

**ANSI Z21.78-2010**  
**CSA 6.20-2010**

American National Standard/  
CSA Standard For  
**Combination Gas Controls**  
**For Gas Appliances**

AMERICAN NATIONAL STANDARD  
ANSI Z21.78-2010

CSA STANDARD  
CSA 6.20-2010

Fourth Edition - 2010  
This Standard is based on the Standard for  
Combination Gas Controls For Gas Appliances

ANSI Z21.78-2005 • CSA 6.20-2005  
and Addenda Z21.78a-2007 • CSA 6.20a-2007,  
Z21.78b-2008 • CSA 6.20b-2008

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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 a combination gas control for gas appliances. It is the result of years of experience in the manufacture, testing, installation, maintenance, inspection and research on combination gas controls for gas appliances 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 combination gas controls, 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 Canadian Standards Association, 5060 Spectrum Way, Suite 100; Mississauga, Ontario, Canada L4W 5N6.

Safe and satisfactory operation of a combination gas control for gas appliances 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*; 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 levels. Users are strongly urged to investigate this possibility through appropriate channels. In the event of a conflict with this standard, the Federal, Territorial, Provincial, state or local regulation should be followed.

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

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

# ***History Of The Development Of Standard For Combination Gas Controls For Gas Appliances***

(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.

At its December 11-12, 1990 meeting the Z21 Automatic Valves, Pressure Regulators and Combination Controls for Gas Appliances Subcommittee agreed with the CGA Standards Committee on Accessories for Gas-Fired Equipment to the development of a harmonized standard for combination gas controls, using the second draft of the proposed American National Standard for Combination Gas Controls for Gas Appliances. Subsequently, a proposed harmonized standard was distributed for industry review in Canada in April 1992.

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.

Following reconsideration of the proposed harmonized draft standard for combination gas controls, in light of comments received, the joint automatic gas controls subcommittee, by letter ballot dated October 24, 1994, adopted the proposed harmonized standard for combinations gas controls and recommended the proposed harmonized standard to the Z21 Committee and the CGA Standards Steering Committee for approval.

Following procedures, the Z21 Committee, at its April 6, 1995 meeting, adopted the proposed harmonized standard for combination gas controls for gas appliances. The CGA Standards Steering Committee adopted the proposed harmonized standard for combination gas controls for gas appliances by a letter ballot dated May 19, 1995.

The first edition of the harmonized Z21/CGA Standard for Combination Controls for Gas Appliances was approved as American National Standard by the American National Standards Institute, Inc. (ANSI), on July 15, 1996. The Interprovincial Gas Advisory Council (IGAC) approved the proposed harmonized standard by a letter ballot dated January 17, 1997.

The second edition of the Z21/CSA Standard for Combination Controls for Gas Appliances was approved by the IGAC on August 22, 2000 and by ANSI, on September 27, 2000.

The third edition of Z21/CSA Standard for Combination Controls for Gas Appliances was approved by the IGAC on April 1, 2005 and by ANSI on March 9, 2005.

This the fourth edition of the Standard was approved by the IGAC on September 27, 2010, and by ANSI on August 30, 2010.

The previous edition of the combination controls for gas appliances standard, and addenda thereto, approved by ANSI and the IGAC are as follows:

Z21.78-1997 • CGA 6.20-M97  
Z21.78a-1998 • CGA 6.20a-M98  
Z21.78b-1999 • CGA 6.20b-M99

Z21.78-2000 • CSA 6.20-2000  
Z21.78a-2001 • CSA 6.20a-2001  
Z21.78b-2004 • CSA 6.20b-2004

Z21.78-2005 • CSA 6.20-2005  
Z21.78a-2007 • CSA 6.20a-2007  
Z21.78b-2008 • CSA 6.20b-2008

The following identifies the designation and year of this standard:

ANSI Z21.78-2010 • CSA 6.20-2010

**Note:** *This edition of Z21.78-2010 • CSA 6.20-2010, incorporates changes to the 2005 edition and addenda thereto. Changes, other than editorial, are denoted by a vertical line in the margin.*

.....

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(January, 2011)

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### Note:

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

# ***American National Standard/CSA Standard For Combination Gas Controls For Gas Appliances***

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

### **1.1 Scope**

#### **1.1.1**

This standard applies to newly produced combination gas controls (see Definitions, Part IV), hereinafter referred to as controls, constructed entirely of new, unused parts and materials.

#### **1.1.2**

The combination control may include other functions such as pilot gas filters, pressure switches, etc., which shall be of an approved type (see Definitions, Part IV), or shall be investigated as an integral part of the combination control for construction and performance equivalent to an approved type.

A control which incorporates two or more automatic valves and no other function, (as defined by combination control, see Definitions, Part IV), may be tested to this *Standard or Automatic Valves for Gas Appliances, Z21.21* • CSA 6.5, at the discretion of the manufacturer.

#### **1.1.3**

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

#### **1.1.4**

This standard applies to combination controls having a maximum operating gas pressure of  $\frac{1}{2}$  psi (3.5 kPa) with one or more of the following fuel gases: natural, manufactured, mixed, liquefied petroleum and liquefied petroleum gas-air mixtures.

#### **1.1.5**

This standard applies to combination controls which are capable of operation in ambient temperatures of 32°F (0°C) to 125°F (51.5°C), unless a higher temperature, lower temperature or both, are specified by the manufacturer.

#### **1.1.6**

Exhibit A, Items Unique to the United States, contains items unique to the United States.

#### **1.1.7**

Exhibit B, Items Unique to Canada, contains items unique to Canada.

#### **1.1.8**

Exhibit C, List of Reference Standards, specifically referenced in this standard, and sources from which these reference standards may be obtained.

### **1.1.9**

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.

### **1.1.10**

All references to psi through this standard are to be considered gauge pressure unless otherwise specified.

## **1.2 General**

### **1.2.1**

Construction shall be in accordance with reasonable concepts of safety, substantiality and durability. 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.

### **1.2.2**

Any automatic operating mechanism of the combination control susceptible to mechanical damage which could result in faulty or unsafe operation, shall be protected so as to prevent interference with the safe operation of the combination control.

### **1.2.3**

Parts of combination controls coming in contact with a diaphragm shall not have sharp edges which might chafe or abrade it.

### **1.2.4**

If a control can be partially or completely disassembled without the use of special tools, construction shall be such that either:

- a. The parts of the control cannot be readily reassembled improperly in a manner which could result in an unsafe condition; or
- b. The standard fasteners are covered with a sealing means to discourage disassembly. The sealing means shall be suitable for exposure to the minimum and maximum ambient temperatures specified for the control.

This provision does not apply to parts of a control intended for field replacement or servicing (see 1.10-m).

### **1.2.5**

A combination control that requires an external manual force to effect operation shall not exhibit impairment to proper operation in the event the user does not follow the manufacturer's specified sequence of operation to effect passage of gas to the burner(s).

### **1.2.6**

The design of the combination control intended for use with a continuous ignition source shall be such that main burner gas flow cannot occur while the pilot is being lit.

### **1.2.7**

When a metallic flexible diaphragm constitutes the only gas seal, the atmospheric side of the diaphragm shall be protected to prevent accidental damage to the diaphragm.

### 1.2.8

Where a flexible nonmetallic diaphragm constitutes the only gas seal, the atmospheric side of the diaphragm shall be enclosed to limit the leakage to atmosphere in the event of diaphragm rupture, or shall be provided with means for venting the gas in the event of diaphragm rupture.

## 1.3 Specific Functions

The combination control shall comply with the following requirements as appropriate, for each of the functions noted below which it incorporates.

### 1.3.1

Manual Valve.

