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NATIONAL STANDARD

ANSI/CAN/UL/ULC 407:2022

STANDARD FOR SAFETY

Manifolds for Compressed Gases

Approved American National Standard
ANSI

ANSI/UL 407-2022

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SCC FOREWORD

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UL Standard for Safety for Manifolds for Compressed Gases, ANSI/CAN/UL/ULC 407

Eighth Edition, Dated December 14, 2022

Summary of Topics

This new edition of ANSI/CAN/UL/ULC 407 dated December 14, 2022 merges relevant content from ULC/ORD-C407 with ANSI/UL 407 to create a single, joint standard applicable in both the USA and Canada.

The new requirements are substantially in accordance with Proposal(s) on this subject dated March 18, 2022 and July 1, 2022.

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ANSI/UL 407-2022

DECEMBER 14, 2022

ANSI/CAN/UL/ULC 407:2022

Standard for Manifolds for Compressed Gases

The first, second and third editions were titled High-Pressure Gas Manifolds.

First Edition – December, 1952
Second Edition – October, 1967
Third Edition – October, 1972
Fourth Edition – April, 1978
Fifth Edition – July, 1993
Sixth Edition – October, 1997
Seventh Edition – June, 2004

Eighth Edition

December 14, 2022

This ANSI/CAN/UL/ULC Safety Standard consists of the Eighth Edition.

The most recent designation of ANSI/UL 407 as an American National Standard (ANSI) occurred on December 14, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, Preface or SCC Foreword.

This standard has been designated as a National Standard of Canada (NSC) on December 14, 2022.

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MANUFACTURING AND PRODUCTION TESTS

MARKING AND INSTRUCTIONS

Preface

This is the Eighth Edition of ANSI/CAN/UL/ULC 407, Standard for Manifolds for Compressed Gases.

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

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

This ANSI/CAN/UL/ULC 407 Standard is under continuous maintenance, whereby each revision is approved in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization. In the event that no revisions are issued for a period of four years from the date of publication, action to revise, reaffirm, or withdraw the standard shall be initiated.

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

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

To purchase UL Standards, visit the UL Standards Sales Site at http://www.shopulstandards.com/HowToOrder.aspx or call tollfree 1-888-853-3503.

This Edition of the Standard has been formally approved by the UL Standards Technical Panel (STP) on Compressed Gas Regulators and Accessories, STP 252.

This list represents the STP 252 membership when the final text in this standard was balloted. Since that time, changes in the membership may have occurred.

STP 252 Membership

Name	Represent	Interest Category	Region
Bob Carney	Western/Scott Fetzer Co.	Producer	USA
David Gailey	Lincoln Electric CO Harris Calorific	Producer	USA
Edgar Wolff-Klammer	UL Solutions	Testing and Standards Org.	USA
James Petersen	Petersen Engineering	General Interest	USA
Jason Keister	NASA Glenn Research Center	Government	USA
Marcel Mandin	Mutual Propane LTD	Commercial / Industrial User	Canada
Miles Mailvaganam	Standards Individuals	General Interest	Canada
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Richard Johnson	Thomas Associates	General Interest	USA
Jeff Prusko	UL Standards & Engagement	Project Manager – Non-voting	USA
John Wade	ULC Standards	STP Chair – Non-Voting	Canada

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This Standard is intended to be used for conformity assessment.

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

CETTE NORME NATIONALE DU CANADA EST DISPONIBLE EN VERSIONS FRANÇAISE ET ANGLAISE

INTRODUCTION

1 Scope

1.1 These minimum requirements cover equipment for manifolding high-pressure gas cylinders to supply gas for various industrial and commercial applications. Cylinders are manifolded for the purpose of centralizing the gas supply, to provide a continuous supply of gas, or to provide gas at a rate in excess of that which may be obtained from a single cylinder.

1.2 The requirements apply to manifolds for the following gases:

a) Acetylene;

b) Oxygen;

c) Fuel gases other than acetylene;

d) Nitrogen, carbon dioxide, air, and inert gases; and

e) Nonflammable medical gases.

1.3 Manifolds covered by this Standard are intended to be installed and used in accordance with the applicable Codes and Regulations as determined by the Authority Having Jurisdiction (AHJ), such as, but not limited to:

a) In the United States:

1) For manifolds other than for nonflammable medical gas, the Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes, NFPA 51;

2) For LP-Gas manifolds, the Liquefied Petroleum Gas Code, NFPA 58;

3) For nonflammable medical gas manifolds, the Standard for Healthcare Facilities, NFPA 99.

b) In Canada:

1) The Natural gas and propane storage and installation code, CSA B149 Series; and

2) Provincial or other Regulations.

