ANSI/CAN/UL 330A:2024

JOINT CANADA – UNITED STATES NATIONAL STANDARD

STANDARD FOR SAFETY

Hose and Hose Assemblies for Use With Dispensing Devices Dispensing Gasoline and Gasoline/Ethanol Blends With Nominal Ethanol Concentrations Up To 85 Percent (E0 – E85)

ANSI/UL 330A-2024

SCC FOREWORD

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UL Standard for Safety for Hose and Hose Assemblies for Use With Dispensing Devices Dispensing Gasoline and Gasoline/Ethanol Blends With Nominal Ethanol Concentrations Up To 85 Percent (E0 – E85), ANSI/CAN/UL 330A

Second Edition, Dated May 31, 2024

Summary of Topics

This new Second Edition of ANSI/CAN/UL 330A dated May 31, 2024 is being issued as a new joint US/Canada Standard reflecting the latest ANSI and SCC approval dates and incorporating the proposal dated February 2, 2024 and April 5, 2024.

The new requirements are substantially in accordance with Proposal(s) on this subject dated February 2, 2024 and April 5, 2024.

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ANSI/UL 330A-2024

MAY 31, 2024

1

ANSI/CAN/UL 330A:2024

Standard for Hose and Hose Assemblies for Use With Dispensing Devices Dispensing Gasoline and Gasoline/Ethanol Blends With Nominal Ethanol Concentrations Up To 85 Percent (E0 – E85)

First Edition – November, 2019

Second Edition

May 31, 2024

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

The most recent designation of ANSI/UL 330A as an American National Standard (ANSI) occurred on May 31, 2024. 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 May 31, 2024.

No Text on This Page

CONTENTS

MANUFACTURING AND PRODUCTION TESTS

MARKING

ANNEX A (Normative) – TEST FLUIDS

No Text on This Page

Preface

This is the Second Edition of ANSI/CAN/UL 330A, Standard for Hose and Hose Assemblies for Use With Dispensing Devices Dispensing Gasoline and Gasoline/Ethanol Blends With Nominal Ethanol Concentrations Up To 85 Percent (E0 – E85).

ULSE 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 330A 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.

Annex A isidentified as Normative, as such, form mandatory parts of this Standard.

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 Second Edition joint American National Standard and National Standard of Canada is based on, and now supersedes, the First Edition of UL 330A.

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 Collaborative Standards Development System (CSDS) at https://csds.ul.com.

This Edition of the Standard has been formally approved by the Technical Committee (TC) on Hose And Hose Assemblies For Dispensing Flammable Liquids, TC 330.

This list represents the TC 330 membership when the final text in this Standard was balloted. Since that time, changes in the membership may have occurred.

TC 330 Membership

Name	Representing	Interest Category	Region
D. Boyd	BP America Inc	Commercial / Industrial User	USA
D. Duncan	Irpco LLC	Producer	USA
J. Dutton	Standards Individuals	General Interest	Canada
J. Grau	Parker Hannifin	Producer	USA

TC 330 Membership Continued on Next Page

TC 330 Membership Continued

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W. Koch	Technology Resources International, Inc.	Commercial / Industrial User	USA
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International Classification for Standards (ICS): 23.040.70, 75.200, 75.160.20

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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 hose and hose assemblies, including vapor recovery hose and assemblies, for use on dispensing devices for motor fuels. A flammable liquid hose assembly consists of flexible hose and fittings suitable for attachment to motor fuel dispensing equipment. Motor fuels, as defined by these requirements, include one or more of the fuels described in 1.3.

1.2 Hose and hose assemblies for gasoline/ethanol blends with nominal ethanol concentrations up to 85 percent (E0 – E85) shall be constructed to comply with the following:

a) The requirements defined in UL 330, Standard for Hose and Hose Assemblies for Dispensing Flammable and Combustible Liquids, and

b) The requirements in this Standard.

1.3 Hose and hose assemblies covered by these requirements are intended for use with one or more of the following motor fuels:

a) Gasoline formulated in accordance with the Standard Specification for Automotive Spark-Ignition Fuel, ASTM D4814;

b) Gasoline/ethanol blends with nominal ethanol concentrations up to 25 percent ethanol (E25), consisting of gasoline formulated in accordance with the Standard Specification for Automotive Spark-Ignition Fuel, ASTM D4814, when blended with denatured fuel ethanol formulated to be consistent with the Standard Specification for Denatured Fuel Ethanol for Blending With Gasoline for Use as Automotive Spark-Ignition Engine Fuel, ASTM D4806; or

c) Gasoline/ethanol blends with nominal ethanol concentrations above 25 percent formulated in accordance with the Standard Specifications in (b) or formulated in accordance with the Standard Specification for Ethanol Fuel Blends for Flexible-Fuel Automotive Spark-Ignition Engines, ASTM D5798, as applicable.

1.4 Products 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) Flammable and Combustible Liquids Code, NFPA 30;

2) Code for Motor Fuel Dispensing Facilities and Repair Garages, NFPA 30A;

b) In Canada:

1) The National Fire Code of Canada;

2) Provincial or other Regulations.

1.5 These requirements cover hose and hose assemblies (hose with couplings attached) in sizes up to and including 1.5 inches (38.1 mm).

1.6 Hose for conveying liquid fuel is intended for use at a maximum working pressure of 50 psig (345 kPa). Hose for conveying fuel vapors is intended for use at a maximum working pressure of 0.5 psig (3.4 kPa), including slight negative pressures from vacuum assist systems.

1.7 These requirements cover hose and hose assemblies for use at temperatures down to –40 °F (–40 °C) or optionally down to –65 °F (–54 °C).

1.8 These requirements also cover fuel hose assemblies optionally designated as “low permeation.” For the purposes of this Standard, permeation is considered to encompass fuel loss through the flexible hose, fuel loss at the fittings and fuel loss at the connection between the hose assembly and the equipment to which it is intended to be attached in the dispensing system.

1.9 These requirements do not cover hose or hose assemblies, intended for use in automotive vehicles or in confined areas, except for locations inside the housings of dispensing devices complying with the Standard for Power-Operated Dispensing Devices for Gasoline and Gasoline/Ethanol Blends with Nominal Ethanol Concentrations Up To 85 Percent (E0 – E85), UL 87A.

1.10 These requirements do not cover hoses or hose assemblies for use with any other fuel other than as described in 1.3.

1.11 Products intended to be rated for use with gasoline or gasoline/ethanol blends with nominal ethanol concentrations:

a) Up to 25 % (E0 – E25) shall be evaluated using the CE25a test fluid as the only applicable test fluid;

b) Up to 40 % (E0 – E40) shall be evaluated using both the CE25a and CE40a test fluid; or

c) Up to 85 % shall be evaluated using both the CE25a and the CE85a test fluids.

1.12 For requirements for hose and hose assemblies for biodiesel fuel, diesel/biodiesel blends with nominal biodiesel concentrations up to 20 % (B20), refer to UL 330B.

2 Units of Measurement

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

3 Referenced Publications

3.1 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.

3.2 The following publications are referenced in this Standard:

ASME B1.20.1, *Standard for Pipe Threads, General Purpose (Inch)*

ASME B36.10M, *Standard for Welded and Seamless Wrought Steel Pipe*

ASTM A653/A653M, *Specification for Sheet Steel, Zinc Coated (Galvanized) or Zinc-Iron-Alloy Coated (Galvannealed) by the Hot Dip Process*

ASTM D412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension*

ASTM D413, *Standard Test Methods Rubber Property – Adhesion to Flexible Substrate*

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

ASTM D573, *Standard Test Method for Rubber – Deterioration in an Air Oven*

ASTM D1149, *Standard Test Method for Rubber Deterioration – Cracking in an Ozone Controlled Environment*

ASTM D3183, *Standard Practice for Rubber – Preparation of Pieces for Test Purposes from Products*

ASTM D3699, *Standard Specification for Kerosene*

ASTM D4806, *Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel*

ASTM D4814, *Standard Specification for Automotive Spark-Ignition Fuel*

ASTM D5798, *Standard Specification for Ethanol Fuel Blends for Flexible-Fuel Automotive Spark-Ignition Engines*

ASTM G155, *Standard Practice For Operating Xenon Arc Lamp Apparatus For Exposure Of Materials*

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

NFPA 30, *Flammable and Combustible Liquids Code*

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Garages*

NFPA 58, *Liquefied Petroleum Gas Code*

NFC, *National Fire Code of Canada*

UL 157, *Gaskets and Seals*

UL 330, *Hose and Hose Assemblies for Dispensing Flammable and Combustible Liquids*

UL 330B, *Hose and Hose Assemblies for Use With Dispensing Devices Dispensing Diesel Fuel, Biodiesel Fuel, Diesel/Biodiesel Blends With Nominal Biodiesel Concentrations Up To 20 Percent (B20), Kerosene, and Fuel Oil*

UL/ULC 567A, *Emergency Breakaway Fittings, Swivel Connectors, and Pipe-Connection Fittings for Gasoline and Gasoline/Ethanol Blends with Nominal Ethanol Concentrations of 85 Percent (E0 – E85)*

UL 969, *Marking and Labeling Systems*

UL 1332, *Organic Coatings for Steel Enclosures for Outdoor Use Electrical Equipment*

4 Glossary

4.1 For the purposes of this Standard, the following definitions apply.

4.2 AUTHORITY HAVING JURISDICTION (AHJ) – The governmental body responsible for the enforcement of any part of this Standard or the official or agency designated by that body to exercise such a function.

