JOINT CANADA-UNITED STATES
NATIONAL STANDARD

ANSI/CAN/UL 330:2021

STANDARD FOR SAFETY

Hose and Hose Assemblies for Dispensing Flammable and Combustible Liquids

Approved American National Standard
ANSI
ANSI/UL 330-2021

SCC CCN

SCC FOREWORD

National Standard of Canada

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UL Standard for Safety for Hose and Hose Assemblies for Dispensing Flammable and Combustible Liquids, ANSI/CAN/UL 330

Ninth Edition, Dated February 11, 2021

SUMMARY OF TOPICS

This New Ninth Edition of ANSI/CAN/UL 330, Standard for Hose and Hose Assemblies for Dispensing Flammable and Combustible Liquids, has been issued to reflect the latest ANSI and SCC approval dates, and to incorporate the proposals dated June 26, 2020 and October 2, 2020.

The new requirements are substantially in accordance with Proposal(s) on this subject dated June 26, 2020 and October 2, 2020.

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FEBRUARY 11, 2021

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Standard for Hose and Hose Assemblies for Dispensing Flammable and Combustible Liquids

The First edition was titled the Standard for Construction of Rubber Hose for Conducting Gasoline. The Second edition was titled the Standard for 3/4-, 1-, and 1-1/4-inch Hose for Conducting Gasoline. The Third edition was titled the Standard for Hose for Conducting Gasoline. The Fourth edition was titled the Standard for Gasoline Hose. The Fifth edition was titled the Standard for Hose and Hose Assemblies for Dispensing Flammable Liquids.

First Edition – September, 1917
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Fourth Edition – June, 1973
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Sixth Edition – August, 1996
Seventh Edition – December, 2009
Eighth Edition – June, 2017

Ninth Edition

February 11, 2021

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

The most recent designation of ANSI/UL 330 as an American National Standard (ANSI) occurred on February 11, 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 February 11, 2021.

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MARKING

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Preface

This is the Ninth Edition of ANSI/CAN/UL 330, Standard for Hose and Hose Assemblies for Dispensing Flammable and Combustible Liquids.

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 330 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 Eighth Edition of UL 330 as well as CAN/ULC-S612:2016.

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.

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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 Hose and Hose Assemblies for Dispensing Flammable Liquids, STP 330.

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

STP 330 Membership

Name	Representing	Interest Category	Region
Boyd, Dennis	BP America Inc	Commercial/Industrial User	USA
Grau, Jeff	Parker Hannifin Corp	Producer	USA
Koch, W.	Technology Resources International	General	USA
Legault, Pierre	Integrated Review Services – Consulting	General	Canada

STP 330 Membership Continued on Next Page

STP 330 Membership Continued

Name	Representing	Interest Category	Region
Mailvaganam, Miles	M Mailvaganam	General	Canada
Miller, Steve	Downstream Data Corp	Commercial/Industrial User	USA
Nelson, Bill	Franklin Fueling Systems Inc	Producer	USA
Prusko, Jeffrey	Underwriters Laboratories Inc.	Project Manager – Non-voting member	USA
Severin, Steve	Great Plains Industries Inc.	Producer	USA
Speidel, Andy	Contitech USA Inc.	Producer	USA
Wade, John A.	ULC Standards	STP Chair – Non-voting member	Canada
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This Standard is intended to be used for conformity assessment.

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

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

INTRODUCTION

1 Scope

1.1 This Standard sets forth minimum requirements for hose and hose assemblies, including vapor recovery hose and assemblies, for use on dispensing devices for flammable and combustible liquids. A hose assembly consists of flexible hose and fittings suitable for attachment to flammable and combustible liquid dispensing equipment.

1.2 Hose assemblies are intended for use:

a) In the United States, in accordance with the Automotive and Marine Service Station Code of National Fire Protection Association, NFPA 30A; or

b) In Canada, in accordance with the National Fire Code of Canada.

1.3 These requirements cover hose and hose assemblies (hose with couplings attached) in sizes up to and including 1-1/2 in (40 mm).

1.4 Hose for conveying liquid fuel is intended for use at a maximum working pressure of 50 psi (350 kPa). Hose for conveying vapors of fuel is intended for use at a maximum working pressure of 0.5 psi (3.5 kPa), including slight negative pressures from vapor assist systems.

1.5 These requirements cover hose and hose assemblies for use at temperatures down to −40° F (−40°C) or −65°F (−54°C) and up to +125°F (+52°C).

NOTE: Products tested for performance at −40°F(−40°C) only are not marked for lowest operating temperature. Only products tested for performance at −65°F (−54°C) are marked accordingly.

1.6 These requirements also cover fuel hose assemblies designated as “low permeation”, intended for use on dispensing devices for flammable and combustible liquids.

1.7 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 Petroleum Products, UL 87.

1.8 This Standard does not cover hose or hose assemblies for aircraft refueling service.

2 General

2.1 Units of measurements

2.1.1 When a value for measurement is followed by a value in other units in parentheses, the first stated value is the requirement.

2.2 Referenced Publications

2.2.1 The documents shown below are referenced in the text of this Standard. Unless otherwise stated elsewhere in this Standard such reference shall be considered to indicate the edition and/or revisions of the document available at the date on which the Committee approved this UL Standard.

