ANSI Z21.75-2007
CSA 6.27-2007

American National Standard/
CSA Standard For

Connectors For Outdoor Gas Appliances And Manufactured Homes

AMERICAN NATIONAL STANDARD
ANSI Z21.75-2007

CSA STANDARD
CSA 6.27-2007

Second Edition
This Standard is based on the Standard for

Connectors For Outdoor Gas Appliances And Manufactured Homes

ANSI Z21.75-2001 • CSA 6.27-2001
and Addenda Z21.75a-2002 • CSA 6.27a-2002,
Z21.75b-2003 • CSA 6.27b-2003

APPROVED

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Secretariats

CSA AMERICAM INC.
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The Canadian Standards Association (CSA), under whose auspices this National Standard has been produced, was chartered in 1919 and accredited by the Standards Council of Canada to the National Standards system in 1973. It is a not-for-profit, nonstatutory, voluntary membership association engaged in standards development and certification activities.

CSA standards reflect a national consensus of producers and users — including manufacturers, consumers, retailers, unions and professional organizations, and governmental agencies. The standards are used widely by industry and commerce and often adopted by municipal, provincial, and federal governments in their regulations, particularly in the fields of health, safety, building and construction, and the environment.

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In addition to its head office and laboratory complex in Toronto, CSA has regional branch offices in major centres across Canada and inspection and testing agencies in eight countries. Since 1919, the Association has developed the necessary expertise to meet its corporate mission: CSA is an independent service organization whose mission is to provide an open and effective forum for activities facilitating the exchange of goods and services through the use of standards, certification and related services to meet national and international needs.

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The American National Standards Institute (ANSI), Inc. is the nationally recognized coordinator of voluntary standards development in the United States through which voluntary organizations, representing virtually every technical discipline and every facet of trade and commerce, organized labor and consumer interests, establish and improve the some 10,000 national consensus standards currently approved as American National Standards.

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

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

ANSI approval of standards is intended to verify that the principles of openness and due process have been followed in the approval procedure and that a consensus of those directly and materially affected by the standards has been achieved. ANSI coordination is intended to assist the voluntary system to ensure that national standards needs are identified and met with a set of standards that are without conflict or unnecessary duplication in their requirements.

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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 connectors for outdoor gas appliances and manufactured homes. It is the result of years of experience in the manufacture, testing, installation, maintenance, inspection and research on connectors for outdoor gas appliances and manufactured homes designed for utilization of gas. There are risks of injury to persons inherent in some appliances that, if completely eliminated, would defeat the utility of the appliance. The provisions in this standard are intended to 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 connectors for gas appliances and manufactured homes, the 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 should be forwarded to the Chairman of Accredited Standards Committee Z21/83, 8501 East Pleasant Valley Road, Cleveland, Ohio 44131, or the Chairman of the CSA Standards Steering Committee on Gas Burning Appliances and Related Accessories, 5060 Sprectrum Way, Suite 100; Mississauga, Ontario, Canada L4W 5N6.

Safe and satisfactory operation of a connectors for outdoor gas appliances and manufactured homes depends to a great extent upon its proper installation. 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; the (U.S.) Manufactured Home Construction and Safety Standard, Title 24 CFR, Part 3280, or when such standard is not applicable, the Standard for Manufactured Home Installations, Sites and Communities, ANSI/NFPA 501A, or the Standard for Mobile Homes, CAN/CSA-Z240 MH Series; or the manufacturers' installation instructions and local municipal codes.

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

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

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

EFFECTIVE DATE: An organization using this standard for product evaluation as a part of its certification program will normally establish the date by which all products certified by that organization should comply with this standard. In Canada the Interprovincial Gas Advisory Council normally stipulates an effective date for the standard, delayed sufficiently to permit suppliers (manufacturers) to make adjustments.

History Of The Development Of The Standard For Connectors For Outdoor Gas Appliances And Manufactured Homes

(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.

A draft harmonized standard for connectors for outdoor appliances and manufactured homes was prepared by the subcommittee memebers and CSA staff. On September 15, 1998, the Z21/CSA Joint Subcommittee on Connectors for Gas Appliances reviewed, by letter ballot, the first draft harmonized connectors for outdoor appliances and manufactured homes standard based on current coverage from the American National Standard/CGA Standard for Connectors for Gas Appliances, Z21.24/CGA 6.10-1997, and the U.S. Requirement for Gas Connectors for Connection of Fixed Appliances for Outdoor Installation, Park Trailers and Manufactured (Mobile) Homes to the Gas Supply, A.G.A. 3-87 and CSA Standard, CSA 6.27.

The September letter ballot was approved by the joint subcommittee to distribute the draft standard for review and comment in December 1998. At its July 14, 1999 meeting, following reconsideration and modifications in light of comments received on the proposed draft standard, the joint subcommittee recommended the proposed draft to the Accredited Standards Committee Z21/83 and the CSA Technical Committee for approval.

The proposed draft of the harmonized standard for connectors for outdoor appliances and manufactured homes, as modified by the joint subcommittee, was approved by the Z21/83 Committee on April 13, 2000, and by the CSA Technical Committee by letter ballot dated March 24, 2000.

The first edition of the harmonized American National Standard/CSA Standard for Connectors for Outdoor Appliances and Manufactured Homes was approved by the Canadian Interprovincial Gas Advisory Council on February 15, 2001 and by the American National Standards Institute, Inc., on November 27, 2001.

This, the second edition of the harmonized Standard for Connectors for Outdoor Gas Appliances and Manufactured Homes was approved by the IGAC on January 4, 2006, and by ANSI on May 18, 2007.

The previous edition of the Standard for Connectors for Outdoor Gas Applinaces and Manufactured Homes, and addenda thereto, approved by the IGAC and ANSI are as follows:

Z21.75-2001 • CSA 6.27-2001
Z21.75a-2002 • CSA 6.27a-2002
Z21.75b-2003 • CSA 6.27b-2003

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

ANSI Z21.75-2007 • CSA 6.27-2007

NOTE: Changes, other than editorial, are denoted by a vertical line in the margin.

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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 IO, is 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.

Standard For Connectors For Outdoor Gas Appliances And Manufactured Homes

Part I: Construction

1.1 Scope

1.1.1 This standard applies to newly produced assembled connectors constructed entirely of new, unused parts and materials. Such connectors are intended for exterior use above ground for making the following nonrigid connections:

a. Between the gas supply and the gas inlet of an appliance for outdoor installation that is not frequently moved after installation. These connectors are not intended for use with wheeled, caster mounted or portable appliances;

b. Between the permanent gas outlet of a manufactured home community (mobile home park) or individual site and the piping inlet on a park trailer or a manufactured (mobile) home; or

c. Between sections of a multiple section manufactured (mobile) home.

