAT		Btu	1.055×10^{3}	9.478×10^{-4}	J	joule
		Btu	1.055	9.478×10^{-1}	kJ	kilojoule
	horsepower hour	hphr	2.685×10^{6}	3.724×10^{-7}	J	joule
	horsepower hour	hphr	2.685	3.724×10^{-1}	MJ	megajoule
	kilowatt hour	kwhr	3.6×10^{6}	2.777×10^{-7}	J	joule
	kilowatt hour	kwhr	3.6	2.777×10^{-1}	MJ	megajoule
POWER, HEAT FLOW RATE		Btu/hr	2.931×10^{-1}	3.412	W	watt
		Btu/hr	2.931×10^{-4}	3.412×10^{3}	kW	kilowatt
		hp	7.457×10^{2}	1.341×10^{-3}	W	watt
		hp	7.457×10^{-1}	1.341	kW	kilowatt
	ton refrigeration (12,000 Btu/hr)		3.516×10^{3}	2.844×10^{-4}	W	watt
	ton refrigeration (12,000 Btu/hr)		3.516	2.844×10^{-1}	kW	kilowatt
	Btu/hour•foot^2	Btu/hr•ft^2	3.155	3.1695×10^{-1}	W/m^2	watt/meter^2
HEAT CAPACITY	Btu/degree F	Btu/°F	1.899×10^{3}	5.265×10^{-4}	J/°C	joule/degree Celsius
SPECIFIC	Btu/pound•degree F	Btu/lb•°F	4.187×10^{3}	2.388×10^{-2}	J/kg•°C	joule/kg•degree Celsius
HEAT CAPACITY	Btu/pound•degree F	Btu/lb•°F	4.187	2.388×10^{-5}	kJ/kg•°C	kilojoule/kg•degree Celsius
LATENT HEAT	Btu/pound	Btu/lb	2.326×10^{3}	4.299×10^{-4}	J/kg	joule/kilogram
	Btu/pound	Btu/lb	2.326	4.299×10^{-1}	kJ/kg	kilojoule/kilogram
VOLUME AT STD. CONDITIONS**	ft^3 (60°F, 30 inches Hg, sat)		.9826	1.0177	ft^3 (60°F, 30 inches Hg, dry)	
	" " "		.02784	35.92	m^3 (15°C, 760 mm Hg, dry)	
	" " "		.02832	35.31	m^3 (15°C, 760 mm Hg, sat)	
	" " "		.02639	37.89	m^3 (0°C, 760 mm Hg, dry)	
	" " "		.02655	37.66	m^3 (0°C, 760 mm Hg, sat)	

* SI Units (International System of Units) have been adopted by the International Gas Union for use within the gas industry. Where the same quantities have been defined by ISO (International Standards Organization, they are identical to the SI Units.

Standard cubic foot (SCF) measured @ 60°F and 30 inches Hg, Saturated. (U.S. Conditions)
Standard cubic meter (ms^3) measured @ 15°C and 760 mm Hg, dry. (SI Conditions)
Normal cubic meter (mn^3) measured @ 0°C and 760 mm Hg, dry.

Temperature Scales And Conversions

The unit of temperature in the International System of Units (SI) is the kelvin (K), but it is generally accepted practice to express temperature differences in terms of degrees Celsius (°C) because the degree intervals are identical. The term "centigrade" was abandoned in 1948 by the General Conference on Weights and Measures but in fact is still in common use. The accepted abbreviation for centigrade is also °C and for all practical purposes the degree intervals of centigrade, Celsius and kelvin, are identical.

Many temperature measurements are still made in terms of degrees Fahrenheit (°F). Although a formal definition of the Fahrenheit scale does not exist, it is based on:

a. The freezing (ice) point of water = 32°F

b. The boiling point of water under standard pressure conditions = 212°F

c. The formula for absolute temperature, 5/9 (°F—32) = °C

d. The formula for "temperature rise," 5/9 °F = °C

°C	°F	°C	°F	°C	°F
—40	—40.0	25	77.0	70	158.0
—20	— 4.0	30	86.0	80	176.0
0	32.0	35	95.0	90	194.0
10	50.0	40	104.0	100	212.0
15	59.0	50	122.0	110	230.0
20	68.0	60	140.0	120	248.0

Multiples And Submultiples Of Basic Units

Factor by which the unit is multiplied			Prefix	Symbol
1 000 000 000 000	=	10^{12}	tera	T
1 000 000 000	=	10^{9}	giga	G
1 000 000	=	10^{6}	mega	M
1 000	=	10^{3}	kilo	k
100	=	10^{2}	hecto	h
10	=	10^{1}	deka	da
0.1	=	10^{-1}	deci	d
0.01	=	10^{-2}	centi	c
0.001	=	10^{-3}	milli	m
0.000 001	=	10^{-6}	micro	µ
0.000 000 001	=	10^{-9}	nano	n
0.000 000 000 001	=	10^{-12}	pico	p

List Of Harmonized Z21/Z83 • CSA/CGA Series Of American National Standards • CSA/Canadian Gas Association Standards For Gas Appliances And Gas Appliance Accessories

(The information in this list is informative and is not to be considered part of the standard.)