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

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered by this standard shall comply with the requirements for that component.

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

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

b) Is superseded by a requirement in this standard.

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

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

2.1.5 A component, as assembled as part of a manifold, shall comply with the requirements for the construction, performance, and use for that component.

2.2 Units of measurement

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

2.3 Reference publications

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

UL 21, *LP-Gas Hose*

UL 508A *Industrial Control Panels*

UL 569, *Pigtails and Flexible Hose Connectors for LP-Gas*

UL 1331, *Station Inlets and Outlets*

UL 1357, *Outline of Investigation for Oxygen-Fuel Gas Combination Flash Arrester and Backpressure Check Valves*

UL 1477, *Outline of Investigation for Compressed Gas Shutoff Valves*

UL 2061, *Adapters and Cylinder Connection Devices for Portable LP-Gas Cylinder Assemblies*

ANSI/CAN/UL/ULC 125, *Standard for Flow Control Valves for Anhydrous Ammonia and LP-Gas*

ANSI/CAN/UL 144, *LP-Gas Regulators*

ANSI/CAN/UL/ULC 252, *Compressed Gas Regulators*

ANSI/CAN/UL/ULC 252A, *Compressed Gas Regulator Accessories*

ANSI/CAN/UL/ULC 404, *Gauges, Indicating Pressure, for Compressed Gas Service*

AIAA G-095A, *Guide to Safety of Hydrogen and Hydrogen Systems*

ASME B31.12 *Hydrogen Piping and Pipelines*

ASTM B858, *Standard Test Method for Ammonia Vapor Test for Determining Susceptibility to Stress Corrosion Cracking in Copper Alloys*

ASTM D471, *Standard Test Method for Rubber Property – Effect of Liquids*

ASTM F1459, *Standard Test Method for Determination of the Susceptibility of Metallic Materials to Hydrogen Gas Embrittlement (HGE)*

ASTM G142, *Standard Test Method for Determination of Susceptibility of Metals to Embrittlement in Hydrogen Containing Environments at High Pressure, High Temperature, or both*

CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*

CSA/AM ANSI/CSA CHMC 1, *Test methods for evaluating material compatibility in compressed hydrogen applications – Metals*

CSA/AM CSA/ANSI CHMC 2:19, *Test methods for evaluating material compatibility in compressed hydrogen applications – Polymers*

CSA 8.1, *Standard for Elastomeric composite hose and hose couplings for conducting propane and natural gas*

CSA 8.3, *Standard for Thermoplastic hose and hose couplings for conducting propane and natural gas*

CSA B149 Series

CSA C22.2 No. 0.14, *Industrial Control Equipment*

CSA C22.2 No. 0.15, *Adhesive Labels*

CSA-C22 No. 286, *Industrial Control Panels And Assemblies*

CAN/CSA-Z305.5, *Medical Gas Terminal Units*

CAN/CSA-Z5359, *Anaesthetic and Respiratory Equipment – Low-Pressure Hose Assemblies for Use with Medical Gases, Medical Vacuum, Medical Support Gases, and Anaesthetic Gas Scavenging Systems*

CAN/CSA-Z9170-1, *Terminal Units for Medical Gas Pipeline Systems – Part 1: Terminal Units for Use with Compressed Medical Gases, Vacuum, and Anaesthetic Gas Scavenging Systems*

ISO 5175-1, *Gas welding equipment – Safety devices – Part 1: Devices incorporating a flame (flashback) arrestor*

ISO TR 15916, *Basic considerations for the safety of hydrogen systems*

NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*

NFPA 58, *Liquefied Petroleum Gas Code*

NFPA 99, *Standard for Healthcare Facilities*

NFC, *National Fire Code of Canada*

3 Types

3.1 Stationary manifolds are those which consist essentially of a wall- or floor-supported header provided with fittings for connection of cylinders by means of leads. One or more permanently mounted regulators serve to reduce and regulate the pressure of the gas from the cylinders to the point of consumption.