4.3 ADJUSTED MASS LOSS – The mass loss of the blank (unfilled hose assembly) subtracted from the mass loss of a filled hose assembly. The purpose of this is to adjust for factors other than fuel permeation that may affect mass loss.

4.4 BALANCE VAPOR RECOVERY HOSE – A coaxial hose consisting of an inner line for conveying fuel and an outer line. Fuel vapors are permitted to return to the fuel dispenser in the annular space between the two lines.

4.5 BLENDING OPTION – Blending at the dispenser level that blends two specific fuels into the fuel to be dispensed. The fuel to be dispensed can be any of a number of set points. For example, blending includes blend options where gasoline and ethanol can be blended to achieve E40, E60, and E85 as the actual dispensed fuel.

4.6 DISPENSING DEVICE – A product consisting of various components that is used to control and meter the flow of liquid from an upstream storage device.

4.7 HOSE ASSEMBLY VOLUME (V) – The total volume in cubic centimeters of a capped hose assembly, calculated as follows:

$$V = D^2 (L + 2d)\pi / 4$$

in which:

D = the inner diameter of the hose in centimeters, as determined in 17.5.3

L = the length of the hose in centimeters, as determined in 17.5.1

d = the depth of the cap in centimeters, as determined in 17.5.2

4.8 LEAST SQUARES FIT LINE – A best fit line drawn through a set of data such that the sum of the squared residuals has its least value, a residual being the difference between an observed value (data point) and the line.

4.9 PERMEATION SURFACE AREA – The length of the hose as determined in 17.5.1 multiplied by the inner circumference of the hose, expressed in square meters. For vacuum-assist vapor recovery hose, the length of the hose is multiplied by the inner circumference of the outer hose. For balance vapor recovery hose, the length of the hose is multiplied by the average inner circumference of the outer hose.

4.10 REINFORCEMENT – Natural or synthetic fibers or fabric, or metallic wire that is wrapped, braided or spiral wound in one or more layers over the tube, intended to provide longitudinal and transverse (hoop) strength to the hose.

4.11 SEAL, DYNAMIC – A seal that is subject to mechanical movement or other applied forces that result in movement or flexing of the seal under normal use conditions.

4.12 SEAL, STATIC – A seal that is not subject to mechanical movement or other applied forces other than compressing forces that are applied during installation and maintained during normal use conditions.

4.13 VACUUM-ASSIST VAPOR RECOVERY HOSE – A coaxial hose consisting of an inner vacuum line for vapor recovery and an outer line. Fuel is dispensed through the annular space between the two lines.

CONSTRUCTION

5 Tube and Cover

5.1 Single-line hose and double-line vapor recovery hose

5.1.1 The tube shall be made from a material resistant to the fuels anticipated by these requirements.

5.1.2 The cover shall be made from a material resistant to the fuels anticipated by these requirements and to ozone.

5.1.3 The tube and cover shall be of uniform thickness, and free from pitting, blisters, or other imperfections. This requirement is not intended to exclude the use of a corrugated cover.

5.2 Coaxial vapor recovery hose

5.2.1 The tube and cover, if any, of the inner hose shall be made from materials resistant to the fuels anticipated by these requirements.

5.2.2 The tube of the outer hose or a homogeneous outer hose shall be made from materials resistant to the fuels anticipated by these requirements.

5.2.3 The cover of the outer hose or a homogeneous outer hose shall be made from a material resistant to the fuels anticipated by these requirements and ozone. An outer homogeneous thermoplastic hose with no separate layer of reinforcement shall also be made from a material resistant to sunlight.

5.2.4 The tube and cover shall be of uniform thickness and free from pitting, blisters, or other imperfections. This requirement is not intended to exclude the use of a corrugated tube, cover, or outer vapor hose.

6 Thickness of Cover

6.1 The thickness of the cover shall not be less than 0.047 inch (1.19 mm) when measured in accordance with 6.2 – 6.6.

Exception: This requirement does not apply to the cover of the inner hose and the outer vapor hose of a coaxial type vapor recovery hose.

6.2 For removing irregularities in samples, the buffing machine or skiving machine outlined in ASTM D3183, shall be used.

6.3 The abrasive wheel of the buffing machine shall be No. 30 – 60 grit and the diameter and rotary velocity of the wheel shall be such that it will have a peripheral speed of 4000 ±700 feet per minute (20.3 ±3.6 m/second). The machine shall be provided with a slow feed so that very little compound can be removed at one cut to avoid overheating of the specimen.

6.4 A dial micrometer graduated to 0.001 inch (0.03 mm) that exerts a load of 2.82 – 3.00 ounces (80 – 85 g) by means of a weight shall be used to measure thickness. The load shall be applied through a flat contact foot 0.25 ±0.01 inch (6.4 ±0.3 mm) in diameter.

6.5 To determine the thickness of the tube and cover, a strip, 6 – 8 inches (152.4 – 203.2 mm) long and 1 inch (25.4 mm) wide, or as close to 1 inch (25.4 mm) as possible from small diameter hose, shall be cut longitudinally from the hose, and the part separated from the plies. When the thickness of the part is not uniform around the circumference of the hose, the strip shall be cut from the thinnest portion of the sample.

6.6 The strip specimen shall be buffed or skived to remove the impressions left by the fabric or braid or other surface irregularities, using the equipment described in 6.2 and 6.3. A series of five thickness measurements shall be taken within the area from which the impressions have been removed, and the maximum reading obtained shall be taken as the thickness of the part.

7 Internal Diameter

7.1 The internal diameter of a hose shall be equal to the nominal diameter ±1/32 inch (0.8 mm) for sizes up to and including 3/4 inch (19.0 mm) and ±1/16 inch (1.6 mm) for larger sizes.

7.2 A tapered plug gauge of wood or metal having a taper of 3/8 inch per foot (31.3 mm/m), marked to indicate variations of 1/64 inch (0.4 mm) in diameter, or a set of wood or metal plug gauges, straight or ball type, in increments no greater than 0.01 inches (0.25 mm) for hoses in sizes 1 inch (25.4 mm) and less and 0.02 inches (0.51 mm) for hoses in sizes greater than 1 inch (25.4 mm), shall be used for measuring the internal diameter. An expanding ball gauge, and a micrometer or other equivalent means to accurately measure the expanded ball, are required in some cases. See 7.3.

7.3 The end of the hose shall be cut square. When a tapered plug gauge is used, the plug gauge shall be inserted in the hose sample until a close fit is obtained without forcing. The diameter of the gauge at the end of the sample, to the nearest 1/64 inch (0.4 mm), shall be recorded as the internal diameter of the hose. When a set of straight or ball-type plug gauges is used, the diameter of the gauge, which when inserted in the hose sample gives a close fit without forcing, shall be recorded as the internal diameter of the hose. When the end of a wire-braided hose is constricted or flared, the inside diameter shall be measured 1 inch (25.4 mm) from the end to be representative of the inside diameter by means of an expanding ball gauge.

8 Reinforcement

8.1 Reinforcement, if present, shall be evenly and firmly applied over the tube of hose conveying liquid fuel.

9 Electrical Bonding

9.1 A hose shall be constructed so as to provide an electrically conductive path continuously along its length in order to dissipate static electricity.

9.2 A hose assembly shall be constructed so as to provide an electrically conductive path continuously along its length, and the couplings shall provide an electrically conductive path bonded to the hose in order to dissipate static electricity. The couplings shall provide a means of electrical bonding to a grounding system.

10 Couplings

10.1 Couplings provided on hose assemblies shall be made from metals and shall be constructed with a section for tightening with tools. See Materials, Section 11.

10.2 The coupling provided on single-line hose assemblies shall have male pipe threads complying with ASME B1.20.1.

10.3 The couplings provided on coaxial type vapor recovery hose assemblies shall have male 1-7/8 – 12 SAE straight threads when the inner hose is intended to dispense the liquid fuel into the vehicle and 1-1/4 inch – 18 SAE Straight, M34 by 1.5 metric thread or 1 inch – 11-1/2 NPT threads, as required when the outer hose is intended to dispense the liquid fuel into the vehicle. All fittings shall be designed to fit the accessories connected to the hose couplings to form a leak-tight connection.

