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EI 1529

Aviation fuelling hose and hose assemblies

6th edition

AVIATION FUELLING HOSE AND HOSE ASSEMBLIES

EI STANDARD 1529

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May 2005

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FOREWORD

This sixth edition of EI Standard 1529 has been produced jointly by the American Petroleum Institute (API) Aviation Technical Services Subcommittee and the Energy Institute (EI)[1] Aviation Committee, with technical feedback from other industry stakeholders. It replaces the fifth edition published by the API and the provisions of the previous edition dating from 1998 should therefore be disregarded.

EI standards are published as an aid to procurement of standardised equipment and materials. These standards are not intended to inhibit purchasers or producers from purchasing or producing products made to specifications other than those of EI. An alternative and widely used standard for aviation hoses is the European Standard EN 1361 *Rubber hoses and hose assemblies for aviation fuel handling – Specification*.

Purchasers should be aware of the difference in requirements for Type E hose between this Standard and EN 1361. Type E hose in EN 1361 is an electrically bonded hose which calls for at least two low-resistance electrically conductive wires to be present within the materials of construction in addition to a conductive cover. Type E hose has been reintroduced to this sixth edition of EI 1529 with the metallic conducting helical support embedded in a conductive layer but it is not a requirement to have the two additional electrically conductive wires.

For the purpose of this publication the definitions given in Annex A apply irrespective of any other meaning the words may have in other connections.

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It is hoped and anticipated that this publication will assist those involved in aviation fuel handling at airports. Every effort has been made by the Energy Institute to assure the accuracy and reliability of the data contained in this publication; however, EI makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaim any liability or responsibility for loss or damage resulting from its use or for the violation of any local or regional laws or regulations with which this publication may conflict.

Suggested revisions are invited and should be submitted to the Technical Department, Energy Institute, 61 New Cavendish Street, London, W1G 7AR or e: technical@energyinst.org.

[1] Formerly the Institute of Petroleum.

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1

INTRODUCTION

1.1 SCOPE

This standard addresses performance requirements and manufacturer's test procedures for aircraft fuelling hose, hose couplings and hose assemblies suitable for a broad range of aviation fuel servicing equipment, including fuellers and hydrant servicers. The hoses to which this standard is applicable must be capable of handling the full spectrum of aviation fuels as specified in ASTM and UK Defence Standards. The following types of aviation fuelling hoses are not within the purview of this standard (also see section 2.4.1):

— Fully collapsible.
— Type A hoses.
— Type B hoses.

The specifications of this standard are intended for the convenience of both manufacturers and users. Users and manufacturers are not prohibited from purchasing or producing hoses that conform to other standards. The user should refer to the Rubber Manufacturer's Association *Hose Handbook*, and other specifications.

Each purchaser should conduct test verifications independent of any tests or inspections performed by the hose manufacturer. Such user tests should be performed in accordance with this standard.

1.2 RETROACTIVITY

For a hose assembly to be represented and labelled as meeting EI Standard 1529 specifications, it has to comply fully with the requirements of this sixth edition. If a hose assembly has qualified to the fifth edition of API Bulletin 1529, it must conform to the specifications of the sixth edition within six months to retain qualification.

1.3 METRICATION

Customary units have been converted to SI units wherever practicable and rounded off. It should be noted, however, that hoses and couplings constructed to SI units may be incompatible with hoses and couplings constructed to customary units.

2

HOSE DESCRIPTION

2.1 GENERAL

A hose is a reinforced, flexible conduit used to move liquids from one point to another. The flexibility of a hose permits it to accommodate motion and changes in alignment, vibration and thermal expansion and contraction. Portability, ease of routing, and ease of installation are additional virtues. Most hoses are made up of the following three elements:

1. An inner tube.
2. A reinforcement.
3. An outer cover.

2.2 CLASSIFICATION

Aviation fuel hoses are generally classified by the following characteristics:

— Internal diameter.
— Working pressure.
— Operating temperature.
— Conductivity.

The categorization of hoses by grade and type is determined by these characteristics.

2.3 GRADES

2.3.1 Grade 1

Grade 1 hoses, up to a maximum 38 mm (1,5 inches) internal diameter are acceptable for conformity to this standard. Hoses of a diameter greater than 38 mm (1,5 inches) shall conform to the requirements of Grade 2. A Grade 1 hose shall never be used in a Grade 2 application. Manufacturers should make users aware of this restriction.

A hose is classified as a Grade 1 hose if it is distinguished by the following properties:

— A maximum internal diameter of 38 mm (1,5 inches) or less.
— Operability within a temperature range of −30 °C to 55 °C (−22 °F to 131 °F). For Cold Temperature (CT) hose: operability within a temperature range of −40 ˚C to 55 ˚C (−40 ˚F to 131 ˚F).
— The ability of the hose to meet specification requirements detailed in section 4 will not be impaired by exposure to temperatures in the range −40 °C to 70 °C (−40 °F to 158 °F) or −48 ˚C to 70 ˚C (−55 ˚F to 158 ˚F) for CT hose.
— Ability to withstand working pressures up to 1 000 kPa (150 psi).

2.3.2 Grade 2

Grade 2 hoses are acceptable for conformity to this standard. A hose is classified as a Grade 2 hose irrespective of its internal diameter if it is distinguished by the following properties:

— Operability within a temperature range of −30 °C to 55 °C (−22 °F to 131 °F). For CT hose operability within a temperature range of −40 ˚C to 55 ˚C (−40 ˚F to 131 ˚F).

— The ability of the hose to meet specification requirements detailed in section 4 will not be impaired by exposure to temperatures in the range −40 °C to 70 °C (−40 °F to 158 °F) or −48 ˚C to 70 ˚C (−55 ˚F to 158 ˚F) for CT hose.
— Ability to withstand working pressures up to 2 000 kPa (300 psi).

2.4 TYPES

2.4.1 Hose types A and B

The following hose types are not addressed in this standard:

— Type A – non-electrically bonded.
— Type B – electrically bonded.

2.4.2 Type C

A Type C hose is a non-electrically bonded hose incorporating a semi-conductive cover compound having an electrical resistance between l x 10^3 and l x 10^6 ohms/metre.

2.4.3 Type E

A Type E hose is an electrically conducting hose incorporating at least one metallic conducting helical support bonded to the couplings and a conductive cover. This helical support shall be embedded in the hose material in such a manner that a conductive path remains even if the helix is broken in service. This type of hose may be used as a riser hose in a hydrant servicer or refueller to supply fuel to an elevating platform or as a suction hose between a refueller and a trailer.

2.4.4 Type F

A Type F hose is a hardwall hose that incorporates non-metallic helix reinforcement and has a semi-conductive cover compound with an electrical resistance between 1 x 10^3 and 1 x 10^6 ohms/metre.

Note: Non-marking hose is defined in Annex A.

2.4.5 Type CT

A Type CT hose is a non-electrically bonded hose incorporating a semi-conductive cover compound having an electrical resistance between 1 x 10^3 and 1 x 10^6 ohms/metre and is specifically to be used in cold temperature applications where standard hose is not suitable due to extreme cold temperatures. In comparison with standard hose, CT hose may be softer and less abrasion-resistant when used at normal temperatures.

