INTERNATIONAL STANDARD

ISO 19013-1

First edition
2005-03-15

Rubber hoses and tubing for fuel circuits for internal combustion engines — Specification —

Part 1: Diesel fuels

Tuyaux de caoutchouc et flexibles pour les circuits de carburant pour les moteurs à combustion interne — Spécifications —

Partie 1: Carburants diesel

Reference number
ISO 19013-1:2005(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 19013-1 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 1, *Hoses (rubber and plastics)*.

Together with Part 2 (see below), this part of ISO 19013 cancels and replaces ISO 4639-1:1987, ISO 4639-2:1995 and ISO 4639-3:1995, which have been technically revised.

ISO 19013 consists of the following parts, under the general title *Rubber hoses and tubing for fuel circuits for internal combustion engines — Specification*:

— *Part 1: Diesel fuels*

— *Part 2: Gasoline fuels*

Rubber hoses and tubing for fuel circuits for internal combustion engines — Specification —

Part 1: Diesel fuels

WARNING — Persons using this part of ISO 19013 should be familiar with normal laboratory practice. This part of ISO 19013 does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

1 Scope

This part of ISO 19013 specifies the requirements for rubber tubing and hoses used in diesel fuel circuits for internal combustion engines. The diesel fuels covered include "bio-diesels" which consist of the methyl ester of rape seed oil at levels up to 20 % by volume in conventional diesel fuels. In addition, this specification may also be applied as a classification system to enable original equipment manufacturers (OEMs) to detail a "line call-out" of tests for specific applications where these are not covered by the main types specified (see example in Annex E). In this case, the hose or tubing would not carry any marking showing the number of this part of ISO 19013 but may detail the OEM's own identification markings as shown on their part drawings.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 188, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

ISO 1402, *Rubber and plastics hoses and hose assemblies — Hydrostatic testing*

ISO 1629, *Rubber and latices — Nomenclature*

ISO 1746, *Rubber or plastics hoses and tubing — Bending tests*

ISO 1817, *Rubber, vulcanized — Determination of the effect of liquids*

ISO 3302-1, *Rubber — Tolerances for products — Part 1: Dimensional tolerances*

ISO 4671, *Rubber and plastics hoses and hose assemblies — Methods of measurement of dimensions*

ISO 4672:1997, *Rubber and plastics hoses — Sub-ambient temperature flexibility tests*

ISO 4926, *Road vehicles — Hydraulic brake systems — Non-petroleum base reference fluids*

ISO 6133, *Rubber and plastics — Analysis of multi-peak traces obtained in determinations of tear strength and adhesion strength*

ISO 7233:1991, *Rubber and plastics hoses and hose assemblies — Determination of suction resistance*

ISO 7326:1991, *Rubber and plastics hoses — Assessment of ozone resistance under static conditions*

ISO 8031, *Rubber and plastics hoses and hose assemblies — Determination of electrical resistance*

ISO 8033, *Rubber and plastics hoses — Determination of adhesion between components*

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

SAE J2027, *Standard for Protective Covers for Gasoline Fuel Line Tubing*

SAE J2044:2002, *Quick Connect Coupling Specification for Liquid Fuel and Vapor/Emissions Systems*

SAE J2260, *Nonmetallic Fuel System Tubing with One or More Layers*

EN 14214, *Automotive fuels — Fatty acid methyl esters (FAME) for diesel engines — Requirements and test methods*

3 Classification

The product shall consist of extruded rubber materials with or without an integral reinforcement which may or may not be pre-formed before final vulcanization. The product may also have a rubber or thermoplastic barrier layer, either as an internal layer or forming the inner liner, to impart improved fluid resistance and/or reduced fuel vapour permeability.

Seven hoses and tubings for specific applications are specified, as follows:

Type 1 Class A = Pressurized [7 bar (0,7 MPa) working pressure] feed and return lines from the fuel tank to the engine compartment (–40 °C to +80 °C continuous)

Class B = Pressurized [2 bar (0,2 MPa) working pressure] feed and return lines from the fuel tank to the engine compartment (–40 °C to +80 °C continuous)

Type 2 Class A = Pressurized [7 bar (0,7 MPa) working pressure] feed and return lines in the engine compartment (–40 °C to +100 °C continuous)

Class B = Pressurized [2 bar (0,2 MPa) working pressure] feed and return lines in the engine compartment (–40 °C to +100 °C continuous)

Type 3 Class A = Pressurized [7 bar (0,7 MPa) working pressure] feed and return lines in the engine compartment (–40 °C to +125 °C continuous)

Class B = Pressurized [2 bar (0,2 MPa) working pressure] feed and return lines in the engine compartment (–40 °C to +125 °C continuous)

Type 4 Low pressure [1,2 bar (0,12 MPa) working pressure] fuel filler, vent and vapour handling (–40 °C to +80 °C continuous)

4 Sizes

4.1 Tubing

When determined by the methods described in ISO 4671, internal diameters and wall thicknesses shall be as specified in Table 1.