- a. The diameters of the tapered plug cavity in a plug type valve finished by lapping, shall correspond to those of the plug which it contains, as follows:
  1. The smallest diameter shall be at least 0.003 in (0.076 mm) larger than the smallest diameter of the taper on the plug for a minimum distance of 0.047 in (1.19 mm).
  2. The largest diameter shall be at least 0.003 in (0.076 mm) larger than the largest diameter of the taper on the plug.
- b. A manual valve shall be provided with a means, other than gravity, to maintain a continuous seating force to compensate for manufacturing tolerances, operational variations, or displacement of lubricant(s).
- c. A manual valve shall have stops to limit the extremes of movement of the movable member.
- d. A latching type valve shall be positive in its actions, shall permit ready operation with one hand and shall necessitate not less than two actions to turn on.
- e. A valve having an intermediate "OFF" position between two "ON" positions shall be so constructed that it will become latched in the "OFF" position.

### 1.3.2

Main Gas Electrical Shutoff Switch

- a. An electrical switch provided to turn on or shutoff the gas supply to the main burner(s) shall be positive in its action and shall permit ready operation with one hand.
- b. The switch shall have only two positions one "ON" and one "OFF" without any intermediate positions.
- c. If the switch actuating member is made of a conductive material, it shall be insulated from live parts.
- d. The switch shall be an integral part of the control and shall be constructed such that it has adequate mechanical strength (See 2.15.3).
- e. External load connections shall be limited to resistive loads.
- f. Shall interrupt the ungrounded leg of the electrical power to both valves.

### 1.3.3

#### Automatic Gas Ignition Components.

A combination control providing outlets for more than one pilot shall be constructed so that the connections are such that the gas tubing for the pilots cannot be interchanged.

### 1.3.4

#### Thermostat.

- a. When means are provided for the user to vary the temperature setting, such means shall clearly indicate the direction of movement to increase or decrease the temperature and the minimum and maximum operating positions. One of the dial graduations shall be located at the calibration reference point.
- b. For combination controls provided with dials for use on ovens and broilers, the dials shall be marked with successively numbered temperatures not more than 50°F (28°C) apart. Above 200°F (93.5°C), graduations shall be provided at least every 25°F (14°C).
- c. On combination controls incorporating adjustable type thermostats, the calibration reference points shall be specified by the manufacturer.
- d. Combination controls for use on water heaters shall have a detent or legible marking consistent with a temperature of approximately 120°F (49°C).
- e. Bypass rate adjustments shall be independent of pilot rate adjustments.

### 1.3.5

#### Automatic Valve.

- a. Where a flexible nonmetallic diaphragm constitutes the only gas seal and utilizes control gas to operate the diaphragm, the diaphragm shall be enclosed in a gas tight casing with means provided for bleeding the control gas.
- b. Normally closed electrically operated valves shall remain in, or assume, the closed position upon zero current flow. Normally closed gas operated valves shall remain in, or assume the closed position upon complete loss of pressure (zero psi).
- c. Means for holding electrically operated valves in an open position during power failure shall not be provided.

### 1.3.6

#### Pressure Regulators.

- a. The orifice of a vent limiter shall be protected from foreign particles.
- b. 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.
- c. 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 seal cap assembly.

- d. 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 adjustment means of spring-type regulators shall be concealed.

### 1.3.7

#### Automatic Gas Shutoff Devices.

- a. The automatic gas shutoff device shall have no means for field adjustment of the temperature setting.
- b. An automatic gas shutoff device designed to be part of an electrical system shall be of the manual reset type or the single-use type.
- c. A device with electrical contacts shall shutoff gas only by opening the contacts.

## 1.4 Data Furnished By Manufacturer

The manufacturer shall furnish the following as appropriate, for use by the testing agency in examining combination controls under this standard:

- a. Drawings, blueprints, or photographs that describe each model, as specified by the testing agency.
- b. Manufacturer's specified minimum inlet test pressure of the regulator.
- c. Outlet pressure adjustment range, related inlet pressure [in inch increments not to exceed  $\frac{1}{2}$  psi (3.5 kPa)] and the flow rate for adjustable regulators.
- d. Outlet pressure, related inlet pressure [in inch increments not to exceed  $\frac{1}{2}$  psi (3.5 kPa)] and the flow rate for non-adjustable regulators.
- e. Outlet pressure, related inlet pressure [in inch increments not to exceed  $\frac{1}{2}$  psi (3.5 kPa)] and the flow rate for each setting of a convertible regulator.
- f. Mounting classification (see 2.1.1).
- g. Ambient temperature range in which the control is intended to operate, and element ambient temperature limit.
- h. Gases with which each vent limiter is to be used.
- i. Capacity of the control. A graph of pressure drop vs flow rate showing the pressure drop capacity at 1 in wc (249 Pa) or other pressure drop specified by the manufacturer. (Not applicable if the combination control incorporates a negative pressure regulator.)
- j. Range of regulation capacity for main burner load application only.
- k. Regulation capacity and maximum individual load capacity for main burner and pilot burner load application, and whether for  $\textcircled{P}$  or  $\nabla$  application (see Part IV, Definitions).
- l. Range of regulation capacity for pilot burner application only.
- m. Range of variable load capacity for controls incorporating regulators for use on domestic gas ranges (see 2.9.6).

- n. The rated current(s) at rated voltage.
- o. The minimum and maximum pull-in and drop-out current as applicable of the thermoelectric device.
- p. The manufacturer's specified maximum timings where applicable:
  - 1. Flame-establishing period.
  - 2. Flame failure response time.
- q. The fuel gases for which it is intended.
- r. Thermostat operating temperature range and thermostat calibration reference points.
- s. Supporting documentation relative to the suitability of materials (see [1.9, Materials](#)).
- t. A description of the operating principle.
- u. Shutoff and reset temperature of the automatic gas shutoff device.
- v. Maximum cycling rate(s) for continued operation testing.
- w. For a regulator of a combination control with more than one main burner gas outlet the data required per "-j" and "-k" above shall be provided for each outlet (see [2.1.7](#)). The highest manufacturer's specified regulation capacity for any one of the outlets shall be considered as the limiting value for the regulator as a whole.
- x. Whether intended for use on food service equipment ".
- y. The manufacturer's specified minimum and maximum vacuum pressure when a negative pressure regulator is incorporated.
- z. Minimum and maximum electric resistance of the automatic gas shutoff device.
- aa. The rated current and rated voltage of the automatic gas shutoff device.

## 1.5 Connections

### 1.5.1

When threaded for connection to piping, the inlet, outlet, pilot, or other connections shall have taper pipe threads conforming to the *Standard for Pipe Threads, General Purpose (Inch)*, ANSI/ASME B1.20.1, except as allowed in [1.5.4](#). Threads for connection to a tank or fitting shall comply with ANSI/ASME B1.20.1.

### 1.5.2

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 the *Standard for Automotive Tube Fittings*, ANSI/SAE J512, or the *Standard for Hydraulic Tube Fittings*, SAE J514, as applicable.

### 1.5.3

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

- a. A tapping sealed by a minimum  $\frac{1}{8}$  in NPT plug or cap with cleanly cut taper pipe threads in accordance with the *Standard for Pipe Threads, General Purpose (Inch)*, ANSI/ASME B1.20.1. If the plug is of the slotted type, it shall also incorporate square or hex flats; or
- 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 that 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.

#### **1.5.4**

Pipe thread length and length to shoulder dimensions shall be as shown in Table I-A, Minimum Thread Length and Length to Shoulder, or I-B, Minimum Distance From Inlet to Any Shoulder at End of Thread For Combination Controls Used on Cooking Equipment, as applicable.

#### **1.5.5**

A combination control equipped with pipe or tubing threads shall be designed to accept a wrench or special tool provided by the manufacturer for use in assembly and disassembly to piping.

#### **1.5.6**

Vent connections of combination controls not incorporating integral vent limiters shall be substantially bossed and tapped for a connection not less than  $\frac{1}{8}$  in 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.

#### **1.5.7**

Inlet and outlet gas connections shall be designed so that when a pipe which is threaded two threads beyond standard size (for the size in question) is run into the threaded portion of a valve body, it will not adversely affect the operation of the valve.

### **1.6 Threaded Fasteners**

Bolts, nuts, screws and other threaded parts intended to be removable shall have threads conforming to the *Standard for Unified Inch Screw Threads, (UN and UNR Thread Form)*, ANSI B1.1.

### **1.7 Adjustments**

#### **1.7.1**

Convenient means shall be provided for the purpose of making any necessary adjustments.

