



UL 330B

STANDARD FOR SAFETY

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

ULNORM.COM : Click to view the full PDF of UL 330B 2020

UL Standard for Safety for 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 330B

First Edition, Dated December 18, 2015

SUMMARY OF TOPICS

This revision of ANSI/UL 330B dated April 16, 2020 includes the following changes in requirements:

Adding renewable diesel to the scope of the standard; [1.2](#)

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The new requirements are substantially in accordance with Proposal(s) on this subject dated January 31, 2020.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical, photocopying, recording, or otherwise without prior permission of UL.

UL provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will UL be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if UL or an authorized UL representative has been advised of the possibility of such damage. In no event shall UL's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

Users of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold UL harmless from and against any loss, expense, liability, damage, claim, or judgment (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 330B 2020

DECEMBER 18, 2015
(Title Page Reprinted: April 16, 2020)



ANSI/UL 330B-2020

1

UL 330B

Standard for 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

First Edition

December 18, 2015

This ANSI/UL Standard for Safety consists of the First Edition including revisions through April 16, 2020.

The most recent designation of ANSI/UL 330B as an American National Standard (ANSI) occurred on March 31, 2020. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

UL's Standards for Safety are copyrighted by UL. Neither a printed nor electronic copy of a Standard should be altered in any way. All of UL's Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of UL.

COPYRIGHT © 2020 UNDERWRITERS LABORATORIES INC.

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 330B 2020

CONTENTS

INTRODUCTION

1	Scope	7
2	General	7
2.1	Units of Measurement	7
2.2	Undated References	8
3	Glossary	8

CONSTRUCTION

4	Tube and Cover	8
5	Thickness of Cover	8
6	Internal Diameter	9
7	Reinforcement	9
8	Electrical Bonding	9
9	Couplings	9
10	Materials	10
10.1	Metallic materials	10
10.2	Nonmetallic materials	11

PERFORMANCE

11	General	13
12	Repeating Bending Test (Empty)	14
12.1	General	14
12.2	Sample	14
12.3	Apparatus	14
12.4	Method	14
13	Hydrostatic Strength Test	16
13.1	General	16
13.2	Sample	16
13.3	Apparatus	16
13.4	Method	16
14	Repeated Bending Test (Filled)	16
14.1	General	16
14.2	Sample	17
14.3	Apparatus	17
14.4	Method	17
15	Permeation Test (For Low Permeation Hose)	17
15.1	General	17
15.2	Test equipment	18
15.3	General test procedure and instructions	18
15.4	Samples	19
15.5	Pretest procedure	19
15.6	Preconditioning procedure	20
15.7	Permeation test procedure	20
15.8	Steady state criteria	21
16	Electrical Resistance Tests for Hose Having Nonmetallic Electrically Conductive Materials	22
16.1	General	22
16.2	Samples	22
16.3	Apparatus	22
16.4	Method	22
17	Leakage and Electrical Continuity Test	23

17.1	General	23
17.2	Sample	23
17.3	Apparatus.....	23
17.4	Method.....	23
18	Swivel Joint Operation Test.....	23
18.1	General	23
19	Pull Test	24
19.1	General	24
19.2	Sample	24
19.3	Equipment.....	24
19.4	Method.....	24
20	Adhesion Test.....	24
20.1	General	24
20.2	Sample	25
20.3	Apparatus.....	25
20.4	Method.....	25
21	Deformation Test.....	25
22	Kink Test	25
23	Tensile Strength and Elongation Tests for Hose Components	26
23.1	General	26
23.2	Samples.....	26
23.3	Apparatus.....	26
23.4	Method.....	26
24	Accelerated Air Oven Aging Test for Hose Components	27
24.1	General	27
24.2	Samples.....	27
24.3	Apparatus.....	27
24.4	Method.....	27
25	Ozone Exposure Test	28
25.1	General	28
25.2	Samples.....	28
25.3	Apparatus.....	28
25.4	Method.....	28
26	Immersion Tests for Hose Components.....	28
26.1	Tensile strength and ultimate elongation	28
26.2	Volume change.....	29
27	Low Temperature Test	30
27.1	General.....	30
27.2	Sample	30
27.3	Apparatus.....	31
27.4	Method.....	31
28	Long Term Exposure Test for Hose and Hose Assemblies	31
28.1	General	31
28.2	Samples.....	31
28.3	Method.....	32
29	Bending Test for Hose Assemblies with Internal Spring	32

MANUFACTURING AND PRODUCTION TESTS

30	General	33
----	---------------	----

MARKING

31	Details.....	33
----	--------------	----

SUPPLEMENT SA – TEST FLUIDS

SA1	Representative Aggressive Combustible Test Fuel Mixtures	35
-----	--	----

ULNORM.COM : Click to view the full PDF of UL 330B 2020

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 330B 2020

INTRODUCTION

1 Scope

1.1 These requirements cover hose and hose assemblies for use on dispensing devices for fuels. A flammable liquid hose assembly consists of flexible hose and fittings suitable for attachment to fuel dispensing equipment. Fuels, as defined by these requirements, include one or more of the fuels described in [1.2](#).