1.1.2 Connectors covered by this standard are considered suitable for use with natural, manufactured, mixed and liquefied petroleum (LP) gases and LP gas-air mixtures.

1.1.3 Connectors covered by this standard are for use on piping systems operating at fuel gas pressures not in excess of $^1/_2$ lb/in^2 (3.5 kPa).

1.1.4 Connectors covered by this standard shall have a nominal length of not less than 1 ft (0.31 m) nor more than 6 ft (1.83 m).

1.1.5 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.

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

1.1.7 Exhibit A contains provisions that are unique to Canada.

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

1.2 General

1.2.1 The construction of connectors not specifically covered by this standard 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 A connector shall be free from acid residue, scale and loose oxides.

1.2.3 There shall be no visible porosity in welds.

1.2.4 The nominal length of a connector shall refer to the over-all length, including fittings. The actual length shall be within minus $^{1}/_{2}$ in (12.7 mm) to plus 2 in (50.8 mm) of the nominal length.

1.2.5 Tubing shall be constructed of metal of uniform thickness (commercial tolerances allowed) but no section of such tubing shall be less than 0.010 in (0.254 mm) thick. Tubing shall be free from dents, flaws or other defects. Austenitic stainless steel with a minimum thickness of 0.008 in (0.203 mm) is acceptable.

1.3 Materials

1.3.1 Materials used in the construction of connector assemblies shall comply with Table I, Materials for Fittings, within commercial tolerances.

1.3.2 Materials applied in the internal, gas-carrying construction of the connector shall be resistant to deterioration from natural and liquefied petroleum gases.

1.3.3 Materials applied in the exterior construction of a connector shall be resistant to deterioration from exposure to sunlight, ozone, and moisture.

1.4 Fittings

1.4.1 Both ends of each connector shall have a union terminating in a standard taper pipe thread. For the purpose of this standard, a flare-type tube connection is considered a union.

1.4.2 Threads on pipe-end connections of fittings shall be taper pipe threads conforming to the Standard for *Pipe Threads, General Purpose (Inch), ANSI/ASME B1.20.1*.

1.4.3 Union seats shall not depend upon gaskets for gastightness.

1.4.4 Fittings shall be faced or otherwise finished externally to provide adequate hexagonal or octagonal wrench grips.

1.4.5 Soldering or brazing shall not be used in the construction of connectors.

1.4.6 Surfaces of fittings which normally may come in contact with the tubing shall have a smooth finish.

1.4.7 A connector shall not incorporate a connector nut employing threads which are capable of being assembled to standard taper pipe threads.

1.5 Instructions

Instructions covering proper usage and installation shall be attached to each assembled appliance connector. Instructions may be in a language(s) other than English when distributed in areas outside the U.S. and Canada.

1.5.1 The instructions shall include a statement that the connector is for use on a piping system operating at fuel gas pressures not in excess of $^{1}/_{2}$ lb/in^{2} (3.5 kPa).

1.5.2 The instructions shall include a statement concerning the intended use of the connector. This statement shall state in effect that the connector is suitable for those installations in section 1.1.1 (Scope), as applicable.

1.5.3 The instructions shall indicate the maximum capacity of the connector capacity in Btu per hour.

1.5.4 The instructions shall include statements that the connector:

a. Is not to be used for connection to an LP-gas container mounted on or adjacent to a park trailer or the manufactured (mobile) home;

b. Is not to be installed underground or for use in contact with the ground; and

c. Is designed for occasional movement after installation. Repeated bending, flexing or vibration must be avoided. Normal operation of a clothes dryer, rooftop HVAC unit or similar outdoor appliance does not constitute extreme vibration or movement.

1.5.5 Unless tested for such use under another standard, the instructions shall include statements that the connector is not for connecting appliances within a recreational vehicle, park trailer, manufactured (mobile) home, a residence or commercial building.

1.5.6 The instructions shall include statements to the effect that:

a. A readily accessible manual shutoff valve must be available upstream of the connector assembly.

b. The connector must not be concealed within or run through any wall, floor, or partition. The entire connector must be visible for inspection.

c. The connector shall be of an appropriate length for the intended application. Do not stretch the connector nor bend it smaller than $1^{1}/_{2}$ in (38.1 mm) internal diameter (approximately the size of a golf ball). Make sharp bends with pipe fittings.

d. The connector must not be kinked or twisted about its own axis.

e. Contact with foreign objects or substances must be avoided.

f. The final assembly must be tested for leaks. CAUTION: Test for leaks only with leak test solution. Rinse with clear water after leak testing to remove any corrosive residue. DO NOT USE OPEN FLAME TO TEST FOR GAS LEAKS.

g. The connector must not be reused for any other installation. A new connector must be installed. All connectors shall bear the following warning in 10 point type provided on a Class IIIA marking material: "DO NOT REUSE."

h. The connector must be replaced if the connector is damaged or deteriorated.

i. This connector complies with the Standard for Connectors for Outdoor Gas Appliances and Manufactured Homes, ANSI Z21.75 • CSA 6.27 (unless this is shown as a marking, see 1.6.2-d).

1.5.7 The instructions shall be sufficiently durable and attached in a manner which meets or exceeds a Class IIIA permanent label (see 1.6.1).

1.5.8 The instructions shall be examined by the testing agency for readability, accuracy, and durability.

1.6 Marking

1.6.1 Marking material shall be identified by class number and shall meet the following specifications. All metal marking materials shall be rustproof. All markings shall be suitable for application to the type of surface upon which applied. The designation of any class of marking shall not preclude the use of marking of a lower number class.

Class I. Integral Marking

Marking that is embossed, cast, stamped or otherwise formed in the part. This includes markings baked into an enameled surface.

Class IIA-3. Permanent Plate

Shall be made of metal having a thickness less than 0.006 in (0.152 mm). Such plates shall be attached by means of nonwater-soluble adhesive.

Class IIA-4. Permanent Plate

Shall be made of pressure-sensitive metal foil requiring no solvent or activator.

Class IIIA-1. Permanent Label

Shall be made of material not adversely affected by water, shall be attached by means of nonwater-soluble adhesive.

Class IIIA-2. Permanent Label

Shall be made of material not adversely affected by water, shall be attached by means of nonwater-soluble adhesive. These materials shall not be located on surfaces having temperatures exceeding 175°F (79.5°C).

Class IIIB. Waterproof Marking

Shall be printed directly on the part with waterproof marking not adversely affected by a temperature of 175°F (79.5°C). This marking shall not be used on surfaces having temperatures exceeding 175°F (79.5°C).