3

SELECTING AVIATION FUELLING HOSES

Aviation fuelling hoses are installed on refuelling vehicles (hydrant servicers and fuellers) to deliver fuel to aircraft. Aviation fuelling hoses may also be used for the bottom loading and off-loading of fuellers and over-the-road tank trucks engaged in aviation product service as well as in other hydrant system servicing vehicles. Because of the pressures that may be present in a fuelling system, the aircraft fuelling hose selected should have a working pressure rating sufficient to withstand any surge or pressure increase that may be encountered during fuelling.

In applications where hydrant pressures less than 140 kPa (20 psi) are encountered and the hydrant servicer is equipped with a booster pump, a Type F hose should be used on the hydrant-to-vehicle connection to ensure against collapse of the hose as a result of excessive suction caused by the booster pump. Type F hoses are also recommended when defuelling at a vacuum greater than 10 inches of mercury (5 psi).

Note: Hoses should preferably be ordered with the couplings installed on both ends by the hose manufacturer or its authorised distributor or representative (see section 7). Manufacturers should advise purchasers/users as to the suitability or otherwise of the couplings supplied for reattaching by end users.

Note: EI 1540, *Design, construction, operation and maintenance of aviation fuelling facilities,* section 7 gives advice on refitting couplings.

4

AVIATION FUELLING HOSE SPECIFICATIONS

4.1 GENERAL

All of the specifications of this section must be met for each hose category except where noted. Fully collapsible hoses are not covered by these specifications. The manufacturer shall record test results demonstrating that the stated specifications have been satisfied. All required tests shall be carried out in full accordance with the provisions of sections 6.4.1 through 6.4.7 and sections 6.5.1 through 6.5.14. Manufacturers should provide certification as defined in sections 8.1 and 8.2.

4.2 CONSTRUCTION MATERIALS

The tube shall be of petroleum-resistant synthetic rubber compounds and shall have a thickness not less than 1,6 mm (0,063 inch) at any point. The tube shall be free from foreign materials or defects (e.g. holes, pitting, blisters, etc.). The reinforcement shall be braided or spiralled and be free from defects and geometrical irregularities. The cover shall be of petroleum-resistant rubber compounds. It shall have a thickness not less than 1,6 mm (0,063 inch) at any point for hoses with inside diameters of less than 50 mm (2 inch) and 2,0 mm (0,079 inch) for hoses with inside diameters of 50 mm (2 inch) or larger. The cover shall be free of defects (e.g. holes, pitting, blisters, foreign materials, etc.) and be resistant to damage by abrasion, cracking, and exposure to weathering, as defined by the tests in this publication.

4.3 HOSE COMPONENT SPECIFICATIONS – RUBBER COMPOUNDS

4.3.1 Tensile strength

The tensile strength of the tube and cover shall be at least 7 000 kPa (1 000 psi).

4.3.2 Minimum elongation

The minimum elongation of the tube shall be 250 % of its initial length. The minimum elongation of the cover shall be 300 % of its initial length.

4.3.3 Volume increase

The volume of the tube when immersed in Reference Fuel B or a mixture of 30 volumes of toluene and 70 volumes of isooctane, as described in ASTM D 471, shall not increase more than 50 %. The volume increase of the cover under the same test conditions shall not exceed 75 %.

4.3.4 Fuel-soluble matter

The hose inner tube after being immersed in the test fluids as described in 4.3.3 shall not yield residual soluble matter in excess of 4 % of the original mass of the test portion for hose types C, E and F. For Type CT hose, this limit is set at 6 %.

4.3.5 Abrasion resistance

The cover material shall be abrasion-resistant. The quantity of material abraded under test conditions, specified in section 6.4.5, shall not exceed 140 mm³ (0,00854 cubic inch) in volume for hose types C, E and F. For CT hose, it shall not exceed 200 mm³ (0,012 cubic inch).

4.3.6 Resistance to aging

The change in tensile strength and elongation at break of tube and cover shall not be greater than ± 30 % of the original values.

4.3.7 Cold embrittlement

The hose tube and cover, tested individually, shall show no signs of cracking when tested at −40 °C ± 1 °C (−40 °F ± 2 °F). For CT hose, the test limit shall be −48 °C ± 1 °C (−54 °F ± 2 °F).

4.4 HOSE SPECIFICATIONS

4.4.1 Tolerance on inside diameter

The tolerance for the inside diameter of hoses having inside diameters of 50-75 mm (2-3 inches) shall be ±1,2 mm (0,047 inch). Hoses with inside diameters of less than 50 mm (2 inches) shall have an inside diameter tolerance of ±0,8 mm (0,031 inch). Hoses with inside diameters exceeding 75 mm (3 inches) shall have an inside diameter tolerance of ±1,6 mm (0,063 inch).

4.4.2 Length

The length shall be specified by the purchaser. All hoses shall be of one continuous length.

4.4.3 Unit weights

The maximum weight per unit run of a hose, all types and grades, without coupling attachments shall be as specified in Table 1.

4.4.4 Pressure specifications

Each manufactured length of hose and hose assembly shall be hydrostatically proof tested to the minimum proof pressure indicated in Table 2. The length shall not change more than ±7 % during the test, and the hose shall show no signs of leakage or failure.

Table 1 Maximum weight per unit run of hose

Inside Diameter of Hose		Maximum Unit Weight			
mm	inches	Type C		Type E & F	
		kg/m	lb/ft	kg/m	lb/ft
19	0,75	0,9	0,60	1,1	0,74
25	1,00	1,1	0,74	1,5	1,00
32	1,25	1,4	0,94	1,9	1,27
38	1,50	1,7	1,14	2,2	1,47
50	2,00	2,7	1,81	3,0	2,01
63	2,50	3,5	2,35	4,0	2,68
75	3,00	4,0	2,69	4,7	3,15
90	3,50	5,4	3,63	6,2	4,15
100	4,00	6,5	4,37	7,5	5,02

Table 2 Pressure specifications for hoses

Grade of Hose	Hose Diameter	Maximum Working Pressure kPa/psi	Minimum Burst Pressure kPa/psi	Minimum Proof Pressure kPa/psi
1	Up to 38 mm (1,5”)	1 000/150	4 000/600	2 000/300
2	All	2 000/300	8 000/1 200	4 000/600

4.4.5 Adhesion

The adhesion between the hose components shall be a minimum of 3 Newton/mm (17,1 pounds force/inch) of width for dry components and 2 Newton/mm (11,4 pounds force/inch) of width after contact with fuel.

4.4.6 Vacuum resistance

Type C and Type CT hose assemblies having internal diameters of 63 mm (2,5 inches) or less shall withstand a suction of 5 inches of mercury (2,5 psi) and retain 80 % of the original internal diameter when tested at 20 °C ± 5 °C (68 °F ± 9 °F).