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

- a) Diesel fuel, which includes renewable diesel, and diesel fuel/biodiesel blends with nominal biodiesel concentrations up to 5 percent (B0 – B5) formulated in accordance with the Standard Specification for Diesel Fuel Oils, ASTM D975.
- b) Diesel/biodiesel and renewable diesel/biodiesel blends with nominal biodiesel concentrations from 5 percent up to 20 percent (B6 – B20) formulated in accordance with the Standard Specification for Diesel Fuel Oil, Biodiesel Blends (B6 – B20), ASTM D7467.
- c) Biodiesel (B99.9/B100) formulated in accordance with the Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels, ASTM D6751.
- d) Kerosene formulated in accordance with the Standard Specification for Kerosene, ASTM D3699.
- e) Fuel Oil (heating oil) formulated in accordance with the Standard Specification for Fuel Oils, ASTM D396.

1.3 Hose assemblies are intended for use in accordance with the Code for Motor Fuel Dispensing Facilities and Repair Garages, NFPA 30A.

1.4 These requirements cover hose and hose assemblies (hose with couplings attached) in sizes up to and including 1-1/2 inches (38.1 mm).

1.5 Hose for conveying liquid fuel is intended for use at a maximum working pressure of 50 psig (345 kPa).

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

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 Outline for Power-Operated Dispensing Devices for Diesel Fuel, Biodiesel Fuel, Diesel/Biodiesel Blends with Nominal Biodiesel Concentrations Up to 20 Percent (B20), Kerosene, and Fuel Oil, UL 87B.

1.8 These requirements do not cover hoses or hose assemblies for use with any other fuel other than as described in [1.2](#).

2 General

2.1 Units of Measurement

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 Undated References

2.2.1 Any undated reference to a code or standard appearing in the requirements of this Outline shall be interpreted as referring to the latest edition of that code or standard.

3 Glossary

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

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

3.3 PERMEATION SURFACE AREA – The length of the hose as determined in [15.5.4](#) 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.

3.4 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.

3.5 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.

3.6 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.

CONSTRUCTION

4 Tube and Cover

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

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

4.3 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 Thickness of Cover

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

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, is to be used.

5.3 The abrasive wheel of the buffing machine is to be No. 30 – 60 grit and the diameter and rotary velocity of the wheel are to be such that it will have a peripheral speed of 4000 ±700 feet per minute (20.3 ±3.6 m/s). The machine is to 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 inch (0.03 mm) that exerts a load of 2.82 – 3.00 ounces (80 – 85 grams) by means of a weight is to be used to measure thickness. The load is to be applied through a flat contact foot 0.25 ± 0.01 inch (6.4 ± 0.3 mm) in diameter.

5.5 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, is to 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 is to be cut from the thinnest portion of the sample.

5.6 The strip specimen is to 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 are to be taken within the area from which the impressions have been removed, and the maximum reading obtained is to 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 $\pm 1/32$ inch (0.8 mm) for sizes up to and including $3/4$ inch (19.0 mm) and $\pm 1/16$ inch (1.6 mm) for larger sizes.

6.2 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.

6.3 The end of the hose is to be cut square. When a tapered plug gauge is used, the plug gauge is to 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), is to 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, is to be recorded as the internal diameter of the hose. When the end of a wire-braided hose is constricted or flared, the inside diameter is to be measured 1 inch (25.4 mm) from the end to be representative of the inside diameter by means of an expanding ball gauge.

7 Reinforcement

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

8 Electrical Bonding

8.1 Hose and hose assemblies shall be constructed so as to provide an electrically conductive and bonding path between the couplings at each end of the length in order to dissipate static electricity.

9 Couplings

9.1 Couplings provided on hose assemblies shall be made from metals and shall be constructed with a section for tightening with tools. See Materials, Section [10](#).

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

9.3 When the threads of the couplings of a single-line hose assembly or vapor recovery hose assembly are not as specified in [9.2](#), 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 [31.8](#).

10 Materials

10.1 Metallic materials

10.1.1 General

10.1.1.1 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. See the Long Term Exposure Test, Section, [27](#).

10.1.1.2 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, [10.1.2](#).

10.1.1.3 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.

10.1.1.4 With reference to the above requirements, metallic parts include metallic materials used to form fluid confining parts as well as metallic coatings or plating that may be applied to a base material.

10.1.2 Atmospheric corrosion

10.1.2.1 Metallic materials used for fluid confining parts shall be resistant to atmospheric corrosion. Standard pipe and fittings conforming to the Standard for Welded and Seamless Wrought Steel Pipe, ASME B36.10M are acceptable when uncoated.

10.1.2.2 A protective coating shall provide resistance against atmospheric corrosion to a degree not less than that provided by the protective coatings specified in [10.1.2.3](#).

10.1.2.3 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 [10.1.2.1](#) 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 the Specification for Sheet Steel, Zinc Coated (Galvanized) or Zinc-Iron-Alloy Coated (Galvannealed) by the Hot Dip Process, ASTM A653/A653M; or

b) Coatings which have been determined to be equivalent to G90 under the requirements of the Standard for Organic Coatings for Steel Enclosures for Outdoor Use Electrical Equipment, UL 1332.