Appliances

Gas Clothes Dryers,
- Volume I (Z21.5.1 • CSA 7.1) Type 1 Clothes Dryers
- Volume II (Z21.5.2 • CSA 7.2) Type 2 Clothes Dryers

Gas Water Heaters,
- Volume I (Z21.10.1 • CSA 4.1) Storage Water Heaters With Input Ratings of 75,000 Btu Per Hour or Less
- Volume III (Z21.10.3 • CSA 4.2) Storage, With Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous Water Heaters

Gas-Fired, Heat Activated Air Conditioning and Heat Pump Appliances,Z21.40.1 • CGA 2.91

Gas-Fired, Work Activated Air-Conditioning and Heat Pump Appliances (Internal Combustion), Z21.40.2 • CGA 2.92

Performance Testing and Rating of Gas-Fired Air-Conditioning and Heat

Pumping Appliances, Z21.40.4 • CGA 2.94

Gas-Fired Central Furnaces (Except Direct Vent Central Furnaces), Z21.47 • CSA 2.3

Vented Decorative Gas Appliances, Z21.50 • CSA 2.22

Gas-Fired Pool Heaters, Z21.56 • CSA 4.7

Outdoor Cooking Gas Appliances, Z21.58 • CGA 1.6

Decorative Gas Appliances for Installation in Solid-Fuel Burning Fireplaces, Z21.60 • CGA 2.26

Portable Camp Heaters of Other Than the Catalytic Type for Use With Liquefied Petroleum Gases, Z21.63 • CSA 11.3

Portable Camp Cook Stoves for Use With Propane Gas, Z21.72 • CSA 11.2

Portable Camp Lanterns for Use With Propane Gas, Z21.73 • CSA 11.1

Vented Gas-Fired Space Heating Appliances, Z21.86 • CSA 2.32

Vented Gas Fireplace Heaters, Z21.88 • CSA 2.33

Accessories

Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves, Z21.15 • CGA 9.1

Domestic Gas Conversion Burners, Z21.17 • CSA 2.7

Gas Appliance Pressure Regulators, Z21.18 • CSA 6.3

Automatic Valves for Gas Appliances, Z21.21 • CSA 6.5

Relief Valves for Hot Water Supply Systems, Z21.22 • CSA 4.4

Connectors for Gas Appliances, Z21.24 • CSA 6.10

Pilot Gas Filters, Z21.35 • CGA 6.8

Quick-Disconnect Devices for Use With Gas Fuel, Z21.41 • CSA 6.9

Has Hose Connectors for Portable Outdoor Gas-Fired Appliances, Z21.54 • CGA 8.4

Automatic Vent Damper Devices for Use With Gas-Fired Appliances, Z21.66 • CGA 6.14

Connectors for Movable Gas Appliances, Z21.69 • CSA 6.16

Connectors for Outdoor Gas Appliances and Manufactured Homes, Z21.75 • CSA 6.27

Manually-Operated Piezo-Electric Spark Gas Ignition Systems and Components, Z21.77 • CGA 6.23

Combination Gas Controls for Gas Appliances, Z21.78 • CSA 6.20

Gas Appliance Sediment Traps, Z21.79 • CGA 6.21

Line Pressure Regulators, ANSI Z21.80 • CSA 6.22

Cylinder Connection Devices, ANSI Z21.81 • CSA 6.25

Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.87 • CSA 4.6

List Of Harmonized Z83/CGA Series Of American National Standard/caNadian Gas Association Standards

Direct Gas-Fired Make-Up Air Heaters, Z83.4 • CSA 3.7

Gas-Fired Construction Heaters, Z83.7 • CSA 2.14

Gas Unit Heaters and Gas-Fired Duct Furnaces, Z83.8 • CGA 2.6

Gas Food Service Equipment, Z83.11 • CGA 1.8

List Of Lc Series Of Harmonized Standards For Gas Equipment

Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST), LC1 • CSA 6.26

List Of Z21 Series Of American National Standards For Gas Appliances And Gas Appliance Accessories

Appliances

Household Cooking Gas Appliances, Z21.1

Gas-Fired Room Heaters, Z21.11
Volume II (Z21.11.2) Unvented Room Heaters

Gas-Fired Low-Pressure Steam and Hot Water Boilers, Z21.13

Domestic Gas Conversion Burners, ANSI Z21.17

Refrigerators Using Gas Fuel, Z21.19

Gas-Fired Illuminating Appliances, Z21.42

Recreational Vehicle Cooking Gas Appliances, Z21.57

Gas-Fired Toilets, Z21.61

Portable Catalytic Camp Heaters for Use With Propane Gas, Z21.62

Portable Refrigerators for Use With HD-5 Propane Gas, Z21.74

Gas-Fired Unvented Catalytic Room Heaters for Use With Liquified Petroleum (LP) Gases, Z21.76