Hose Type C and Type CT shall withstand a suction of 25,5 inches of mercury (12,5 pounds per square inch) for 10 minutes at 20 °C ± 5 °C (68 °F ± 9 °F) without suffering visual collapse of the tube, reinforcement, or outer cover. Hose Types E and F shall withstand a suction of 20 inches of mercury (10 pounds per square inch) for 10 minutes at 20 °C ± 5 °C (68 °F ± 9 °F) and retain 80 % of the original internal diameter without suffering visual collapse of the tube, reinforcement, or outer cover.

4.4.7 Flexibility

The flexibility of the hose at 20 °C ± 5 °C (68 °F ± 9 °F) shall be such that, when empty, it may be coiled around a test drum having an external diameter as specified in section 6.5.6 without suffering structural damage or kinking. After the hose is uncoiled, it shall show no signs of fatigue or permanent deformation (including length change) and, for Types C, CT and F hoses, no increase in electrical resistance outside the limits specified in 4.4.8.

The hose shall be flexible and retain pressure capabilities at temperatures ranging down to −30 °C ± 1 °C (−22 ˚F ± 2 °F) for normal hose and −40 °C ± 1 °C (−40 ˚F ± 2 °F) for CT hose. The manufacturer shall submit hose testing results indicating the maximum registered torque required to bend the hose around the test drum at a temperature of −30 °C (−22 °F) for normal hose and −40 °C (−40 °F) for CT hose. The test hose specimen shall be pre-conditioned in a cold chamber at the test temperature for 24 hours prior to testing. The test drum and specimen for hoses with inside diameters of 75 mm (3 inches) and smaller shall be kept in the cold box/bath during the test to ensure the test temperature is maintained. For hoses with inside diameters larger than 75 mm (3 inches), the test drum and specimen must be at the test temperature but may be removed from the cold box/bath for the test procedure. In this case the test must be initiated within 30 seconds of removal from the cold box/bath. The test drum must be rotated 180 degrees within a maximum time of 10 seconds. Test results shall be recorded in Newton-metres (N-m) or foot-pounds force (lb-ft).

4.4.8 Electrical resistance

The electrical resistance for Types C, CT and F hoses shall be between 1 x 10^3 (minimum) to 1 x 10^6 (maximum) ohms/metre for an unpressurised hose after the proof pressure and flexibility tests.

The electrical resistance for Type E hose shall be not more than 100 ohms/metre.

Two electrical resistance tests shall be performed; one on the outer cover along the whole length of the hose and one to confirm continuity of the whole assembly.

4.4.9 Kink resistance

There shall be no observable permanent deformation or structural damage and no increase in electrical resistance outside the limits specified per 4.4.8 after the kink resistance test.

Note: When hose is bent at too sharp an angle it may kink and shorten the effective hose life, and any such kinking is not an acceptable or safe practice. The requirement for a kink resistance test is included to prevent potential problems with hose kinking in actual field use.

4.4.10 Fuel contamination

Fuel contamination shall not exceed 10 mg/100 ml of test fluid (reference Fuel B, as described in ASTM D 471).

4.4.11 Fuel discolouration

The colour of the effluent fuel following the fuel contamination test shall not be less than +15 saybolt for normal hose and +10 saybolt for CT hose.

4.4.12 Ozone resistance

The cover material shall not show signs of cracking when subjected to the ozone test.

4.4.13 Concentricity

The concentricity shall not be more than 1,0 mm (0,039 inch). For hoses of spiral-wrapped construction (Type E) with inside diameters of 50 mm (2 inches) or more, the concentricity shall be no more than 1,5 mm (0,059 inch).

4.4.14 Security of coupling attachment

The hose and tested coupling shall be free of leakage during the security of coupling attachment test. No damage to the hose or coupling shall be evident following the test. Slippage at the hose/coupling connection shall not exceed 0,8 mm (0,031 inch). See section 6.5.14.

5

IDENTIFYING, PACKAGING, SHIPPING AND STORING AVIATION HOSE ASSEMBLIES

5.1 IDENTIFICATION

Each hose shall have durable identification labels at intervals not exceeding 2,0 metres (6,5 feet). Each label shall include the following information:

— The designation "Aircraft Fuelling Hose – EI 1529/(edition date it meets; e.g. 1529/2005)".
— Manufacturer's name or trademark or both.
— Hose type, grade, and serial or batch or reference number.
— Quarter and year of manufacture; e.g. 3Q/2005.
— Maximum working pressure in kPa (psi).
— For CT hose, in addition to "Type C-CT" add the words "Cold Temperature". For CT hose, add a 13 mm (0,5 inch) wide green stripe continuously along hose for quick identification of the hose. The stripe shall be resistant to damage from handling, bending, water, oil, fuel, and environmental effects.

Note: Though not a requirement of this standard, the outer casing of the hose may contain spiral stripes to identify the type of hose or it may contain brightly coloured stripes to aid location and identification at night. A coloured wear indicator may also be included beneath the cover.

5.2 SHIPPING AND PACKAGING

Each hose shall be cleansed, flushed with water, dried, and sealed with corrosion-resistant dust caps before shipment from the manufacturer. It is vital that hose ends are kept capped as ozone contact will affect the inner lining.

5.2.1 Marking

The interior and exterior of hose shipping containers shall be marked with the following information:

— Stock number.
— Part number.
— Purchase order number.
— Hose length, inside diameter, and working pressure.
— Coupling part number.

Individually wrapped hoses shall be marked with the date of manufacture.

5.2.2 Hose shipment conditions

To prevent kinking damage during shipment and storage, each 4,5 m (15 feet) or longer section of hose shall be individually coiled in a box or wrapped on a spool having a diameter not less than ten times the hose inside diameter. When the hose section is furnished with end fittings, the wrapping shall be carried out so that one end fitting can be nested or embedded tangentially in the core. If a spool is used, it shall be designed so that it will not damage adjacent hoses when hoses are stacked without boxes. Hose sections of 4,5 m (15 feet) or less may be shipped straight when installed in paperboard tubes.

5.3 STORAGE

Hose manufacturers and hose assembly distributors should apply the storage conditions included in section 7 of EI 1540, *Design, construction, operation and maintenance of aviation fuelling facilities*.

6

TESTING AND TEST RESULTS

6.1 CERTIFICATION

All tests in this section shall be conducted on the first article or prototype hose, and proper documentation certifying the results shall be provided to the purchaser as requested.

Requests for waiver based on product similarity, prior certification, or other criteria shall not be permitted.

The hose manufacturer is responsible for conducting all tests either at in-house facilities or an independent testing laboratory.

6.2 TEST FREQUENCIES

Table 3 gives the minimum frequency of testing.

Type approval is obtained when the manufacturer supplies evidence that all the requirements of this standard have been met by the method of manufacture and hose design used. Type approval tests shall be repeated a minimum of every three years or whenever a change in manufacturing method or materials occurs.

6.3 REJECTION AND RETEST

When an item selected from a production run fails to meet the specifications of sections 4.3.1 through 4.3.7 and sections 4.4.1 through 4.4.14, the item shall be retested in accordance with ASTM D 380. Subsequent failure shall result in rejection of items still on hand or produced in the lot under test.

Where it is not possible for sufficient material to be obtained from a hose for the specifications in sections 4.3.1 – 4.3.7 and sections 4.4.1 – 4.4.14 to be met, the item shall be tested in accordance with ASTM D 380.