#### **1.7.2**

Suitable means for maintaining all adjustments shall be provided. Lock nuts or adjusting nuts held by springs or compression will be considered satisfactory except where their adjustment can be accidentally disturbed.

#### **1.7.3**

Field adjustments shall be capped or otherwise protected in such a manner as to resist tampering or accidental change in adjustment. A thermostat which by its design is intended for concealed installation shall be considered as complying with this provision.

### 1.7.4

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.

### 1.7.5

No means shall be provided for field adjustment of ignition timings.

## 1.8 Electrical

(Refer to either Exhibit A, Items Unique to the United States, or Exhibit B, Items Unique to Canada, as applicable.)

## 1.9 Materials

### 1.9.1

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.

### 1.9.2

For a control containing part(s) intended for contact with potable water, the manufacturer shall supply evidence satisfactory to the testing agency that material used as a protective coating for thermal sensing element tubes is suitable for the service, particularly with respect to toxicity, solubility, brittleness and temperature limits. Evidence of current certification under National Sanitation Foundation *Standard Plastic Piping System Components and Related Materials*, ANSI/NSF 14, with appropriate end use shall be deemed acceptable.

### 1.9.3

Materials, or coatings of materials provided with protective coatings, for automatic mechanisms and current-carrying components exposed to fuel gases shall be resistant to moisture, sulfur compounds, corrosion and the effects of such gases. Parts containing in excess of 65 percent copper exposed to fuel gas, other than cast or forged bodies, shall be protected from the effects of sulfur-bearing compounds.

### 1.9.4

Control bodies, casings, vent limiters, regulator adjustment sealing means and other parts intended to maintain gas tightness to the atmosphere when the gas controlling devices of the combination control are in either the open or closed position shall be made of material having a melting point of not less than 800°F (427°C). Shaft seals, gaskets, and lubricants shall be exempt from this provision. This provision is not intended to address materials used to provide gas tightness through the control to the control outlet. Such materials are to be evaluated for their intended usage (see 1.9.1).

## 1.10 Instructions

The manufacturer shall provide printed instructions and diagrams adequate for the proper installation and operation of the combination control. Included in these instructions, as applicable, shall be:

- a. Diagrams to illustrate the specified mounting position(s).

- b. Method of adjusting the regulator pressure setting.
- c. Method of converting the convertible regulator.
- d. Method of adjusting multistage controls.
- e. Method of venting the regulator.
- f. Applicable timings.
- g. Maximum and minimum ambient temperatures in which the control is intended to operate.
- h. The type(s) of fuel gas for which the combination control is intended.
- i. Type of ignition source.
- j. Electrical ratings.
- k. Electrical diagrams indicating the external connections necessary for the control's intended application(s).
- l. Method of making electrical and mechanical connections.
- m. Information identifying parts intended for field servicing and procedures for servicing or replacing such parts.
- n. The following statement:

"WARNING

This is a NEGATIVE PRESSURE REGULATED gas control. Replace ONLY with the same model number. Carbon monoxide poisoning, fire or explosion could result from improper control replacement."

The minimum print size shall be 7.5 point for the words appearing in all capitol letters and 6 point for all other words.

## **1.11 Markings**

### **1.11.1**

Controls shall be marked, as applicable, to indicate the following:

- a. Name, trademark, or symbol of the manufacturer or listee.
- b. Model designation or other positive means for identification.
- c. Except for thermoelectric devices: voltage, current and, frequency ratings.
- d. Symbol of the organization making the tests for compliance with the standard.
- e. A separate marking indicating the date of manufacture. This marking shall as specified in "-1," "-2" or "-3" below:

1. The date in the form of
  - (a) The month, day and year; or
  - (b) 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; or

2. A four digit date code consisting of:

- (a) The first and second digits indicating the calendar year in which the component was manufactured (e.g., 10 for 2010).
- (b) The third and fourth digits indicating the week in which the component 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 code. If additional numbers are used, they shall be separated from the four digit code.

3. A five digit code consisting of:

- (a) The first and second digits indicating the calendar year in which the combination gas control was manufactured (e.g., 10 for 2010); and
- (b) The third, fourth and fifth digits indicating the day of the year in which the component was manufactured (e.g., 183 for the one hundred and eighty third day in the year 2010, which is July 2, 2010).

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.

- f. Outlet pressure setting for a nonadjustable or factory set adjustable regulator or outlet pressure adjustment range. If this marking is not adjacent to the pressure adjustment means of an adjustable regulator, the means shall bear an identifying marking which may be abbreviated.
- g. Maximum operating pressure of  $\frac{1}{2}$  psi (3.5 kPa).
- h. The outlet pressure and fuel gas for each position of a convertible regulator. Abbreviations for the type of gas may be used, but must be visible during the act of conversion.
- i. When the range of regulation capacity includes pilot flow, the appropriate symbol,  $\textcircled{P}$  or  $\nabla$  shall appear adjacent to the model number. This marking cannot be used on multistage regulators.
- j. Direction of gas flow.
- k. Separable vent limiters shall be suitably identified.

- l. Regulators not incorporating an integral vent limiter shall be marked "vent" adjacent to the vent opening.
- m. A combination control for use on food service equipment which includes a manual valve shall bear a legible permanent marking " " with the letter "C" not less than  $\frac{3}{32}$  in (2.4 mm) high.
- n. The shut-off temperature or temperature code and corresponding identification number for an automatic gas shutoff device.
- o. Identification of any pressure taps, and pilot adjustment means provided on the control. These markings may be abbreviated.
- p. The following statement:

**"WARNING**

This is a NEGATIVE PRESSURE REGULATED gas control. Replace ONLY with the same model number. Carbon monoxide poisoning, fire or explosion could result from improper control replacement."

The minimum print size shall be 7.5 point for the words appearing in all capitol letters and 6 point for all other words.

- q. When a main gas electrical shutoff switch has provisions for external load connections, the voltage, current and, frequency ratings of the external load.

### **1.11.2**

Markings which identify the knob, lever, etc. positions necessary for the user to make the appliance operational or shut the appliance down shall comply with the following:

- a. The following words shall be incorporated, as applicable: "ON," "OFF," "PILOT," "IGN" or "IGNITION," "SET," "RESET," and shall be in a color which contrasts from the background.

These markings shall use uppercase letters and shall be boldfaced type having a minimum letter height of 0.10 in (2.54 mm).\*

- b. To facilitate proper setting of the operating position(s), the control shall either:
  - 1. Incorporate by its design an obvious pointer; or
  - 2. Have a setting position indicator which contrasts in color from its background.

### **1.11.3**

The markings on the combination control provided for the user to adjust temperature shall be in a color which contrasts from the background. The characters shall be boldfaced type having a minimum height of 0.080 in (2.03 mm).\*\* The indicator noting the point for setting the temperature shall also be of a color contrasting from its background or shall be incorporated into the design of the control so as to be obvious to the user.

\* This letter height corresponds to 10 point type.

\*\* This letter height corresponds to 8 point type.



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

### **2.1 General**

#### **2.1.1**

Mounting Position(s). The manufacturer shall specify one or more of the following mounting classifications (see 1.4-f):

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 (1.56 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 tests specified herein shall be conducted with the control mounted in the manufacturer's specified upright position, unless otherwise specified.

#### **2.1.2**

Unless otherwise specified, the tests herein shall be conducted at ambient temperatures of 32° and 125°F (0°C and 51.5°C) unless either higher, lower, or both higher and lower temperatures are specified by the manufacturer. Where room temperature is specified, the tests shall be conducted at a temperature of 77 ± 10°F (25 ± 5.5°C).

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

#### **2.1.3**

For controls which use a single valve seat to perform more than one function, the continued operation test for each of these functions shall be conducted on the same unit.

#### **2.1.4**

Unless otherwise specified, each performance test shall be conducted on one sample of the combination control.

#### **2.1.5**

There shall be no evidence of chattering or objectionable noise during tests.

#### **2.1.6**

Electrical contacts shall be tested at the manufacturer's specified electrical ratings, unless otherwise specified.