UL Standards

UL 87, *Standard for Power-Operated Dispensing Devices for Petroleum Products*

UL 157, *Standard for Gaskets and Seals*

UL 969, *Standard for Marking and Labeling Systems*

Other Standards

ANSI/ASME B1.20.1, *Standard for Pipe Threads, General Purpose (Inch)*
ASTM D380, *Standard Test Methods for Rubber Hose*
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/ANSI D4806, *Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel*
ASTM/ANSI D975, *Diesel fuel formulated in accordance with the Standard Specification for Diesel Fuel Oils*
ASTM/ANSI D3699, *Kerosene formulated in accordance with the Standard Specification for Kerosene*
ASTM D396, *Fuel oil (heating fuel) formulated in accordance with the Standard Specification for Fuel Oils*
ASTM G153, *Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials*
ASTM G155, *Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials*
CSA C22.2 No. 0.15, *Adhesive Labels*
NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Garages*
NRC, *National Fire Code of Canada*

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
NRC – National Research Council of Canada

3 Glossary

3.1 For the purposes of this standard, the following definitions apply.

3.2 ASTM IRM 903 / IRM 903 – A high-swelling petroleum base oil described in ASTM D471, Standard Test Method for Rubber Property – Effect of Liquids.

3.3 ASTM REFERENCE FUEL B – 70 % Isooctane +30 % Toluene by volume.

3.4 ASTM REFERENCE FUEL H – 85 % of combined 50 % Isooctane +50 % Toluene by volume; +15 % Anhydrous Denatured Ethanol by volume.

3.5 AUTHORITY HAVING JURISDICTION – 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.

3.6 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.

3.7 BALANCE VAPOR RECOVERY HOSE ASSEMBLY – 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.

3.8 COUPLED LENGTH OF HOSE – A length cut from a manufactured hose to which couplings have been attached for testing purposes.

3.9 FLAMMABLE AND COMBUSTIBLE LIQUID – Gasoline, fuel oil, kerosene and diesel fuel, including gasoline with small amounts of additives such as detergents, solvents for detergents and anti-icing chemicals; diesel with up to 5 % biodiesel and gasoline with up to 10 % ethanol.

3.10 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 14.5.3

L = the length of the hose in centimeters, as determined in 14.5.1

d = the depth of the cap in centimeters, as determined in 14.5.2

3.11 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.

3.12 PERMEATION – The 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.

3.13 PERMEATION SURFACE AREA – The length of the hose as determined in 14.5.1 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.

3.14 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.

3.15 SAMPLE – A coupled length of hose, or a hose assembly, provided by the manufacturer at the length required for a specific test.

3.16 SPECIMEN – A test subject cut from a strip.

3.17 STRIP – A rectangle of material cut from the nonmetallic hose component of a sample.

3.18 VACUUM-ASSIST VAPOR RECOVERY HOSE ASSEMBLY – 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

4 Tube and Cover

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

4.1.1 The tube shall be made from a material resistant to gasoline and diesel fuel.

4.1.2 The cover shall be made from a material resistant to gasoline, diesel fuel, oils, and ozone.

4.1.3 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.

NOTE: This Standard provides requirements for both coaxial vapor recovery hose types where the liquid is conveyed through the inner hose and the vapor is recovered from the outer hose, as well as, vice versa.

4.2 Coaxial vapor recovery hose

4.2.1 The tube and cover, if any, of the inner hose shall be made from materials resistant to gasoline and diesel fuel.

4.2.2 The tube of the outer hose or a homogeneous outer hose shall be made from materials resistant to gasoline and diesel fuel.

4.2.3 The cover of the outer hose or a homogeneous outer hose shall be made from a material resistant to gasoline, diesel fuel, oil, and ozone.

4.2.4 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 recovery hose.

5 Thickness of Cover

5.1 The thickness of the cover shall not be less than 0.047 in (1.19 mm) when measured in accordance with 5.2 – 5.6.

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

5.2 For removing irregularities in samples, the buffing machine or skiving machine outlined in the Standard Practice for Rubber – Preparation of Product Pieces for Test Purposes from Products, ASTM D3183, shall be used.

5.3 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 ft/min (20.3 ±3.6 m/s). 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.

5.4 A dial micrometer graduated to 0.001 in (0.03 mm) that exerts a load of 2.82 – 3.00 oz (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 in (6.4 ±0.3 mm) in diameter.

5.5 To determine the thickness of the cover, a strip, 6 – 8 in (152.4 – 203.2 mm) long and 1 in (25.4 mm) wide, or as close to 1 in (25.4 mm) as possible from small diameter hose, shall be cut longitudinally from the cover, 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 part.

5.6 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 5.2 and 5.3. 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.

6 Internal Diameter

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

6.2 A tapered plug gauge of wood or metal having a taper of 3/8 in/ft (31.3 mm/m), marked to indicate variations of 1/64 in (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 in (0.25 mm) for hoses in sizes 1 in (25.4 mm) and less and 0.02 in (0.51 mm) for hoses in sizes greater than 1 in (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 6.3.

6.3 The end of the hose sample 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 in (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 in (25.4 mm) from the end to be representative of the inside diameter by means of an expanding ball gauge.

7 Electrical Bonding

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

7.2 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.