Class IV. Semi-Permanent Label

Shall be made of material which may be soluble in water, and may use water-soluble adhesive for attachment means.

Class V. Printed Marking

Marking shall be clear and prominent and may be applied directly by any printing means.

Class VI. Attached Tags

1.6.2 Each connector shall bear a Class I marking, on either a nonremovable ring or a portion of a nonremovable fitting not subject to tool usage, on which shall appear the following:

a. The manufacturer's name or trademark, including plant identification if there is more than one manufacturing location.

b. A number, not less than $^{3}/_{32}$ in (2.38 mm) in height, identical to the last two numbers of the calendar year in which the connector is manufactured, to identify the year of manufacture.

c. A letter(s), not less than $^{3}/_{32}$ in (2.38 mm) in height, identifying either the month or batch of manufacture. The batch size shall be determined by the manufacturer.

d. A marking to identify this standard as follows: "ANSI Z21.75 • CSA 6.27," if the standard is not identified in the instructions.

e. Symbol or name of the organization making the tests for compliance with this standard.

1.6.3 Removable end fittings of assembled connectors other than union end pieces, shall be stamped, etched or otherwise permanently marked with the connector manufacturer's name, trademark or symbol. Three-part unions shall bear the marking of the union manufacturer.

Part II: Performance

2.1 General

2.1.1 Unless otherwise specified, a connector employing a nonmetallic protective coating shall comply with the provisions of this standard without its protective coating.

2.1.2 During tests for compliance with this standard, unless otherwise specified, connections shall be made using a torque of 1040 in/lb (117.50 N-m) per inch of nominal connector I.D.

2.1.3 Unless otherwise specified, all tests for leakage in Part II shall be made consistent with section 2.2, Leakage.

During tests for compliance with this standard, unless otherwise specified, examination for leakage shall be conducted with one end of the connector attached to a pneumatic system capable of supplying clean dry air at 3 psi (20.7 kPa) pressure. This system may terminate in a stationary pipe to support the connector as specified in certain tests, or in suitable pneumatic tubing if the connector is to be moved as specified in other tests. A pressure measuring device such as a manometer and a flow measuring device capable of accurately indicating the allowable flow rate shall be located downstream from a shutoff valve provided to isolate the connector under test from the pneumatic system. The other end of the connector shall be sealed gastight. Air shall then be admitted to the connector until a pressure equivalent to 3 psi (20.7 kPa) is obtained.

Compliance with leakage tests shall be determined by one or more of the following, as specified in the Method of Test for each provision.

a. Any leakage, as determined by a sudden drop in pressure as indicated by the pressure measuring device, after the shutoff valve has been closed, shall be cause for failure.

b. The flow measuring device shall be observed and no indication of leakage in excess of 10 cm^3/hr of air corrected to 30 in Hg column (101.3 kPa) and 60°F (15.5°C) shall be noted.

2.1.4 References in this standard to the inlet and outlet ends of a connector are for convenience only. It is recognized that the two ends may be identical or interchangeable.

2.2 Leakage

A connector and its fittings shall not leak. For the purpose of this section, leakage is defined as a flow rate in excess of 10 cm^3/hr at 3 psig (20.7 kPa).

Method of Test

This test shall be conducted at room temperature.

One end of the connector shall be connected to a flow-measuring device, capable of accurately indicating the allowable flow rate, and a pneumatic system capable of supplying clean air at a test pressure of 3 lb/in^2 (20.7 kPa). An airtight connection shall be made at the opposite end of the connector.

Air shall be admitted to the system slowly and maintained at the specified test pressure. The leakage rate shall be measured and shall not exceed 10 cm^3/hr of air corrected to standard conditions of 30 in Hg column (101.3 kPa) and 60°F (15.5°C).

2.3 Strength

2.3.1 A connector shall withstand, without bursting or evidence of leakage, an internal hydrostatic pressure of 250 lb/in^2 (1.72 MPa).

Method of Test

A new, unused connector shall be used for this test.

A 2 ft (610 mm) connector shall be assembled in a hydraulic pressure test system, including a pump, gage and heavy-duty pipe fittings, capable of sustaining the desired pressure, care being taken to purge all air from the system.

The applied pressure shall be maintained for 1 minute. If no bursting or evidence of leakage occurs during this period, this provision shall be deemed met.

2.3.2 A connector shall withstand, without evidence of leakage or becoming detached, a lengthwise pull of 800 lb/in (3.56 kN) of nominal connector I.D.

Method of Test

A new, unused connector shall be used for this test.

One end of a 2 ft (610 mm) connector shall be securely attached to a stationary pipe to which an air supply system and pressure gage is connected. The other end shall be securely attached in a similar manner to a closed pipe connected to a mechanical means by which a constant pulling force of the necessary magnitude can be applied.

The required tension shall be applied to the connector and maintained for the duration of the test. At the end of 5 minutes the connector shall be subjected to 3 psi (20.7 kPa) air pressure. The air shall then be shut off, and there shall be no leakage as evidenced by the pressure gage during a period of 1 minute thereafter (see 2.1.3-b).

2.3.3 A connector shall be sufficiently resistant to crushing to support a transverse load of 75 lb per linear in (1.35 kg/mm) without loss of capacity beyond that specified in the following Method of Test and without developing leakage.

Method of Test

This test shall be conducted after the capacity of a 6 ft (1.83 m) connector has been determined as specified in 2.9, Capacity.

The connector shall be laid on a hard, flat, smooth surface and a 75 lb (34.0 kg) weight with $^1/_{16}$ in (1.59 mm) radiused edges and a smooth metallic face 1 in (25.4 mm) wide shall be applied for 1 minute without impact in turn to 3 places selected along the length of the connector, none of which is closer than 3 in (76.2 mm) to either of the end fittings.

After removal of the weight, the connector shall be inspected and shall not be obviously deformed. Minor effects such as a slight flattening of corrugations are not cause for failure.

The connector shall not leak.

If no leakage is noted, the connector shall again be subjected to the capacity test specified in 2.9, Capacity, and the capacity shall not be less than 95 percent of the capacity previously determined.

2.3.4 A connector shall not leak, break or be otherwise adversely affected by application of a tightening torque of 1040 in/lb (117.50 N-m) of nominal connector I.D.

Method of Test

A new, unused connector shall be used for this test.

The end fitting shall be attached to a short length of pipe which is securely capped or otherwise made gas-tight. This length of pipe shall be rigidly held in a vise or by other means. The end fitting shall be tightened on the pipe to a final tightening torque of 1040 in/lb (117.5 N-m) per inch of nominal connector I.D., after which it shall be visually examined for breakage. The connector shall not leak.