10.4 When the threads of the couplings of a single-line hose assembly or vapor recovery hose assembly are not as specified in 10.2 or 10.3, the installation instructions which accompany each assembly shall indicate the specific equipment which can be connected to the fitting or shall be marked in accordance with 35.10.

11 Materials

11.1 Metallic materials

11.1.1 General

11.1.1.1 A metallic part, in contact with the fuels anticipated by these requirements, shall be resistant to the action of the fuel if degradation of the material will result in leakage of the fuel or if it will impair the function of the device. For all fuel ratings, see Corrosion due to fluid, 11.1.2.1. For products rated for gasoline/ethanol blends with nominal ethanol concentrations greater than 40 %, see Metallic materials – system level, 11.1.3.

11.1.1.2 The exposed surfaces of metallic parts shall be resistant to atmospheric corrosion if this corrosion will lead to leakage of the fluid or if it will impair the function of the device. The material shall comply with the requirements in Atmospheric corrosion, 11.1.2.2.

11.1.1.3 Metallic parts in contact with the fuels anticipated by these requirements shall not be constructed of lead, or materials that are substantially lead. In addition, no coatings or platings containing lead shall be used, such as terne-plated steel.

11.1.2 Metallic materials – material level

11.1.2.1 Corrosion due to fluid

11.1.2.1.1 All metallic materials used for fluid confining parts shall be resistant to corrosion caused by motor fuels. Compliance is verified by the Long Term Exposure Test, Section 31.

11.1.2.1.2 A coating or plating, applied to a base metal, shall be resistant to the action of motor fuels as determined by the Long Term Exposure Test, Section 31.

11.1.2.2 Atmospheric corrosion

11.1.2.2.1 Metallic materials used for fluid confining parts shall be resistant to atmospheric corrosion. Standard pipe and fittings conforming to ASME B36.10M are acceptable when uncoated.

11.1.2.2.2 A protective coating shall provide resistance against atmospheric corrosion to a degree not less than that provided by the protective coatings specified in 11.1.2.2.3.

11.1.2.2.3 Cadmium plating shall not be less than 0.0003 inch (0.008 mm) thick, and zinc plating shall not be less than 0.0005 inch (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 inch (0.0038 mm) thick. Metallic parts are considered to comply with 11.1.2.2.1 when they are protected against atmospheric corrosion by:

a) Hot dipped, mill galvanized sheet steel complying with the coating designation G90 in Table I of ASTM A653/A653M; or

b) Coatings which have been determined to be equivalent to G90 under the requirements of UL 1332.

11.1.2.2.4 A metallic material other than as described in 11.1.2.2.1 – 11.1.2.2.3 shall be painted or protected in a manner that has been determined to be equivalent.

11.1.3 Metallic materials – system level

11.1.3.1 Combinations of metallic materials in products rated for use with gasoline/ethanol blends with nominal ethanol concentrations greater than 40 % shall be chosen to reduce degradation due to galvanic corrosion in accordance with 11.1.3.2 – 11.1.3.4.

11.1.3.2 Table 11.1 shows the galvanic series for metallic materials exposed to a conductive solution of sea water. The most active material in a given combination will experience increased levels of corrosion, while the most passive material in the combination will experience reduced levels of corrosion. The greater the separation of the materials is in the galvanic series of Table 11.1, the more pronounced the effects would be. Table 11.1 serves as a guide in selecting the appropriate test conditions based on manufacturer specified material combinations.

Table 11.1
Galvanic Series of Metal Materials

Most passive	Platinum
	Gold
	Graphite
	Silver
	Stainless Steel Type 316 (Passive)
	Stainless Steel Type 304 (Passive)
	Titanium
	13 % Chromium Stainless Steel (Passive)
	76 Ni – 16 Cr – 7 Fe Alloy (Passive)
	Nickel (Passive)
	Silver Solder
	M-Bronze
	G-Bronze
	70:30 Cupro Nickel
	Silicon Bronze
	Copper
	Red Brass
	Aluminum Brass
	Admiralty Brass

Table 11.1 Continued on Next Page

Table 11.1 Continued

	Yellow Brass 60 Ni – 30 Mo – 6 Fe – 1 Mn 76 Ni – 16 Cr – 7 Fe Alloy (Active) Nickel (Active) Manganese Bronze Tin Stainless Steel Type 316 (Active) Stainless Steel Type 304 (Active) 13 % Chromium Stainless Steel (Active) Cast Iron Wrought Iron Mild Steel Aluminum 2024 Cadmium Alclad Aluminum 6053 Aluminum 1100 Galvanized Steel Zinc Magnesium Alloys
Most active	Magnesium
NOTE: Reprinted with permission from NACE. Based on table titled “Galvanic Series of Metals Exposed to Seawater” from NACE Corrosion Engineer’s Reference Book, Third Edition ©NACE International 2002.	

11.1.3.3 Platings, such as nickel plating, can be used to reduce or eliminate dissimilar metal contact areas, as long as the plating material complies with 11.1.3.2 as the contact metal. If used, the plating shall comply with the Long Term Exposure Test, Section 31.

11.1.3.4 Gaskets or nonmetallic spacers used to reduce or eliminate dissimilar metal contact areas, where permitted, shall be subjected to the applicable requirements for static seals in Nonmetallic materials, 11.2, when they are in contact with the fluid.

11.2 Nonmetallic materials

11.2.1 General

11.2.1.1 A nonmetallic part in contact with motor fuel shall be resistant to the action of the fuel if degradation of the material will result in leakage of the fuel, or if it will impair the function of the device. Gaskets and seals are tested in accordance with 11.2.1.2 – 11.2.3.2. Hose materials are tested in accordance with the following:

a) Tensile Strength and Elongation, Section 25;

b) Accelerated Air Oven Aging Test, Section 26;

c) Ozone Exposure, Section 27;

d) Ultraviolet Light and Water Exposure Test, Section 28, if applicable;

e) Immersion Tests, Section 29.

11.2.1.2 Gaskets or seals shall be designated as dynamic and/or static seals. See 4.11 and 4.12 respectively. If the type of seal cannot be determined, then the material shall be treated as both a static and a dynamic seal.

11.2.1.3 Gaskets and seals shall comply with the requirements as outlined in Nonmetallic materials – material level, 11.2.2; Coupling seals, 11.2.3; and Nonmetallic materials – system level, 11.2.4.

11.2.1.4 Nonmetallic materials in contact with the fuels anticipated by these requirements shall not be constructed of the following:

a) Polysulfide rubber;

b) Ethylene propylene diene monomer (EPDM) rubber;

c) Methyl-Methacrylate;

d) Polyvinyl Chloride (PVC);

e) Nylon 6/6; or

f) Polyurethane.

11.2.2 Nonmetallic materials – material level

11.2.2.1 Static seals

11.2.2.1.1 Static seals shall be evaluated in accordance with UL 157, modified as indicated in 11.2.2.1.2 – 11.2.2.1.3. If a specific material complies with these requirements, the material can be considered to be qualified for system testing.

11.2.2.1.2 Static seals shall be subjected to the Volume Change and Extraction Test in accordance with UL 157, except for the following modifications:

a) The test duration shall be 1000 hours;

b) The applicable test fluids shall be as described in Annex A; and

c) For all materials, the average volume change shall not exceed 40 % swell (increase in volume) or 1 % shrinkage (decrease in volume). In addition, the weight loss shall not exceed 10 %. There shall be no visual evidence of cracking or other degradation as a result of the exposure.

11.2.2.1.3 Static seals shall be subjected to the Compression Set Test in accordance with UL 157, except for the following modifications:

a) The test duration shall be 1000 ±0.5 hours;

b) The samples shall be immersed, at room temperature, in the applicable test fluids as described in Annex A while compressed for the entire test duration. No oven conditioning is required;

c) The recovery period shall consist of removing the sample from the compression device and immersing it in the applicable test fluid for at least 30 minutes at room temperature. The sample shall not be allowed to dry out due to exposure to air. The 30 minute immersion shall use the same fluid as the test fluid for each sample; and

d) For all materials, the average compression set is calculated and shall not exceed 35 %.

Exception: This requirement does not apply to composite gasket or thermoplastic materials as defined in accordance with UL 157.

11.2.2.2 Dynamic seals

11.2.2.2.1 Dynamic seals shall be evaluated in accordance with UL 157 modified as indicated in 11.2.2.2.2 – 11.2.2.2.3. If a specific material complies with these requirements, the material is qualified for system testing.