3.2 Portable manifolds are of two types:

a) In one type the gas passes from the connected cylinders through individual leads to a single common coupler block, and from there through a single pressure-reducing regulator to the consuming device.

b) In a second type the cylinders are connected by means of coupler tees attached to the shutoff valve of each cylinder. Gas from each cylinder passes through the coupler tee and joins the main stream flowing through a common line composed of leads joining coupler tee to successive coupler tee. From there the gas passes through a single pressure-reducing regulator to the consuming device.

CONSTRUCTION

4 General

4.1 Cast iron and other castings having low tensile strength or low ductile characteristics shall not be used in the construction of manifold parts handling gas at cylinder pressure.

4.2 Joints in manifolds shall be made up using unions or shall be threaded, welded, brazed, or of the socket type using a brazing alloy having a melting point exceeding 1000 °F (538 °C).

4.3 Gaskets shall not be used for making up joints in the manifold.

4.4 Each manifold shall be designed for attachment of one or more compressed-gas regulators for controlling the pressure of the delivered gas.

4.5 Manifolds designed for acetylene, fuel gases other than acetylene, and those designed for nonflammable medical gases, shall be provided with a back-flow check valve between each cylinder and the header, coupler block, or coupler tee to prevent the loss of gas from a bank of connected cylinders if for any reason the pressure-relief device of an individual cylinder should activate and open or a lead is severed. This check valve shall be located in the cylinder lead connecting fitting on the header or coupler block, or in the manifold end of the lead. Where portable manifolds are provided with coupler tees, the check valve shall be located in that portion of the tee connected to the shutoff valve of the cylinder.

4.6 Headers of stationary manifolds may be provided with a manual shutoff valve at each point where a single or a pair of cylinders can be connected.

4.7 Each section of multiple-header type stationary manifolds shall be provided with section shutoff valves to segregate from each other those sections designed to be operated alternately.

4.8 Headers of stationary manifolds shall be mounted on a supporting member, or the necessary mounting plates or brackets for making an installation shall be furnished with each manifold.

4.9 Leads for making connections between cylinders and the manifold shall withstand the specified design rupture strength of the manifold with which they are to be used and shall also withstand manipulation under normal service conditions without kinking, splitting, or cracking.

4.10 Caps or blind plugs provided to close unused cylinder-connecting openings in the manifold and intended for occasional use shall be attached by lengths of chain.

4.11 All manifolds and parts exposed to gas shall be free from grease, oil, dirt, or other foreign substances.

4.12 Copper or copper-bearing alloys exceeding 65 % copper shall not be used in the construction of acetylene-handling parts.

4.13 A decomposition flash arrester designed for use with high-pressure acetylene shall be installed between each cylinder and the manifold and shall comply with the requirements in the following standards as applicable:

a) For CE Code-based installations, ISO 5175-1; and

b) For NEC-based installations, UL 1357.

4.14 Metal parts in contact with oxygen shall be stainless steel or nonferrous metal. Aluminum or aluminum alloys shall not be used for parts in contact with oxygen or oxygen enriched gases, where the percentage of oxygen exceeds 21 % by volume, on manifolds intended to reduce a pressure greater than 435 psig (3000 kPa) to the use pressure.

4.15 Piping or tubing used in the construction of stationary acetylene manifold headers shall have an internal diameter not greater than that of a nominal 1-1/4-inch double extra strong steel pipe.

4.16 Passages in manifolds handling high-pressure acetylene shall be maintained as small as practicable, and all unnecessary voids or spaces shall be eliminated.

4.17 Each stationary acetylene manifold shall be provided with one or more back-pressure seal assemblies for installation in the piping system on the discharge side of pressure-reducing regulators. These seal assemblies may be of either the hydraulic or the dry-seal type.

4.18 Manifolds for nonflammable medical gases service shall be of the stationary multiple header type designed for connection of two primary supply cylinders and secondary supply cylinders.

4.19 Manifolds for nonflammable medical gases shall have a manually operated shutoff valve installed on the high-pressure side of each compressed-gas regulator.

5 Nonflammable Medical Gases Change-Over Device and Operating Alarm Control

5.1 Each nonflammable medical gas manifold shall include in its assembly a change-over device or arrangement whereby the secondary supply is placed in service automatically as the primary supply becomes exhausted. There shall be no interruption of the gas service during the change-over.

5.2 Each nonflammable medical gas manifold assembly shall include provision for connection of a control which will actuate an operating alarm system when change-over from primary to secondary supply has taken place.