8 Couplings

8.1 All coupling areas exposed while in service shall be made from non-sparking metals such as brass, copper, aluminum or zinc and shall be constructed with a section for tightening with tools.

8.2 A copper or a copper-alloy part shall not be used where it is in contact with dissimilar metals such as aluminum, unless one of the parts is coated with chromium or other equivalent metallic coating to preclude electrolytic action. A coating shall have a thickness of not less than 0.0002 in (0.005 mm).

8.3 When atmospheric corrosion of a ferrous material part interferes with the proper function of a coupling, the part shall be provided with a corrosion-resistant protective coating.

8.4 A protective coating shall provide resistance against corrosion to a degree not less than that provided by the protective coatings specified in 8.5.

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

8.6 The coupling provided on single-line hose assemblies shall have male pipe threads complying with the Standard for Pipe Threads, General Purpose (Inch), ANSI/ASME B1.20.1.

8.7 The couplings provided on coaxial 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 1-1/4in – 18 SAE Straight, M34 by 1.5 metric thread or 1 in – 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.

8.8 When the threads of the couplings of a single-line hose assembly or vapor recovery hose assembly are not as specified in 8.6 or 8.7, 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 30.4.

PERFORMANCE

9 General

9.1 The performance tests in this standard apply to hose and hose assemblies, unless the test indicates that it is applicable to hose assemblies only.

9.2 All pressure readings specified in this Standard are in gauge pressures.

10 Repeated Bending Test (Empty)

10.1 General

10.1.1 A sample shall withstand 3,000 cycles of repeated bending and shall then withstand the hydrostatic pressure as specified in the Hydrostatic Strength Test, Section 11.

10.2 Sample

10.2.1 An approximately 11 ft (3300 mm) coupled length of hose shall be used for this test.

10.3 Apparatus

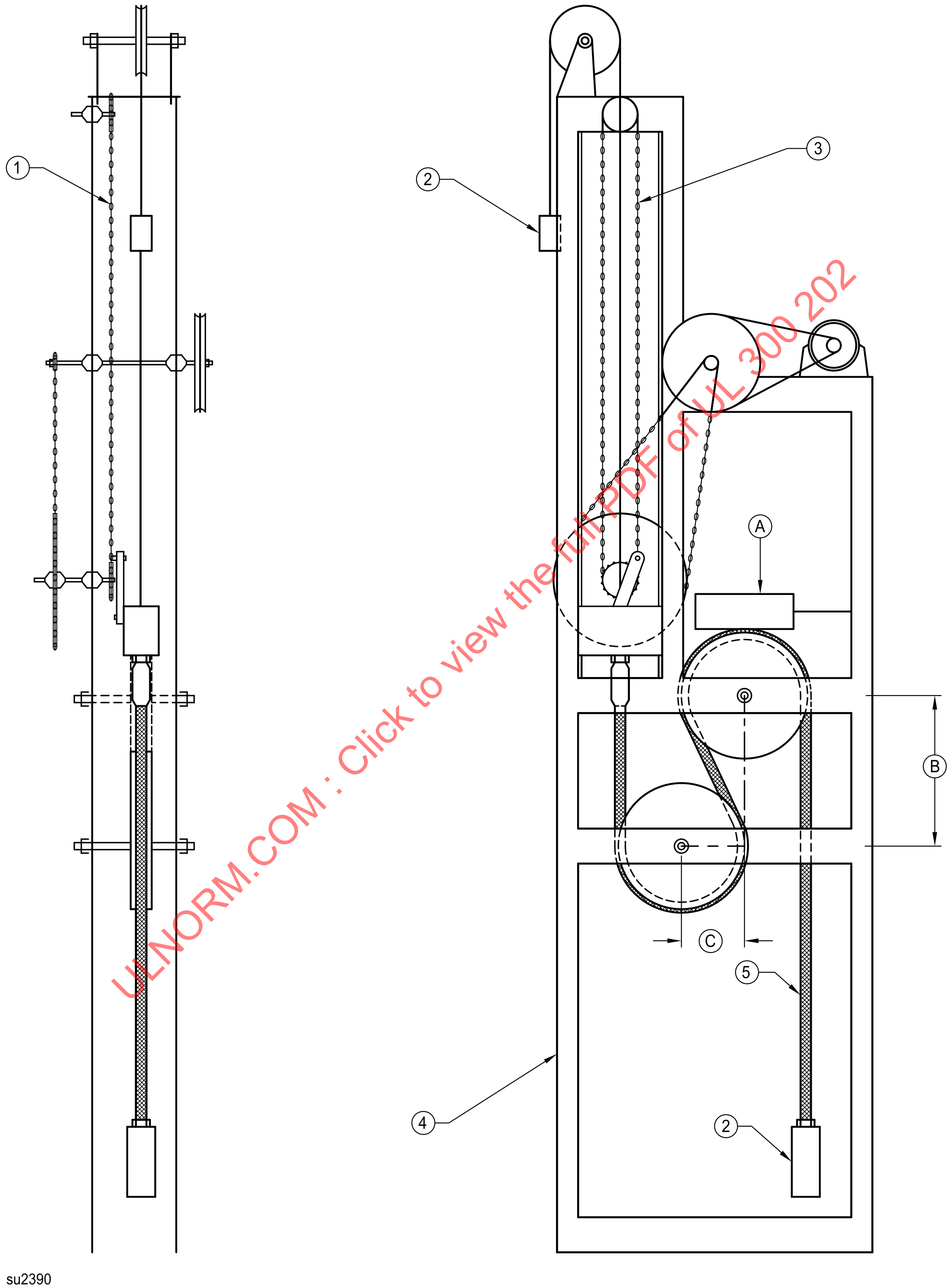
10.3.1 A bending machine, as shown in Figure 10.1 with drums having a radius of 7 in (180 mm), shall be used for this test. The vertical distance between centers of the drums is 17 in (430.08 mm). The horizontal distance between centers of the drums is 7 in (180 mm).