10.1.2.4 A metallic material other than as described in [10.1.2.1](#) – [10.1.2.3](#) shall be painted or protected in a manner that has been determined to be equivalent.

10.2 Nonmetallic materials

10.2.1 General

10.2.1.1 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 [10.2.1.2](#) – [10.2.3.2](#). Hose materials are tested in accordance with the following:

- a) Tensile Strength and Elongation, Section [22](#);
- b) Accelerated Air Oven Aging Test, Section [23](#);
- c) Ozone Exposure, Section [24](#);
- d) Immersion Tests, Section [26](#).

10.2.1.2 Gaskets or seals shall be designated as dynamic and/or static seals. See [3.4](#) and [3.5](#) respectively. If the type of seal cannot be determined, then the material shall be treated as both a static and a dynamic seal.

10.2.1.3 Gaskets and seals shall comply with the requirements as outlined in Nonmetallic materials – material level, [10.2.2](#); and Nonmetallic materials – system level, [10.2.3](#).

10.2.1.4 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.

10.2.2 Nonmetallic materials – material level

10.2.2.1 Static seals

10.2.2.1.1 Static seals shall be evaluated in accordance with the Standard for Gaskets and Seals, UL 157, modified as indicated in [10.2.2.1.2](#) – [10.2.2.1.3](#). If a specific material complies with these requirements, the material can be considered to be qualified for system testing.

10.2.2.1.2 Static seals shall be subjected to the Volume Change and Extraction Test in accordance with the Standard for Gaskets and Seals, 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 Supplement [SA](#); and
- c) For all materials, the average volume change shall not exceed 40 percent swell (increase in volume) or 1 percent shrinkage (decrease in volume). In addition, the weight loss shall not exceed

10 percent. There shall be no visual evidence of cracking or other degradation as a result of the exposure for any material including coated fabrics.

10.2.2.1.3 Static seals shall be subjected to the Compression Set Test in accordance with the Standard for Gaskets and Seals, UL 157, except for the following modifications:

- a) The test duration shall be 1000 hours;
- b) The samples shall be immersed, at room temperature, in the test fluids (see item c) while compressed for the entire test duration. No oven conditioning is required;
- c) The applicable test fluids shall be as described in Supplement [SA](#);
- d) The recovery period shall consist of removing the sample from the compression device and immersing it in the applicable test fluid for 30 minutes at room temperature. The sample shall not be allowed to dry out due to exposure to air. The 30-minute immersion should use the same fluid as the test fluid for each sample; and
- e) For all materials, the average compression set is calculated and shall not exceed 35 percent.

10.2.2.2 Dynamic seals

10.2.2.2.1 Dynamic seals shall be evaluated in accordance with the Standard for Gaskets and Seals, UL 157 modified as indicated in [10.2.2.2.2](#) – [10.2.2.2.3](#). If a specific material complies with these requirements, the material can be considered to be qualified for system testing.

10.2.2.2.2 Dynamic seals shall be subjected to the Volume Change and Extraction Test in accordance with the Standard for Gaskets and Seals, 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 Supplement [SA](#); and
- c) For all materials, the average volume change for a gasket or seal material shall not exceed 40 percent swell (increase in volume) or 1 percent shrinkage (decrease in volume). In addition, the weight loss shall not exceed 10 percent. There shall be no visual evidence of cracking or other degradation as a result of the exposure for any material including coated fabrics.

10.2.2.2.3 Dynamic seals shall be subjected to the Immersion Test in accordance with the Standard for Gaskets and Seals, 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 Supplement [SA](#); and
- c) For all materials, the average tensile strength and the average elongation of materials shall not be less than 60 percent of the as-received values.

10.2.3 O-rings

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

10.2.3.2 Seals (O-rings) shall retain a minimum of 60 percent of tensile strength and elongation after 70 hours oven aging at 100°C (212°F). The test methods and apparatus used are described in the Standard for Gaskets and Seals, UL 157.

10.2.4 Nonmetallic materials – system level

10.2.4.1 For all materials, gaskets and seals that have been shown to comply with the applicable requirements for static seals in the Standard for Gaskets and Seals, UL 157, or with the requirements under material level tests shall be subjected to the system level tests for the applicable component after the Long Term Exposure Test, Section [28](#). Static seals shall be provided in accordance with [28.2.4](#).

PERFORMANCE

11 General

11.1 The performance tests in Sections [12](#) – [28](#) of this standard apply to hose and hose assemblies as indicated in the individual test.

11.2 All tests involving a test fluid shall be performed using the test fluid specified for that test. There shall be no substitution of test fluids. If the product is rated for use with diesel fuel (B0 – B5), a diesel/biodiesel blend above 5 percent but not greater than 20 percent biodiesel (B6 – B20), kerosene or fuel oil, then the test shall be performed using the FB25a test fluid. If the product is rated for use with biodiesel (B99.9/B100), fuel oil, or kerosene, then the test shall be performed using the B100a test fluid. FB25a and B100a test fluids shall be prepared as described in Supplement [SA](#).