2.3.5 Fitting assemblies of connectors shall be capable of withstanding impact, specified in Table II, Impact Applied During Conduct of Test, without evidence of leakage, cracking or breakage.

Method of Test

A new, unused connector shall be used for this test.

One end of a connector shall be secured to a Schedule 80 pipe nipple or fitting mounted on a rigid surface so the free end of the supporting member is not greater than 2 in (50.8 mm). The connector nut shall be tightened to a torque of 1040 in/lb (117.5 N-m) per inch of nominal connector I.D.

The connector nut shall then be struck at a 90 degree (1.57 rad) right angle to the gasway with a striking weight having a smooth, hard metal face adjusted to deliver an impact as specified above. The center line of contact between the striking weight and a wrench flat of the nut shall be at the longitudinal center of the flat.

After this impact, the fittings shall be visually checked and there shall be no cracks or breaks.

The connector shall not leak.

2.4 Bending

A connector shall withstand 30 bends without leakage or damage to the tubing or fittings.

Method of Test

A new, unused connector shall be used for this test.

One end of a 2 ft (610 mm) connector shall be securely attached to a fixed pipe to which an air supply system and manometer is connected. The other end shall be closed gastight. Two $2^{1}/_{4}$ in (57.2 mm) diameter mandrels shall be placed, one at each side of the fixed end of the connector, in contact with the connector nut. The center lines of the mandrels shall be in line with the tubing end of the nut.

Air shall then be admitted to the connector until a pressure equivalent to 3 psi (20.7 kPa) is obtained. The tubing shall be bent from the starting position "A" along the path shown by the dotted circle in Figure 1 (Illustration of Bending Test) to the position indicated by "B." It shall then be bent back to the starting position and bent in the opposite direction to position "C." Each 180 degree (3.14 rad) bend and subsequent return to the starting position shall be counted as one cycle. This process shall be repeated until 30 cycles have been completed, the bending motion being applied uniformly at the rate of 5 cycles per minute.

Following completion of the 30 bends, the assembly shall not leak. This test shall be applied to each nominal diameter, type and material of connector submitted.

2.5 Torsion

A connector shall withstand, without leakage or damage to the tubing or fittings, 15 applications of 90 degree (1.57 rad) twists in alternate directions.

Method of Test

One end of a 2 foot (610 mm) connector shall be securely attached to a rigid frame and loaded in tension as specified in Table III, Applied Load During Torsion Test.

An air pressure equivalent to 3 psi (20.7 kPa) shall be maintained in the system while the tubing is rotated 90 degrees (1.57 rad) at the lower fitting, in a plane perpendicular to the axis of the tubing, and then returned to the original position and rotated 90 degrees (1.57 rad) in the opposite direction. Each 90 degree (1.57 rad) twist and subsequent return to the original position shall be counted as one cycle, and the twisting motion shall be applied uniformly at a rate of 5 cycles per minute. If the connector shows no indication of leakage when immersed under not more than a 2 in (50.8 mm) depth of water, this provision shall be deemed met. This test shall be applied to each nominal diameter, type and material of connector submitted.

2.6 Reconnection Of Fittings

A connector shall not leak as a result of being connected, disconnected and reconnected.

Method of Test

A connector employing a protective coating shall comply with this test with its protective coating.

The connector to be tested shall be connected to a leakproof system in such a manner that the pipe thread end of the fitting is held rigid.

The union shall be tightened by the application of a torque not to exceed the minimum torque specified in Table IV, Applied Torque During Reconnection of Fittings Test. The connector shall be tested as described in Section 2.2, Leakage. If the connector leaks, the torque shall be increased sufficient amount to overcome the leakage, but shall not be increased in excess of the maximum torque specified in Table IV. Evidence of leakage following application of the maximum permissible torque shall be considered as noncompliance with this provision.

A split section of rigid pipe, clamped together to obtain a snug fit over the connector, with edges rounded at the ends, shall then be snugly fitted over the tubing with its nearest edge a distance from the top of the fitting equal to the internal diameter of the tubing. This pipe is to be used as a handle to deflect the tubing at the fitting 60 degrees (1.05 rad) in one direction from the center line of the fitting. The tubing shall then be returned to its original position, deflected 60 degrees (1.05 rad) in the opposite direction, and again returned to its original position. The test for leakage shall again be applied as outlined above. There shall be no leakage in excess of that specified in 2.2, Leakage.

The union shall then be disconnected, the tubing rotated 55 degrees (0.96 rad) in a clockwise direction, and the union again assembled to the fitting and tightened by the application of a torque not to exceed the torque determined to be necessary to overcome leakage in the previous connection. Leakage tests shall again be applied as outlined above. If no leakage occurs, or if leakage is observed and can be overcome by an increase in torque not to exceed the maximum torque specified in Table IV, Applied Torque During Reconnection of Fittings Test, the tubing shall be deflected as described in the preceding paragraph after which leakage tests shall be applied as outlined above.

The procedure outlined in the preceding paragraph shall be performed a total of 8 times without leakage in excess of that specified in 2.2, Leakage.

2.7 Performance After Exposure To Temperature Extremes

A connector shall not show evidence of leakage after being cycled through temperature extremes as outlined in the following Method of Test.

Method of Test

A new, unused connector shall be used for this test.

One end of the connector shall be sealed gastight. The other end shall be attached to an air supply system as described in 2.1.3 and air pressure equivalent to 3 psi (20.7 kPa) applied. It shall be verified that no leakage occurs as specified in 2.1.3-b.

Fittings shall not be tightened during the course of or at the completion of this test.

When tightening tubing nuts to adapter fittings, the torque applied shall be 1040 in/lb (117.5 N-m) of nominal connector I.D.

The connector shall then be disconnected from the air supply system and alternately exposed to temperatures of -40°F (-40°C), room temperature [77 ± 10°F (25 ± 5.5°C)], 150°F (65.5°C) and room temperature. At each exposure, the temperature of the connector, as measured by

a thermocouple taped to the end fitting, shall attain the test temperature and be maintained at that temperature for at least $^1/_2$ hour. The connector shall be cycled according to the above sequence a total of 5 times.

After the final heating and cooling to room temperature, there shall be no leakage.

2.8 Durability At High Temperature

A connector shall be capable of withstanding a temperature of 800°F (427°C) without leakage.

During this test, a manual valve supplied as an end connection shall be removed and replaced with a plug.