11.2.2.2.2 Dynamic seals shall be subjected to the Volume Change and Extraction Test in accordance with UL 157, except for the following modifications:

a) The test duration shall be 1000 ±0.5 hours;

b) The applicable test fluids shall be as described in Annex A; and

c) For all materials, the average volume change for a gasket or seal material shall not exceed 40 % (increase in volume) or 1 % shrinkage (decrease in volume). In addition, the weight loss shall not exceed 10 %. There shall be no visual evidence of cracking or other degradation as a result of the exposure.

11.2.2.2.3 Dynamic seals shall be subjected to the Immersion Test in accordance with UL 157, except for the following modifications:

a) The test duration shall be 1000 ±0.5 hours;

b) The applicable test fluids shall be as described in Annex A; and

c) For all materials, the average tensile strength and the average elongation of materials shall not be less than 60 % of the as-received values.

11.2.3 O-rings

11.2.3.1 Seals (O-rings) shall show no cracking when flexed at –40 ±3.6 °F (–40 ±2 °C), or –65 ±3.6 °F (–54 ±2 °C) when hose is marked for use down to –54 °C (–65 °F), after conditioning at test temperature for 24 ±0.5 hours. The test methods and apparatus used are described in UL 157.

11.2.3.2 Seals (O-rings) shall retain a minimum of 60 % of tensile strength and elongation after 70 hours oven aging at 212 ±3.6 °F (100 ±2 °C). The test methods and apparatus used are described in UL 157.

11.2.4 Nonmetallic materials – system level

11.2.4.1 All materials, gaskets and seals that have been shown to comply with the material level tests shall be subjected to the system level tests for the applicable component after the Long Term Exposure Test, Section 31.

11.2.5 Internal parts

11.2.5.1 Nonmetallic parts located internally to a fluid confining part, degradation of which would not directly result in leakage, is not required to comply with Nonmetallic materials, 11.2. The part shall be tested in accordance with 11.2.5.2.

11.2.5.2 Internal nonmetallic parts shall be tested during the Long Term Exposure Test, Section 31. During this test, the part shall not degrade to the extent that visible particles can be observed in the fluid.

11.2.6 Blending options

11.2.6.1 Hose assemblies intended for use with dispensing equipment that provides for a blending option, at gasoline/ethanol blends with nominal ethanol concentrations above 25 %, shall be subjected to the Blend Cycling Test, Section 32.

PERFORMANCE

12 General

12.1 The performance tests in Sections 13 – 33 of this Standard apply to hose and hose assemblies as indicated in the individual test.

12.2 All tests involving a test fluid shall be performed using the test fluid specified for that test. For hose and hose assemblies rated for use with gasoline or a gasoline/ethanol blend with a nominal ethanol concentration of up to 25 % (E0 – E25), the test shall be performed using the CE25a test fluid. For hose and hose assemblies rated for use with gasoline or a gasoline/ethanol blend with a nominal ethanol concentration of up to 40 % (E0 – E40), the test shall be performed using the CE40a test fluid. For hose and hose assemblies rated for use with a gasoline/ethanol blend with a nominal ethanol concentration above 40 %, the test shall be performed using both the CE25a and CE85a test fluids. The CE25a and CE85a test fluids shall be prepared as described in Annex A. There shall be no substitution of test fluids.

12.3 Certain tests shall be performed using the same sample in a specific test sequence, as indicated for each test. To reduce the effects of dry out of nonmetallic materials due to removal of the test fluid after specific tests, the tests in a given sequence shall be started within 4 hours of removal of the test fluid. If necessary to coordinate testing, the sample may be left filled with the most recent test fluid at room temperature until the next test is initiated. If the previous test used an aerostatic or hydrostatic source, the sample shall be filled with kerosene.

12.4 Hoses and hose assemblies shall be subjected to the test sequences as shown in 12.5 and 12.6 after being subjected to the Long Term Exposure Test, Section 31.

12.5 One 11-foot (3.35 m) hose sample for each fluid exposure shall be subjected to the following sequence:

a) Long Term Exposure, Section 31;

b) Leakage and Electrical Continuity Test, Section 19;

c) Hydrostatic Strength Test, Section 14; and

d) Ozone Test, Section 27.

12.6 One 1-foot (0.3 m) hose sample for each fluid exposure shall be subjected to the following sequence:

a) Long Term Exposure, Section 31, and

b) Pull Test for Hose Assemblies, Section 21.

12.7 The remaining tests in this Performance Section shall be performed in any order or as indicated in the actual test methods.

13 Repeating Bending Test (Empty)

13.1 General

13.1.1 A hose shall withstand 3,000 cycles of repeated bending and shall then withstand the hydrostatic pressure as specified in the Hydrostatic Strength Test, Section 14.

13.2 Sample

13.2.1 An 11 foot (3.35 m) coupled length of hose shall be used for this test.

13.3 Apparatus

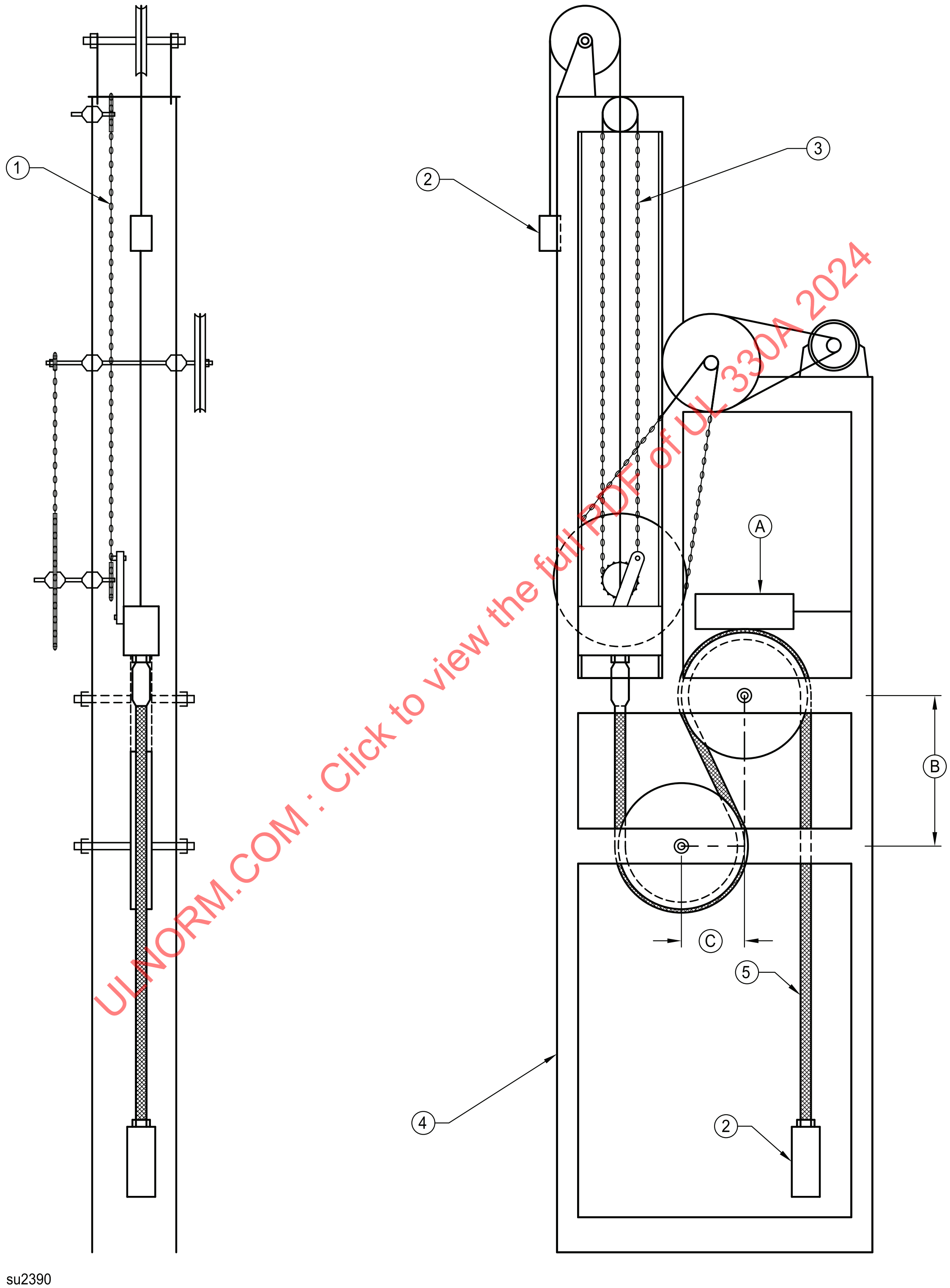
13.3.1 A bending machine, as shown in Figure 13.1 with drums having a radius of 7 ±0.06 inches (178 ±1.5 mm), is to be used for this test. The vertical distance between centers of the drums is 17 inches (431.8 mm). The horizontal distance between centers of the drums is 7 inches (178 mm).