11.3 Certain tests are to 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.

11.4 Hoses and hose assemblies shall be subjected to the test sequences as shown in [11.4.1](#) and [11.4.2](#) after being subjected to the Long Term Exposure Test, Section [27](#).

11.4.1 One 11-foot hose sample for each fluid exposure is to be subjected to the following sequence:

- a) Long Term Exposure, Section [27](#);
- b) Leakage and Electrical Continuity Test, Section [16](#);
- c) Hydrostatic Strength Test, Section [13](#); and
- d) Ozone Test, Section [24](#).

11.4.2 One 1-foot hose sample for each fluid exposure is to be subjected to the following sequence:

- a) Long Term Exposure, Section [27](#), and
- b) Pull Test for Hose Assemblies, Section [18](#).

11.5 The remaining tests in this Performance Section are to be performed in any order or as indicated in the actual test methods.

12 Repeating Bending Test (Empty)

12.1 General

12.1.1 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 [13](#).

12.2 Sample

12.2.1 An 11 foot (3.35 m) coupled length of hose is to be used for this test.

12.3 Apparatus

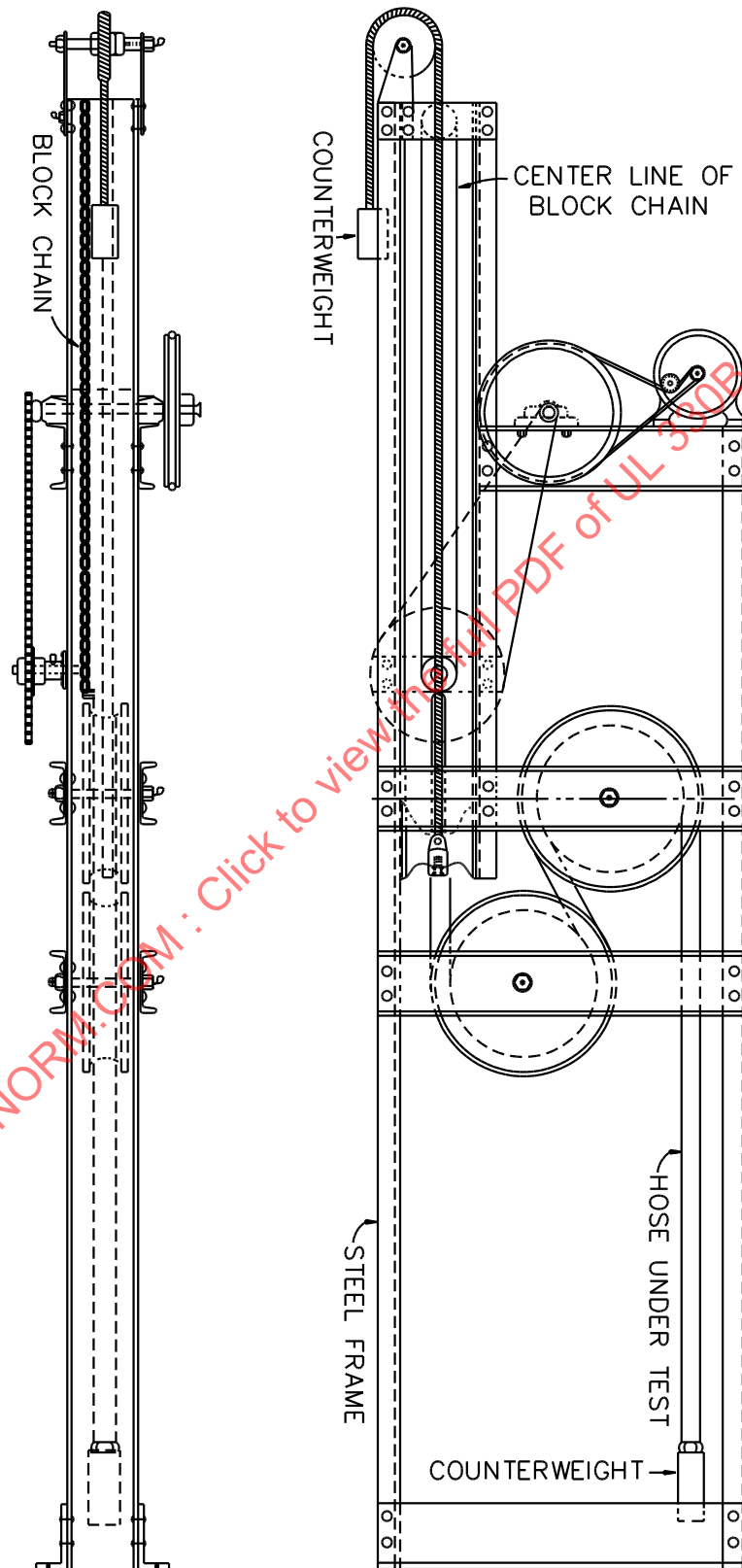
12.3.1 A bending machine, as shown in [Figure 12.1](#) with drums having a radius of 7 inches (178 mm), is to be used for this test. The vertical distance between centers of the drums is 17 inches (431.8 mm). The horizontal distance between centers of the drums is 7 inches (431.8 mm).