6 Nonflammable Medical Gases Lead Couplings

6.1 Couplings on the cylinder end of leads of oxygen manifolds shall be designed for connection to the standard cylinder valve outlet connection No. 540, Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections, CGA V-1.

6.2 Couplings on the cylinder end of leads of nitrous oxide manifolds shall be designed for connection to the standard cylinder valve outlet connection No. 326, Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections, CGA V-1.

7 Gauges

7.1 Gauges for pressures of 1,000 psig (6.9 MPa) up to 5,000 psig (34.5 MPa) shall comply with the requirements in ANSI/CAN/UL/ULC 404.

7.2 Gauges for pressure under 1,000 psig (6.9 MPa) shall comply with the requirements in ANSI/CAN/UL/ULC 252A.

8 LP-Gas Hose

8.1 LP-Gas hose shall comply with the requirements in the following standards, as applicable:

a) For CE Code-based installations: CSA 8.1 or CSA 8.3; and

b) For NEC-based installations: UL 21 or UL 569.

9 Positive Shutoff Valves

9.1 An LPG manually operated positive shutoff valve shall be provided with an attached hand wheel, lever, handle, or the like. The valve shall have a service pressure rating of 2.4 MPa (350 psig) and shall comply with the requirements in ANSI/CAN/UL/ULC 125.

9.2 Compressed gas shutoff valves shall be provided with an attached hand wheel, lever, handle, or the like. The valve shall comply with the requirements in UL 1477.

10 LP-Gas Regulators

10.1 LP-Gas regulators shall comply with ANSI/CAN/UL 144, where applicable.

11 Regulators

11.1 Regulators shall comply with the requirements in ANSI/CAN/UL/ULC 252, where applicable.

12 Quick Connect Coupling

12.1 A LP-Gas manifold with a quick connect coupling hose assembly shall require a tool to uncouple it unless provided with a check valve in the manifold side of the coupling.

13 Station Inlets and Outlets

13.1 Station inlets outlets shall comply with the requirements in the following standards, as applicable:

a) For CE Code-based installations: CAN/CSA-Z305.5 and/or CAN/CSA-Z9170-1; and

b) For NEC-based installations: UL 1331.

14 Medical Hose Assemblies

14.1 Medical hose assemblies shall comply with the requirements in the following standards, as applicable:

a) For CE Code-based installations: CAN/CSA-Z5359; and

b) For NEC-based installations: UL 1331.

15 Control Panels

15.1 Control panels which form a portion of manifold intended for nonflammable gases, either alone or in conjunction with the manifold, shall comply with the requirements in the following standards, as applicable:

a) For CE Code-based installations: CSA-C22.2 No. 14 or CSA-C22 No. 286; and

b) For NEC-based installations: UL 508A

16 Hydrogen Material

16.1 Materials in contact with hydrogen shall be resistant to the action hydrogen embrittlement and hydrogen accelerated fatigue. This shall include the surface finishing techniques (e.g., electro-polishing) and welding which may also introduce hydrogen into a metal, resulting in accelerated embrittlement.

16.2 Materials and design shall be such that there will be no significant change in the functioning of the device, deformation, or mechanical change in the device, and no harmful corrosion, deformation, or deterioration of the materials. Additional consideration shall be made for nonmetallic materials since hydrogen diffuses through these much easier than through metals.

16.3 Dissimilar metals in interconnecting piping, tubing, fittings, and other components shall be avoided, or properly addressed to prevent electrolytic and/or galvanic corrosion. Metal fittings should be compatible with metal tubing materials. If the use of materials from different galvanic groups are used, standard commercial corrosion mitigation methods shall be used.

Note: A Technical Database for Hydrogen Compatibility of Materials may be found at Sandia National Laboratory Technical Reference for Hydrogen Compatibility of Materials. Additional guidance may be found in:

AIAA G-095A, Guide to Safety of Hydrogen and Hydrogen Systems

ASME B31.12 Hydrogen Piping and Pipelines

CSA/AM ANSI/CSA CHMC 1, Test methods for evaluating material compatibility in compressed hydrogen applications – Metals

CSA/AM CSA/ANSI CHMC 2:19 Test methods for evaluating material compatibility in compressed hydrogen applications - Polymers

ISO TR 15916, Basic considerations for the safety of hydrogen systems

16.4 The manufacturer shall provide documentation verifying the materials' suitability including consideration for such characteristics as permeability, creep, long-term aging, stress cracking, and retention of mechanical properties as appropriate. Acceptable materials include stainless steels (304, 304L, 308, 316, 316L, 321, 347, or PH17-7, PH18-8), aluminum alloys, copper, and copper alloys. Unacceptable materials include nickel, most nickel alloys, titanium alloys, gray iron, ductile iron, and malleable cast iron.