#### **2.1.7**

The pressure regulator of a combination control with more than one main burner gas outlet shall be tested under 2.3, Strength and Deformation, and 2.9.1 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 1.4-w).

## 2.2 Test Gases And Pressures

### 2.2.1

Fuel gas(es), air or nitrogen may be used for the tests unless otherwise specified. Where the use of a fuel gas(es) is specified for conduct of a test(s), propane gas shall be used for those tests conducted at temperatures of 32°F (0°C) and above and natural gas shall be used for those tests conducted at temperatures below 32°F (0°C). When conducting tests which specify the use of a fuel gas(es), a gas with the characteristics approximately as specified in the test shall be used.

### 2.2.2

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

### 2.2.3

Inlet test pressures shall be as specified in Table XII, Inlet Test Pressure.

### 2.2.4

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

### 2.2.5

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 2, Typical Arrangement of Test Apparatus for Combination Control with Negative Pressure Regulator, Section A).

The maximum and minimum vacuum test pressures shall be those specified by the manufacturer (see 1.4-y).

## 2.3 Strength And Deformation

### 2.3.1

Bending Moment.

A control shall be capable of operation without cracking, breaking, or leaking while being subjected to a bending moment using the weight specified in Table IV, Load for Bending Moment Test, in accordance with the following Method of Test.

### Method of Test

This test shall be conducted at room temperature. A new sample shall be subjected to the specified test.

- a. The inlet and outlet connections shall be assembled leaktight to the appropriate fittings as described below. The length of the inlet fitting shall be such that, after assembly the dimension from the control inlet to the end of the inlet fitting will be 13 in ± 1/2 in (330 mm ± 12.7 mm). The tightening torque for threaded pipe or tubing connections shall be one-half that shown in Table V, Torques for Turning Effort Test.

1. Pipe threaded connections shall be assembled to Schedule 40 iron pipe, or pipe fitting, using non-Teflon type pipe joint compound.
  2. Tubing connections shall be assembled to steel tubing conforming to the *Standard for Welded and Cold Drawn Low Carbon Steel Tubing Annealed for Bending and Flaring, SAE J525*, which has a minimum wall thickness of 0.028 in (0.711 mm), using the attachment means specified by the manufacturer.
  3. Connections designed for other than threaded pipe or tubing shall be assembled to test fixture(s) representative of the intended connection means.
- b. The outlet fitting shall be rigidly supported 1 in (25.4 mm) from the control outlet, unless the following exceptions apply. When the control has an integral mounting means independent of the inlet and outlet connections, it shall be mounted using the integral mounting means as specified by the manufacturer. When the control is intended to be mounted by either the integral mounting means or the outlet, the mounting means which produces the most severe test condition shall be used. The control inlet shall be in the horizontal position.
  - c. The control shall be tested for leakage as specified in 2.4.1 and 2.4.2 except at room temperature and shall comply.
  - d. With all valves in the off position, the system shall be pressurized at 21 in wc (5.23 kPa) and the appropriate weight as specified in Table IV, Load for Bending Moment Test, shall then be suspended on the inlet fitting, without shock, 12 in (305 mm) from the inlet of the control for 15 minutes. Without removing the weight, the control shall then be tested for leakage as specified in 2.4.1 and 2.4.2, except at room temperature and a pressure of 21 in wc (5.23 kPa).
  - e. The test in “-d” shall be repeated three times with the control being rotated 90 degrees (1.57 rad) around the horizontal inlet axis between each test. If the application of any bending moment is in a direction which would tend to rotate the control with respect to the outlet, that bending moment need not be applied. Between tests, a manual valve, if provided, shall be cycled on and off three times with the weight removed.

At the completion of the above tests, the weight shall be removed and the control then subjected to the leakage test as specified in 2.4.1 and 2.4.2 except at room temperature. The control shall then be removed and examined for deformation and breakage.

### 2.3.2

#### Turning Effort.

The control shall be capable of withstanding without deformation, breakage or leakage, stresses resulting from installation. If a flange connection(s) that is not supplied as an integral part of the control is provided to install the control, the specified turning effort shall be applied to the flange(s) and the control shall be exempt from this test.

## Method of Test

This test shall be conducted at room temperature. A new sample shall be subjected to this test. If the control includes a thermostat function, it shall be calibrated at its calibration reference point only as specified in 2.13.1 (see 1.3.4-c), prior to conducting this test.

The tests in “-a” through “-d” apply to the gas connections of the control. The test in “-e” applies to a control with a threaded mounting means which is not a gas connection.

- a. A control with both the inlet and outlet threaded for connection to iron pipe with standard taper pipe threads shall be subjected to the following test.
  1. A length of new, clean and properly threaded Schedule 40 iron pipe or pipe fitting, as applicable, lubricated with SAE 10 viscosity machine oil applied to the pipe threads, shall be threaded to the inlet of the closed control with the turning effort specified in Table V, Torques for Turning Effort Test, by gripping the wrench flats on the valve or any suitable area of the control, if wrench flats are not provided. If wrench flats are provided on both ends of the control, the inlet end wrench flats shall be used. If wrench flats are not provided, a special tool provided by the control manufacturer may be used for this test. With all valves in the off position, the turning effort shall be applied for 15 minutes and then released.
  2. The procedure outlined in “-a1” shall be repeated for the outlet of the control using the outlet wrench flats, if provided.
  3. The control, with the inlet and outlet pipes in place, shall be tested for leakage as specified in [2.4.1](#) and [2.4.2](#) at room temperature and shall comply. The inlet and outlet pipes shall then be removed and the control examined for deformation and breakage.
- b. A control with both the inlet and outlet designed for connection to tubing shall be subjected to the following test.
  1. A length of the proper size of aluminum tubing with the end squared and deburred shall be assembled to the inlet end of the closed control with the turning effort specified in Table V, Torque for Turning Effort Test, using the attachment means specified by the manufacturer.

When applying the turning effort, the control shall be rigidly supported by the wrench flats or any suitable area on the combination control, if wrench flats are not provided. If wrench flats are provided on both ends of the control, the inlet end wrench flats shall be used. With all valves in the off position, the turning effort shall be applied to the tubing fitting for 15 minutes and then released.
  2. The procedure outlined in “-b1” shall be repeated for the outlet of the control using the outlet wrench flats, if provided.
  3. The control, with the inlet and outlet tubing in place, shall be tested for leakage as specified in [2.4.1](#) and [2.4.2](#) repeat room temperature and shall comply. The inlet and outlet tubing shall then be removed and the control examined for deformation and breakage.
- c. For a control having only one threaded connection for iron pipe, the pipe thread end shall be tested as in “-a” above, as appropriate.
- d. For a control having only one tubing connection, the tubing connection shall be tested as in “-b” above, as appropriate.
- e. The mounting means of the control shall be threaded to an appropriately sized, threaded fitting. SAE 10 viscosity machine oil shall be applied to the threads and the controls shall be threaded to the test fitting with the turning effort specified in Table V, Torque for Turning Effort Test. The turning effort shall be applied by gripping the wrench flats on the control or by use of a special tool provided by the control manufacturer. The turning effort shall be applied for 15 minutes and then released. The control shall then be subjected to the applicable leakage tests specified in [2.4, Leakage](#), at room temperature and shall comply. The mounting means shall then be removed from the test fitting and the control examined for deformation and breakage.

If the control includes a thermostat function, the accuracy of temperature set point test shall be repeated at the calibration reference point only. Any change in calibration shall not exceed  $\pm 5^{\circ}\text{F}$  ( $\pm 3^{\circ}\text{C}$ ) or 2.5 percent of the temperature adjustment range, whichever is greater. For a refrigerator thermostat, any calibration change shall not exceed  $\pm 2.5^{\circ}\text{F}$  ( $\pm 1.5^{\circ}\text{C}$ ).

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

## 2.4 Leakage

### 2.4.1

#### External Gas Leakage.

Combination controls when tested with air at the leakage test pressure specified below shall not leak externally at a rate in excess of 200 cc/hr at standard conditions (see 2.2.4).