10.4 Method

10.4.1 The position of the sample is shown in Figure 10.1. The sample shall be moved back and forth for a distance of 4 ft (1200 mm) at a rate of 470 cycles/h. The weight used on the end of the sample shall be the minimum required to make the sample conform to the curvature of the drums during the cycling. During the cycling, the sample shall be empty.

Figure 10.1

Bending Machine



1 – Block Chain, 2 – Counterweight, 3 – Centreline of Block Chain, 4 – Steel Frame, 5 – Hose Under Test

A – 1.6 kg, B – 430 mm, C – 180 mm

11 Hydrostatic Strength Test

11.1 General

11.1.1 The liquid conveying hose of a sample that was previously subjected to the Repeated Bending Test (Empty), Section 10, shall withstand a hydrostatic test pressure of 250 psi (1,724 kPa) for 1 min without leakage, ballooning, or rupture.

11.1.2 The vapor recovery hose of a sample that was previously subjected to the Repeated Bending Test (Empty), Section 10, shall withstand a hydrostatic test pressure of 2.5 psi (17.2 kPa) for 1 min without leakage, ballooning, or rupture. A hose assembly shall also withstand the test pressure without slippage or leakage of the couplings.

11.1.3 Hose assemblies shall withstand a hydrostatic test pressure of 250 psi (1,724 kPa) for 1 min 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 psi (1,724 kPa) for 1 min, and the vapor recovery hose shall be pressurized to 2.5 psi (17.2 kPa) for 1 min.

11.2 Sample

11.2.1 An approximately 11 ft (3300 mm) coupled length of hose subjected to the Repeated Bending Test (Empty), Section 10, shall be used for this test.

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

11.3 Apparatus

11.3.1 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 sample at a uniform rate of 700 – 1000 psi/min (4825 – 6895 kPa/min) for hose and hose assemblies intended for conveying liquid and no more than 5.0 psi/min (34.5 kPa/min) for hose and hose assemblies intended for recovering vapors. All pressures shall be measured using a calibrated pressure gauge.

11.3.2 Adapter fittings, which permit the separate pressurization of the inner and outer hoses, shall be connected to the couplings on coaxial vapor recovery hose samples.

11.4 Method

11.4.1 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 is then to be closed and the pressure in the hose shall be increased at a uniform rate of 700 – 1000 psi/min (4,825 – 6,895 kPa/min) for hose and hose assemblies intended for conveying liquid and no more than 5.0 psi/min (34.5 kPa/min) for hose and hose assemblies intended for recovering vapors.

11.4.2 The test pressure shall be held for at least 1 min during which time the sample shall be examined for leakage, ballooning, and rupture. A hose assembly sample shall show no evidence of slippage or leakage of the coupling or damage to the hose at the couplings after examination.

12 Test for Resistance to External Pressure

12.1 General

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

12.2 Sample

12.2.1 An approximately 3 ft (900 mm) coupled hose assembly shall be used for this test.

12.3 Apparatus

12.3.1 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 psi (4,826 – 6,895 kPa)/min for the outer hose intended for conveying liquid and no more than 5.0 psi (34.5 kPa)/min for the inner hose intended for recovering vapors. All pressures shall be measured using a calibrated pressure gauge.

12.3.2 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.

12.4 Method

12.4.1 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 is then to be closed and the pressure in the outer hose shall be increased at a uniform rate of 700 – 1,000 psi (4,825 – 6,895 kPa)/min until a pressure of 250 psi (1,724 kPa) is reached. After the test pressure has been maintained for 1 min, and while still under pressure, air or water shall be allowed to flow into the inner hose at a pressure of 0.5 psi (3.5 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.

13 Repeated Bending Test (Filled)

13.1 General

13.1.1 The sample, filled with ASTM Reference Fuel H, shall be subjected to repeated bending, in the manner described in 10.4.1, for 3,150 cycles/day for 6 days. There shall be no breakdown of the sample or any of its parts and the electrical resistance of the hose shall not be greater than 70,000 Ω/ft (233,000 Ω/m) before and after the test. The total loss of liquid during the bending periods shall not exceed that specified in Table 13.1. A hose assembly sample shall also comply with the requirements of the Leakage and Electrical Continuity Test, Section 16, after being subjected to repeated bending described in 13.4.1 and 13.4.2.