Method of Test

A 1 ft (305 mm) connector shall be connected to a pressure-tight system. Thermocouples shall be soldered, brazed or otherwise firmly attached to end fittings to determine their temperature. The connector shall then be placed in a preheated oven. When the temperature of the fittings reaches 790°F (421°C), the oven temperature shall be adjusted so that the temperature of the fittings does not exceed 810°F (432°C) nor drop below 790°F (421°C) in the succeeding 15 minutes. An internal air pressure of 3 ± 0.25 psi (20.7 ± 1.72 kPa) shall be maintained throughout the test, unless a drop in pressure occurs. In this event the test shall be discontinued. Otherwise, the connector shall be removed from the oven, cooled to room temperature and shall not leak.

2.9 Capacity

The capacity of a connector shall be determined at a pressure drop of 0.5 iwc (124 Pa) and shall not be less than that specified in Table V, Minimum Connector Capacity. During the conduct of this test, end fittings, other than appliance connector valves used as end fittings, shall be in place.

Method of Test

Standard weight pipe, of proper size, reamed to remove burrs caused by cutting, shall be fitted to the inlet and outlet connections of the flexible metal tubing connector. The straight run of pipe before and after the connector shall be of a length not less than 10 pipe diameters (I.D.). Two short lengths of pipe or metal tubing shall be soldered to the pipe, one before the inlet and the other after the outlet connections. Pressure tappings shall be located five pipe diameters (I.D.) from the inlet and outlet connections. A drill shall be inserted in the short length of pipe or metal tubing and a hole drilled through the wall of the large pipe, care being taken to remove any burrs caused thereby. The two pressure tappings shall be connected to a differential pressure gage which may be read directly to at least 0.01 iwc (2.5 Pa).

Either gas or air may be used for the test. If gas is used, it shall be vented or burned as far away from the connector, test meter and other test instruments as will preclude the heating of such equipment. The flow rate shall be adjusted to give an indication on the gage approximately equal to the pressure drop specified above and the necessary observations made and recorded. Observations may also be made at a number of different pressure drops.

Capacity of the connector shall be resolved from these data according to the following formula:

or, since

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

then

$$sp\ grt = \frac{sp\ gr_1(pt - at)}{Pt} + \frac{at(sp\ gr_2)}{Pt}$$

where

$$qsc = KQ_1\sqrt{\frac{sp\,gr_1(Pt - at) + at\,(sp\ gr_2)}{pd_t \times \theta_t}}$$

K = 3685 for U.S. customary units (244.040 for metric units);

qsc = capacity with gas of 1000 Btu/ft^3 (37.2 MJ/m3) and 0.64 sp gr [saturated with water at 60°F (15.5°C) and 30 in. mercury column (101.6 kPa)], Btu per hr (kW);

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

sp gr_1 = specific gravity of dry test gas (or air) referred to dry air as 1.0;

sp gr_t = corrected or actual specific gravity of test gas (or air), as metered;

P_t = absolute pressure of test gas (or air) as metered, in Hg column (kPa);

at = aqueous tension of water vapor in test gas (or air), in Hg column (Pa);

sp gr_2 = 0.62 = specific gravity of water vapor referred to dry air as 1.0;

CAUTION - Mercury is a definite health hazard and therefore equipment for the detection and removal of mercury vapor produced in vaporizing is recommended. The use of rubber gloves in testing is advisable.

pd_t = observed pressure drop (corrected for difference in velocity head, if any, due to change of area at points tappings are taken), iwc (Pa); and

= temperature of test gas (or air) as metered, F absolute (K).

θ_t event the areas at the inlet and outlet tappings are different:

$$pd_t = pd_o + hv_1 - hv_2$$

where

The velocity head, iwc (Pa), at the inlet tapping (hv1) or outlet tapping (hv2) is found by the following formula:

and

$$hv = \frac{C\, x_1^2\, x\, P\, x\, sp\, grt}{D^4\ t}$$

C = 1.0335 x 10-5 for U.S. customary units (2.1923 x 10-10 for metric units);

pd_o = pressure drop (may be negative) between inlet and outlet pressure tappings on manifold as observed, in. water column (kPa);

D = inside diameter of pipe at inlet or outlet pressure tappings, in (m); and

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

2.10 Resistance To Outdoor Atmosphere-Gas Conduit Fabricated From Copper Alloy

Copper alloy connectors and fittings shall not develop faults which could result in gas leakage under the following Method of Test.

Method of Test

The test specified shall be applied to each nominal diameter, type and material of connector submitted.

On connectors employing a protective coating, this test shall be conducted with the coating in place.

Using the procedure specified in 2.4, the connector shall be bent two times around a $1^1/_2$ in (38.1 mm) diameter mandrel. The connector shall then be subjected to a lengthwise pull as specified in Table III, Applied Load During Torsion Test, for a period of 30 seconds. The loaded connector shall be subjected to two 90 degree (1.57 rad) torsions applied only in the direction consistent with tightening the connector fitting.

The connector shall then be bent around a $1^1/_2$ in (38.1 mm) diameter mandrel to form a "U" shape. The ends shall be secured with a nonmetallic material to hold the connector in this shape. One end of the connector shall be attached to an air supply system equipped with a manometer downstream from a shutoff valve and the other end sealed gastight. Air shall then be admitted to the connector until a pressure equivalent to 3 psi (20.7 kPa) is obtained and the shutoff valve closed.

The connector, from the back of one connector nut to the back of the opposite connector nut, shall be suspended in a sealed plastic container to which 500 milliliters of ammonia solution containing 54 milliliters of full strength ammonia (28 percent) and 446 milliliters of water have been added. (More than one connector may be placed in the container at one time.)

Note: The connector(s) must not come in contact with the ammonia solution at any time. See Figure 2 (Illustration of Ammonia Vapor Corrosion Test).

If a sudden drop in pressure occurs, the test shall be discontinued. Otherwise, the connector shall be removed from the container after 18 hours and shall not leak.

2.11 Resistance To Outdoor Atmosphere-Gas Conduit Fabricated From 300 Series Stainless Steel

Connectors and fittings shall not develop faults which could result in gas leakage under the following condition of test.

Method of Test

This test shall be applied to each nominal diameter, type and material of connector and fitting.

External coatings, if any, shall be in place.

Prior to conduct of the test a new, unused connector shall be bent through $1^1/_2$ cycles as specified in 2.4, Bending, so that after bending, the connector remains in a U shape.

The fittings at each end shall be retightened to a torque of 1040 in/lb (117.5 N-m) per in of nominal connector I.D. The connector shall be pressurized as specified in 2.1.3 and the shutoff valve closed.