6.4 HOSE COMPONENT TESTS

6.4.1 Tensile strength test

The tensile strength of the tube and cover shall be tested as specified in ASTM D 380 and D 412 or ISO 37 (dumbbell test pieces). The test results shall satisfy the requirements of section 4.3.1.

6.4.2 Minimum elongation test

The minimum elongation test of the tube and cover shall be performed as specified in ASTM D 380 and D 412 or ISO 37 (dumbbell test pieces). The test results shall satisfy the requirements of section 4.3.2.

6.4.3 Volume increase test

The volume increase test of the tube and cover in Reference Fuel B or a mixture of 30 volumes of toluene and 70 volumes of isooctane shall be performed in accordance with ASTM D 380 and D 471 or 8.2 of ISO 1817 (48 hours at 40 °C). The test results shall meet the requirements of section 4.3.3.

Table 3 Approval and production testing

Property	Type Approval Test	Production Acceptance Tests		Per Hose
		per Lots*	per 10 Lots*	
Component Tests				
Tensile strength of tube and cover	X	X		
Minimum elongation of tube and cover	X	X		
Volume increase	X	X		
Fuel-soluble matter	X		X	
Abrasion resistance	X		X	
Resistance to aging	X		X	
Cold embrittlement	X		X	
Hose Tests				
Tolerance on inside diameter	X	X		
Hose length	X	X		X
Measurement of mass per unit length	X		X	
Proof pressure	X			X
Burst pressure	X	X		
Adhesion (after contact with fuel)	X	X		
Adhesion (dry)	X	X		
Vacuum resistance	X	X		
Flexibility at 20 °C (68 °F) (all hoses)	X		X	
Flexibility at −30 °C (−22 °F) (all hoses except CT)	X		X	
Flexibility at −40 °C (−40 °F) (CT only)	X		X	
Electrical resistance	X			X
Kink resistance	X		X	
Fuel contamination	X		X	
Fuel discoloration	X		X	
Ozone resistance	X		X	
Concentricity	X			X
Thickness of tube and cover	X			X
Security of coupling attachment	X		X	
Coupling assembly pressure specifications	X		X	

Note: A minimum of three production hose samples will be tested to ensure the quality of the production hose does not vary from the hose tested during the first article testing. Samples shall be chosen at the convenience of the manufacturer but must be representative of each 500 m (1 641 feet) of production ±10 m (33 feet).

* A lot is either 500 m (1 641 feet) of hose or 500 kg (1 103 pounds) of lining and cover compound.

6.4.4 Fuel-soluble matter test

Perform the fuel-soluble matter test in accordance with the procedures given below.

(a) Cut a sample of hose tube under test into pieces of 3 mm ± 2 mm square (0,12 inch square).

Note: If a sample of tube taken from a hose is to be tested, buff the portion of the tube to be sampled to remove any adhering reinforcement fabric before comminuting.

(b) Extract 5 g ±0,01 g of the comminuted sample with 100 ml of Reference Fuel B, as specified in ASTM D 471, i.e. 30 volumes of toluene and 70 volumes of isooctane.

(c) Store the test fluid containing the comminuted sample in a glass flask for 96 hours at 40 °C ± 1 °C (104 °F ± 2 °F). Precautions should be taken to prevent loss by evaporation.

(d) Filter the flask contents into a preweighed hemispherical glass dish, washing both the residue in the flask and the filter with a further quantity of solvent mixture. See ASTM D 5452 for information on apparatus and guidance.

(e) Evaporate the contents of the dish on a boiling water bath and heat the residue in a ventilated air oven for two hours at 150 °C ± 3 °C (302 °F ± 5,4 °F). See ASTM D 381 for information on apparatus and guidance.

Note: Precautions to avoid overheating are essential, as any degradation of the polymer caused by overheating can not be estimated and could produce a falsely high result.

(f) Calculate the mass of residual fuel-soluble matter as a percentage of the original mass of the test portion. The mass of the residual fuel-soluble matter shall not exceed the limit of section 4.3.4.

6.4.5 Abrasion resistance test

The abrasion resistance of the cover material shall be ascertained using the procedures of Method A of ISO 4649. The test result shall be within the limit specified in section 4.3.5.

6.4.6 Resistance to aging test

The change in tensile strength and elongation at break of tube shall be measured in accordance with ISO 188 (Air Oven Method) or ASTM D 573 [seven days at 70 °C (158 °F)]. The test result shall be within the tolerance specified in section 4.3.6.

6.4.7 Cold embrittlement test

The apparatus for the cold embrittlement test is shown in Figure 1.

The hose tube and cover shall be tested individually for cold embrittlement at −40 °C ± 1 °C (−40 °F ± 2 °F) for normal hose; −48 ˚C ± 1 ˚C (−55 ˚F ± 2 ˚F for CT hoses) in accordance with either ASTM D 380 or the procedures given below. The test results shall satisfy the requirement of section 4.3.7.

(a) Fix a test sample measuring 150 mm x 25 mm x 2 mm (± 0,5 mm) in two grips (see Figure l) so that it lies in one plane with an exposure of 127 mm between the grips. Reduce the distance between the grips by 1 mm.

Note: If a sample of tube or cover from a hose is to be tested, remove any adhering reinforcement.

(b) Place the clamped test sample in a Dewar vessel containing a coolant so that the sample is completely immersed.

Note: A temperature of −40 °C ± 1 °C (−40 °F ± 2 °F) or −48 °C ± 1 °C (−55 °F ± 2 °F) may be attained by using methanol or ethanol with crushed dry ice (solid carbon dioxide) and maintained by adding further pieces of dry ice.

(c) Maintain the temperature of −40 °C ± 1 °C (−40 °F ± 2 °F) or −48 °C ± 1 °C (−55 °F ± 2 °F) for 30 minutes. Then reduce the distance between the grips by 25 mm ± 2 mm in 20 seconds by moving one grip directly toward the other in the same plane.

(d) Examine the test sample for cracks.

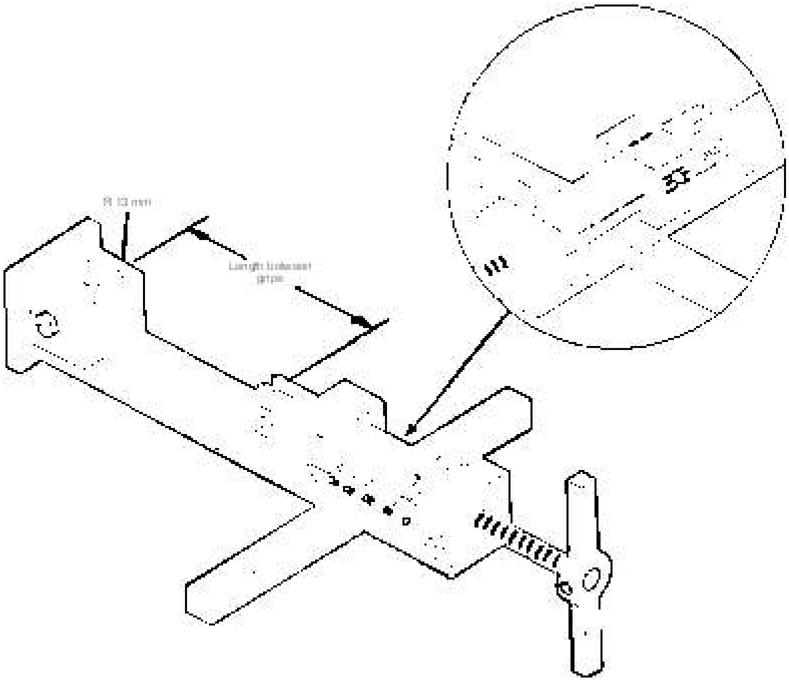

Figure 1 - Apparatus for cold embrittlement test

6.5 HOSE TESTS

6.5.1 Tolerance on inside diameter

Measure the inside diameter of the hose. The tolerance for the inside diameter shall be within the limits specified in section 4.4.1.