Table 13.1
Allowable Liquid Loss

Nominal hose diameter, inches	Max allowable loss, percentage
1-1/2	20
1-1/4	24
1	30
7/8	34
3/4	40
5/8	48
1/2	60

13.2 Sample

13.2.1 An approximately 11 ft (3300 mm) coupled length of hose is to shall be used for this test.

13.3 Apparatus

13.3.1 The bending machine shown in Figure 10.1 shall be used for this test.

13.3.2 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 a sample having a bonding path 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 100,000 Ω ±10 %. The test circuit shall have a nominal open-circuit potential of 500 V d.c., and a short-circuit current of 5 mA.

13.4 Method

13.4.1 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 in (355.6 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 is then to be filled with a measured amount of, ASTM Reference Fuel H, and subjected to repeated bending as described in 10.4.1 for 3,150 cycles/day for 6 days. At the start of the second day, and each subsequent day, the sample shall be removed from the bending machine, filled to the original level, when needed, with a measured amount of test liquid and suspended in a vertical or U-shaped position. After the final bending period, the sample shall be removed from the bending machine and filled to the original level, when needed, with a measured amount of test liquid. The percent loss of liquid shall be calculated using the amount of liquid required to fill the hose at the start of the test and the total amount of liquid added at the end of each bending period. After a total of 18,900 cycles of repeated bending, an examination shall be made for any evidence of breakdown of the sample or any of its parts, and the electrical resistance shall be measured again.

13.4.2 When conducting the test described in 13.4.1 on a coaxial vapor recovery hose assembly sample, the hose component intended to convey liquid shall be filled with the test liquid.

14 Permeation Test (For Low Permeation Hose)

14.1 General

14.1.1 The steady state permeation rate for each of five hose assemblies when tested in accordance with 14.2 – 14.8 shall not exceed 3.80/oz/ft^2/day (10.0 g/m^2/day).

14.2 Test equipment

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

a) Torque wrench capable of measuring torque from 50 to 130 ft-lb (68 to 177 N·m);

b) Balance with a range of 0 to 17.6 lb (0 to 8 kg) or greater, capable of weighing to an accuracy of 0.00035 oz (0.01 g);

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

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

e) Test chamber capable of maintaining a temperature of 100 ±3°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 ±3°F (±2°C) and relative humidity to ±1 % at intervals of 10 min or less; and

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

14.2.2 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).

14.2.3 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 the Standard Test Method for Rubber Property-Effect of Liquids, ASTM D471 and the Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel, ASTM D4806.

14.3 General test procedure and instructions

14.3.1 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 the 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 14.8.

14.3.2 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 14.7.6.

14.3.3 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 the weighings.

14.3.4 Care must be taken to avoid spilling fuel on the hose or fittings during filling and emptying of the hose assemblies. A vise or similar device shall be used to secure the hose assembly when capping, uncapping or filling the 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.

14.3.5 All masses shall be measured and reported in ounces (grams) to ±0.00035 oz (0.01 g).

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

14.3.7 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 and combustible 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 14.1.

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 (67.79 ±6.78 N·m). Alternative capping instructions shall be followed when a submitter requests that they be applied in accordance with the installation instructions that are routinely supplied to users with the hose assembly.

Table 14.1
Torque Requirements for Pipe Thread (NPT) Connections

Nominal pipe size	Torque	
inches	lb-ft	(N·m)
1/2	65	88
3/4	85	116
1	100	136
1-1/4	120	163
1-1/2	130	177

14.4 Samples

14.4.1 Six 11 ft (3.35 m) long identical hose assemblies shall be used for this test. Vacuum-assist vapor recovery hose assemblies shall be provided with the inner tube removed. The samples shall be the same length ±0.39 in (10 mm) and shall be taken from the same production run.

14.5 Pretest procedure

14.5.1 Measure and record the length (L) of each hose assembly to ±0.39 in (±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.

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

14.5.3 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.

14.5.4 Calculate and record the permeation surface area as defined in 3.12, the hose assembly volume as defined in 3.10, and the test fuel volume which equals 90 % of the hose assembly volume.

14.6 Preconditioning procedure

14.6.1 One of the six hose assembly samples shall be selected at random and subjected to the Repeated Bending Test (Filled) as specified in Section 13. This hose assembly shall be marked as sample number 1. At the completion of this test, the hose assembly shall not be subjected to the Leakage and Electrical Continuity test; it shall remain filled and capped until the permeation test is commenced.

14.6.2 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 described in 14.3.7. These assemblies shall be marked as samples 2 through 5.

14.6.3 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.

14.6.4 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 that 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.

14.7 Permeation test procedure

14.7.1 Within 72 h 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 empty assemblies shall be capped with their intended cap and weighed to determine their unfilled mass.

14.7.2 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 described in 14.3.7.

14.7.3 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 ties. 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 14.7.6.

14.7.4 Each of the six hose assemblies shall be weighed. The mass shall be recorded and the time of weighing shall be recorded within ±1 min.

14.7.5 On each successive weighing day, the coiled hose assemblies shall be removed from the test chamber, weighed, and returned to the chamber within 15 min. 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.

14.7.6 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 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 h of its removal.

14.7.7 When a hose assembly reaches steady state permeation as defined in 14.8, 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.

14.7.8 If at any time during the permeation test the permeation rate for a hose assembly is greater than 5.7 oz/ft^2/day (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 14.1.1.