12.4 Method

12.4.1 The position of the hose is shown in [Figure 12.1](#). The hose is to 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 is to be the minimum required to make the hose conform to the curvature of the drums during the cycling. During the cycling, the hose is to be empty.

ULNORM.COM : Click to view the full PDF of UL 330B 2020

Figure 12.1
Bending machine



S2826

13 Hydrostatic Strength Test

13.1 General

13.1.1 Hose shall withstand a hydrostatic test pressure of 250 psig (1,724 kPa) for 1 minute without leakage, ballooning, or rupture.

13.1.2 Hose assemblies shall withstand a hydrostatic test pressure of 250 psig (1,724 kPa) for 1 minute without slippage or leakage of the couplings or damage to the hose.

13.2 Sample

13.2.1 Samples used for this test are those that have been subjected to either the Repeated Bending Test (Empty), described in Section [12](#), or the Long Term Exposure Test – Leakage and Electrical Continuity Sequence described in Section [27](#) and [16](#) respectively.

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

13.3 Apparatus

13.3.1 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 (6,895 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 are to be measured using a calibrated pressure gauge.

13.4 Method

13.4.1 The hose sample, while lying straight, is to 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 is to be increased at a uniform rate of 700 – 1000 psig (4,826 – 6,895 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 is to be held for 1 minute during which time the hose is to 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.

14 Repeated Bending Test (Filled)

14.1 General

14.1.1 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 [11.2](#) are to be subjected to repeated bending, in the manner described in [12.4.1](#), for 3,150 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 70,000 ohms per foot (233,000 ohms/m) before and after the test. The total loss of liquid during the bending periods shall not exceed that specified in [Table 14.1](#).

14.1.2 Hose assemblies shall also comply with the requirements of the Leakage and Electrical Continuity Test, Section [16](#).

Table 14.1
Allowable liquid loss

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

14.2 Sample

14.2.1 An 11 foot (3.4 m) coupled length of hose is to be used for this test.

14.3 Apparatus

14.3.1 The bending machine shown in [Figure 12.1](#) is to be used for this test.

14.3.2 A low-voltage ohmmeter is to be used for measuring the electrical resistance of hose having bonding paths with an electrical resistance of 1000 ohms or less. For hose bonding paths with an electrical resistance greater than 1000 ohms, the resistance measurements are to be made by means of a suitably calibrated ohmmeter having an effective internal resistance of 100,000 ohms ± 10 percent. The test circuit is to have a nominal open-circuit potential of 500 volts, direct current, and a short-circuit current of 5 milliamperes.

14.4 Method

14.4.1 The electrical resistance is to be measured from coupling to coupling. While the ohmmeter leads are attached to the couplings, the hose is bent 180 degrees around a 14 inch (355.6 mm) diameter mandrel at several different locations throughout the length of the hose, and the highest reading obtained is to be considered the resistance of the hose. The hose is then to be filled with a measured amount of the applicable test fluid as specified in [11.2](#), and subjected to repeated bending as described in [12.4.1](#) for 3,150 cycles per day for 6 days. At the start of each bending period, the hose is to 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 V-shaped position. The percent loss of liquid is to be calculated using the amount of liquid required to fill the hose at the start of the test and the total liquid added at the end of each bending period. After a total of 18,900 cycles of repeated bending, an examination is to be made for any evidence of breakdown of the hose or any of its parts, and the electrical resistance is to be measured again.

15 Permeation Test (For Low Permeation Hose)

15.1 General

15.1.1 This shall apply to low permeation hose, as marked in Section [31.5](#). The steady state permeation rate for each of five hose assemblies when tested in accordance with [15.2](#) – [15.8](#) shall not exceed 10.0 g/m²/day.

15.2 Test equipment

15.2.1 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 ± 5 ft-lb (68 to 177 N·m);
- b) Balance with a range of 0 to 8 kg (0 to 17.6 pounds) or greater, capable of weighing to 0.01 g;
- c) Tapered plug gauge having a taper of 3/8 in. per foot (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 1.0 cm (0.39 in);
- e) Test chamber capable of maintaining a temperature of 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 ± 0.2 C degrees and relative humidity to ± 1 percent at intervals of 10 minutes or less; and
- g) 1000 ml (33.8 ounces) graduated cylinder with 10 ml (0.34 ounces) gradations.

15.2.2 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).

15.2.3 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.

15.3 General test procedure and instructions

15.3.1 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 [15.8](#).

15.3.2 During the test, no hose assembly shall exceed a fuel loss of more than 5 percent of the initial fuel charge. Before a 5 percent fuel loss occurs, the hose assembly shall be removed from the test chamber, emptied of fuel, and refilled, as described in [15.7.6](#).

15.3.3 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.

15.3.4 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 is to 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.

15.3.5 All masses shall be measured and reported in grams to ± 0.01 g.

15.3.6 During the permeation test, hose assembly weighings shall be at the same time (± 30 min) 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 min.

15.3.7 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 15.1](#).

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. 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 15.1
Torque requirements for pipe thread (NPT) connections

Nominal pipe size inches	Torque	
	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

15.4 Samples

15.4.1 Six 3.35 m (11 ft) identical hose assemblies are to 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 ± 1.0 cm (0.39 in), 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.