Tolerances shall be selected from the appropriate categories specified in ISO 3302-1: M3 for moulded hoses: E2 for extrusions.

The thickness of the barrier layer, where applicable, shall be included in the total nominal wall thickness shown in Table 1.

Table 1 — Tubing internal diameters and wall thicknesses

Internal diameter mm	Wall thickness mm
3,5	3,5
4	3,5
5	4
7	4,5
9	4,5
11	4,5
13	4,5

NOTE For information, the unions on which the tubing is to be fitted have the following diameters: 4 mm, 4,5 mm, 6 mm or 6,35 mm, 8 mm, 10 mm, 12 mm and 14 mm.

4.2 Hoses

When determined by the methods described in ISO 4671, the dimensions and concentricity of hoses shall comply with Tables 2 and 3.

The thickness of the barrier layer, where applicable, shall be included in the total nominal wall thickness shown in Table 2.

Table 2 — Hose dimensions

Dimensions in millimetres

Internal diameter	Tolerance	Wall thickness	Outside diameter	Tolerance
3,5	± 0,3	3	9,5	± 0,4
4	± 0,3	3	10	± 0,4
5	± 0,3	3	11	± 0,4
6	± 0,3	3	12	± 0,4
7	± 0,3	3	13	± 0,4
7,5	± 0,3	3	13,5	± 0,4
8	± 0,3	3	14	± 0,4
9	± 0,3	3	15	± 0,4
11	± 0,3	3,5	18	± 0,4
12	± 0,3	3,5	19	± 0,4
13	± 0,4	3,5	20	± 0,6
16	± 0,4	4	24	± 0,6
21	± 0,4	4	29	± 0,6
31,5	$^{+0,5}_{-1}$	4,25	40	± 1
40	$^{+0,5}_{-1}$	5	50	± 1

Table 3 — Hose concentricity

Internal diameter mm	Maximum variation from concentricity mm
Up to and including 3,5	0,4
Over 3,5	0,8

5 Performance requirements for hose and tubing

Tests shall be selected from the following list for each application of hose or tubing, based on the performance requirements for the finished product. Type approval tests (as defined in Clause 7) for each hose or tubing group are given in Annex F.

a) **Burst pressure**: When determined in accordance with ISO 1402, the minimum burst pressure for Types 1, 2 and 3, Class A, shall be 30 bar gauge (3,0 MPa) and for Class B shall be 12 bar gauge (1,2 MPa). Type 4 shall be 5 bar gauge (0,5 MPa). Additionally, after fuel resistance testing [test m)], hoses and tubing shall not have a burst pressure of less than 75 % of the original burst pressure.

b) **Adhesion** (for all constructions with two or more bonded layers only): When determined by the appropriate procedure in ISO 8033, the adhesion between each pair of bonded layers shall not be less than 1,5 kN/m.

c) **Low-temperature flexibility**: When tested in accordance with ISO 4672:1997, procedure B, a length of hose or tubing which has been previously kept filled with ISO 1817 liquid C for 72 h ± 2 h at 21 °C ± 2 °C and then kept cooled at −40 °C ± 2 °C for 72 h ± 2 h shall not exhibit any cracking when examined under × 2 magnification after bending around a similarly cooled mandrel the radius of which is 12 times the nominal bore size of the hose or 25 times the nominal bore size of the tubing. The hose or tubing shall then conform to the burst strength requirement of test a).

d) **Internal cleanliness**: When determined in accordance with Annex A, the insoluble impurities shall not exceed 5 g/m^2 and the fuel-soluble impurities shall not exceed 3 g/m^2.

e) **Extractable waxy materials**: When determined in accordance with Annex A, the extractable waxy materials shall not exceed 2,5 g/m^2.

f) **Tear resistance** (applicable to tubing only): When determined in accordance to Annex B, the minimum tear resistance shall be 4,5 kN/m.

g) **Ozone resistance**: When tested in accordance with method 1 of ISO 7326:1991 under the following conditions, the hose or tubing shall not show cracking when examined under × 2 magnification:

Partial pressure of ozone	50 mPa ± 3 mPa
Duration	72 h ± 2 h
Temperature	40 °C ± 2 °C
Elongation	20 %

h) **Heat ageing resistance**: After ageing for one or more of the following times and temperatures in accordance with ISO 188, all constructions shall meet the adhesion requirements of test b), the low-temperature flexibility requirements of test c) and the ozone resistance requirements of test g):

1) 1 000 h at 80 °C

2) 1 000 h at 100 °C

3) 1 000 h at 125 °C

4) 168 h at 100 °C

5) 168 h at 125 °C

6) 168 h at 140 °C

NOTE The 1 000 h tests represent long-term working temperatures and the 168 h tests represent short-term peak working temperatures.

i) **Resistance to surface contamination by engine oil**: When tested in accordance with Annex C using ISO 1817 oil 3, all constructions shall meet the adhesion requirements of test b), the cold flexibility requirements of test c) and the ozone resistance requirements of test g).