13.4 Method

13.4.1 The position of the empty hose is shown in Figure 13.1. The hose shall be moved back and forth for a distance of 4 feet (1.22 m) at a rate of 470 cycles per hour. The weight used on the end of the hose shall be the minimum required to make the hose conform to the curvature of the drums during the cycling.

Figure 13.1

Bending Machine



1 – Block Chain, 2 – Counterweight, 3 – Centreline of Block Chain, 4 – Steel Frame, 5 – Hose Under Test
A – 3.5 lb (1.59 kg), B – 17 in (432 mm), C – 7 in (177.8 mm)

14 Hydrostatic Strength Test

14.1 General

14.1.1 Hose intended for conveying liquid and previously subjected to the Repeated Bending Test (Empty), Section 13, shall withstand a hydrostatic test pressure of 250 psig (1724 kPa) for at least 1 minute without leakage, ballooning, or rupture.

14.1.2 Hose intended for recovering vapors and previously subjected to the Repeated Bending Test (empty), Section 13, shall withstand a hydrostatic test pressure of 2.5 psig (17.2 kPa) for at least 1 minute without leakage, ballooning, or rupture. A hose assembly shall also withstand the test pressure without slippage, leakage of the couplings, or damage to the hose at the couplings.

14.1.3 Hose assemblies shall withstand a hydrostatic test pressure of 250 psig (1724 kPa) for at least 1 minute without slippage or leakage of the couplings or damage to the hose. For vapor recovery hose assemblies, the liquid conveying hose shall be pressurized to 250 psig (1724 kPa) for at least 1 minute, and the vapor conveying hose shall be pressurized to 2.5 psig (17.2 kPa) for at least 1 min.

14.2 Sample

14.2.1 Samples used for this test are those that have been subjected to either the Repeated Bending Test (Empty), described in Section 13, or the Long Term Exposure Test – Leakage and Electrical Continuity Sequence described in Section 31 and 19 respectively.

14.2.2 When a hose assembly is to be tested, the assembly shall be marked prior to the test with a pencil or other suitable device at a point immediately adjacent to each coupling.

14.3 Apparatus

14.3.1 Hydrostatic pressure shall be applied by means of a hand- or power-operated pump or an accumulator system capable of increasing the pressure in the hose at a uniform rate of 700 –1000 psig (4826 - 6895 kPa) per minute for hose and hose assemblies intended for conveying liquid and no more than 5.0 psig (34.5 kPa) per minute for hose and hose assemblies intended for recovering vapors. All pressures shall be measured using a calibrated pressure gauge.

14.3.2 Adapter fittings, which permit the separate pressurization of the inner and outer hoses, shall be used on coaxial vapor recovery hose and hose assemblies.

14.4 Method

14.4.1 The hose sample, while lying straight, shall be connected to the pump and filled with water, leaving the petcock open to allow the air to escape. The petcock shall then be closed and the pressure in the hose shall be increased at a uniform rate of 700 – 1000 psig (4826 – 6895 kPa) per minute for hose and hose assemblies intended for conveying liquid and no more than 5.0 psig (34.5 kPa) per minute for hose and hose assemblies intended for recovering vapors. The test pressure shall be held for at least 1 minute during which time the hose shall be examined for leakage, ballooning, and rupture. Hose assemblies shall be examined for evidence of slippage or leakage of the coupling or damage to the hose at the couplings.

15 Resistance To External Pressure for Inner Vapor Recovery Hose

15.1 General

15.1.1 The inner vapor recovery hose of a coaxial vapor recovery hose assembly shall convey air or water at a pressure of 0.5 psig (3.4 kPa) when the outer hose is pressurized to 250 psig, (1724 kPa) and shall show no evidence of damage when examined after the test.

15.2 Sample

15.2.1 A 3 ft (0.91 m) coupled hose assembly shall be used for this test.

15.3 Apparatus

15.3.1 Hydrostatic pressure shall be applied by means of a hand-or power-operated pump or an accumulator system that increases the pressure at a uniform rate of 700 – 1000 psig (4826 – 6895 kPa) per minute for the outer hose intended for conveying liquid and no more than 5.0 psig (34.5 kPa) per minute for the inner hose intended for recovering vapors. All pressures shall be measured using a calibrated pressure gauge.

15.3.2 Adapter fittings, which permit the flow of air or water through the inner hose while the outer hose is pressurized, shall be used on each of the end couplings.

15.4 Method

15.4.1 The outer hose, while lying straight, shall be connected to the pump and filled with water, leaving the petcock open to allow the air to escape. The petcock shall then be closed and the pressure in the outer hose shall be increased at a uniform rate of 700 – 1000 psig (4826 – 6895 kPa) per minute until a pressure of 250 psig (1724 kPa) is reached. After the test pressure has been maintained for at least 1 minute, and while still under pressure, air or water shall be allowed to flow into the inner hose at a pressure of 0.5 psig (3.4 kPa). The outlet of the inner hose shall be observed for passage of air or water. After the test, the inner hose shall be removed and shall show no evidence of damage after examination.

16 Repeated Bending Test (Filled)

16.1 General

16.1.1 Hose and hose assemblies constructed of a hose that has not met the requirements of this section, when filled with the appropriate test fluid as specified in 12.2 shall be subjected to repeated bending, in the manner described in 13.4.1, for 3150 cycles per day for 6 days. There shall be no breakdown of the hose or any of its parts and the electrical resistance of the hose shall not be greater than 70000 Ω/foot (229660 Ω/m) before and after the test. The total loss of liquid during the bending periods shall not exceed that specified in Table 16.1.

16.1.2 Hose assemblies not intended to be subjected to the Permeation Test in Section 17 shall also comply with the requirements of the Leakage and Electrical Continuity Test, Section 19.

Table 16.1
Allowable Liquid Loss

Nominal hose diameter in	Max allowable loss %
1/2	66
5/8	54
3/4	46
7/8	40
1	36
1-1/4	30
1-1/2	26

16.2 Sample

16.2.1 An 11 foot (3.35 m) coupled length of hose shall be used for this test.

16.3 Apparatus

16.3.1 The bending machine shown in Figure 13.1 shall be used for this test.

16.3.2 A low-voltage ohmmeter shall be used for measuring the electrical resistance of hose having bonding paths with an electrical resistance of 1000 Ω or less. For hose bonding paths with an electrical resistance greater than 1000 Ω, the resistance measurements shall be made by means of a suitably calibrated ohmmeter having an effective internal resistance of 100000 Ω ±10 %. The test circuit shall have a nominal open-circuit potential of 500 V, direct current, and a short-circuit current of 5 mA.

16.4 Method

16.4.1 The electrical resistance shall be measured from coupling to coupling. While the ohmmeter leads are attached to the couplings, the hose is bent 180° around a 14 ±0.25 inch (355.6 ±6.4 mm) diameter mandrel at several different locations throughout the length of the hose, and the highest reading obtained shall be considered the resistance of the hose. The hose shall then be filled with a measured amount of the applicable test fluid as specified in 12.2, and subjected to repeated bending as described in 13.4.1 for 3150 cycles per day for 6 days. At the start of each bending period, the hose shall be removed from the bending machine, filled to the original level, when needed, with a measured amount of test fluid and suspended in a vertical or V-shaped position. The % loss of fluid shall be calculated using the amount of fluid required to fill the hose at the start of the test and the total fluid added at the end of each bending period. After a total of 18900 cycles of repeated bending, an examination shall be made for any evidence of breakdown of the hose or any of its parts, and the electrical resistance shall be measured again.

16.4.2 When conducting the test described in 16.4.1 on coaxial vapor recovery hose assemblies, the hose intended to convey liquid shall be filled with the test liquid.

17 Permeation Test (For Low Permeation Hose)

17.1 General

17.1.1 The steady state permeation rate for each of five hose assemblies when tested in accordance with 17.2 – 17.8 shall not exceed 10.0 g/m^2/day.

