ANSI/CAN/UL 536:2021

JOINT CANADA-UNITED STATES
NATIONAL STANDARD

STANDARD FOR SAFETY

Flexible Metallic Hose

ANSI/UL 536-2021

SCC FOREWORD

National Standard of Canada

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UL Standard for Safety for Flexible Metallic Hose, ANSI/CAN/UL 536

Eleventh Edition, Dated August 9, 2021

Summary of Topics

This new edition of ANSI/CAN/UL 536 has been issued to reflect the latest ANSI and SCC approval dates, and to incorporate the proposals dated April 9, 2021.

The new requirements are substantially in accordance with Proposal(s) on this subject dated April 9, 2021.

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ANSI/UL 536-2021

AUGUST 9, 2021

ANSI/CAN/UL 536:2021

Standard for Flexible Metallic Hose

First Edition – August, 1958
Second Edition – January, 1963
Third Edition – July, 1970
Fourth Edition – February, 1972
Fifth Edition – December, 1976
Sixth Edition – August, 1984
Seventh Edition – April, 1989
Eighth Edition – December, 1993
Ninth Edition – July, 1997
Tenth Edition – December, 2014

Eleventh Edition

August 9, 2021

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

The most recent designation of ANSI/UL 536 as an American National Standard (ANSI) occurred on August 9, 2021. 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 August 9, 2021.

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Preface

This is the Eleventh Edition of ANSI/CAN/UL 536, Standard for Flexible Metallic Hose.

UL is accredited by the American National Standards Institute (ANSI) and 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 536 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.

This Joint American National Standard and National Standard of Canada is based on, and now supersedes, the Tenth Edition of UL 536 as well as ULC/ORD-C536:1998-R2018.

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 toll free 1-888-853-3503.

This Edition of the Standard has been formally approved by the UL Standards Technical Panel (STP) on LP-Gas Hose, Pigtails, and Flexible Connectors, STP 21.

This list represents the STP 21 membership when the final text in this standard was balloted. Since that time, changes in the membership may have occurred.

STP 21 Membership

Name	Representing	Interest Category	Region
Rick Baxter	The Inspections Group	AHJ	Canada
Timothy Hampton	Parker Hannifin	Producer	USA
Terry Jackson	Accuflex Industrial Hose Ltd.	Producer	Canada
Yeon Kim	US Consumer Product Safety Commission	Non-voting member	USA

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STP 21 Membership Continued

Name	Representing	Interest Category	Region
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International Classification for Standards (ICS): 75.200, 75.160.30

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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 requirements cover flexible metallic hose supplied with fittings on each end that facilitate connection without twisting the hose. They have a corrugated metal core or a nonmetallic inner core which are covered with a stainless steel braid. They have a nominal inside diameter of not more than 4 in (101 mm) intended for use in piping systems carrying compressed gases, such as anhydrous ammonia, and combustible fuel gases such as natural gas, liquefied petroleum gas, propane, and butane, at pressures not exceeding 500 psig (3.45 MPa) and temperatures not greater than 450 °F (232 °C) or lower than –40 °F (–40 °C).

1.2 Flexible metallic hose is intended for aboveground applications and for underground applications not involving contact with soil.

1.3 Flexible metallic hose is not considered a substitute for standard pipe or tubing and its use should be confined to applications where flexible connections cannot be avoided.

1.4 Flexible metallic hose is not intended to be subjected to excessive torsion, tension, compression, or bending stresses and shall be protected against physical damage and ignition sources.

1.5 This standard does not apply to hose connectors used in natural gas processing plants, refineries, petrochemical plants, marine terminals, or gas-transmission and distribution-piping systems.

1.6 These products have not been evaluated for use after fires, natural disasters such as earthquakes, or excessive physical damage beyond the expected assembly, installation and uses as identified in these requirements.

1.7 These products are intended to be periodically inspected and maintained for continued service, or taken out of service if necessary by qualified persons in accordance with industry recommended practices and/or the manufacturer's instructions.

1.8 Products covered by these requirements are intended to be installed and used in systems 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) National Fuel Gas Code, NFPA 54/ANSI Z223.1;

2) Liquefied Petroleum Gas Code, NFPA 58; and

3) Applicable Federal and State regulations for gas piping.

b) In Canada:

1) National Fire Code of Canada;

2) Installation Code for Oil Burning Equipment, CSA B139;

3) The Environmental Codes of Practice for Aboveground and Underground Storage Tank Systems containing Petroleum and Allied Products;

4) Natural Gas Installation Code, CAN/CGA-B149.1; and

5) Propane Installation Code, CAN/CGA-B149.2.