The connector shall be totally immersed in a solution by weight, of 20 percent sodium chloride, 1 percent sodium nitrate and 79 percent distilled water.

The mixture shall be heated to 212°F (100°C) and maintained at this temperature at atmospheric pressure. (Boil off shall be condensed and returned to the mixture.)

If a sudden drop in pressure occurs, the test shall be discontinued. Otherwise, the connector shall be removed from the container after 14 hours. The connector shall then be carefully straightened from its 180 degree (3.14 rad) (U-shape) configuration to a 90 degree (1.57 rad) configuration (i.e., returned half-way to the straight condition) and shall not leak.

2.12 Salt Spray

Connectors shall be tested to the Standard *Test Practice for Salt Spray (Fog) Testing Apparatus, ASTM B117*, without damage, such as pitting, flaking or cracking, to the exterior construction of connector conduits and coatings when exposed for 96 hours to the conditions specified therein

Tables Referenced In Part I, Part II And Exhibits

Table I
Materials For Fittings

Type of Fitting	Specification
Pure copper	Prohibited when in contact with fuel gas
Cast iron fittings	Prohibited
Malleable Iron fittings	Shall conform to the specification for Cupola Malleable Iron, ASTM A197, and shall be protected with a corrosion-resistant finish such as cadmium plate or shall be galvanized zinc plate and chromate dip.
Steel fittings	Shall be protected with corrosion-resistant metallic finish, such as cadmium plate, or shall be galvanized.
Brass machined fittings	60% Cu minimum 85% Cu maximum
Welded and seamless brass tubing	65% Cu minimum 85% Cu maximum
Stainless steel tubing	300 series stainless steel or stainless steels of equivalent corrosion resistance
All other material	Shall be reasonably in accord with the above and shall meet the provisions of this standard.

Table II
Impact Applied During Conduct Of Test

Nominal Connector I.D., Inch	Inpact LB-FT (N•m)
Up to 5/8	10 (13.56)
5/8 and larger	15 (20.33)

Table III
Applied Load During Torsion Test

Nominal Connector I.D., Inch	Weight, Pounds (kg)	
1/4	12.50	(5.7)
3/8	18.75	(8.5)
1/2	25.00	(11.3)
5/8	31.25	(14.2)
3/4	37.50	(17.0)
1	50.00	(22.7)

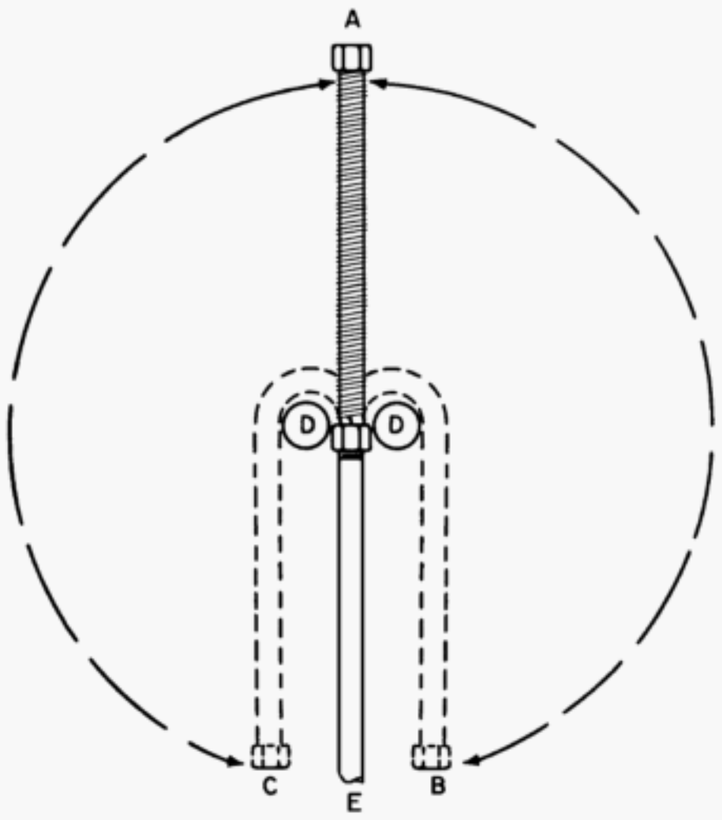
Table IV
Applied Torque During Reconnection Of Fittings Test

Nominal Connector I.D., Inch	Torque, Inch-Pounds (N-m)			
	Minimum		Maximum	
1/4	150	(16.95)	260	(29.38)
3/8	200	(22.60)	390	(44.06)
1/2	250	(28.25)	520	(58.75)
5/8	300	(33.90)	650	(73.44)
3/4	400	(45.19)	780	(88.13)
1	450	(50.84)	1040	(117.50)

Table V
Minimum Connector Capacity

Nominal Connector ID,Inch	Straight Length Capacity - Btu Per Hr (W).0.64 Sp Gr, 1000 Btu Per Cu Ft (37.2 MJ/m3) Gas at 0.5 inch Water Column (124 Pa) Pressure Drop							
	1 foot (0.30 m)	1 1/2 Foot (0.46 m)	2 Foot (0.61 m)	2 1/2 Foot (0.76 m)	3 Foot (0.91 m)	4 Foot (1.22 m)	5 Foot (1.52 m)	6 Foot (1.83 m)
1/4	48,000 (14 067)	43,800 (12 837)	40,000 (11 723)	36,400 (10 668)	33,400 (9 789)	28,300 (8 294)	24,900 (7 297)	23,100 (6 770)
3/8	102,000 (29 893)	93,100 (27 285)	85,000 (24 911)	77,100 (22 596)	71,100 (20 837)	60,500 (17 731)	53,200 (15 591)	49,100 (14 390)
1/2	180,000 (52 753)	164,200 (48 122)	150,000 (43 961)	136,000 (39 858)	125,000 (36 634)	106,000 (31 066)	93,200 (27 314)	86,000 (25 204)
5/8			177,000 (51 874)	170,200 (49 881)	162,500 (47 624)	147,800 (43 316)	131,800 (38 627)	116,200 (34 055)
3/4			290,900 (85 254)	270,500 (79 276)	255,900 (74 997)	215,000 (63 010)	197,400 (57 852)	173,900 (50 965)
1			581,800 (170 509)	545,200 (159 782)	515,900 (151 196)	442,700 (129 743)	398,900 (116 906)	347,800 (101 930)

Figures Referenced In Part I, Part II And Exhibits



A - Position of free end at start of bending test.

B and C - Position of free end after bending around mandrel.

D - Mandrel - $2^{1}/_{4}$ in (57.2 mm) diameter.