15.5 Pretest procedure

15.5.1 Measure and record the length (L) of each hose assembly to ± 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.

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

15.5.3 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.

15.5.4 Calculate and record the permeation surface area as defined in [3.4](#), the hose assembly volume as defined in [3.5](#), and the test fuel volume which equals 90 percent of the hose assembly volume.

15.6 Preconditioning procedure

15.6.1 One of the six hose assembly samples shall be selected at random and subjected to the Repeated Bending Test (Filled) as specified in Section [14](#) 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.

15.6.2 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 [15.3.7](#). These assemblies shall be marked as samples 2 through 5.

15.6.3 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.

15.6.4 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.

15.7 Permeation test procedure

15.7.1 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.

15.7.2 The five previously filled hose assemblies shall be filled to the test fuel volume (90 percent of the hose assembly volume) $\pm$ 10 ml (0.34 ounces) with CE-10 fuel, and capped as in [15.3.7](#).

15.7.3 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 [15.7.6](#).

15.7.4 Each of the six hose assemblies shall be weighed. The mass shall be recorded and the time of weighing shall be recorded within $\pm$ 1 minute.

15.7.5 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 percent prior to the next weighing.

15.7.6 When, during periodic weighings, it is anticipated that fuel loss will exceed 5 percent 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 hour of its removal.

15.7.7 When a hose assembly reaches steady state permeation as defined in [15.8](#), 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.

15.7.8 If at any time during the permeation test the permeation rate for a hose assembly is greater than 15.0 g/m²/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 [15.1.1](#).

15.8 Steady state criteria

15.8.1 The mass loss rate and the moving average mass loss at each weighing shall be calculated using the procedure in [15.8.2](#). Steady state permeation shall be determined using the criteria in [15.8.3](#).

15.8.2 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 [15.7.6](#), 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/m²/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.

15.8.3 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 [15.8.2](#) 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 percent 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 [15.8.3](#) 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.

16 Electrical Resistance Tests for Hose Having Nonmetallic Electrically Conductive Materials

16.1 General

16.1.1 Hose relying on nonmetallic electrically conductive materials for electrical conductivity shall not have an electrical resistance greater than 70,000 ohms per foot (233,000 ohms/m) before and after the exposures specified in [16.4.1](#) and [16.4.2](#).

16.2 Samples

16.2.1 Four samples of coupled hose, each 1 foot (0.3 m) in length, measured between couplings, are to be used. A separate sample is to be used for each of the exposures specified in [16.4.1](#). 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, are to be subjected to the exposures specified in [16.4.2](#).

16.3 Apparatus

16.3.1 The oven described in Standard Test Method for Rubber – Deterioration in an Air Oven, ASTM D573, a water bath that maintains a temperature of $87^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($189 \pm 3.6^{\circ}\text{F}$), the ohmmeter specified in [14.3.2](#), and a cold chamber that maintains a temperature of $\text{minus } 40 \pm 2^{\circ}\text{C}$ ($\text{minus } 40 \pm 3.6^{\circ}\text{F}$).

16.4 Method

16.4.1 A separate sample is to be subjected to each of the following exposures:

- a) $70 \pm 1/2$ hours in an air oven at $100 \pm 2^{\circ}\text{C}$ ($212 \pm 3.6^{\circ}\text{F}$) and then allowed to cool for 1 hour at $23 \pm 2^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$). The sample is to be open at both ends.
- b) Hose capped at one end is to be filled with the appropriate test fluid as specified in [11.2](#), sealed and conditioned at $23 \pm 2^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) for $168 \pm 1/2$ hours. The sample is to 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) $16 \pm 1/2$ hours at $\text{minus } 40.0 \pm 2^{\circ}\text{C}$ ($\text{minus } 40.0 \pm 3.6^{\circ}\text{F}$) for hose marked for use down to $\text{minus } 40^{\circ}\text{C}$ ($\text{minus } 40^{\circ}\text{F}$) or $16 \pm 1/2$ hours at $\text{minus } 54 \pm 2^{\circ}\text{C}$ ($\text{minus } 65 \pm 3.6^{\circ}\text{F}$) for hose marked for use down to $\text{minus } 54^{\circ}\text{C}$ ($\text{minus } 65^{\circ}\text{F}$). The sample is to be open at both ends and shall be tested while still in the cold chamber.
- d) $16 \pm 1/2$ hours in a circulating air oven at $60 \pm 2^{\circ}\text{C}$ ($140 \pm 3.6^{\circ}\text{F}$). The sample is to be open at both ends and shall be tested while still in the oven.

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

a) 168 $\pm$ 1/2 hours immersion in distilled or deionized water at a temperature of 87 $\pm$ 2°C (189 $\pm$ 3.6°F) and then allowed to cool for 1 hour at 23 $\pm$ 2°C (73.4 $\pm$ 3.6°F).

b) 168 $\pm$ 1/2 hours immersion in IRM 903 Oil at 23 $\pm$ 2°C (73.4 $\pm$ 3.6°F), then blotted to remove oil from the couplings and tested immediately.