Manually Lighted, Natural Gas Decorative Gas Appliances for Installation in Solid-Fuel Burning Fireplaces, Z21.84

Accessories

Gas Hose Connectors for Portable Indoor Gas-Fired Equipment, Z21.2

Draft Hoods, Z21.12

Automatic Gas Ignition Systems and Components, Z21.20

Gas Appliance Thermostats, Z21.23

Automatic Intermittent Pilot Ignition Systems for Field Installation, Z21.71

Installation

Domestic Gas Conversion Burners, Z21.8

List Of Z83 Series Of American National Standards

Gas-Fired Infrared Heaters, Z83.6

Gas-Fired Unvented Commercial and Industrial Heaters, Z83.16

Direct Gas-Fired Industrial Air Heaters, Z83.18

List Of Lc Series Of American National Standards For Gas Equipment

Direct Gas-Fired Circulating Heaters for Agricultural Animal Confinement Buildings, LC2

Appliance Stands and Drain Pans, LC 3

List Of CSA/CGA Series Of Canadian Gas Association Standards/national Standards Of Canada For Gas Appliances And Gas Appliance Accessories

Appliances

Domestic Gas Ranges, CAN1-1.1-M81

Domestic Hot Plates and Laundry Stoves, CGA 1.3

Refrigerators Using Gas Fuel, CGA 1.4

Propane-Fired Cooking Appliances for Recreational Vehicles, CAN1-1.16

Gas-Fired Unvented Construction Heaters (Unattended Type), CGA 2.14

Gas-Fired Domestic Lighting Appliances, CAN1-2.15

Gas-Fired Appliances for Use at High Altitudes, CGA 2.17

Gas-Fired Appliances for Outdoor Installation, CAN1-2.21

Gas-Fired Steam and Hot Water Boilers, CGA 4.9

Gas-Fired Waterless Toilet, CGA 5.2

Portable Type Gas Camp Refrigerators, CAN1-11.4

Accessories

Lever Operated Pressure Lubricated Plug Type Gas Shut-Off Valves, CGA 3.11

Lever Operated Non-Lubricated Gas Shut-Off Valves, CGA 3.16

Draft Hoods, CAN1-6.2

Automatic Gas Ignition Systems and Components, CAN1-6.4

Gas Appliance Thermostats, CAN1-6.6

Internal Relieved Service Regulators for Natural Gas, CGA 6.18

Residential Carbon Monoxide Detectors, CAN/CGA-6.19

Elastomeric Composite Hose and Hose Couplings for Conducting Propane and Natural Gas, CAN/CGA-8.1

Thermoplastic Hose and Hose Couplings for Conducting Propane and Natural Gas, CAN1-8.3

Manually Operated Shut-Off Valves for Gas Piping Systems, CGA 9.2

Installation

Definitions and General Field Recommendations, CGA 3.0

Natural Gas and Propane Installation Code, CGA B149.1

Code for Digester Gas and Landfill Installations, CAN/CGA-B105

Code for the Field Approval of Fuel-Related Components on Appliances and Equipment, CAN/CGA-B149.3

Performance

Testing Method for Measuring Annual Fuel Utilization Efficiencies of Residential Furnaces and Boilers, CGA P.2

Testing Method for Measuring Energy Consumption and Determining Efficiencies of Gas-Fired Water Heaters, CAN/CSA-P.3

Testing Method for Measuring Per-Cycle Energy Consumption and Energy Factor of Domestic Gas Clothes Dryers, CGA P.5

Testing Method for Measuring Thermal and Operating Efficiencies of Gas-Fired Pool Heaters, CGA P.6

Testing Method for Measuring Energy Loss of Gas-Fired Instantaneous Water Heaters, CAN/CSA-P.7

Thermal Efficiencies of Industrial and Commercial Gas-Fired Package Furnaces, CGA P.8

List Of Canadian Gas Association Commercial/Industrial Standards

Gas-Fired Infra-Red Heaters, CAN1-2.16

Gas-Fired Appliances for Use at High Altitudes, CGA 2.17

Gas-Fired Brooders, CAN1-2.20

Gas-Fired Portable Infra-Red Heaters, CAN1-2.23

Decorative Gas Appliances for Installation in Solid Fuel Burning Fireplaces, CGA-2.26

Industrial and Commercial Gas-Fired Package Boilers, CAN1-3.1

Industrial and Commercial Gas-Fired Package Furnaces, CGA 3.2

Industrial and Commercial Gas-Designed Atmospherical-Fired Vertical Flue Boilers and Hot Water Supply Heaters, CGA 3.3

Industrial and Commercial Gas-Fired Conversion Burners, CGA 3.4

Gas-Fired Equipment for Drying Farm Crops, CAN/CGA-3.8

Direct Gas-Fired Door Air Heaters, CAN1-3.12

Internal Relieved Service Regulators for Natural Gas, CGA 6.18

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