17.2 Test equipment

17.2.1 Test equipment meeting or exceeding the following specifications shall be used to conduct the permeation test:

a) a) Torque wrench capable of measuring torque from 50 to 130 ±5 ft-lb (68 to 176 ±6.8 N·m);

b) Balance with a range of 0 to 17.6 lb (0 to 8 kg) or greater, capable of weighing to 0.004 oz (0.01 g);

c) Tapered plug gauge having a taper of 3/8 inches per foot (31.3 mm/m) marked to indicate variations of 1/64 inches (0.4 mm) in internal diameter, or straight or ball-type plug gauge;

d) Tape measure capable of measuring hose assembly length to 0.39 inches (1.0 cm);

e) Test chamber capable of maintaining a temperature of 100.4 ± 3.6 °F (38 ±2 °C) with safety venting controls that are triggered to respond to a Lower Explosive Limit (LEL) detector;

f) A temperature/relative humidity recording device capable of measuring and recording the temperature of the test chamber to ±0.36 °F (±0.2 °C) and relative humidity to ±1 % at intervals of 10 minutes or less; and

g) 1000 mL (33.8 oz) graduated cylinder with 10 mL (0.34 oz) gradations.

17.2.2 Additional material required to conduct test are as follows:

a) Fuel can and funnel for transferring fuel; and

b) Caliper or micrometer capable of measuring to 0.01 in. (0.25 mm).

17.2.3 The test fuel used for the repeated bending preconditioning shall be ASTM Reference Fuel H. The test fuel used for the permeation test shall be CE-10, consisting of 90 volumes of ASTM Reference Fuel C and 10 volumes of anhydrous denatured ethanol as specified in ASTM D471 and ASTM D4806.

17.3 General test procedure and instructions

17.3.1 The general test procedure involves filling hose assemblies of known dimensions (length and internal diameter) with a known quantity of fuel, capping the assemblies with a closure device of known dimensions, and periodically weighing the assemblies. From these weighings and hose assembly dimensions, a permeation rate is calculated for each hose assembly. The test is terminated for each hose assembly when it reaches steady state permeation as defined by 17.8.

17.3.2 During the test, no hose assembly shall exceed a fuel loss of more than 5 % of the initial fuel charge. Before a 5 % fuel loss occurs, the hose assembly shall be removed from the test chamber, emptied of fuel, and refilled, as described in 17.7.6.

17.3.3 When storing, handling or transporting hose assemblies care must be taken to assure that anything that comes in contact with the assembly is clean, so as not to contaminate the hose assembly and affect weighings.

17.3.4 Care must be taken to avoid spilling fuel on the hose or fittings during filling and emptying of hose assemblies. A vise or similar device shall be used to secure the hose assembly when capping, uncapping or filling hose assemblies. In the event of spillage of fuel onto the hose assembly, the hose and fittings shall be immediately wiped dry with a clean rag. The extent and time of the spillage shall be recorded.

17.3.5 All masses shall be measured and reported in ounces to ±0.004 ounces (0.01 g).

17.3.6 During the permeation test, hose assembly weighings shall be at the same time (±30 minutes) each day, with at least 48 hours between weighings (typically weighing on Monday, Wednesday and Friday). The time of each weighing shall be recorded within ±1 minute.

17.3.7 The following capping procedure shall be followed:

a) When capping hose assemblies with NPT style threaded couplings, a standard NPT cap and a pipe joint sealing compound or tape certified for flammable liquid dispensing applications shall be used. Alternatively, other methods of sealing the threads on NPT style couplings that reflect common in-use practice for sealing hose assemblies of this type shall be used if so requested and supplied by the submitter. The threaded joint of the capped hose assembly shall be torqued as specified in Table 17.1.

b) When sealing vapor recovery hose assemblies, caps representative of the mating parts to which the hose assembly is intended to be connected shall be used. The caps shall be tightened to 50 ±5 ft-lb (68 ±6.8 N·m). Alternative capping instructions shall be followed when a submitter requests the certification agency to follow installation instructions that are routinely supplied to users with the hose assembly.

Table 17.1
Torque Requirements for Pipe Thread (NPT) Connections

Nominal pipe size	Torque	
in	lb-ft	(N·m)
1/2	65	(88)
3/4	85	(115)
1	100	(136)
1-1/4	120	(163)
1-1/2	130	(176)

17.4 Samples

17.4.1 Six 11 foot (3.35 m) identical hose assemblies shall be used for this test. The samples shall be the same length ±0.39 inches (10 mm), and shall be taken from the same production run. A full description of the hose construction including layers of construction and dimensional drawings shall be provided with the hose assemblies. A length of uncoupled hose (the outer hose of a vapor recovery hose assembly) shall also be supplied.

17.5 Pretest procedure

17.5.1 Measure and record the length (L) of each hose assembly to ±0.39 inches (10 mm), as measured from the base of the nut just below the fitting threads or from the o-ring seat for non-NPT fittings. Hose that does not lie straight due to its natural curvature shall be straightened by hand using the minimum necessary tension force or shall be placed in a straight frame.

17.5.2 Measure and record the depth (d) of each style of hose cap ±0.197 inches (5 mm) from the start of the threads, past the end of the threads to the lowest internal depth of the cap.

17.5.3 Measure the internal diameter (D) of the outer hose wall of each hose using a suitable plug gauge or the equivalent. If the outer hose wall is not cylindrical in geometry, (e.g., corrugated), the internal diameter shall be determined from dimension drawings submitted with the hose with an average internal diameter for the outer hose calculated from the maximum and the minimum inner diameter of the outer hose given in the dimension drawings.

17.5.4 Calculate and record the permeation surface area as defined in 4.8, the hose assembly volume as defined in 4.6, and the test fuel volume which equals 90 % of the hose assembly volume.

17.6 Preconditioning procedure

17.6.1 One of the six hose assembly samples shall be selected at random and subjected to the Repeated Bending Test (Filled) as specified in Section 16 with the exception that the assembly shall not be subjected to the Leakage and electrical Continuity test, Section 19. This hose assembly shall be marked as sample number 1. At the completion of this test, this filled hose assembly shall be recapped until the permeation test is commenced.

17.6.2 Four additional hose assemblies shall be filled with ASTM Reference Fuel H in the same manner (in the same fuel containment path) as the assembly subjected to the Repeated Bending Test (Filled), and capped as in 17.3.7. These assemblies shall be marked as samples 2 through 5.

17.6.3 The remaining unfilled hose assembly shall be capped in the same manner as the filled samples and shall be marked as sample 6. This sample functions in the test procedure as a blank.

17.6.4 The four filled hose assemblies and the unfilled assembly shall be placed in the work area where the Repeated Bending Test (Filled) is conducted, so all hose assemblies are subjected to the same environmental conditions. The unfilled assembly shall be stored in the work area at a sufficient distance from the filled assemblies to prevent absorption of evolved fuel vapors.

17.7 Permeation test procedure

17.7.1 Within 72 hours of the completion of the Repeated Bending Test (Filled), the hose assemblies shall be prepared for the permeation test as follows:

a) Fuel shall be emptied from the filled hose assemblies into an appropriate container avoiding spilling fuel onto the outside of the hose;

b) The inner tube of the vapor recovery hose assemblies, including the unfilled assembly, shall be removed, avoiding dripping of fuel onto the outside of the hose; and

c) The empty assemblies shall be capped with their intended cap and weighed to determine their unfilled mass.

17.7.2 The five previously filled hose assemblies shall be filled to the test fuel volume (90 % of the hose assembly volume) ± 0.34 oz (10 mL) with CE-10 fuel, and capped as in 17.3.7.

17.7.3 The five filled assemblies and the capped unfilled assembly shall be configured into a three-coil configuration and shall, if necessary, be secured in that shape using a means such as a plastic cable tie. The hose assemblies shall remain in that configuration for the duration of the test, unless the loss of fuel makes it necessary to refill them, as specified in 17.7.6.

17.7.4 Each of the six hose assemblies shall be weighed. The mass shall be recorded and the time of weighing shall be recorded within ±1 minute. The five filled assemblies shall then be placed into the 38 °C chamber.

17.7.5 On each successive weighing day, the coiled hose assemblies shall be removed from the test chamber, weighed, and returned to the chamber within 15 minutes. The time of each weighing shall be recorded and the total mass loss of fuel shall be checked to determine whether it is anticipated that the fuel loss will exceed 5 % prior to the next weighing.

17.7.6 When, during periodic weighings, it is anticipated that fuel loss will exceed 5 % before the next weighing, the assembly shall be emptied of fuel, refilled with the test fuel volume of fresh CE-10, capped, recoiled and weighed. It shall then be returned to the 100 °F (38 °C) chamber. The time and date that the refilled assembly was returned to the chamber, and the mass of the refilled assembly shall be recorded. This procedure shall be accomplished such that the assembly is returned to the test chamber within 1 hour of its removal.

17.7.7 When a hose assembly reaches steady state permeation as defined in 17.8, testing of that hose assembly shall be terminated. The permeation test shall be considered completed when all five filled hose assemblies have reached steady state permeation.