### Method of Test

This test shall be conducted at both the manufacturer's specified minimum and maximum ambient temperatures and at an inlet test pressure of 21 in wc (5.23 kPa). Any bypass or other openings to the atmosphere not essential to the operation of the control during this test shall be sealed. If a manual valve is incorporated in the control, this test shall be conducted with the manual valve in the "ON" position, the "OFF" position and when applicable, the "pilot" position. All other valves in the control shall be in their normal open position. (See Table VI, Test Conditions for External Gas Leakage, for a list of tests.)

The inlet(s) and outlet(s) of the control shall be connected to a pneumatic system capable of supplying clean dry air at the specified leakage test pressures. Air shall be admitted slowly and maintained at 21 in wc (5.23 kPa) test pressure. Leakage, shall be determined by a flow measuring device, capable of accurately indicating the allowable leakage, located between the air supply and the inlet of the control.

### 2.4.2

#### Internal Gas Leakage.

Leakage of air through the control when any one valve is in the closed position, assumed as a result of normal operation, shall not exceed the following, as applicable:

- a. For valves other than thermostatic valves (see Part IV, Definitions), leakage shall not exceed (1) 235 cc/hr at standard conditions (see 2.2.4) for all manual valves and for other valves having a seal-off diameter of 1 in (25.4 mm) or less, or (2) 235 cc/hr/in of seal-off diameter at standard conditions (see 2.2.4) for valves other than manual valves having a seal-off diameter greater than 1 in (25.4 mm).
- b. For thermostatic valves, leakage shall not exceed the applicable value shown in Table VII, Allowable Valve Seat Leakage for Thermostatic Valves.

### Method of Test

This test shall be conducted at both the manufacturer's specified minimum and maximum ambient temperature at leakage test pressures of 2 in wc (498 Pa) and 21 in wc (5.23 kPa).

When a bypass is incorporated as a part of the control and designed so that bypass gas is discharged into the main gas supply before the outlet of the control, the bypass shall be sealed.

The inlet of the control shall be connected to a pneumatic system capable of supplying clean dry air at the specified range of leakage test pressures. An airtight connection shall be made to each gas outlet, terminating in a flow measuring device capable of accurately indicating flow rates equal to the maximum allowable leakage.

Each operating valve in the control shall be individually tested for leakage past the seat. All valves in the control shall be in their normal open position except the valve to be tested which shall be in the closed position assumed as the result of a few cycles of normal operation. If a manual valve is incorporated in a control, the manual valve shall be in the "ON" position for all other valves tested. The manual valve shall also be tested for internal leakage when the manual valve is in the "OFF" position and all other valves are in their normal open positions. In the "OFF" position, leakage shall be measured at both the pilot gas outlet and the main gas outlet. When the manual valve has a "pilot" position, leakage in this position shall also be tested at the main gas outlet with all other valves in their normal open position.

A test pressure of 2 in wc (498 Pa) shall be applied to the control inlet for a period of 1 minute. During this time, leakage through the valve under test shall not exceed the allowable rate at any gas outlet or combination of gas outlets. The test shall be repeated at an inlet test pressure of 21 in wc (5.23 kPa). (See Table VIII, Test Conditions for Internal Gas Leakage, for tabulated tests.)

### **2.4.3**

#### **Manual Valve Shaft Seals.**

The structure surrounding a shaft seal shall be such as to confine the seal properly and, with the seal removed and the valve in any position, to allow, when tested at room temperature, not more than 2.0 ft<sup>3</sup>/hr (15.7 cm<sup>3</sup>/sec) of gas having 0.64 specific gravity at a pressure of 7.0 in wc (1.74 kPa) to leak past the shaft. Seals in such applications (1) may be exposed to gas pressure when the valve is in any position and (2) need not comply with 1.9.4.

### **2.4.4**

#### **Water Leakage into Gas Channels.**

A control for liquid immersion shall show no leakage of water into gas channels or through the mechanism housing when subjected throughout one heating and cooling cycle to a hydrostatic pressure of 300 psi (2.07 MPa) on all surfaces normally exposed to water.

## **Method of Test**

The control shall be installed in the side of a test tank in a manner that will permit the application of hydrostatic pressure to all surfaces normally in contact with water. The tank shall be connected through a manual shutoff water valve to the outlet side of a suitable boiler test pump and shall be equipped so that water contained in the tank may be heated from room temperature to 180°F (82°C) in approximately 1/2 hour. A pressure gauge, graduated in increments of not more than 5 psi (34.5 kPa), and an adjustable pressure relief valve set to relieve at 300 psi (2.07 MPa) shall be connected in the system near the control.

The manual shutoff water valve shall be closed and heating begun. The water temperature shall be increased [the pressure being held constant at 300 psi (2.07 MPa) by means of a relief valve] until a temperature of 180°F (82°C) is attained. The water temperature shall be maintained at this point for a period of 5 minutes and then allowed to cool to 100°F (38°C) or less. Throughout the cooling cycle the above specified hydrostatic pressure shall be maintained by means of the boiler test pump. Following this test, the control shall be examined for evidence of water in the gas channels.

## 2.5 Electrical Characteristics

### 2.5.1

The current input to the control shall not exceed the marked rating by more than 10 percent when the control is operated under conditions of rated voltage and frequency.

#### Method of Test

The current shall be measured at the time equilibrium temperature has been established during the test conducted under 2.10.1.

### 2.5.2

The electrical operator of a control with normally closed automatic valve having terminals or wire leads shall be subjected to an overvoltage for a period of 5 minutes as follows:

|                                        |                    |
|----------------------------------------|--------------------|
| Millivoltage and<br>Low-Voltage Valves | 120 volts          |
| Line Voltage Valves                    | Twice line voltage |

Following this test, the valve shall comply with the provisions of 2.4.1 and 2.4.2 except at room temperature and 21 in wc (5.23 kPa) test pressure.

### 2.5.3

This provision does not apply to millivolt circuits:

A control employing a low-voltage circuit shall be capable of withstanding for 1 minute, without breakdown, the application of a 60 hertz alternating potential of 500 volts applied between uninsulated low-voltage live-metal parts of opposite polarity, between uninsulated low-voltage live-metal parts and the enclosure and grounded dead-metal parts.

#### Method of Test

Upon completion of the continued operation test specified in 2.10.4, a line voltage control shall be capable of withstanding for 1 minute, without breakdown, the application of a 60 hertz alternating potential of 1000 volts, plus twice the maximum rated voltage:

- a. Between uninsulated live-metal parts and
  1. live-metal parts of opposite polarity;
  2. an enclosure;
  3. a grounded dead-metal part; and
  4. an exposed dead-metal part insulated with a barrier or liner.
- b. Between uninsulated live-metal parts of high- and low-voltage circuits and different high-voltage circuits.

This test shall be conducted at room temperature upon completion of the applicable continued operation test specified in 2.10.4.

Dielectric strength tests shall be made with a suitable testing transformer, the output voltage of which can be regulated. Starting at zero, the applied potential shall be raised gradually until the specified test value is reached, and shall be held at that value for 1 minute. There shall be no evidence of electric breakdown during any of these tests.

#### **2.5.4**

For thermoelectric devices, the pull-in current, as applicable, and the dropout current shall be within the manufacturer's specified values.

### **Method of Test**

A direct current power source of appropriate voltage in series with an ammeter shall be used. Each control shall be tested three times under the following test conditions, as applicable:

a. Pull-In Current.

For automatic pull-in devices the current shall be set at a value below the manufacturer's specified pull-in current. The current shall be slowly increased. The current at which the device pulls in shall not be greater than the manufacturer's specified pull-in current.

b. Drop-Out Current.

The current shall be set at the manufacturer's specified maximum operating current. The resetting mechanism, if provided, shall be operated in accordance with the manufacturer's instructions. The current shall then be slowly decreased. The current at which the valve drops out shall be within the manufacturer's specified maximum and minimum drop-out current.

#### **2.5.5**

Carbon shall not be deposited within thermally actuated valves employing electrical components in the gas way when operated on an easily cracked gas for 48 hours at elevated temperatures.