14.8 Steady state criteria

14.8.1 The mass loss rate and the moving average mass loss at each weighing shall be calculated using the procedure in 14.8.2. Steady state permeation shall be determined using the criteria in 14.8.3.

14.8.2 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 14.7.6, 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 oz/ft^2/day (g/m^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.

14.8.3 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 14.8.2(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 (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.

15 Electrical Resistance Tests for Hose Having Nonmetallic Electrically Conductive Materials

15.1 General

15.1.1 Hose relying on nonmetallic electrically conductive materials for electrical conductivity shall not have an electrical resistance greater than 70,000 Ω/ft (233,000 Ω/m) before and after the exposures specified in 15.4.1 and 15.4.2.

15.2 Samples

15.2.1 Four samples of coupled hose, each approximately 1 ft (300 mm) in length, measured between couplings, shall be used. A separate sample shall be used for each of the exposures specified in 15.4.1. For samples having an electrically conductive cover, an additional two samples, each approximately 1 ft (300 mm) in length, capped at both ends, shall be subjected to the exposures specified in 15.4.2.

15.3 Apparatus

15.3.1 The oven described in Standard Test Method for Rubber – Deterioration in an Air Oven, ASTM D573, a water bath that maintains a temperature of 189 ±3.6°F (87 ±2°C), the ohmmeter specified in 13.3.2, and a cold chamber that maintains a temperature of −40 ±3.6°F (−40 ±2°C).

15.4 Method

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

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

b) A sample capped at one end shall be filled with ASTM Reference Fuel H sealed and conditioned at 73.4 ±3.6°F (23 ±2°C) for 168 ±1/2 h. The test exposure shall be conducted with the hose attached to a reservoir filled with the test liquid. After the 168 h exposure the test liquid shall be drained from the sample and the coupled hose shall be tested immediately.

c) 16 ±1/2 h at −40 ±3.6°F (−40 ±2°C) for hose used down to −40°F (−40°C) or 16 ±1/2 h at −65 ±3.6°F (−54 ±2°C) for hose marked for use down to −54°C (−65°F). The sample shall be open at both ends and the electrical resistance, shall be measured from coupling to coupling while the sample is still in the cold chamber.

d) 16 ±1/2 h in a circulating air oven at 140 ±3.6°F (60 ±2°C). The sample shall be open at both ends and the electrical resistance, shall be measured from coupling to coupling while the sample is still in the oven.

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

a) 168 ±1/2 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 ±1/2 h 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.

15.4.3 After the samples have been exposed in accordance with 15.4.1 (a) and (b) and 15.4.2, the electrical resistance shall be measured from coupling to coupling.

16 Leakage and Electrical Continuity Test

16.1 General

16.1.1 A hose assembly sample (liquid conveying hose for vapor recovery hose assembly sample) shall not have an electrical resistance greater than 70,000 Ω/ft (233,000 Ω/m) before and after being pressurized with air, nitrogen or kerosene to 75 psi (518 kPa) for at least 1 min. While the hose assembly is pressurized, it shall show no visible signs of leakage.

16.1.2 For vapor recovery hose assembly samples, the hose intended to recover vapors shall show no visible signs of leakage after being pressurized with air, nitrogen, or kerosene to 0.75 psi (5.2 kPa).

16.2 Sample

16.2.1 An approximately 24 in (610 mm) long hose assembly shall be used for this test.

16.3 Apparatus

16.3.1 A system that maintains a pressure in a hose assembly sample filled with air, nitrogen or kerosene shall be used. The pressure shall be measured with a calibrated pressure gauge. The ohmmeter specified in 13.3.2 shall be used for measuring the electrical resistance of the hose.

16.4 Method

16.4.1 The electrical resistance from coupling to coupling shall be measured by means of the appropriate ohmmeter specified in 13.3.2. When the coupling has a swivel, the swivel shall be rotated 360° while the leads of the ohmmeter are attached to the couplings, and the highest reading obtained shall be considered the resistance of the hose assembly sample. The hose assembly sample (liquid conveying hose for vapor recovery hose assemblies) shall then be pressurized to 75 psi (518 kPa) with air, nitrogen or kerosene and held for at least 1 min. 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 psi (518 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 psi (518 kPa) for one min. If no leakage is observed and the electrical resistance is less than that specified in 16.1.1 the hose assembly sample shall be considered acceptable.

16.4.2 For a vapor recovery hose assembly sample, the hose intended to recover vapors shall be separately pressurized to 0.75 psi (5.2 kPa) with air or nitrogen. The hose assembly sample shall be observed for leakage at the test pressure.

17 Swivel Joint Operation Test

17.1 General

17.1.1 An approximately 24 in (610 mm) hose assembly sample having couplings with swivel joints shall comply with the requirements for leakage and electrical continuity specified in 16.1.1 after being subjected to 100,000 cycles of operation as described in 17.3.

17.2 Sample

17.2.1 An approximately 600 mm long hose assembly sample having couplings with swivel joints shall be used for this test.