E - Fixed pipe.

Figure 1. Illustration of Bending Test

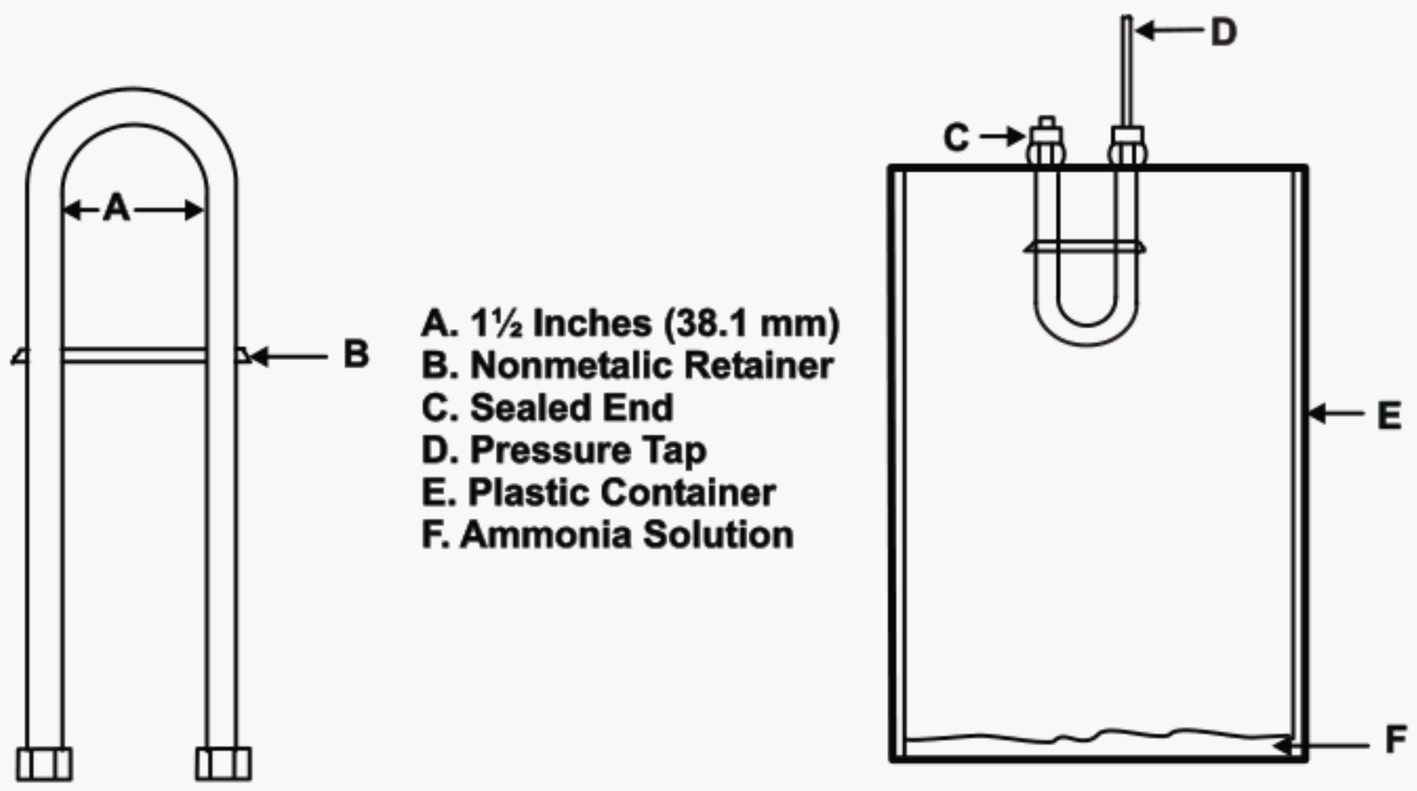


Figure 2. Illustration of Ammonia Vapor Corrosion Test

Exhibit A

Items Unique To Canada

Exhibit A does not apply to ANSI Z21.75.

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

	Wording to be translated	French
1.5 Instructions		
1.5.6-g	"Do Not Reuse."	«Ne pas réutiliser.»

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

Exhibit B
List Of Reference Standards

AMERICAN GAS ASSOCIATION
400 N. Capitol Street, N. W., Washington, D.C. 20001

ANSI Z223.1-1998/NFPA 54-1998, National Fuel Gas Code

AMERICAN SOCIETY OF MECHANICAL ENGINEERS
United Engineering Center,
345 East 47th Street, New York, New York 10017

ANSI/ASME B1.20.1-1993 (R1992), Pipe Threads, General Purpose (Inch)

ASTM INTERNATIONAL
100 Barr Harbor Dr., West Conshohocken, Pennsylvania 19428-2959

ASTM B117, Standard Test Practice for Salt Spray (Fog) Testing Apparatus

ASTM A197, Cupola Malleable Iron

IEEE/ASTM SI 10, Standard for use of the International System of Units (SI): The Modern Mertic System

CANADIAN STANDARDS ASSOCIATION
5060 Spectrum Way, Suite 100, Mississauga, Ontario, Canada L4W 5N6

CAN/CSA-Z240 MH Series-92, Mobile Homes

CSA 6.16-M97 - ANSI Z21.69-1997, Connectors for Moveable Gas Appliances

CSA B149.1-2000, Natural Gas and Propane Installation Code

CSA AMERICA, INC.
8501 East Pleasant Valley Road, Cleveland, Ohio 44131

ANSI Z21.69-1997 • CSA 6.16-M97, Connectors for Moveable Gas Appliances

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

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Washington, D.C. 20410

Manufactured Home Construction and Safety Standard, Title 24 CFR, Part 3280 [formerly the Federal Standard for Mobile Home Construction and Safety, Title 24, HUD (Part 280) 1975]

NATIONAL FIRE PROTECTION ASSOCIATION
Batterymarch Park, Quincy, Massachusetts 02269

NFPA 54-1998/ANSI Z223.1-1998, National Fuel Gas Code

ANSI/NFPA 501A-1999, Manufactured Home Installations

UNDERWRITERS LABORATORIES INC.
Publication Stock, 333 Pfingsten Road, Northbrook, Illinois 60062

ANSI/UL 62-1997, Flexible Cord and Fixture Wire

Part III: Manufacturing And Production Tests

The manufacturer shall submit to the certifying agency a plan which is mutually acceptable to the manufacturer and the certifying agency and which describes the programs and test procedures specified in 3.1, 3.2 and 3.3 and the records which are to be kept by the manufacturer.