16.4.3 After the samples have been exposed in accordance with [16.4.1](#) a) and b) and [16.4.2](#), the electrical resistance is to be measured, coupling to coupling in accordance with [14.3.2](#).

17 Leakage and Electrical Continuity Test

17.1 General

17.1.1 A hose assembly shall not have an electrical resistance greater than 70,000 ohms per foot (233,000 ohms/m) before and after being pressurized with air, nitrogen or kerosene to 75 psig (518 kPa) for 1 minute. While the hose assembly is pressurized, it shall show no visible signs of leakage.

17.2 Sample

17.2.1 A 24 inch (610 mm) hose assembly is to be used for this test.

17.3 Apparatus

17.3.1 A system that maintains a pressure of up to 75 psig (518 kPa) in a hose assembly filled with air, nitrogen or kerosene is to be used. The pressure is to be measured with a calibrated pressure gauge. The ohmmeter specified in [14.3.2](#) is to be used for measuring the electrical resistance of the hose.

17.4 Method

17.4.1 The electrical resistance from coupling to coupling is to be measured by means of the ohmmeter specified in [14.3.2](#). When the coupling has a swivel, the swivel is to be rotated 360 degrees while the leads of the ohmmeter are attached to the couplings, and highest reading obtained is to be considered the resistance of the hose assembly. The hose assembly is then to be pressurized to 75 psig (518 kPa) with air, nitrogen or kerosene and held for 1 minute. The hose assembly is to be observed for leakage at the test pressure, and the electrical resistance is to be measured while the hose assembly is at 75 psig (518 kPa). When testing with air or nitrogen, the sample is to be immersed in water. When leakage occurs using air or nitrogen, the test shall be repeated with kerosene maintained at 75 psig (518 kPa) for one minute.

18 Swivel Joint Operation Test

18.1 General

18.1.1 A 24 inch (610 mm) hose assembly having couplings with swivel joints shall comply with the requirements of the Long Term Exposure Test/Operation Test sequence for swivel joints in the Outline of Investigation for Emergency Breakaway Fittings, Swivel Connectors, and Pipe Connection Fittings for Use With Diesel Fuel, Biodiesel Fuel, Diesel/Biodiesel Blends With Nominal Biodiesel Concentrations Up To 20 Percent (B20), Kerosine, and Fuel Oil, UL 567B.

19 Pull Test

19.1 General

19.1.1 A hose assembly shall withstand a 400-pound (1.779 kN) pull force, as-received and after conditioning, as described in [19.4.1](#).

19.2 Sample

19.2.1 One 1-foot (0.3m) hose assembly is to be used for each conditioning exposure and applicable test fluid.

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, is to be used. The rate of travel of the power-actuated grip is to be 1.0 ± 0.1 inch (25.4 ± 2.5 mm) per minute.

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

19.4 Method

19.4.1 A separate assembly shall be subjected to the following conditions before being tested in accordance with [19.4.2](#).

- a) Exposed to the Long Term Exposure, Section [28](#) (See [11.4.2](#));
- b) Conditioned at $23 \pm 2^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) for at least 24 hours; and
- c) Placed in an oven for $70 \pm 1/2$ hours at a temperature of $100 \pm 2^{\circ}\text{C}$ ($212 \pm 3.6^{\circ}\text{F}$), and allowed to cool at $23 \pm 2^{\circ}\text{C}$ (73.4°F) for at least 24 hours.

19.4.2 The couplings on each end of the sample are then to be connected to corresponding companion parts. The assembly is then to 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 are to 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 inch (25.4 mm) in width, is not greater than 1 inch (25.4 mm) per minute when a weight of 10 pounds (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 [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 One inch (25.4 mm) wide ring-shaped specimens cut from a representative sample of hose are to be used for this test.

20.3 Apparatus

20.3.1 Adhesion tests are to 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 are to 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 are to be made to separate these components by hand.

20.4.3 The adhesion is to 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.

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 [13](#), after having been subjected to the deformation procedure in [21.2](#).

21.2 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) per 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 (1,723 kPa) for 1 minute.

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 [13](#), after having been subjected to the procedure in [22.2](#).

22.2 A 1 foot (305 mm) length of coupled hose shall be subjected to 100 cycles of bending around a 3 inch (76 mm) diameter mandrel. Each cycle shall consist of bending the center of the hose 180 degrees 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 (1,723 kPa) for 1 minute.

23 Tensile Strength and Elongation Tests for Hose Components

23.1 General

23.1.1 For hose components subjected to frequent or continuous exposure to fuel, the tensile strength shall not be less than 1,000 psi (6,895 kPa), and the ultimate elongation shall not be less than 150 percent [from 1 to 2-1/2 inches (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 percent [from 1 to 3 inches (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 Samples

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

23.2.2 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.

23.3 Apparatus

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

23.3.2 The rate of travel of the power actuated grip is to be 20 ± 1 inches (51 ± 2.54 cm) per minute.

23.3.3 The elongation is to be measured by means of a scale or other devices which is to 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).

23.3.4 The specimens obtained from finished hose are to be buffed or skived with the equipment specified in [5.2](#), as necessary to obtain a specimen suitable for testing.