1.9 This standard does not cover the following:

a) Gas appliance hose connectors for handling fuel gases at 5 psig (34.5 kPa) or less, which is covered by Connectors for Gas Appliances, CSA 6.10/ANSI Z21.24;

b) Portable outdoor cooking appliance fuel hose, which is covered by Gas Hose Connectors for Portable Outdoor Gas-Fired Appliances, CSA 8.4/ANSI Z21.54;

c) LP-Gas and natural gas delivery hose or fuel supply systems, which is covered by the Standard for Pigtails and Flexible Hose Connectors for LP-Gas, UL 569 and the Standard for LP-Gas Hose, UL 21 or the Standard for Elastomeric composite hose and hose couplings for conducting propane and natural gas, CSA 8.1, and the Standard for Thermoplastic hose and hose couplings for conducting propane and natural gas, CSA 8.3;

d) Underground piping products for liquid fuels, which is covered by the Outline of Investigation for Metallic Underground Fuel Pipe, UL 971A, or the Standard for Metallic and Nonmetallic Underground Piping for Flammable and Combustible Liquids, CAN/ULC-S679;

e) Flexible connector piping for liquid fuels, which is covered by the Standard for Flexible Connector Piping for Fuels, UL 2039, or the Standard for Flexible Connector Piping for Fuels, CAN/ULC-S633;

f) Motor fuel dispensing hose, which is covered by the Standard for Hose and Hose Assemblies for Dispensing Flammable and Combustible Liquids, ANSI/CAN/UL 330.

2 Components

2.1 Except as indicated in 2.2, a component of a product covered by this standard shall comply with the requirements for that component.

2.2 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.

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

2.4 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.

3 Units of Measurement

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

4 Referenced Publications

4.1 The documents shown below are referenced in the requirements text of this standard. Unless otherwise stated elsewhere in this Standard such reference shall be interpreted as referring considered to indicate the latest edition and/or revisions of that code the document available at the date on which the Committee approved this UL/ULC Standard.

UL Standards
ANSI/UL 21, *Standard for LP-Gas Hose*
ANSI/CAN/UL 330, *Standard for Hose and Hose Assemblies for Dispensing Flammable and Combustible Liquids*
ANSI/UL 569, *Standard for Pigtails and Flexible Hose Connectors for LP-Gas*
UL 971A, *Outline of Investigation for Metallic Underground Fuel Pipe*
ANSI/UL 2039, *Standard for Flexible Connector Piping for Fuels*

ULC Standards
CAN/ULC-S633, *Standard for Flexible Connector Piping for Fuels*
CAN/ULC-S679, *Standard for Metallic and Nonmetallic Underground Piping for Flammable and Combustible Liquids*

Other Standards
ASME B1.20.1, *Standard for Pipe Threads, General Purpose (Inch)*
ANSI/ASME B36.10M, *Standard for Welded and Seamless Wrought Steel Pipe*
ASTM D380, *Standard Test Methods for Rubber Hose*
ASTM B858, *Standard Test Method for Ammonia Vapor Test for Determining Susceptibility to Stress Corrosion Cracking in Copper Alloys*
ASTM D3902, *Standard Test Method for Rubber Hose for Gas Diffusion of Liquefied Petroleum Gas*
ASTM D471, *Standard Test Method for Rubber Property – Effect of Liquids*
CSA B149 Series, *Propane storage and handling code*
CSA 6.10/ANSI Z21.24, *Connectors for Gas Appliances*
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 8.4/ANSI Z21.54, *Gas Hose Connectors for Portable Outdoor Gas-Fired Appliances*
NFC, *National Fire Code of Canada*
NFPA 54, *National Fuel Gas Code*
NFPA 58, *Liquefied Petroleum Gas Code*

Abbreviations
ANSI – American National Standards Institute
ASME – American Society of Mechanical Engineers
ASTM – American Society for Testing and Materials
CSA – CSA Group
NFPA – National Fire Protection Association

CONSTRUCTION

5 Materials

5.1 Flexible metallic hose may be metallic, nonmetallic, or composite. The nonmetallic or composite inner hose shall be provided with a metal braid covering which may be additionally covered by a jacket.

5.2 As ammonia containing minute quantities of water will react rapidly with copper, zinc, tin, and many alloys, especially those of copper base, only iron, steel, and nonferrous alloys shown to be acceptable for ammonia service shall be used for flexible metallic hose intended for anhydrous ammonia service.