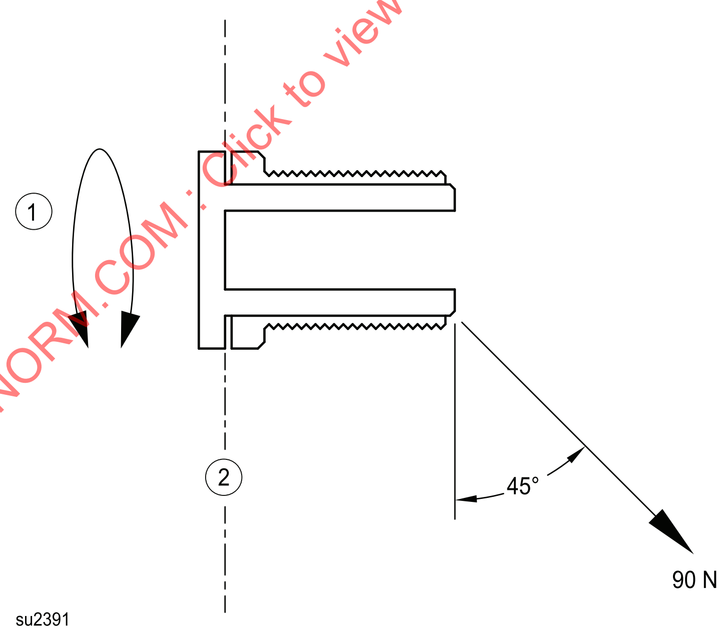
17.3 Method

17.3.1 Preparatory to the test, the hose assembly sample shall be connected to a test liquid line containing ASTM Reference Fuel H. For the duration of the test, the liquid shall be under a pressure of 50 psi (345 kPa). The operating mechanism shall be arranged so that, during each cycle of operation, each swivel joint is rotated through an arc of 180° at a rate of not more than 30 cycles/min. If the hose assembly sample is constructed with more than one swivel joint, and it is not feasible to operate all joints simultaneously, then any one joint may be operated separately. Rotation of the joint 180° and then back to the initial position shall be considered one cycle of operation.

17.3.2 During the cycling, a force of 20 lbf (89 N) shall be applied to the swivel at an angle of 45° from the plane of rotation, in a manner such that the force acts as a bending moment at the joint. The force shall be applied at the point on the swivel farthest from the joint. Depending on the swivel construction, the Swivel Joint Operation Test may need to be conducted on additional samples of the swivel with the load applied on the opposite side of the plane of rotation. See Figure 17.1, Figure 17.2, and Figure 17.3 for examples.

Figure 17.1

Application of Test Force for Axial Swivel

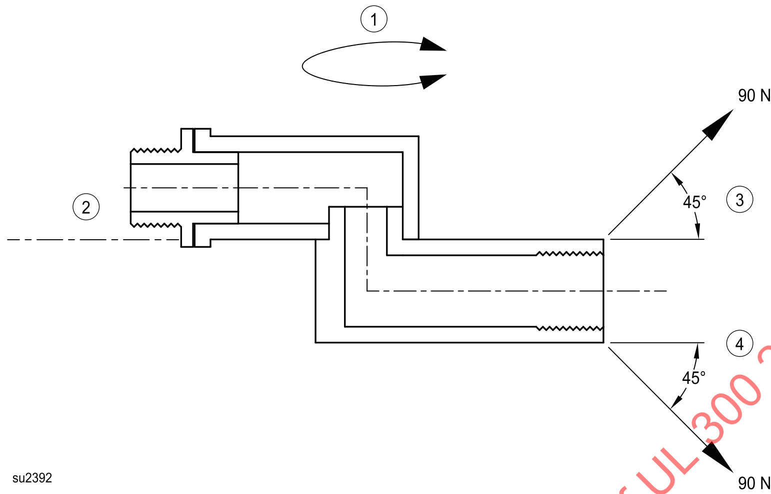


1 – Direction of Rotation

2 – Plane of Rotation

Figure 17.2

Application of Test Force for Compound Swivel



1 – Direction of Rotation

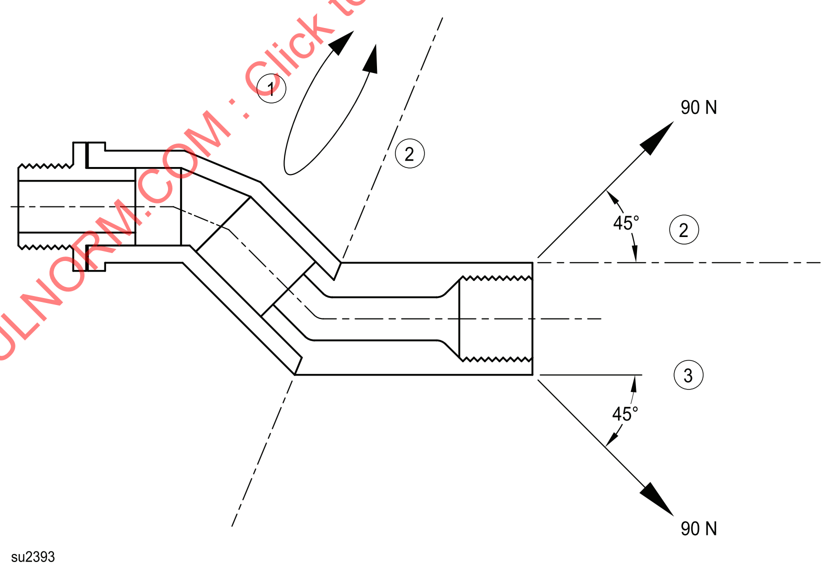
2 – Plane of Rotation

3 – Side One

4 – Opposite Side

Figure 17.3

Application of Test Force on Compound Swivel with 45° Outlet



1 – Direction of Rotation

2 – Plane of Rotation

3– Opposite Side

18 Check Valve Endurance Test

18.1 A check valve, whose failure would allow leakage from the liquid conveying portion of the hose to the vapor recovery portion of the hose of a vapor recovery hose assembly sample, shall perform in its intended manner when tested as described in 18.2 and 18.3. There shall be no external leakage before and after the endurance test. There shall be no sticking of the valve, nor shall the valve become inoperative after the endurance test.