23.3.5 Die C, as described in the Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension, ASTM D412, is to be used for cutting the specimens.

23.3.6 A dial micrometer, as described in [5.4](#), is to be used to measure thickness of specimens.

23.4 Method

23.4.1 Tensile strength and elongation are to be determined in accordance with the test methods outlined in the Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension, ASTM D412.

23.4.2 The parts to be tested are to 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 is to be used. The separated parts are then to be placed so as to permit free evaporation of the solvent from the parts for at least 1 hour before further preparation of specimens.

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

23.4.4 Dumbbell specimens are to 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 are to be 1 inch (25.4 mm) wide, when possible.

23.4.5 The specimens are to 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 is to 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.

23.4.6 Three measurements for thickness are to be made in the constricted portion of the specimen in calculating the tensile strength. The minimum value obtained is to be used as the thickness of the specimen in calculating the tensile strength.

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

24 Accelerated Air Oven Aging Test for Hose Components

24.1 General

24.1.1 The tensile strength and ultimate elongation of specimens of components that have been conditioned for $70 \pm 1/2$ hours in air at a temperature of $100 \pm 2^\circ\text{C}$ ($212 \pm 3.6^\circ\text{F}$) shall not be less than 80 percent of the tensile strength or 50 percent of the elongation of specimens that have not been oven conditioned.

24.2 Samples

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

24.3 Apparatus

24.3.1 The apparatus specified in Standard Test Method for Rubber – Deterioration in an Air Oven, ASTM D573, is to be used for this test.

24.3.2 The equipment for the tensile strength and ultimate elongation determinations is to be as described in [23.3.1](#) – [23.3.6](#).

24.4 Method

24.4.1 Three specimens are to be prepared in the same manner as for the Tensile Strength and Elongation Tests, Section [23](#), before placing the specimens in the oven, except the 1 inch (25.4 mm) bench marks, when used, are to be placed on the specimens after conditioning as specified in [24.1.1](#). The test is to be conducted in accordance with the test procedures specified in Standard Test Method for Rubber – Deterioration in an Air Oven, ASTM D573.

24.4.2 For comparative purposes three specimens of each component that have not been exposed to air oven aging are to be subjected to tensile and elongation tests. The methods for preparing samples and measuring the tensile strength and elongation are to be as described in [23.3.1](#) – [23.4.7](#).

25 Ozone Exposure Test

25.1 General

25.1.1 The cover of a hose shall show no visible signs of cracking after the hose has been subjected to the Long Term Exposure Test, Section [31](#), the Leakage and Electrical Continuity Test, Section [17](#), and the Hydrostatic Strength Test, Section [13](#), sequence and then exposed to ozone as described in [25.4.2](#).

25.2 Samples

25.2.1 Three specimens, each 3-3/4 inches (95 mm) long by 1 inch (25.4 mm) wide, are to be cut longitudinally from the cover of a hose sample subjected to the test sequence indicated in [25.1.1](#).

25.3 Apparatus

25.3.1 The ozone test chamber for this test is to comply with the requirements outlined in the Standard Test Methods for Rubber Deterioration-Cracking in an Ozone Controlled Environment, ASTM D1149. The specimen holder is to comply with the requirements specified in Procedure B of the Standard Test Methods for Rubber Deterioration-Cracking in an Ozone Controlled Environment, ASTM D1149.

25.4 Method

25.4.1 The specimens are to be suspended and allowed to dry without touching each other for $70 \pm 1/2$ hours at an ambient temperature within the range of $10 - 40^{\circ}\text{C}$ ($50 - 104^{\circ}\text{F}$). Following the drying period the specimens are to be buffed or skived to remove only surface irregularities caused by reinforcement members. The specimens are then to be exposed to ozone as described in [25.4.2](#).

25.4.2 The specimens are to be mounted in the specimen holder in a looped position, and retained in an ozone-free atmosphere. The outer surface of the cover is to be on the outside of the looped specimen. The ozone test chamber is to be regulated to give an ozone partial pressure of 100 ± 10 mPa and a temperature of 40°C (104°F). When constant test conditions have been obtained in the ozone test chamber, and after the mounted specimens have remained in an ozone-free atmosphere for $24 \pm 1/2$ hours, the specimens are to be placed in the test chamber for $70 \pm 1/2$ hours. After the test exposure, the specimens are to be removed from the test chamber and examined with a 7-power magnifying glass for cracking in the looped portion while still in the specimen holder.

26 Immersion Tests for Hose Components

26.1 Tensile strength and ultimate elongation

26.1.1 General

26.1.1.1 For non-metallic hose and hose assembly components subjected to exposure to fuel, liquid or vapors, the tensile strength and ultimate elongation of specimens that have been immersed in applicable test fluid from [11.2](#) at $23 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) for $1000 \pm 1/2$ hours shall not be less than 60 percent of the corresponding properties of specimens that have not been immersed in the test liquid.

26.1.1.2 For hose components that come in contact with oil or grease, the tensile strength and ultimate elongation of specimens that have been immersed in IRM 903 Oil at $100 \pm 2^{\circ}\text{C}$ ($212 \pm 3.6^{\circ}\text{F}$) for $70 \pm 1/2$