17.7.8 If at any time during the permeation test the permeation rate for a hose assembly is greater than 15.0 g/m^2/day for three consecutive data points, and all test parameters, such as test chamber temperature are within specifications, the testing of the assembly shall be terminated and the assembly shall be considered to not meet the permeation limit set in 17.1.1.

17.8 Steady state criteria

17.8.1 The mass loss rate and the moving average mass loss at each weighing shall be calculated using the procedure in 17.8.2. Steady state permeation shall be determined using the criteria in 17.8.3.

17.8.2 Procedure for calculating mass loss rate and 2-datapoint moving average mass loss shall be as follows:

a) The mass loss at each weighing shall be calculated for each hose assembly by subtracting the current recorded mass from the mass recorded for the immediately previous weighing. In the event the fuel has been refreshed as described in 17.7.6, mass loss shall be calculated by subtracting the current recorded mass from the immediately previous refreshed mass;

b) An adjusted mass loss shall be calculated by subtracting the mass loss for the unfilled hose assembly (the blank) from the mass loss of each of the filled assemblies;

c) The mass loss rate in g/m^2/day (oz/ft^2/day) shall be calculated by dividing the adjusted mass loss by the permeation surface area of the hose and by the number of elapsed days since the previous mass loss recording; and

d) After two mass loss rates have been calculated and for each succeeding mass loss rate datapoint, the 2-datapoint moving average of these mass loss rates shall be calculated by averaging the current and immediately previous mass loss rates.

17.8.3 Procedure for determining steady state permeation shall be as follows:

a) When mass loss rate data have been obtained for a minimum of 28 days, a least squares fit line shall be calculated from the current and four most previous 2-datapoint moving averages as defined in 17.8.2(d). (On a plot of moving average mass loss rate vs. data points, the degree to which the least squares fit line is horizontal indicates the closeness of the data to steady state permeation.) The value of the average (midpoint) and one extreme (end point) of this line, as plotted over the five datapoints, shall be recorded;

b) The percent variation of the extreme (end point) from the average (midpoint) of the least squares fit line shall be calculated by subtracting the extreme from the average and then dividing this result by the average. If the percent variation is within the range of ±0.05 (within ±5 % of the average), then the hose assembly has reached its first criteria for steady state;

c) Weight loss data shall continue to be collected and analyzed in accordance with the procedure in 17.8.3 (a) and (b) until the criteria for steady state has been satisfied for two consecutive weighing days; and

d) The reported steady state permeation rate for the hose shall be the permeation rate at the average (midpoint) of the least squares fit line calculated in step (a) for the second consecutive weighing day that the steady state criteria was satisfied.

18 Electrical Resistance Tests for Hose Having Nonmetallic Electrically Conductive Materials

18.1 General

18.1.1 Hose relying on nonmetallic electrically conductive materials for electrical conductivity shall not have an electrical resistance greater than 70000 Ω/foot (229660 Ω/m) before and after the exposures specified in 18.4.1 and 18.4.2.

18.2 Samples

18.2.1 Four samples of coupled hose, each 1 foot (0.3 m) in length, measured between couplings, shall be used. A separate sample shall be used for each of the exposures specified in 18.4.1. For hose having an electrically conductive cover, an additional two samples of coupled hose, each 1 foot (0.3 m) in length, capped at both ends, shall be subjected to the exposures specified in 18.4.2.

18.3 Apparatus

18.3.1 The oven described in ASTM D573, aa water bath that maintains a temperature of 189 ±3.6 °F (87 ±2 °C), the ohmmeter specified in 16.3.2, and a cold chamber that maintains a temperature of –40 ±3.6 °F (–40 ±2 °C).

18.4 Method

18.4.1 A separate sample shall be subjected to each of the following exposures:

a) 70 ±0.5 hours in an air oven at 100 ±2 °C (212 ±3.6 °F) and then allowed to cool for 1 hour at 23 ±2 °C (73.4 ±3.6 °F). The sample shall be open at both ends.

b) Hose capped at one end shall be filled with the appropriate test fluid as specified in 12.2, sealed and conditioned at 23 ±2 °C (73.4 ±3.6 °F) for 168 ±0.5 hours. The sample shall be periodically examined during the test and test liquid added, when necessary, to maintain the original liquid levels. In lieu of periodic examination, the test exposure shall be conducted with the hose attached to a reservoir filled with the test liquid. After the 168 hour exposure the test fluid shall be drained from the sample and the coupled hose shall be tested immediately.

c) 16 ±0.5 hours at –40.0 ±2 °C (–40.0 ±3.6 °F) for hose marked for use down to –40 °C (–40 °F) or 16 ±0.5 hours at –54 ±2 °C (–65 ±3.6 °F) for hose marked for use down to –54 °C (–65 °F). The sample shall be open at both ends and shall be tested while still in the cold chamber.

d) 16 ±0.5 hours in a circulating air oven at 60 ±2 °C (140 ±3.6 °F). The sample shall be open at both ends and shall be tested while still in the oven.

18.4.2 For hose having an electrically conductive cover, a separate sample, empty and capped at both ends, shall be subjected to each of the follow exposures:

a) 168 ± 0.5 h immersion in distilled or deionized water at a temperature of 189 ±3.6 °F (87 ±2 °C) and then allowed to cool for 1 h at 73.4 ±3.6 °F (23 ±2 °C).

b) 168 ±0.5 hours immersion in IRM 903 Oil at 73.4 ±3.6°F (23 ±2°C), then blotted to remove oil from the couplings and tested immediately.

18.4.3 After the samples have been exposed in accordance with 18.4.1 (a) and (b) and 18.4.2, the electrical resistance shall be measured, coupling to coupling in accordance with 16.3.2.

19 Leakage and Electrical Continuity Test

19.1 General

19.1.1 A hose assembly (liquid hose for vapor recovery hose assemblies) shall not have an electrical resistance greater than 70,000 Ω/foot (229,660 Ω/m) before and after being pressurized with air, nitrogen or kerosene to 75 psig (517 kPa) for at least 1 minute. While the hose assembly is pressurized, it shall show no visible signs of leakage.

19.1.2 For vapor recovery hose assemblies, the hose intended to convey vapors shall show no visible signs of leakage after being pressurized with air, nitrogen, or kerosene to 0.75 psig (5.2 kPa).

19.2 Sample

19.2.1 A 24 inch (610 mm) hose assembly shall be used for this test.

19.3 Apparatus

19.3.1 A system that maintains a pressure of up to 75 psig (517 kPa) in a hose assembly filled with air, nitrogen or kerosene shall be used. The pressure shall be measured with a calibrated pressure gauge. The ohmmeter specified in 16.3.2 shall be used for measuring the electrical resistance of the hose.

19.4 Method

19.4.1 The electrical resistance from coupling to coupling shall be measured by means of the ohmmeter specified in 16.3.2. When the coupling has a swivel, the swivel shall be rotated 360° while the leads of the ohmmeter are attached to the couplings, and highest reading obtained shall be considered the resistance of the hose assembly. The hose assembly (liquid hose for vapor recovery hose assemblies) shall then be pressurized to 75 psig (517 kPa) with air, nitrogen or kerosene and held for at least 1 minute. The hose assembly shall be observed for leakage at the test pressure, and the electrical resistance shall be measured while the hose assembly is at 75 psig (517 kPa). When testing with air or nitrogen, the sample shall be immersed in water. When leakage occurs using air or nitrogen, the test shall be repeated with kerosene maintained at 75 psig (517 kPa) for at least one minute.

19.4.2 For vapor recovery hose assemblies, the hose intended to convey vapors shall be separately pressurized to 0.75 psig (5.2 kPa) with air or nitrogen. The hose assembly shall be observed for leakage at the test pressure.

20 Swivel Joint Operation Test

20.1 General

20.1.1 A 24 inch (610 mm) hose assembly having couplings with swivel joints shall comply with the requirements of the Long Term Exposure/Operation Test sequence for swivel joints in UL/ULC 567A.

21 Pull Test

21.1 General

21.1.1 A hose assembly shall withstand a 400-lb (1.779 kN) pull force, as-received and after conditioning, as described in 21.4.1.

21.2 Sample

21.2.1 A 1-foot (0.3 m) hose assembly shall be used for each conditioning exposure and applicable test fluid.

21.3 Equipment

21.3.1 A power-operated machine, as described in ASTM D412, shall be used. The rate of travel of the power-actuated grip shall be 1.0 ±0.1 inch (25.4 ±2.5 mm) / minute.

21.3.2 The oven specified in ASTM D573, shall be used for this test.

21.4 Method

21.4.1 A separate assembly shall be subjected to the following conditions before being tested in accordance with 21.4.2.

a) Exposed to the Long Term Exposure, Section 31 (See 12.6);

b) Conditioned at 73.4 ±3.6 °F (23 ±2 °C) for at least 24 hours; and

c) Placed in an oven for 70 ±0.5 hours at a temperature of 212 ±3.6 °F (100 ± 2 °C), and allowed to cool at 73.4 ±3.6 °F (23 ±2 °C) for at least 24 hours.