16.5 When the manufacturer is unable to provide conclusive evidence of the compatibility of all materials in the hydrogen gas stream, then the embrittlement test shall be performed.

PERFORMANCE

17 Hydrostatic Strength Test

17.1 General

17.1.1 The samples are to be connected to a source of hydrostatic pressure. A positive shut-off valve and a pressure-measuring device are to be installed in the hydrostatic pressure supply piping. The pressure-measuring device is to be installed in the piping between the shut-off valve and the sample under test.

17.1.2 Each pressure-measuring device shall be calibrated over the range that it is used. The test pressure measured shall be not less than 20 % nor more than 80 % of the full-scale reading of the device.

17.1.3 The pressure shall be raised slowly to the required test pressure and held for at least 1 min and withstand rupture or permanent deformation.

17.2 Manifolds for acetylene

17.2.1 Manifolds, cylinder leads, and other parts handling acetylene at cylinder pressure shall withstand, without rupture, a hydrostatically applied test pressure of 10,000 psig (69 MPa).

17.2.2 All other components of the manifold that are subjected to pressure during intended use shall withstand, without rupture or permanent deformation, a hydrostatic pressure of 5 times the rated pressure. The samples shall be tested in the open position and the outlets shall be sealed.

17.3 Acetylene back-pressure seal assembly

17.3.1 Hydraulic back-pressure seal assemblies shall withstand, without rupture, a hydrostatically applied test pressure of 500 psig (3.4 MPa). Sheet steel used in the construction shall have a thickness of not less than 0.053 in (1.35 mm) (No. 16 MSG).

17.3.2 Each hydraulic back-pressure seal assembly shall incorporate a mechanical back-flow check valve to prevent water from the hydraulic chamber being forced into the manifold piping under a back-pressure condition.

17.3.3 Each hydraulic chamber shall be provided with a water-fill opening and a drain opening. Such openings shall be closed by threaded caps or plugs.

17.3.4 The effective depth of the water seal in the hydraulic chamber, and the volume of water in the chamber, shall provide an effective seal.

17.3.5 A back-pressure seal assembly shall be designed to provide flash-back protection.

17.3.6 A mechanical relief valve set to start to discharge at a pressure of not more than 21 psig (144.8 kPa), shall be provided on each back-pressure seal assembly. This relief shall be designed for mechanical self-opening and for connection of vent piping at the installation.

17.4 Manifolds for oxygen

17.4.1 Manifolds, cylinder leads, and other parts handling oxygen at cylinder pressure shall withstand, without rupture, a hydrostatically applied test pressure of 10,000 psig (69 MPa).

17.5 Manifolds for fuel gases other than acetylene

17.5.1 Manifolds, cylinder leads, and other parts handling fuel gases other than acetylene at cylinder pressure shall withstand, without rupture, a hydrostatically applied test pressure of 10,000 psig (69 MPa) or five times the maximum cylinder gas pressure at 70 °F (21.1 °C), whichever is the lesser, but in no case less than 1,000 psig (6.9 MPa).

17.5.2 All other components of the manifold that are subjected to pressure during intended use shall withstand, without rupture, a hydrostatic pressure of five times the rated pressure. The samples shall be tested in the open position and the outlets shall be sealed. Permanent deformation is acceptable.

17.6 Manifolds for nonflammable medical gases, nitrogen, carbon dioxide, air, and inert gases

17.6.1 Manifolds, cylinder leads, and other parts handling gas at cylinder pressure shall withstand, without rupture, a hydrostatically applied test pressure of 10,000 psig (69 MPa) or five times the maximum cylinder gas pressure at 70 °F (21.1 °C), whichever is the lesser.

17.6.2 All other components of the manifold that are subjected to pressure during intended use shall withstand, without rupture, a hydrostatic pressure of five times the rated pressure. The samples shall be tested in the open position and the outlets shall be sealed. Permanent deformation is acceptable.