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

3.2 The manufacturer shall test each appliance connector tube for leakage.

3.3 The manufacturer shall use a program which includes an agreed upon schedule(s) to conduct:

a. Bending tests;

b. Torsion tests;

c. Resistance to ammonia atmosphere test;

d. Reconnection of fittings tests; and

e. Impact tests on fittings provided with both external and internal threads.

3.4 The manufacturer's test method(s) used shall be capable of relating back to the test(s) specified in the standard.

Part IV: Definitions

(For the purpose of this Standard, the following terms shall be defined as stated herein.)

ADAPTER. As used in this standard a metal fitting designed to connect standard taper pipe threads to the connector nut.

APPLIANCE. All gas utilization equipment.

CAPACITY. As used in this standard the amount of a specified gas that will flow through a connector at a specified pressure drop in a fixed period of time.

CONDUIT, GAS. The structure enclosing the gas passageway of the connector.

CONNECTOR, GAS APPLIANCE (ANSI Z21.24 - CGA 6.10). A factory-fabricated assembly of gas conduit and related fittings designed to convey gaseous fuel, and used for making connections between a gas supply piping outlet and the gas inlet to an appliance or a manufactured (mobile) home. It is equipped at each end for attachment to standard taper pipe threads. A gas appliance connector is not for vibration isolation. Connectors for Gas Appliances, Z21.24 - CGA 6.10, are not designed for repeated movement after being connected nor for repeated disconnecting and connecting. For installation requiring movement of the appliance on a regular basis, refer to ANSI Z21.69 - CSA 6.16, Connectors for Movable Gas Appliances.

1. **Connector for Manufactured (mobile) Homes.** A connector for use between the permanent gas outlet of a manufactured (mobile) home park lot and the piping inlet on a manufactured (mobile) home.

2. **Crossover Connector.** A connector for use between the sections of a multiple section manufactured (mobile) home.

3. **Connector for Stationary Appliance for Outdoor Installation.** A connector for use betwe en the gas supply and the gas inlet of a stationary appliance installed outdoors.

CONNECTOR, MOVABLE GAS APPLIANCE (ANSI Z21.69 - CSA 6.16). A connector for use with all castered appliances as well as Food Service appliances that may, or may not utilize casters and, under conditions of normal use are moved on a regular basis for service, positioning or area cleanliness. A connector of this type is not designed for continuous movement and may be equipped with a quick-disconnect device.

CONNECTOR, OUTDOOR GAS APPLIANCES AND MANUFACTURED (MOBILE) HOMES (ANSI Z21.75 • CGA 6.27). A connector for use between the gas supply and the gas inlet of an appliance for outdoor installation that is not frequently moved after installation. These connectors are not intended for use with wheeled, caster mounted or portable appliances;

1. **Connector for Manufactured (mobile) Homes.** A connector for use between the permanent gas outlet of a manufactured (mobile) home park lot and the piping inlet on a manufactured (mobile) home.

2. **Crossover Connector.** A connector for use between the sections of a multiple section manufactured (mobile) home.

CONNECTOR NUT. A threaded nut permanently attached to a connector conduit which mates with an adapter or manual valve to form a union joint.

GAS HOSE CONNECTOR. A connector designed for use only with portable gas-burning equipment. The gas conduit depends for gastightness on the wall structure of the hose material. The conduit may be supported with internal metal or other reinforcement. The design and application presuppose that the connector will not be pressurized when the appliance served by the connector is not in use. Gas hose connector includes

1. **Gas Hose Connector for Portable Outdoor Gas-Fired Appliance.** A gas hose connector for use with portable gas-burning equipment used outdoors.

TUBING. As used in this standard, the material from which the gas conduit of a connector is fabricated.

UNION. An assembly of parts to facilitate connection or disconnection between the connector and gas piping without rotation of the connector tubing.

UNION, GROUND JOINT. A union consisting of three parts (nut, swivel and end piece) concentrically machined to provide alignment.

GAS VALVE. A manually operated valve which permits control of the flow of gas at any rate from none to "full on."

LISTED. Equipment or materials included in a list published by a nationally recognized testing laboratory, inspection agency, or other organization concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner.

PROTECTIVE COATING. As used in this standard, material applied to the exterior surface of the connector to enhance resistance to corrosive materials.

Appendix
Table Of Conversion Factors

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

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

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

Standard cubic foot (SCF) measured @ 60°F and 30 inches Hg, Saturated. (U.S. Conditions)

Standard cubic meter (m^3_s) measured @ 15°C and 760 mm Hg, dry. (SI Conditions)

Normal cubic meter (m^3_n) measured @ 0°C and 760 mm Hg, dry.

Temperature Scales And Conversions

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

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

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

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

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

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

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

Multiples And Submultiples Of Basic Units

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

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

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

APPLIANCES

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

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

Gas-Fired Low Pressure Steam and Hot Water Boilers, Z21.13 • CSA 4.9

Refrigerators Using Gas Fuel, Z21.19 • CSA 1.4

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

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

Performance Testing and Rating of Gas-Fired Air-Conditioning and Heat Pumping Appliances, Z21.40.4•CGA 2.94

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

Vented Decorative Gas Appliances, Z21.50 • CSA 2.22

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

Outdoor Cooking Gas Appliances, Z21.58 • CSA 1.6

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

Portable Type Camp Heaters, Z21.63 • CSA 11.3

Portable Type Camp Cook Stoves, Z21.72 • CSA 11.2

Portable Type Camp Lights, Z21.73 • CSA 11.1

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

Vented Gas Fireplace Heaters, Z21.88 • CSA 2.33

Outdoor Cooking Specialty Gas Appliances, Z21.89 • CSA 1.18

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

Domestic Gas Conversion Burners, Z21.17 • CSA 2.7

Gas Appliance Pressure Regulators, Z21.18 • CSA 6.3 Automatic Valves for Gas Appliances, Z21.21 • CSA 6.5

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

Connectors for Gas Appliances, Z21.24 • CSA 6.10

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

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

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

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

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

Gas Appliance Sediment Traps, Z21.79 • CGA 6.21

Line Pressure Regulators, ANSI Z21.80 • CSA 6.22

Cylinder Connection Devices, ANSI Z21.81 • CSA 6.25

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

Gas Convenience Outlets and Optional Enclosures, ANSI Z21.90 • CSA 6.24

Manually Operated Electric Gas Ignition Systems and Components, ANSI Z21.92 • CSA 6.29

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

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

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

Gas Food Service Equipment, Z83.11 • CGA 1.8

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Fuel Gas Piping Systems Using Corrugated

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

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Direct Gas-Fired Door Air Heaters, CAN1-3.12

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STANDARDS PROPOSAL FORM

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