18.2 The check valve shall be operated for 100,000 cycles. One cycle is completed by applying an aerostatic pressure sufficient to unseat the valve and then releasing the pressure.

18.3 Following the completion of the endurance test, the sample shall not leak when subjected to an appropriate liquid or aerostatic pressure of 1-1/2 times its maximum design pressure.

19 Pull Test

19.1 General

19.1.1 A hose assembly sample shall withstand a 400 lbf (1.8 kN) pull force, as-received and after conditioning, as described in 19.4.1.

19.2 Sample

19.2.1 Two hose assembly samples each having a length of approximately 1 ft (300 mm), shall be used.

19.3 Equipment

19.3.1 A power-operated machine, as described in the Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension, ASTM D412, shall be used. The rate of travel of the power-actuated grip shall be 1.0 ±0.1 in/min (25.4 ±2.5 mm/min).

19.3.2 The oven specified in Standard Test Method for Rubber – Deterioration in an Air Oven, ASTM D573, shall be used for this test.

19.4 Method

19.4.1 One sample shall be conditioned at 73.4 ±3.6°F (23 ±2°C) for at least 24 h and one sample shall be placed in an oven for 70 ±1/2 h at a temperature of 212 ±3.6°F (100 ±2°C). After the oven conditioning, the sample shall be allowed to cool at 73.4 ±3.6°F (23 ±2°C) for at least 24 h.

19.4.2 The couplings on each end of the sample are then to be connected to corresponding fittings. The resulting assembly shall then be placed in the tension testing machine and connected so that both end fittings, the couplings, and the hose element 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.

20 Adhesion Test

20.1 General

20.1.1 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 in (25.4 mm) in width, is not greater than 1 in/min (25.4 mm/min) – when a weight of 10 lb (4.5 kg) is applied.

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

20.1.3 Hose having components with less adhesion than specified in 20.1.1 and 20.1.2 and hose without reinforcement shall comply with the requirements of Sections 21 and 22.

20.1.4 The requirements in 20.1.1 and 20.1.2 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.

20.2 Sample

20.2.1 1 in (25.4 mm) wide ring-shaped specimens cut from a representative sample of hose shall be used for this test.

20.3 Apparatus

20.3.1 Adhesion tests shall be conducted with the type of apparatus described for the Static-Mass Method for ring specimens specified in the Standard Test Methods for Rubber Property – Adhesion to Flexible Substrate, ASTM D413.

20.4 Method

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

20.4.2 The tests shall be conducted in accordance with the Static-Mass Method test methods for ring specimens outlined in the Standard Test Methods for Rubber Hose, 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.

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

21 Deformation Test

21.1 When required by 20.1.3, the hose shall show no visible signs of damage and shall comply with the requirements of the Hydrostatic Strength Test, Section 11, after having been subjected to the deformation procedure in 21.2.

21.2 The center portion of an 18 in (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 in (152 mm) on a side, mounted on a compression testing machine moving at a rate of 0.5 in/min (12.7 mm/min). 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 psi (1,723 kPa) for 1 min.

22 Kink Test

22.1 When required by 20.1.3, the hose shall show no visible signs of damage and shall comply with the requirements of the Hydrostatic Strength Test, Section 11, after having been subjected to the procedure in 22.2.

22.2 An approximately 1 ft (305 mm) length of coupled hose shall be subjected to 100 cycles of bending around a 3 in (76 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 psi (1,723 kPa) for 1 min.

23 Tensile Strength and Ultimate Elongation Tests

23.1 General

23.1.1 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 2-1/2 in (25.4 to 76.2 mm)].

23.1.2 For hose components subjected to occasional splashing of fuel, 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 in (25.4 to 76.2 mm)].

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

23.2 Strips and specimens

23.2.1 Three strips from each component, approximately 1 in (25.4 mm) wide and 8 in (203 mm) long, shall be cut longitudinally from a representative section. The test specimens shall be obtained from these strips.

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

23.2.3 The strips shall be buffed or skived with the equipment specified in 5.2 and 5.3.

23.2.4 The specimens shall be cut longitudinally from the strips. Wetting the cutting edge of the die with water is a way to facilitate the cutting operation. The strip 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.

23.2.5 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.

23.2.6 A dial micrometer, as described in 5.4, shall be used to measure the thickness of specimens.

23.2.7 As an alternative to obtaining specimens from finished hose, specimens can be obtained from test slabs molded from the compound used to produce the layer.

23.3 Apparatus

23.3.1 Tensile strength and elongation tests shall be made on a power-operated machine, as described in the Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension, ASTM D412.