### **Method of Test**

The control shall be operated in a suitable test oven at the manufacturer's maximum specified operating temperature [but not less than 125°F (51.5°C)] and shall be continuously energized at 110 percent of rated voltage. Pure (99 percent) isobutylene shall be passed through each valve at a rate of approximately 3000 Btu/hr (879 W). After 48 hours of operation, the samples valves shall be removed from the oven, dismantled, and examined for carbon deposit. There shall be no visible carbon deposit within the valve bodies.

#### **2.5.6**

Controls employing electrical components in the gas way, except millivoltage type devices, shall not become damaged or shall not leak after an explosive gas-air mixture is ignited within the control.

### **Method of Test**

A fitting incorporating a means of igniting a gas-air mixture shall be attached to the control at the potential source of ignition. Five feet (1.52 m) of straight piping shall then be attached to the inlet and outlet fittings of the control. A manual valve shall be attached to each end of the straight piping. The control and the two manual valves shall be open. A gas-air test mixture comprised of 20 percent manufactured gas [approximate heating value of 535 Btu/ft<sup>3</sup> (19.9 MJ/m<sup>3</sup>) and specific gravity of 0.38] and 80 percent air (by volume) shall be introduced into the inlet end of the piping system. When a sufficient volume of the test mixture has been introduced to assure a uniform distribution of the test

mixture throughout the piping system, the inlet manual valve shall be closed. The outlet manual valve shall be closed immediately thereafter. The control shall remain open and the gas-air test mixture ignited. After refilling the piping system with the test mixture, the inlet manual valve shall be closed, and immediately thereafter the control shall be closed. The outlet manual valve shall remain open and the gas-air test mixture ignited. Both tests shall be conducted three times.

Following these tests, the control, if operable, shall be cycled five times. Then the control shall comply with the leakage tests specified under 2.4.1 and 2.4.2 except that any normally open valve(s) in the control that is inoperable need not comply with 2.4.2. The leakage tests shall be at room temperature and 21 in wc (5.23 kPa).

## 2.6 Mounting For Test

Typical arrangements of the test apparatus are shown in Figures 1, Typical Arrangement of Test Apparatus, and Figure 2, Typical Arrangement of Test Apparatus for Combination Control with Negative Pressure Regulator.

Schedule 40 iron pipe of proper size, reamed to remove burrs, shall be fitted to the inlet and outlet connections of the control. When a control is provided with semi-rigid tubing connections, fittings and semi-rigid tubing of the proper size, reamed to remove burrs, shall be used instead of Schedule 40 iron 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 "Orifice Metering of Natural Gas" (Gas Measurement Committee Report No. 3, 1969) of the American Gas Association. The length of straight run of pipe between the control 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 securely attached perpendicular to the pipe or semi-rigid tubing, one before the inlet and the others after the outlet connection. The pressure tap before the inlet shall be located five pipe diameters from the discharge end of the inlet pipe or tubing. The pressure taps after the outlet connections shall be located five pipe diameters from the inlet end of the discharge pipe or tubing. A  $\frac{1}{16}$  in (1.59 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 controls to be tested under 2.9.3 and 2.9.6-f, shall be equipped with a pipe tee of suitable size. A pilot flow line consisting of  $\frac{1}{8}$  in (3.18 mm) pipe,  $2\frac{3}{4}$  in (69.9 mm) long, shall be attached to one end of the tee. If a pilot take-off is not provided and the tests specified in 2.9.3 and 2.9.6-g are to be conducted, a pilot flow line also consisting of  $\frac{1}{8}$  in (3.18 mm) pipe,  $2\frac{3}{4}$  in (69.9 mm) long, shall be attached to the side of one of the two pressure taps on the discharge side of the control under test.

The control to be tested shall be placed in the manufacturer's specified upright position. The pressure tap on the inlet side and the pressure taps on the outlet side shall be connected to independent pressure measuring devices and to a differential gauge (one tap being connected to each side), each of which has an accuracy of 1 percent at the observed value. An adjustment control valve of the same pipe size as the control under test, shall be installed not less than the above specified number of pipe or tubing diameters from the control under test. When the control includes an automatic valve function, that automatic valve shall be used to interrupt the gas flow through the control without any change to the outlet adjustment control valve. To permit the interruption of gas flow through a control not including an automatic valve function 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 combination control being tested shall be provided 5 pipe diameters downstream from the outlet pressure tap.

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

## 2.7 Capacity Test

### 2.7.1

The capacity of a control shall not be less than that specified by the manufacturer. This shall be determined by the quantity of a gas expressed in Btu/hr (kW) which can be passed through the control at 1.0 in wc (249 Pa) pressure drop with an inlet pressure of 2 in wc (498Pa) or as specified by the manufacturer.

For controls that require a pressure drop greater than 1.0 in wc (249 Pa) across the control to fully open, the manufacturer may specify the pressure drop. This shall be determined by the quantity of a gas expressed in Btu/hr (kW) which can be passed through the control at the manufacturers specified pressure drop.

### Method of Test

This test shall be conducted at room temperature. With the control mounted as indicated in 2.6, Mounting for Test, the capacity of the device shall be determined with the control in the widest open position it naturally assumes under normal operating conditions. When the control includes a thermostat, the temperature of the sensor shall be reduced to accomplish this and, if adjustable, the temperature selection means shall be set at its maximum setting. When the control includes an adjustable or convertible pressure regulator, the pressure regulator shall be set to deliver its maximum outlet pressure.

The outlet adjustment control valve shall be adjusted to give an indication on the gauges approximately equal to the pressure drop specified above. The inlet pressure shall be maintained as specified above. The necessary observations shall be made and recorded at a number of different pressure drops.

The capacity shall be measured by means of a flow measuring device suitable for air which will provide an accuracy of  $\pm 1$  percent of the specified capacity.

The capacity of the control 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<sup>3</sup> (37.3 MJ/m<sup>3</sup>) and 0.64 sp. gr. [saturated with water at 60°F (15.5°C) and 30 in Hg column (101.3 kPa)] at which a pressure drop of 1.0 inch equivalent water column (249 Pa) occurs, Btu/hr (kW).
- $Q_1$  = quantity of test gas (or air) as metered, ft<sup>3</sup>/hr (m<sup>3</sup>/hr).
- sp gr<sub>1</sub> = specific gravity of dry test gas (or air) referred to dry air as 1.0.
- sp gr<sub>t</sub> = corrected or actual specific gravity of test gas (or air) as metered.
- $P_t$  = absolute pressure of test gas (or air) as metered, in Hg column (kPa).
- $a_t$  = aqueous tension of water vapor in test gas (or air), in Hg column (Pa).
- sp gr<sub>2</sub> = 0.62 = specific gravity of water vapor referred to dry air as 1.0.
- pd<sub>t</sub> = observed pressure drop (corrected for difference in velocity head, if any, due to change of area at points tapings are taken), in wc (Pa).
- $\theta_t$  = temperature of test gas (or air) as metered, °F absolute (K).

When the inlet and outlet connections of a control 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, in in wc (Pa), at the inlet tapping ( $h_{v1}$ ) or outlet tapping ( $h_{v2}$ ) is found by the following formula:

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

and

- $C$  =  $1.0335 \times 10^{-5}$  for U.S. customary units ( $2.1923 \times 10^{10}$  for metric units).
- $Q_1$  = quantity of gas (or air) as metered, ft<sup>3</sup>/hr.
- sp gr<sub>t</sub> = corrected or actual specific gravity of test gas (or air), as metered.
- pd<sub>t</sub> = pressure drop (may be negative) between inlet and outlet pressure tapings on manifold as observed, in wc (kPa).
- $D$  = inside diameter of pipe at inlet or outlet pressure tapping, in (m).

P = absolute pressure of test gas (or air) at inlet or outlet pressure tapping, in Hg column (kPa).

The data obtained shall then be corrected to standard conditions (see 2.2.4) and a graph plotted of pressure drop versus flow rate.