5.3 Flexible metallic hose shall be constructed to resist the effects of external fire. If soldering or brazing is used in the construction of the hose, the filler material shall have a melting point exceeding 1000 °F (538 °C).

5.4 Flexible metallic hose shall be fabricated in lengths, measured between couplings, of not more than 60 in (1.52 m).

5.5 A part shall be resistant to atmospheric corrosion and attack by the gas it may contact during intended service if the corrosion of such a part may permit leakage. Ferrous materials of the thickness and intended for the applications specified in Table 5.1 are considered acceptable when uncoated.

Table 5.1
Thickness of Uncoated Nonstainless Ferrous Materials

Kind of gas in contact with material	Minimum thickness			
	Sheet metal,		Castings,	
	inches	(mm)	inches	(mm)
Manufactured and natural fuel gases	0.068	(1.73)	3/16	(4.8)
LP-Gas at pressure above 1 psig (6.9 kPa)	0.125	(3.18)	1/4	(6.4)
Anhydrous ammonia	0.125	(3.18)	1/4	(6.4)

5.6 Cadmium plating shall not be less than 0.0003 in (0.008 mm) thick, and zinc plating shall not be less than 0.0005 in (0.013 mm) thick, except on parts where threads constitute the major portion of the area, in which case the cadmium or zinc plating shall not be less than 0.00015 in (0.0038 mm) thick.

5.7 A gas containing part shall be made of material having a melting point (solidus temperature) higher than 1000 °F (538 °C) and a tensile strength not less than 10,000 psig (69 MPa) at 400 °F (204 °C).

6 Assembly

6.1 One end of each length of flexible metallic hose shall terminate in a permanently attached pipe flange, separable coupling, or union to facilitate connection without twisting the hose. The other end of each length shall be similarly equipped or shall terminate in a screwed or flanged fitting.

6.2 Pipe threads shall be in accordance with the Standard for Pipe Threads, General Purpose (Inch), ANSI/ASME B1.20.1.

Exception: Flexible metal hose which incorporate other than NPT type threads shall be permitted provided the pipe threads comply with a national pipe thread standard and the thread type is marked on the hose.

6.3 Flexible metallic hose connections that are flanges shall comply with a National/Bi-National Standard for pipe flanges and flanged fittings.

PERFORMANCE

7 General

7.1 Flexible metallic hose shall be tested on the following basis consistent with the intended use of the product:

a) Size or diameter.

b) Minimum length.

c) Minimum radius of bend.

d) Maximum rated pressure.

7.2 The radius of bend to be employed for tests is to be the minimum specified by the manufacturer if less than those specified in Table 7.1. Otherwise, the values specified in Table 7.1 are to apply.

Table 7.1
Radius of Bend for Tests

Nominal inside diameter,		Bending radius (to centerline of hose),	
inches	(mm)	inches	(mm)
1/4	(6.4)	3	(76)
5/16	(7.9)	4	(102)
3/8	(9.5)	5	(127)
1/2	(12.7)	6	(152)
3/4	(19.1)	8	(203)
1	(25.4)	10	(254)
1-1/4	(31.8)	13	(330)
1-1/2	(38.1)	16	(406)
2	(50.8)	20	(508)
2-1/2	(63.5)	25	(635)
3	(76.2)	31	(787)
4	(101.6)	42	(1067)

7.3 If flexible metallic hose is made in larger than 4 in (101.6 mm) diameters, the 4 in (101.6 mm) diameters are considered to be representative of the larger diameter flexible metallic hose.

7.4 If samples are specified for tests involving bending of the sample, the length of sample is to be such that the hose may be bent over an arc of at least 45° with the radius of curvature designated for the test. If samples are specified to be the shortest, they are to be prepared using the minimum length to be designated by the manufacturer as indicated in 7.1(b) or the shortest length the test equipment is capable of testing, whichever is longer.

7.5 Tests are shall be conducted in the order in which they are presented, using new samples for each test. If a manufacturer desires to reduce the number of samples, tests such as the Temperature Test, Section 13, and Flame Test, Section 14, may be conducted using samples previously subjected to other tests, such as the Hydrostatic Strength Test, Section 8.

7.6 Water or other nonhazardous liquid is not prohibited from being used for developing the required pressure in a hydrostatic pressure strength test.

8 Hydrostatic-Strength Test

8.1 A flexible metallic hose assembly of length sufficient to make a 90° bend based on the radius of curvature as specified in 7.2 is to be used in this test. The hose shall not leak nor rupture when subjected for at least 1 min to a hydrostatic pressure equivalent to five times its maximum rated pressure.