21.4.2 The couplings on each end of the sample shall then be connected to corresponding companion parts. The assembly shall then be placed in the tension testing machine and connected so that both end-fittings, fitting joints, and the hose have a straight centerline corresponding to the direction of the machine pull. The machine grips shall be separated until the specified pull force has been reached.

22 Adhesion Test

22.1 General

22.1.1 The adhesion between the cover and the fabric or wire reinforcement, between the tube and the fabric reinforcement, and between the plies of fabric reinforcement shall be such that the rate of separation of a ring-shaped specimen, 1 inch (25.4 mm) in width, is not greater than 1 inch (25.4 mm) / minute when a weight of 10 pounds (4.5 kg) is applied.

22.1.2 The adhesion between the tube and wire reinforcements and between wire braids shall be such that they adhere to each other.

22.1.3 Hose having components with less adhesion than specified in 22.1.1 and 22.1.2 and hose without reinforcement shall comply with the requirements of Sections 23 and 24.

22.1.4 The requirements in 22.1.1 and 22.1.2 are not intended for light fabric braids imbedded in or vulcanized to the cover or tube for the primary purpose of improving the adhesion between the cover or tube and the reinforcements.

22.2 Sample

22.2.1 One inch (25.4 mm) wide ring-shaped specimens cut from a representative sample of hose shall be used for this test.

22.3 Apparatus

22.3.1 Adhesion tests shall be conducted with the type of apparatus described for the Static-Mass Method for ring specimens specified in ASTM D413.

22.4 Method

22.4.1 A band saw with a sharp, fine blade has been found acceptable for preparing samples.

22.4.2 The tests shall be conducted in accordance with the Static-Mass Method test methods for ring specimens outlined in ASTM D380. The adhesion between the tube and wire reinforcements and between wire braids cannot be determined by this method. Attempts shall be made to separate these components by hand.

22.4.3 The adhesion shall be taken as the rate obtained by dividing the total distance separated in inches (mm), to the nearest 1/32 inch (0.8 mm), by the elapsed time in minutes.

23 Deformation Test

23.1 When required by 22.1.3, the hose shall show no visible signs of damage and shall comply with the requirements of the Hydrostatic Strength Test, Section 14, after having been subjected to the deformation procedure in 23.2.

23.2 The center portion of an 18 inch (457 mm) length of coupled hose shall be subjected to 50 cycles of deformation where the sample is compressed and decompressed by a square steel plate measuring 6 inches (152 mm) on a side, mounted on a compression testing machine moving at a rate of 0.5 inches (12.7 mm) / minute. The sample shall be compressed to a point where the opposite sides of the tube just touch each other, and then the plate shall be returned to its original position. After 50 cycles the sample shall be visually examined for damage and shall be subjected to a hydrostatic pressure of 250 psig (1,724 kPa) for at least 1 minute.

24 Kink Test

24.1 When required by 22.1.3, the hose shall show no visible signs of damage and shall comply with the requirements of the Hydrostatic Strength Test, Section 14, after having been subjected to the procedure in 24.2.

24.2 A 1 foot (0.3 m) length of coupled hose shall be subjected to 100 cycles of bending around a 3 ±0.06 inch (76 ±1.5 mm) diameter mandrel. Each cycle shall consist of bending the center of the hose 180 % around the mandrel in one direction (the natural curvature of the hose) and then in the opposite direction. The hose shall be bent at a rate of 8-12 s for each bend. The sample shall then be visually examined for damage and subjected to a hydrostatic pressure of 250 psig (1,724 kPa) for 1 at least minute.

25 Tensile Strength and Elongation Tests for Hose Components

25.1 General

25.1.1 For hose components subjected to frequent or continuous exposure to fuel, liquid or vapor, the tensile strength shall not be less than 1,000 psi (6,895 kPa), and the ultimate elongation shall not be less than 150 % [from 1 to 2.5 inches (25.4 to 63.5 mm)].

25.1.2 For hose components subjected to occasional splashing of fuel, such as the hose cover, the tensile strength shall not be less than 1,000 psi (6,895 kPa), and the ultimate elongation shall not be less than 200 % [from 1 to 3 inches (25.4 to 76.2 mm)].

25.1.3 When the component is a multi-layer construction, the layer in direct contact with fuel shall be subject to these requirements.

25.2 Samples

25.2.1 Three samples, of each component, 1 inch (25.4 mm) wide and 8 inches (203 mm) long, shall be cut longitudinally from a representative section of the hose. The test specimens shall be obtained from these samples.

25.2.2 As an alternative to obtaining specimens from finished hose, when the thickness of a component or layer of a component is less than 0.050 in. (1.27 mm), specimens can be obtained from test slabs molded from the compound used to produce the layer.

25.3 Apparatus

25.3.1 Tensile strength and elongation tests shall be made on a power-operated machine, as described in ASTM D412.

25.3.2 The rate of travel of the power actuated grip shall be 20 ±1 inches (508 ±25.4 mm) per minute.

25.3.3 The elongation shall be measured by means of a scale or other devices which shall be used in such a way as not to damage the specimen and indicates the elongation with an accuracy of 0.1 inch (2.5 mm).

25.3.4 The specimens obtained from finished hose shall be buffed or skived with the equipment specified in 6.2, as necessary to obtain a specimen suitable for testing.

25.3.5 Die C, as described in ASTM D412, shall be used for cutting the specimens.

25.3.6 A dial micrometer, as described in 6.4, shall be used to measure thickness of specimens.

25.4 Method

25.4.1 Tensile strength and elongation shall be determined in accordance with the test methods outlined in ASTM D412.

25.4.2 The parts to be tested shall be separated from the hose reinforcements without the use of solvents, when possible, and without excessive stretch of the parts. When it is necessary to use a solvent, commercial isooctane shall be used. The separated parts shall then be placed so as to permit free evaporation of the solvent from the parts for at least 1 hour before further preparation of specimens.

25.4.3 The constricted portion of the sample shall be buffed or skived to remove fabric impressions or other surface irregularities. The samples shall be buffed or skived prior to cutting with the die.

25.4.4 Dumbbell specimens shall be die cut and have a constricted portion 0.250 inch (6.4 mm) wide and 1.3 inches (33 mm) long (Die C). The enlarged ends shall be 1 inch (25.4 mm) wide, when possible.

25.4.5 The specimens shall be cut longitudinally from the samples. Wetting the cutting edge of the die with water is a way to facilitate the cutting operation. The sample shall rest on a smooth and slightly yielding surface that will not injure the cutting edges of the die. A piece of belting or cardboard can be used for the purpose.

25.4.6 Three measurements for thickness shall be made in the constricted portion of the specimen in calculating the tensile strength. The minimum value obtained shall be used as the thickness of the specimen in calculating the tensile strength.

25.4.7 When an automatic extensometer is not used, two parallel bench marks for use in determining elongation shall be placed centrally 1 inch (25.4 mm) apart on the constricted portion of each of three specimens. Care shall be taken so as not to damage the specimen. The average tensile strength and elongation of three specimens shall be considered the tensile strength and elongation.

26 Accelerated Air Oven Aging Test for Hose Components

26.1 General

26.1.1 The tensile strength and ultimate elongation of specimens of components that have been conditioned for 70 ±0.5 hours in air at a temperature of 212 ±3.6 °F (100 ±2 °C) shall not be less than 80 % of the tensile strength or 50 % of the elongation of specimens that have not been oven conditioned.

26.2 Samples

26.2.1 Three samples of each component, 1 inch (25.4 mm) wide and 8 inches (203 mm) long, shall be cut longitudinally from a representative section of the hose. The test specimens shall be obtained from these samples.

26.3 Apparatus

26.3.1 The apparatus specified in ASTM D573 shall be used for this test.

26.3.2 The equipment for the tensile strength and ultimate elongation determinations shall be as described in 25.3.1 – 25.3.6.

26.4 Method

26.4.1 Three specimens shall be prepared in the same manner as for the Tensile Strength and Elongation Tests, Section 25, before placing the specimens in the oven, except the 1 inch (25.4 mm) bench marks, when used, shall be placed on the specimens after conditioning as specified in 26.1.1. The test shall be conducted in accordance with the test procedures specified in ASTM D573.

26.4.2 For comparative purposes three specimens of each component that have not been exposed to air oven aging shall be subjected to tensile and elongation tests. The methods for preparing samples and measuring the tensile strength and elongation shall be as described in 25.3.1 – 25.4.7.