### 2.7.2

An electrically operated control shall provide at least 90 percent of the flow determined in 2.7.1 when:

- a. Operated at the manufacturer's minimum ambient temperature and 85 percent of the manufacturer's rated voltage.
- b. Operated at the manufacturer's maximum ambient temperature and 85 percent of the manufacturer's rated voltage.

## Method of Test

This test may be conducted in conjunction with the tests specified in 2.7.1.

The control shall be operated at the temperature and voltage conditions specified above. For a control rated from 32°F (0°C) to 125°F (51.5°C), the test shall be conducted only at room temperature. For a low voltage control powered by a transformer, the voltage shall be applied to the primary of the transformer.

For a control where the inlet pressure acts to close a valve in the control, all tests shall be conducted with an inlet pressure of 14 in wc (3.5 kPa).

For a control where the inlet pressure acts to open a valve in the control, all tests shall be conducted with an inlet pressure of 2 in wc (0.498 kPa).

For the test specified in "a," the control shall be cooled to the minimum ambient temperature with no voltage applied. Apply voltage only long enough to observe that the flow has stabilized.

For the test specified in "b," a solenoid type control shall be raised to the maximum ambient temperature with voltage applied until equilibrium temperature is attained. Then remove the voltage only long enough to observe valve closure, reapply voltage and observe flow.

For the test specified in "b," a bimetal type control shall be raised to the maximum ambient temperature with no voltage applied. Apply voltage only long enough to observe that flow has stabilized.

The capacity shall be determined and this valve shall be at least 90 percent of the capacity determined in 2.7.1.

## 2.8 Manual Valve Function

A control which includes a manual valve shall comply with the following requirements, as applicable.

### 2.8.1

Low Temperature Operating Effort.

The manual valve shall comply with the following method of test at the minimum ambient temperature specified by the manufacturer.

## Method of Test

Two new controls shall be subjected to this test. This test shall be conducted after or concurrently with 2.4.1 and 2.4.2.

The controls, with the manual valves in the open position, shall be placed in a chamber maintained at the manufacturer's specified minimum ambient temperature. After each control has attained the specified minimum ambient temperature, this temperature shall be maintained for at least one hour.

Each manual valve shall be cycled from the full open position to the closed position 10 times. During each closing cycle the torque needed to close the manual valve shall be measured and shall not exceed that shown in Table V, Torque for Turning Effort Test.

### 2.8.2

Continued Operation.

Two controls, as received and at the completion of the number of cycles shown in Table X, shall comply with 2.4.1 and 2.4.2 and shall completely open and close on application of a torque not to exceed that specified.

A cycle shall consist of one opening and closing through the extremes of movement of the movable member. For a control that has an intermediate "OFF" position between two "ON" positions, a cycle shall consist of the movement from one "ON" position to the other "ON" position.

## Method of Test

During this test, propane gas (See Part IV, Definitions) at 11.0 in wc (2.74 kPa) pressure shall be passed through each control at an average rate of not less than 0.05 nor more than 0.10 ft<sup>3</sup>/hr (0.393 to 0.786 cm<sup>3</sup>/sec.).

Each control shall be securely connected to a manifold or other suitable pipe fitting and actuated to produce a cycling rate not to exceed that specified by the manufacturer.

A control for operation at ambient temperatures between 32° and 125°F (0° and 51.5°C) shall have all the required cycles (see Table X) conducted at room temperature. A control for operation at ambient temperatures above 125°F (51.5°C) shall be operated alternatively through 1000 cycles at room temperature and 1000 cycles at the higher temperatures specified by the manufacturer, until completion of the total number of cycles specified. A control for operation at ambient temperatures above 125°F (51.5°C) for which a total of 1000 cycles is specified, shall be operated 500 cycles at room temperature and 500 cycles at the higher temperature specified by the manufacturer.

Following cycling, manual valve leakage shall be determined as specified in 2.4.1 and 2.4.2. Each manual valve shall also be capable of completely opening and closing when a torque not greater than that specified in Table IX, Torque Limits for Low Temperature Tests, is applied to the manual valve handle.

### 2.8.3

Adequacy of Seating Means.

This provision does not apply to manual valves having nondisplaceable valve members.

The seating means for all other valves shall comply with the following test.

## Method of Test

This test shall be performed on two control samples with the manual valves in the closed position as outlined in 2.4, Leakage, and all shall comply. This test may be conducted in conjunction with 2.4.

Prior to applying test pressure, the movable member shall be unseated by any convenient means which will not damage the manual valve. The movable member shall then be allowed to reseat and, when tested without rotation, manual valve leakage shall comply with 2.4.1 and 2.4.2.

### 2.8.4

Food Service Equipment Controls.

A combination control suitable for use on food service equipment “” as received and at the end of this test, shall comply with 2.4.1 and 2.4.2 and shall completely open and close upon the application of a torque not to exceed that specified in Table X.

## Method of Test

Five new sample combination controls shall be subjected to this test, all of which shall comply.

Prior to conducting this test, each combination control shall be tested for compliance with 2.4.1 and 2.4.2. The torque necessary to open and close each valve shall be measured and shall not exceed that specified in Table X. Thermocouples shall be firmly secured to the control bodies without peening.

The combination control shall be securely connected to a manifold and placed inside a test chamber capable of maintaining the manufacturer's specified maximum ambient temperature. Propane gas at 11.0 in wc (2.74 kPa) pressure shall be passed through the control at a rate of between 0.05 and 0.10 ft<sup>3</sup>/hr (0.393 to 0.786 cm<sup>3</sup>/s).

The control shall be maintained at the manufacturer's specified maximum ambient temperature, as indicated by thermocouples attached to the combination control bodies, for a period of 18 hours and then at room temperature for 6 hours. Each manual valve shall be turned to its “ON” position at the start of each heating period and to its closed position at the end of each heating period. The torque necessary to completely close the manual valve shall be checked following the 18 hour heating period, and the torque necessary to completely open the manual valve shall be checked following the 6 hour cooling period. The heating and cooling sequence shall be repeated until a total of 30 cycles have been completed.

Upon completion of 30 cycles, the torque necessary to completely close the manual valve at the elevated temperature and to completely open the manual valve at room temperature shall be measured and shall not exceed the applicable torque specified in Table X. Each combination control shall also be tested for compliance with the leakage provisions of 2.4.1 and 2.4.2.

## 2.8.5

### Strength of Latching Means.

A control incorporating a latching type valve shall be capable of withstanding the following torques applied against the latching means without damage which could result in the unseating of the moveable valve member.

Torque, Inch-  
Pounds (N • m)

Controls of pipe sizes less  
than  $\frac{3}{8}$  in (9.5 mm), and valves  
having unthreaded inlets..... 50 (5.6)

Controls of pipe sizes  $\frac{3}{8}$  in  
(9.5 mm) and larger having  
threaded inlets ..... 100 (11.3)

## 2.9 Pressure Regulator Function

A control which includes a pressure regulator shall comply with the following requirements.

A control with a multistage regulator shall have all tests conducted with the regulator at the setting which will deliver the manufacturer's specified maximum outlet pressure. Additional tests, as specified, shall be conducted with the regulator at the setting which will deliver the manufacturer's specified minimum outlet pressure. Maximum and minimum adjustment when specified in the various requirements, are in reference to each particular setting for this type of regulator.

A control with a convertible regulator shall have all tests conducted with the regulator at the setting which will deliver the maximum outlet pressure. Additional tests as specified, shall be conducted at the setting which will deliver the minimum outlet pressure.

A control with a negative pressure regulator shall have the vacuum test pressure established 5 pipe diameters downstream of the outlet adjustment control valve (see Figure 2, Typical Arrangement of Test Apparatus for Combination Control with Negative Pressure Regulator, Section A). The maximum and minimum vacuum test pressures shall be those specified by the manufacturer (see 1.4-y).

### 2.9.1

#### Outlet Pressure Range.

If the manufacturer specifies more than one mounting position, the outlet pressure range test 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 at the minimum outlet pressure setting (if adjustable), and the mounting position which produces the maximum outlet pressure at the maximum outlet pressure setting (if adjustable). The mounting position producing the minimum outlet pressure shall be designated Position A. The mounting position producing the maximum outlet pressure shall be designated Position B. These two mounting positions are to be used for conducting the tests in 2.9.2 and 2.9.3.