8.2 One sample of each diameter is to be used in this test. The sample is to be installed in a straight line, with one end attached to the pressure source and other end plugged and free.

8.3 The pressure is to be uniformly raised to 1-1/2 times rated pressure and maintained at that pressure for at least 1 min. The hose is then to be bent 90° with a radius of curvature as specified in 7.2 and the pressure maintained for one additional minute.

8.4 With the hose maintained in the bent position, the pressure shall be increased to five times the maximum rated pressure and held for at least 1 min.

9 Vibration Test

9.1 Flexible metallic hose shall not leak or show evidence of damage when subjected to vibration as specified in 9.3 while pressurized as specified in 9.4 and 9.5 and subjected to vibration of an amplitude of 0.075 in (1.91 mm) and a frequency of 900 to 1000 vibrations per minute for at least 300 h.

9.2 Two samples 16 in (406 mm) long or the shortest manufactured length, of each diameter, are to be used in this test. One sample of each diameter is to be installed in a vibration machine in a straight line. The other sample of each diameter is to be similarly installed, except that it is to be bent with a radius of curvature as specified in 7.2.

9.3 The vibration machine is to provide means for applying hydrostatic pressure to any one end of the sample, and that end is to be mounted so as to be stationary. The opposite end of the sample is to be plugged and subjected to a motion in one plane. The motion is to have a displacement of 0.15 in (3.81 mm).

9.4 The maximum rated pressure is to be maintained in the sample during the period of vibration.

9.5 The sample is to be subjected to vibration for at least 300 h, after which the hydrostatic pressure is to be increased to 1-1/2 times maximum rated pressure and then immediately released.

10 Flexure Test

10.1 Flexible metallic hose shall not leak or show evidence of damage when pressurized as specified in 10.4 and 10.5 and subjected to 20,000 cycles of flexing in one plane through an appropriate radius of curvature.

10.2 Two samples of each diameter of a length suitable for bending are to be used in this test. Each sample is to be installed in a motion machine capable of bending the hose from a straight-line position through an arc of 45° in one plane with a radius of curvature as specified in 7.2 and then back to a straight-line position. This is one cycle.

10.3 The motion machine is to provide means for applying hydrostatic pressure to one end of the sample, and that end is to be mounted so as to be stationary. The opposite end of the sample is to be plugged.

10.4 The maximum rated pressure is to be maintained in the sample while it is being flexed at the maximum rate of 10 cycles/min for a total of 20,000 cycles.

10.5 At the end of the cycling period, the hydrostatic pressure is to be increased to 1-1/2 times maximum rated pressure and then immediately released.

11 Tension Test

11.1 Flexible metallic hose shall not leak or elongate more than 3 % of its exposed length, as measured between couplings, when pressurized as specified in 11.5 and 11.6, and subjected to the ultimate tension load specified in Table 11.1.

Table 11.1
Maximum Tension for Tests

Inside diameter,		Maximum tension,	
inches	(mm)	lbf	(N)
1/4 – 5/16	(6.4 – 7.9)	250	(1112)
3/8 – 1/2	(9.5 – 12.7)	300	(1334)
3/4	(19.1)	350	(1557)
1	(25.4)	400	(1779)
1-1/4	(31.8)	500	(2224)
1-1/2	(38.1)	600	(2669)
2	(50.8)	800	(3579)
2-1/2	(63.5)	1000	(4448)
3	(76.2)	1200	(5338)
4	(101.6)	1600	(7117)

11.2 One sample of each diameter not exceeding 28 in (711 mm) in overall length is to be used in this test. The samples are to be installed in a tension-testing machine.

11.3 The mounting is to provide means for applying hydrostatic pressure to one end of the sample. The opposite end is to be plugged. An internal pressure of 25 psig (172 kPa) is to be applied to the sample during this test.

11.4 The tension on the sample is then to be applied in increments of 100 lbf (445 N) until the maximum specified in Table 11.1 has been attained.

11.5 The elongation is to be measured under the conditions of maximum tension.

11.6 The tension is then to be relieved and the pressure is to be increased to 1-1/2 times the maximum rated pressure and then immediately released.

12 Torsion Test

12.1 Flexible metallic hose shall not leak or show evidence of damage when subjected to the maximum torsion stresses specified in Table 12.1 and then pressurized as specified in 12.3.