6.5.2 Unit weights test

Determine the weight of hose per unit run. The weight per unit length shall conform to the values specified in section 4.4.3 according to the inside diameter of the hose.

6.5.3 Pressure testing

6.5.3.1 Hydrostatically proof test each manufactured length of hose and hose assembly for signs of leakage or failure in accordance with ASTM D 380. The minimum proof pressure shall be as specified in section 4.4.4.

6.5.3.2 Test the electrical resistance of Types C, CT and F hoses following hydrostatic proof testing to verify that the resistance is within the limits shown in section 4.4.8.

6.5.4 Adhesion tests

6.5.4.1 Dry adhesion
Subject the hose to the adhesion test in accordance with ASTM D 413 and ISO 8033/EN 28033 and determine the minimum value for adhesion between the following components:

— Reinforcement and cover.
— Reinforcement layers.
— Tube and reinforcement.

The test specimens for Type E and F hoses shall be cut as specified in ASTM D 380.

6.5.4.2 Adhesion after contact with fuel
Ascertain the adhesion between hose components after the hose has been in contact with fuel based on ASTM D 413 and ISO 8033/EN 28033 and the following procedures:

(a) Cut a sample of the hose 300 mm ± 5 mm (12 inches, ± 0,25 inch) in length and seal one end.
(b) Fill the hose with Reference Fuel B as described in ASTM 471 and cap the top.
(c) Condition the sample at 20 °C ± 5 °C (68 °F

± 9 °F) for 168 ± 2 hours.

(d) Determine the minimum adhesion between components as stated in items (a) to (c) of 6.5.4.1.

6.5.5 Vacuum resistance test

Test the vacuum resistance of the hose to ensure that the specifications set forth in section 4.4.6 are met.

6.5.6 Flexibility tests

Figure 2 shows a test rig for cold flexibility evaluation.

6.5.6.1 General

The flexibility tests shall be carried out with an empty length of hose, the length of which is calculated as follows:

Hose Length = 3,142D +4D_1

where

D is the test drum diameter;

D_1 is the inner hose diameter.

Determine the external test drum diameter based on the inner hose diameter using Table 4.

6.5.6.2 Flexibility at 20 °C (68 °F)

After determining the hose length and the external test drum diameter from Table 4 and the equation in 6.5.6.1, coil the hose around the test drum at an ambient temperature of 20 °C ± 5 °C (68 °F ± 9 °F). Verify that the hose retains flexibility and manifests no signs of damage as set forth in section 4.4.7. Test the electrical resistance of Types C, CT and F hoses, and that electrical continuity of Type E hoses is maintained, following flexibility testing to verify that there has been no increase in resistance above the upper limit specified in section 4.4 8.

6.5.6.3 Flexibility at –30 °C (–22 °F) and –40 °C (–40 °F)

(a) Determine the hose length and the external test drum diameter from Table 4 and the equation in 6.5.6.1

(b) Attach the hose to the test drum with the clamp as shown in Figure 2.

(c) Place the test drum and hose specimen in a cold box/bath to lower their temperature to –30 °C (–22 °F) for normal hose and –40 °C (–40 °F) for CT hose. The hose specimen should be pre-conditioned in the cold box at test temperature for 24 hours prior to starting the test.

Note: The test drum and specimen for hoses with inside diameters of 75 mm (3 inches) and smaller shall be kept in the cold box/bath during the test to ensure the test temperature is maintained. For hoses with inside diameters larger than 75 mm (3 inches), the test drum and specimen must be at the test temperature but may be removed from the cold box/bath for the test procedure. In this case the test must be initiated within 30 seconds of removal from the cold box/bath.

(d) Rotate the test drum using a torque wrench with a dial indicator. The drum must be rotated 180 degrees within 10 seconds.

(e) Record the maximum registered torque required to bend the hose around the test drum. Report the result in Newton-metres (N-m) or foot-pounds force (lb-ft).

(f) Verify that the hose is flexible and that it can meet pressure test requirements specified in 6.5.3.

Table 4 Test drum external diameter in relation to inner hose diameter

Inner Hose Diameter (D_1)		**Test Drum External Diameter (D)**	
mm	inches	mm	inches
19	0,75	180	7,5
25	1	250	10
32	1,25	325	13
38	1,5	375	15
50	2	500	20
63	2,5	625	25
75	3	750	30
90	3,5	875	35
100	4	1 000	40