17.7 LP-gas quick connect coupling leakage test

17.7.1 A LP-Gas quick connect coupling attached to a LP-Gas hose, before being subjected to the LP-Gas Quick Connect Coupling Endurance Test, Section 18, shall withstand, without leakage, an aerostatic pressure of 1.5 times the maximum rated pressure.

Exception: Adapters, fittings or couplings that incorporate a CGA V-1 Standard Connection No. 791 or 810 components shall comply with the applicable requirements of the Standard for Adapters and Cylinder Connection Devices for Portable LP-Gas Cylinder Assemblies, UL 2061.

17.7.2 Two samples of the LP-Gas quick connect coupling attached to a LP-Gas hose shall be connected to a source of aerostatic pressure. A positive shutoff valve and a calibrated pressure gauge having a minimum pressure range of 1.5 times nor more than 2 times the test pressure are to be installed in the pressure-supply piping. The pressure gauge shall be installed in the piping between the shutoff valve and the sample.

17.7.3 While under the applied test pressure all joints and surfaces are to be examined for evidence of leakage. This shall be done by submerging the sample in water or applying a soap-and-water solution or other leak-detection solution to all the surfaces.

18 LP-Gas Quick Connect Coupling Endurance Test

18.1 The quick connect coupling shall not become inoperative or have its corrosion protection impaired when tested as specified in accordance with 18.2.

Exception: Adapters, fittings or couplings that incorporate a CGA V-1 Standard Connection No. 791 or 810 components shall comply with the applicable requirements of the Standard for Adapters and Cylinder Connection Devices for Portable LP-Gas Cylinder Assemblies, UL 2061.

18.2 Two samples shall be tested. One end of the hose assembly with quick connect couplings shall be connected to a source of aerostatic pressure and secured to a test stand. The mating part that is closed or blocked is to be connected to the supply side of the assembly using forces and torques as appropriate to make the connection. The assembly shall then be pressured to maximum rated pressure and released. The mating part shall then be disconnected from the supply side using forces and torques as appropriate to make the disconnection. This is one cycle. This shall be repeated for a total of 1,000 cycles. After the endurance cycles, each sample shall comply with the LP-Gas Quick Connect Coupling Leakage Test, Section 17.7. Then one sample shall comply with the Hydrostatic Test, Section 17 and the other sample shall comply with the Pull Force Test, Section 19.

19 Pull Force Test

19.1 A LP-Gas quick connect coupling attached to a LP-Gas hose shall withstand the longitudinal pull of 400 lbf (1775 N) without separating or becoming inoperative, when tested in accordance with 19.2.

Exception: Adapters, fittings or couplings that incorporate a CGA V-1 Standard Connection No. 791 or 810 components shall comply with the applicable requirements of the Standard for Adapters and Cylinder Connection Devices for Portable LP-Gas Cylinder Assemblies, UL 2061.

19.2 The connecting fitting on each end of the sample is to be assembled with a corresponding companion part and tightened. With the two parts connected together as intended in service, and one end rigidly anchored, an axial load of 400 lbf (1775 N) is to be applied at a rate not in excess of 600 lbf/min (2700 N/min).

20 Start-to-Discharge Test

20.1 The average start-to-discharge pressure, as defined in 20.2, for a relief valve shall be at least 75 % but shall not exceed 110 % of the manufacturer's setting.

20.2 To determine compliance with 20.1, three samples of the reseating relief device of each pressure rating are to be tested. Each sample is to be connected to a source of oil-free air or nitrogen. With the sample immersed in water at a depth less than 1 in (25.4 mm) the pressure is to be gradually increased at a rate of 25 psi/min (1724 kPa/min) until bubbles start to appear. This start-to-discharge pressure value is to be recorded. The pressure shall be increased to ensure unseating of the relief valve seat. The pressure is then to be gradually decreased until no more bubbles are noted. This reseat pressure value is to be recorded. The reseat pressure value shall be 75 % or more of the measured start-to-discharge pressure value.

21 Moist Ammonia-Air Stress Cracking Test

21.1 After being subjected to the conditions described in 21.2 – 21.4, a brass part containing more than 15 % zinc shall:

a) Show no evidence of cracking, delamination, or degradation; or

b) Perform as intended when tested as described in 21.5.

21.2 One test sample of each size is to be subjected to the physical stresses normally imposed on or within a part as the result of assembly with other components. Samples with female threads, intended to be used for installing the product in the field are to have the threads engaged and tightened to the torque