Table 12.1
Maximum Torsion for Tests

Inside diameter,		Maximum torsion,	
inches	(mm)	lbf·in	(N·m)
1/4 – 5/16	(6.4 – 7.9)	100	(11.3)
3/8 – 1/2	(9.5 – 12.7)	150	(16.9)
3/4	(19.1)	200	(22.6)
1	(25.4)	250	(28.2)
1-1/4	(31.8)	300	(33.9)
1-1/2	(38.1)	350	(39.6)
2	(50.8)	450	(50.8)
2-1/2	(63.5)	550	(62.1)
3	(76.2)	650	(73.4)
4	(101.6)	850	(96.0)

12.2 One sample of the shortest length of each diameter is to be used in this test. One end of the sample is to be firmly secured. The other end is to be so anchored, with the flexible metallic hose in a straight line, that it may be rotated. A torsional stress is then to be applied to the fitting at the rotatable end until the maximum specified in Table 12.1 has been attained.

12.3 With the torsional stress removed, the sample is then to be subjected for at least 1 min to a hydrostatic pressure of 1-1/2 times maximum rated pressure and then immediately released.

13 Temperature Test

13.1 Flexible metallic hose shall not leak when pressurized as specified in 13.3 after being subjected to an elevated temperature specified in 13.2.

13.2 One sample of intermediate length of each diameter is to be used in this test. Each sample shall be placed in a circulating air oven at 450 ±1.8 °F (232.2 ±1 °C) for at least 100 h.

13.3 At the end of the oven exposure, the sample is to be cooled to 77 ±5.4 °F (25 ±3 °C) and is then to be subjected for at least 1 min to a hydrostatic pressure of 1-1/2 times the maximum rated pressure.

14 Flame Test

14.1 Flexible metallic hose shall not leak or show evidence of damage when pressurized as specified in 14.5 and 14.6 after being subjected to the flame test specified in 14.2 – 14.4.

14.2 One sample of each diameter and at least 12 in (305 mm) long between couplings is to be used in this test. A lineal section of 6 in (152 mm) is to be suspended horizontally at a vertical distance of 3 in (76.2 mm) above and parallel to a strip pipe gas burner.

14.3 The burner is to be constructed of 3/4 in (19 mm) Schedule 40 iron pipe (Standard for Welded and Seamless Wrought Steel Pipe, ANSI/ASME B36.10M) having a straight line of 1/16 in (1.6 mm) drilled ports, on 1/2 in (12.7 mm) centers, located along the top for a distance of 8 in (203 mm). A gas pressure equal to 1 in (25.4 mm) water column is to be maintained in the pipe when gas equivalent to natural gas having approximately 1000 BTU/ft^3 (37.3 MJ/m^3) is employed.

14.4 The flame resulting from this apparatus is to burn under at least 6 in (152 mm) of the exposed length of hose and under one coupling or union at one end. The sample is to be subjected to the flame for at least 5 min.

14.5 At the end of the flame exposure, the sample is to be cooled to 77 ±5.4 °F (25 ±3 °C) and is then to be subjected for at least 1 min to a hydrostatic pressure of 1-1/2 times maximum rated pressure.

14.6 The pressure is then to be increased to five times maximum rated pressure and then immediately released.

15 Compression Test

15.1 Flexible metallic hose shall not leak when subjected to the pressure specified in 15.4 after being subjected to an external load specified in 15.3.

15.2 One sample of intermediate length of each diameter is to be used in this test. A hydrostatic pressure of 25 psig (172 kPa) is to be maintained within the sample when under test.

15.3 With the sample supported uniformly along its length, a load of 1000 lbf (4448 N) is to be successively applied by a flat metal surface over a distance of 1 in (25.4 mm) along the length of the hose at three equally spaced locations. The load at each location is to be maintained for at least 1 min.

15.4 The sample is then to be subjected for at least 1 min to a hydrostatic pressure of five times the maximum rated pressure.

16 Bending Test

16.1 Flexible metallic hose shall not leak when pressurized as specified in 16.4 after being subjected to repeated bending specified in 16.2 and 16.3.

16.2 One sample of each diameter of a length suitable for bending is to be used in this test. The sample is to be supported uniformly along its length, as on a table.

16.3 The sample is to be bent and straightened 50 times to an arc of 45° having a radius of 60, then 50, then 40, and 30 % of the minimum radius of bend as specified in 7.2. This is one cycle. The 50 cycles of bending and straightening are to be completed for each radius before bending at the next lower radius is commenced.

16.4 Upon completing 50 bends at 30 % of the minimum bend radius the sample is then to be subjected for at least 1 min to a hydrostatic pressure of 1-1/2 times the maximum rated pressure.

17 Moist Ammonia-Air Stress Cracking Test

17.1 After being subjected to the conditions described in 17.2 – 17.4, 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 17.5.

17.2 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