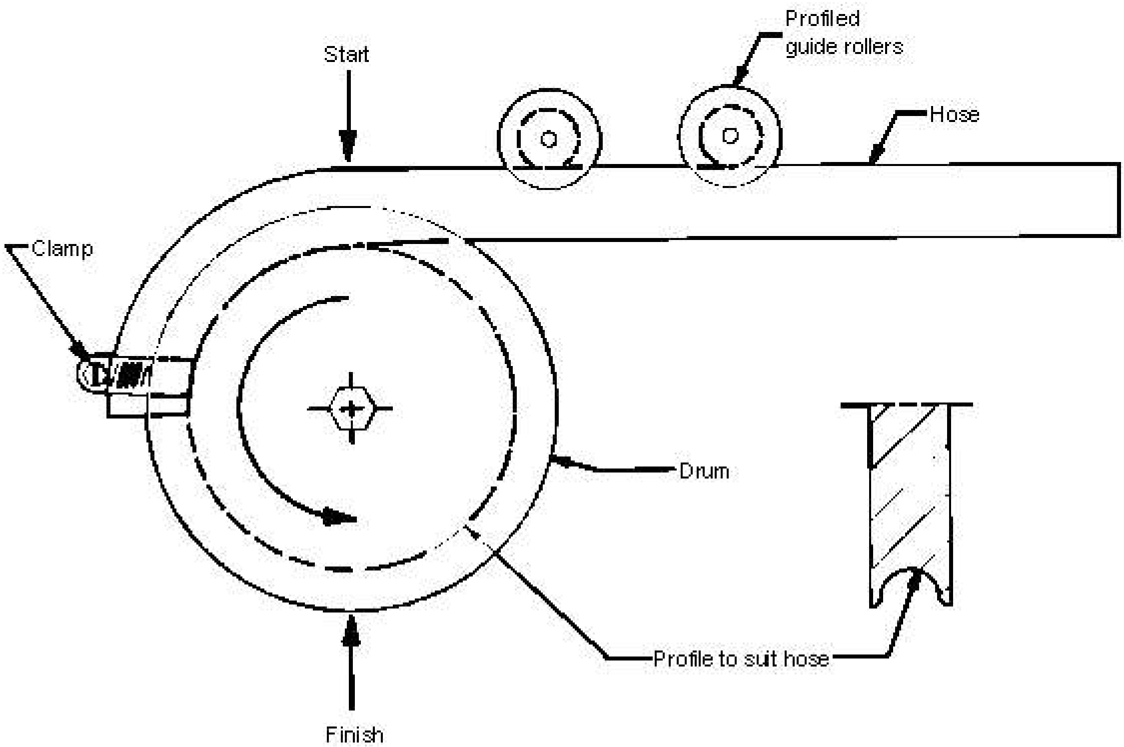

Figure 2 - Test rig for cold flexibility evaluation

6.5.7 Electrical resistance test

Measure the electrical resistance of Types C, CT, E and F hoses in accordance with ISO 8031/EN 28031. The limits for electrical resistance stated in section 4.4.8 shall be met.

6.5.8 Kink resistance test

Use the following procedures to test the hose for kink resistance:

(a) Prepare the test hose by filling it with Reference Fuel B as described in ASTM D 471, and leaving it to soak for 168 ±2 hours at 20 °C ± 5 °C (68 °F ± 9 °F).
(b) Empty the hose and cap both ends.
(c) Bend an empty hose at 20 °C ± 5 °C (68 °F ± 9 °F) to form a kink with an included angle of 60 degrees. Hold the hose in position for one minute.
(d) Release the hose and allow it to recover for two to four minutes.
(e) For all sizes of hose, repeat steps (c) and (d) for 1 000 cycles and visually examine the hose for permanent deformation and structural damage. Measure the electrical resistance while empty to ensure it meets the limits of section 4.4.8.
(f) Pressure test the hose with water up to the minimum proof pressure specified in section 4.4.4. The entire test must be completed within 85 hours of the start of the first cycle. The hose must pass the minimum proof pressure.
(g) Cut a section of the hose at the kink and visually inspect the hose for delamination and structural damage to the tube, reinforcement, or outer cover. Report all findings.

6.5.9 Fuel contamination test

Perform a fuel contamination test in conformity with ASTM D 381 and the following procedures:

(a) Take a suitable length [a minimum of 300 mm (12 inches)] of 75 mm (3-inch) inner diameter hose and plug it at one end with a glass plug.
(b) Fill the hose with Reference Fuel B in compliance with ASTM D 471 or a mixture of 30 volumes of toluene and 70 volumes of isooctane. Allow the fuel to remain in the hose for 72 hours at 20 °C ± 3 °C (68 °F ± 5,4 °F).

(c) Drain the hose and refill it with fuel.
(d) Repeat steps (b) and (c) at 24-hour intervals for four more days.
(e) Fill the hose with fuel. Allow the fuel to remain in the hose for 72 hours at 20 °C ± 3 °C (68 °F ± 5,4 °F).
(f) Test the liquid withdrawn from the hose on the final day in accordance with ASTM D 381 using the 'Unwashed Gum Content' procedure and using air as the vaporizing medium as outlined in section 8 of ASTM D 381. Record any deviation from the specified test temperature range on the test report.
(g) Record the increase in residue in units of mg of residue per 100 ml of test fluid. Ensure that the level of fuel contamination does not exceed the value specified in section 4.4.10.

When testing hoses having inner diameters other than 75 mm (3 inches), the results obtained from the test shall be adjusted to give the final result in terms of the specified reference diameter using the following equation:

$$r_c = r_m x \frac{d_t}{d_0}$$

where

r_c is the computed residue (in mg per 100 ml);
r_m is the measured residue (in mg per 100 ml);
d_t is the diameter of test hose (in same units as d_0);
d_0 is the specified reference hose diameter.

For example, if the measured increase in residue for a 50 mm (2 inch) diameter hose is 12 mg/100 ml, the final result expressed in terms of the specified reference diameter is calculated as follows:

$$r_c = 12\,\text{mg}/100\,\text{ml} \times 50\,\text{mm} \times \frac{50\,\text{mm}}{75\,\text{mm}} = 8\,\text{mg}/100\,\text{ml}$$

This adjustment compensates for the difference in hose tube surface area liquid volume ratio.

6.5.10 Fuel discolouration test

Perform the fuel discolouration test on the test fuel effluent that remains following the contamination test in accordance with ASTM D 156. The colour of the effluent fuel shall meet the requirement of section 4.4.11.

6.5.11 Ozone resistance test

Test the cover material for signs of cracking in accordance with ASTM D 1149 or ISO 7326, using test conditions of 100 parts of ozone per hundred million parts of air by volume for a 72-hour period at a temperature of 40 °C ± 1 °C (104 °F ± 2 °F).

6.5.12 Concentricity test

Determine the concentricity in accordance with ISO 4671 based on a total indicator reading between the bore and the outside surface of the cover. The concentricity shall be within the limits specified in section 4.4.13.

6.5.13 Thickness of tube and cover test

Measure the thickness of the tube and cover. The uniform tube and cover thickness shall be as specified in section 4.2.

6.5.14 Security of coupling attachment test

Test a 1 m (3 feet) hose assembly for the security of the coupling attachments as follows:

(a) Using water as the test medium, raise the test pressure to Stage 1 pressure for the grade of hose under examination as defined in Table 5.
(b) Maintain the Stage 1 pressure for two minutes; then reduce the applied pressure to zero.
(c) Increase the pressure to Stage 2 pressure for the grade of hose under examination as defined in Table 5.
(d) Maintain the Stage 2 pressure for two minutes and examine the hose for leakage; then reduce the applied pressure to zero.
(e) Increase the pressure to Stage 3 pressure for the grade of hose under examination as defined in Table 5.
(f) Maintain the Stage 3 pressure for two minutes and examine the hose for leakage; then reduce the applied pressure to zero.
(g) Cut the end/couplings off and examine the hose coupling connection for slippage, cuts, and hose material/layer failures. Document all findings.

Table 5 Test pressures for security of coupling attachment test

Hose Designation	Test Pressure		
Grade	Stage 1 kPa/psi	Stage 2 kPa/psi	Stage 3 kPa/psi
1	2 000/300	500/75	2 000/300
2	4 000/600	1 000/150	4 000/600

7

HOSE COUPLINGS

7.1 SPECIFICATIONS

Both hose and coupling manufacturers shall provide certification and test results demonstrating that the specifications of 7.1.1 through 7.1.3 are met. Manufacturers that have the couplings fitted by another authorised entity shall instruct that entity to issue to the purchaser/user the appropriate certification relating to the couplings as in section 8.

7.1.1 Construction and materials

Couplings for use on aircraft fuelling and hydrant vehicle inlet hoses shall meet the requirements of section 4.4.14 and section 6.5.14.

Couplings shall be made of material that is of sufficient strength and sufficiently corrosion-resistant for their intended application, and free from porosity and other defects, and all burrs and sharp edges shall be removed.