#### a. Adjustable Regulators Including 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 adjusting means shall not become disengaged.

### Method of Test

The control shall be mounted in the upright position as specified in 2.6, Mounting for Test. Except for a negative pressure regulator, the regulator shall be adjusted to deliver its minimum outlet pressure. A negative pressure regulator shall be tested at the vacuum pressure specified by the manufacturer when set at the minimum adjustment. The cap provided for concealing the adjustment shall be in place. The inlet pressure and flow rate specified by the manufacturer (see 1.4-c) shall be established. The observed outlet pressure shall be established. The observed outlet pressure shall be noted in each mounting position specified by the manufacturer (see 1.4-f) and recorded as the minimum outlet pressure adjustment and shall not be more than that specified by the manufacturer.

Except for a negative pressure regulator, the regulator shall be adjusted to deliver its maximum outlet pressure. A negative pressure regulator shall be tested at the vacuum pressure specified by the manufacturer when set at the maximum adjustment. The inlet pressure and flow rate specified by the manufacturer (see 1.4-c) shall be established. The observed outlet pressure shall be noted in each mounting position specified by the manufacturer (see 1.4-f) and recorded as the maximum outlet pressure adjustment 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 control mounting position which produces the minimum outlet pressure (Position A).

The data noted with the maximum outlet pressure adjustment shall be examined to determine the control mounting position which produces the maximum outlet pressure (Position B).

#### b. Nonadjustable Regulators Including Negative Pressure Regulators

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

### Method of Test

The control shall be mounted in the upright position specified in 2.6, Mounting for Test. The inlet pressure shall be established at the inlet pressure and flow rate specified by the manufacturer. (See 1.4-d). For a negative pressure regulator, the vacuum pressure specified by the manufacturer shall also be established (see 1.4-y). The outlet pressure shall be observed and shall be within the tolerances specified in Table XI, Allowable Outlet Pressure Tolerances.

The above test shall be repeated with the control mounted in each mounting position specified by the manufacturer.

The data shall be examined to determine the control mounting position which produces the minimum outlet pressure (Position A) and the control mounting position which produces the maximum outlet pressure (Position B).

### c. Convertible Regulators

The outlet pressure, at each outlet pressure setting, of convertible regulators shall be within the tolerances specified in Table XI, Allowable Outlet Pressure Tolerances, of the outlet pressure specified by the manufacturer.

This test shall be conducted in accordance with the Method of Test specified in 2.9.1-b.

## 2.9.2

### Range of Regulation Capacity.

The range of regulation capacity as determined by test shall include the upper and lower limits specified by the manufacturer. (See 1.4-j or -l.)

#### a. Non Adjustable Regulators, Except Negative Pressure Regulators

### Method of Test

The control shall be mounted for test as specified in 2.6, Mounting for Test, in Position A (as determined in 2.9.1).

The inlet pressure shall be adjusted to the appropriate minimum value specified in Table XII, Inlet Test Pressure. If this minimum value exceeds the rated inlet pressure, the rated inlet pressure shall be used as the minimum inlet test pressure.

The initial flow rate shall be set at a value less than the lower limit of the manufacturer's specified range of regulation capacity. The lower limit of the range of regulation capacity shall be 0.15 ft<sup>3</sup>/hr (1.18 cm<sup>3</sup>/s) for regulators designated by the  $\textcircled{P}$  symbol and 0.50 ft<sup>3</sup>/hr (3.93 cm<sup>3</sup>/s) for regulators designated by the symbol  $\nabla$ .

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

The inlet test pressure shall then be increased to the maximum inlet test pressure (see Table XII) 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 reading 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.

1. 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 Curve for Non-Adjustable Regulators).
2. A curve constructed from the outlet pressures obtained at the maximum inlet test pressure shall be examined to determine the minimum and maximum flow rates between which the curve does not vary more than  $\pm 20$  percent from the minimum obtainable outlet pressure. (See Figure 3).

The largest minimum flow rate and the smallest minimum 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 entire test shall be repeated with the control mounted in Position B (as determined in [2.9.1](#)).

b. Adjustable Regulators, Except Negative Pressure Regulators

### Method of Test

The control shall be mounted for test as specified in 2.6, Mounting for Test, in Position A (as determined in [2.9.1](#)) and adjusted to deliver the manufacturer’s specified minimum outlet pressure, with the rated inlet pressure and flow rate established as specified by the manufacturer (see 1.4-c). The procedure outlined in [2.9.2-a](#) for Position A shall then be followed, except the curves shall be designated D, E and F as shown in Figure 4, Range of Regulation Curves for Adjustable Regulators.

The control shall then be mounted in Position B (as determined in [2.9.1](#)) and adjusted to deliver the manufacturer’s specified maximum outlet pressure, with the related inlet pressure flow rate established as specified by the manufacturer (see 1.4-c). The procedure outlined in [2.9.2-a](#) for Position B shall then be conducted to develop Curves A, B and C as shown in Figure 4.

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 4).

c. Convertible Regulators, Except Negative Pressure Regulators

Convertible regulators 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 [2.9.2-a](#).

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

d. Multi-Stage Regulators, Except Negative Pressure Regulators

Multistage 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

1. The highest pressure stage shall be examined first. If the highest pressure stage is nonadjustable, it shall be tested following the procedure specified in [2.9.2-a](#).

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

2. The control shall then be mounted in Position A (as determined in [2.9.1](#)) 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 [2.9.2-a](#), except with the control 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 1.4-c). The test shall then be conducted following the procedure specified in 2.9.2-a, except with the control mounted only in Position A.

Curves A, B and C shall be developed as specified in 2.9.2-a except that the maximum flow rate need not exceed the flow rate on the orifice curve for the maximum regulation capacity determined in 2.9.2-d1. (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 pressures shall not vary by more than 20 percent of the lower outlet pressure reading or 0.3 in wc (74.7 Pa), whichever is greater. In no case shall the observed outlet pressure be less than 0.2 in wc (50 Pa).

#### e. Nonadjustable Negative Pressure Regulators

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

### Method of Test

The control shall be mounted for test as specified in 2.6, [Mounting For Test](#), in Position A (as determined in 2.9.1).

#### Test Method A: Using Apparatus Described in Section A, Figure 2, Typical Arrangements of Test Apparatus for Combination Control with Negative Pressure Regulators.

Throughout this test, the vacuum pressure shall be adjusted and maintained at the manufacturer's specified vacuum pressure (see 1.4-y).

The inlet test pressure shall be adjusted to the appropriate minimum value determined according to Table XII, 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 XII, Inlet Test Pressures](#)) 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.

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 6, Range of Regulation Curves for Nonadjustable Negative Pressure 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.

1. 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 6) or 0.2 in wc (50 Pa) (whichever is greater).

2. Curve C shall be examined to determine the minimum and maximum flow rates between which the curve does vary more than plus or minus 20 percent from the minimum differential outlet pressure (see Figure 6) of 0.2 in wc (50 Pa) (whichever is greater).

The largest minimum flow rate and the smallest maximum flow rate determined from either “-1” or “-2” 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 1.4-y).

The entire test procedure shall then be repeated with the control mounted in Position B (as determined in [2.9.1](#)).

### **Test Method B: Using Apparatus Described in Section B, Figure 2.**

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 1.4-y).

The differential inlet test pressure shall be adjusted to the appropriate minimum value specified in [Table XII, Inlet Test Pressures](#). 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 XII) 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.

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 6) 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.

1. 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 6) or 0.2 in wc (50 Pa) (whichever is greater).
2. Curve C shall be examined to determine the minimum and maximum flow rates between which the curve does vary more than plus or minus 20 percent from the minimum differential outlet pressure (see Figure 6) of 0.2 in wc (50 Pa) (whichever is greater).

The largest minimum flow rate and the smallest maximum flow rate determined from either “-1” or “-2” 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 specified maximum specified vacuum pressure (see 1.4-y).

The entire test shall then be repeated with the control mounted in Position B (as determined in [2.9.1](#)).