7.1.2 Pressure specifications

Couplings assembled with hose shall withstand the following pressures without leakage or distortion:

Grade 1 hose: 4 000 kPa (600 psi).
Grade 2 hose: 8 000 kPa (1 200 psi).

The joint between the coupling and the hose shall withstand a maximum cyclic surge pressure from zero to maximum working pressure as defined in Table 2 for 15 000 cycles without leakage or visible coupling movement of more than 0,8 mm (0,031 inch).

The hose manufacturer shall document and have on file test data from the coupling manufacturer verifying that coupling pressure testing has been performed on the first article (unless a change has been made) and subsequent revisions. The hose manufacturer shall also document and have on file test data verifying that cyclic surge pressure testing has been performed successfully on the same type, grade, and size of hose outlined in the purchase order.

Note: Cyclic surge pressure testing must be completed on a first article coupling or whenever there is a change in the production process. Each type, grade, and size of hose assembly must be certified separately.

7.1.3 Threads

The threads on threaded couplings shall conform to ANSI B1.20.1 with particular attention to tolerances listed in Tables 1 through 3. Male threads shall be NPT but when a female thread is required, it shall be NPSH as defined in section 6.4 of ANSI B1.20.1. The female thread is in a free-turning coupling ring that is intended to fit a stationary male NPT thread such that the ring can be tightened without rotating the entire length of hose. The seal is made by an elastomer gasket having resistance to the fuel being handled. The first thread on male couplings shall be chamfered at 45 degrees to the root diameter. The first thread on female couplings shall be countersunk at 45 degrees to the root diameter, or as specified by the purchaser.

Other thread forms, such as BSPP, ISO 228-1/1, may be specified by the purchaser.

7.2 TESTING

7.2.1 First article

The following tests shall be conducted on the first article or prototype coupling:

7.2.1.1 Pressure testing
Pressure test each coupling at 8 000 kPa (1 200 psi) for signs of leakage or distortion.

7.2.1.2 Cyclic surge pressure testing
Subject a 1 m (3 feet) hose assembly, with the couplings attached, at ambient temperature to cyclic surge pressure testing as follows:

(a) Using water as the test medium, raise the test pressure to the maximum working pressure as defined in Table 2.
(b) Maintain the maximum working pressure for 60 seconds; then reduce the pressure to 0 kPa (0 psi) for 30 seconds.
(c) Repeat item (b) for 15 000 cycles.
(d) Verify that no leakage occurs and that the visible coupling movement does not exceed 0,8 mm (0,031 inch).
(e) At the conclusion of the test, remove each coupling to verify that there is no evidence of cuts or failure of the hose tube, reinforcement, or cover.

7.2.2 Hose assembly

The following tests shall be conducted on each hose assembly:

(a) Complete visual inspection.
(b) Proof pressure in accordance with section 6.5.3.
(c) Electrical continuity in accordance with section 6.5.3.2.

7.3 IDENTIFICATION

7.3.1 A test certificate shall be provided for each coupled length of hose and shall include the data specified in section 8.2.

7.3.2 The coupling tests as specified in section 6.5.14 shall be performed for each hose, grade, type and manufacturer.

7.3.3 Each coupling of a coupled length of hose shall be permanently marked with a serial number corresponding to its hydrostatic test certificate.

7.3.4 The hose at the end of each coupling ferrule shall be permanently marked prior to hydrostatic testing to serve as a reference to determine whether a coupling has slipped during testing or while in service.

7.4 SHIPMENT

Couplings shall be shipped in protective packages and be free of metal shavings, chips, or other foreign matter. When attached to the hose, the couplings shall be fitted with corrosion-resistant dust caps (suggest screw-on type). Further, couplings shall not be permitted to cut or otherwise damage hoses through stress or forces applied by the packaging.

7.5 HOSE RECOUPLING

Refer to EI 1540 *Design, construction, operation and maintenance of aviation fuelling facilities* for recommended practices governing hose recoupling.

8

CERTIFICATION AND DOCUMENTATION

8.1 FOR SHIPMENT OF SECTIONS OF HOSE ONLY

Where hoses are shipped without end couplings (i.e. couplings will be added later by authorised distributors and/or representatives) the hose manufacturer shall include in the shipping document all test results of the hoses together with the following information:

— Hose manufacturer's name.
— Recommended coupling manufacturer's name.
— Hose type.
— Hose grade.
— Size and length of hose.
— Serial number or reference number of hose.
— Manufacture date of hose (quarter/year).
— Hydrostatic test pressures.
— Date of certification.

8.2 FOR SHIPMENT OF COMPLETE HOSE ASSEMBLY

Each hose assembly shall be shipped with a certificate demonstrating that the hose assembly has been proof tested, including the above information of the hose and the following:

— Date of test.
— Time of test.
— Location of test.
— Test pressure certified in kPa or psi.
— Pressure rating.
— Manufacture date of hose (quarter/year).
— Full identification of the hose and couplings including hose serial or reference number, coupling thread form, hose length and size.
— Name of the inspector.
— Identification of individual responsible for coupling the hose.
— Name and address of company responsible for coupling the hose.
— Coupled length serial number.
— Model number of couplings.
— Sizes of coupling ferrules.

ANNEX A

GLOSSARY

For the purposes of this publication the following interpretations apply irrespective of any other meanings the words may have in other connections.

abrasion: wearing away of material by friction contact.

adhesion: strength of bond between cured rubber surfaces or between a cured rubber surface and a non-rubber surface.

bend radius: radius of a bent section of hose measured to the innermost surface of the curved portion.

bending force: amount of stress required to induce bending around a specified radius and is a measure of stiffness.

blister: raised area on the hose surface or a separation between layers usually creating a void or air-filled space.

braided hose: incorporates reinforcing material that has been applied as interlaced spiral strands.

burr: thin ridge or area of roughness on a hose or hose component.

burst: rupture caused by internal pressure.

burst pressure: pressure at which rupture occurs under prescribed conditions.

carcass: fabric, cord, or metal reinforcing section of a hose as distinguished from the hose tube or cover.

cold embrittlement: the increased fragility of a hose tube or cover following exposure to a temperature such as −40 °C ± 1 °C (−40 °F ± 2 °F).

cold flexibility: the relative ease with which a hose may be bent after exposure to specified low-temperature conditioning.

comminuting: process of pulverizing or reducing a substance to minute particles.

concentricity: uniformity of hose wall thickness as measured in a plane normal to the axis of the hose.

conductivity: ability to transmit heat or electricity. As applied to hoses, the term denotes the capability of transmitting static electricity.

coupling: device attached to the end of a hose to facilitate connection.

cover: petroleum-resistant rubber compounds applied over the reinforcement. It protects the hose from the environment. The outer cover can be smooth or have a fabric impression finish. It may incorporate conductive compounds that allow static-induced surface charges to drain from the hose.

cracking: sharp break or fissure in the surface of a hose. It is generally caused by strain and environmental conditions.

delamination: type of hose damage in which the constituent layers become separated.

Dewar vessel: flask with space between the walls to prevent heat transfer.

electrical bonding: use of a solid wire connection to conduct static electrical charges. This type or design of hose is not permitted in this standard.

elongation: increase in length expressed numerically as a fraction or percentage of the initial length.

fabric: planar structure produced by interlaced yarns, fibres, or filaments.

fabric-impression finish: pattern in the rubber surface formed by contact with fabric during vulcanisation.

fatigue: weakening or deterioration of a material caused by intermittent or continuous application of stress.

ferrule: short external tube or bushing to ensure a tight joint when a hose coupling is connected.

first article test: test of a prototype to ensure that the design and manufacturing techniques used satisfy specifications.

foreign material: any extraneous matter such as wood, paper, metal, sand, dirt, or pigment that should not normally be present in the tube or cover of a hose.

hardwall hose: hose with a helical reinforcement.

heat resistance: ability to resist the deteriorating effects of elevated temperatures.

hose assembly: length of hose with a coupling attached to each end.

hydrant servicer: cart or vehicle connected between the hydrant and the aircraft to provide pressure regulation, filtering, and flow measurement. Also called a hydrant dispenser.

hydrant servicer/dispenser inlet hose: hose used between the hydrant pit valve and the hydrant servicer/dispenser.

hydrostatic proof testing: pressure testing a hose using water as a medium at two times the maximum rated working pressure of the hose.

kinking: temporary or permanent distortion of the hose induced by bending beyond the minimum bend radius.

manufacturer's identification: code symbol used on or in some hoses to identify the manufacturer.

non-electrically bonded conductive hose: hose that is capable of conducting static electrical charges without the use of a wire connector embedded in the hose.

non-marking hose: hose that will not mark aircraft surfaces when contact is made, whether the hose is new or used.

ozone resistance: ability to withstand the deteriorating effects of ozone (generally cracking).

pitting: damage manifested by small indentations or scars.

porosity: quality of permeability.

production acceptance tests: hose tests carried out per lot or per ten lots.

proof pressure: test pressure of twice the working pressure. It is applied in tests to determine the reliability of a hose under normal working conditions.

reinforcement: textile yarn, cord, wire, or fabric material placed around the tube to prevent excess expansion or contraction of the hose under operating conditions. When hoses must remain fully open under vacuum or low-pressure conditions, a reinforcement in the form of a helix is built into the body. Such hoses are termed hardwall hoses.

rubber: material capable of recovering from large deformations quickly and forcibly, and which can be or has been modified to be essentially insoluble (but subject to swelling) in a boiling solvent such as benzene, methyl ethyl ketone, or ethanoltoluene azeotrope.

specimen: an appropriately shaped and prepared sample ready for use in a test procedure.

spiral hose: hose with a reinforcement without interlacing between individual strands.

surge: rapid and transient rise in pressure.

tensile strength: greatest longitudinal stress a hose or hose component can sustain without structural failure.

tube: innermost continuous all-rubber or plastic element of a hose. It is a non-reinforced, flexible, homogeneous conduit of circular cross-section used to carry liquid and is made of petroleum-resistant rubber compounds.

type approval test: synonymous with *first article test*.

vacuum resistance: ability of a hose to withstand a specified vacuum pressure without damage.

volume change: change in volume of specimen, calculated from changes in its linear dimensions, after immersion in a liquid or exposure to a vapour.

working pressure: maximum pressure to which a hose will be subjected, including the momentary surges in pressure that can occur during service.

ANNEX B

REFERENCES

The following publications are cited in this standard:

American National Standards Institute (ANSI)[2]
B1.20.1 *Pipe threads, General purpose (inch)*

ASTM International[3]
ASTM D 156 *Saybolt color of petroleum products (Saybolt chromometer method)*
ASTM D 380 *Methods of testing rubber hose*
ASTM D 381 *Method of test for existent gum in fuels by jet evaporation*
ASTM D 412 *Methods of tension testing rubber*
ASTM D 413 *Methods of test for rubber property - Adhesion to flexible substrates*
ASTM D 471 *Method of test for change in properties of elastomeric vulcanizates resulting from immersion in liquids*
ASTM D 573 *Method of test for accelerated aging of vulcanized rubber by the oven method*
ASTM D 1149 *Method of test for accelerated ozone cracking of vulcanized rubber*
ASTM D 5452 *Test methods for particulate contaminant in aviation fuels by laboratory filtration*

Comittėe Europėen De Normalization (CEN)[4]
EN 1361 *Rubber hoses and hose assemblies for aircraft fuel handling – Specification*

EI[5]
EI RP 1540 *Design, construction, operation and maintenance of aviation fuelling facilities*

International Standardization Organization (ISO)[6]
ISO 37 *Determination of tensile stress-strain properties*
ISO 1817 *Determination of the effect of liquids*
ISO 188 *Accelerated aging and heat resistance tests*
ISO 228-1 *Pipe threads where pressure-tight joints are not made on the thread* Part 1 *Dimensions, tolerance and designation*
ISO 8031/EN 28031 *Determination of electrical resistance*
ISO 8033/EN 28033 *Determination of adhesion between components*
ISO 4671 *Method of measurement of dimensions*
ISO 4649 *Determination of abrasion resistance using a rotating cylindrical drum device*
ISO 7326/EN 27326 *Assessment of ozone resistance under static conditions* (1984 and 1986 amendment)

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[2] Available from 25 West 43rd Street, 4 floor, New York, NY 10036, USA. Tel: +1 212 642 4900; Fax: +1 212 398 0023, www.ansi.org
[3] Available from ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, USA. www.astm.org
[4] Available from national standards organizations of CEN member states, e.g. BSI, DIN, AFNOR etc.
[5] Available from Portland Customer Services, Commerce Way, Whitehall Industrial Estate, Colchester, CO2 8HP. Tel: +44 (0)1206 796 351, email: sales@portland-services.com;
[6] Available directly from ISO online at www.iso.ch, or through national standards organizations.

Rubber Manufacturer's Association [7]
Hose Handbook

[7] Available from 1400 K Street, NW, Suite 900, Washington, DC 20005, Tel: 1 330 723 2978 ext 242 (outside of US). www.rma.org

Global aviation fuel handling publications

The Energy Institute is the provider of the following portfolio of equipment standards and operational recommended practices to facilitate the safe and efficient handling of aviation fuel, particularly at airports. They are available for use internationally. The titles include those that were developed jointly with the API.

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EI 1582	Specification for similarity for EI 1581 aviation jet fuel filter/separators	1st	978 0 85293 576 7
EI 1583	Laboratory tests and minimum performance levels for aviation fuel filter monitors	5th	978 0 85293 527 9
EI 1590	Specifications and qualification procedures for aviation fuel microfilters	2nd	978 0 85293 577 4
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EI Research report	Electrostatic discharges in 2-inch aviation fuel filter monitors Phase 2: Properties needed to control discharges	1st	978 0 85293 408 1
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Energy Institute
61 New Cavendish Street
London W1G 7AR, UK

t: +44 (0) 20 7467 7157
f: +44 (0) 20 7255 1472
e: **pubs@energyinst.org.uk**
www.energyinst.org.uk

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