j) **Resistance to surface contamination by non-petroleum hydraulic (brake/clutch) fluid**: When tested in accordance with Annex C using hydraulic fluid to ISO 4926, all constructions shall meet the adhesion requirements of test b), the cold flexibility requirements of test c) and the ozone resistance requirements of test g).

k) **Resistance to kinking** (this requirement applies only to straight hoses and tubing with a nominal bore size of 16 mm or less): When determined in accordance with ISO 1746, the maximum coefficient of deformation (T/D) shall not exceed 0,7. The mandrel diameter shall be 140 mm for hoses and tubing up to nominal bore 11 mm, and 220 mm for hoses and tubing of nominal bore from 12 mm to 16 mm.

l) **Resistance to suction** (this requirement applies only to straight hoses and tubing): When the hose or tubing is tested in accordance with ISO 7233:1991, procedure A, at 0,8 bar absolute (0,08 MPa) for 15 s to 60 s duration with a ball of diameter 0,8 × the nominal bore, the ball shall traverse the full length of the hose or tubing.

m) **Resistance to fuels**: When tested in accordance with SAE J2260 for a test duration of 5 000 h using one or more of the following test fuels at a fuel temperature of 80 °C ± 2 °C, all constructions shall meet the adhesion requirements of test b), the cold flexibility requirements of test c), the ozone resistance requirements of test g), the kinking resistance of test k) and the suction resistance of test l):

1) 100 % by volume of liquid F (ISO 1817).

2) A mixture of 80 % by volume of liquid F (ISO 1817) and 20 % by volume of rape seed methyl ester (EN 14214).

n) **Burn-through resistance**: When tested by the burn-through resistance test specified in SAE J2027, the hose or tubing shall withstand a minimum of 60 s exposure to flame without loss of pressure.

o) **Electrical resistance**: When determined in accordance with ISO 8031, the electrical resistance shall not exceed 10 MΩ.

p) **Life-cycle test** (types 1, 2 and 3 only): When tested in accordance with Annex D, hose and tubing shall meet the adhesion requirements of test b), the cold flexibility requirements of test c) and the ozone resistance requirements of test g).

6 Frequency of testing

Type approval and routine tests are specified in Annex F and Annex G, respectively.

Type approval is obtained by the manufacturer supplying evidence that all requirements of this part of ISO 19013 are met by the method of manufacture and the hose design. The tests shall be repeated at a maximum of five-year intervals, or whenever a change in the method of manufacture or the materials occurs.

Routine tests shall be carried out on each finished length of hose prior to despatch.

Production acceptance tests are those tests, specified in Annex H, which should be carried out by the manufacturer to control the quality of his manufacture. The frequencies specified in Annex H are for guidance purposes only.

7 Marking

All constructions shall be continuously marked with the following:

a) the manufacturer's name or trade mark;

b) the number and year of publication of this part of ISO 19013;

c) the classification in accordance with Clause 3;

d) the internal diameter, in millimetres;

e) the fuel, e.g. diesel;

f) the year and quarter of manufacture;

g) the recycling code for the construction material, in accordance with ISO 1629.

EXAMPLE MAN/ISO 19013-1:2005/Type 2 Class A/11/Diesel/1Q05/NBR

Annex A
(normative)

Cleanliness and extractables test

A.1 Scope

This annex specifies a method for the determination of the quantity of insoluble impurities ("dirt"), liquid C solubles and waxy extractables present in hoses and tubing used in liquid-fuel circuits.

A.2 Principle

A quantity of ISO 1817 liquid C is left for a period of 24 h at ambient temperature inside a length of hose or tubing. After this time, the test piece is emptied and the inside washed by gravity flow of liquid C.

The total solution is collected and the insoluble matter filtered out, dried and weighed. The remaining solution is evaporated to dryness and the total content of liquid C soluble material calculated. The waxy material is dissolved from this residue with methanol and the resulting solution is evaporated to dryness and weighed.

A.3 Apparatus and materials

A.3.1 **Glass filter funnel**.

A.3.2 **Evaporating dishes** (two).

A.3.3 **Beaker**, 250 cm.

A.3.4 **Fuel evaporator**, fitted with an extraction hood.

A.3.5 **Ventilated drying oven**, capable of being maintained at 85 °C ± 5 °C.

A.3.6 **Balance**, accurate to 0,1 mg.

A.3.7 **Sintered-glass filter**, porosity grade P3.

A.3.8 **Liquid C**, as specified in ISO 1817.

A.3.9 **Methanol**, minimum purity 99 %.

A.3.10 **Metal stoppers**, to seal the ends of the hoses/tubing.

A.4 Procedure

Take a length of hose or tubing between 300 mm and 500 mm in length and measure its internal dimensions. Plug one end with a metal stopper (A.3.10) and hang vertically. Fill this test piece with liquid C (A.3.8) and seal the top end with another metal stopper. Calculate the internal surface area in contact with liquid C taking into account the area in contact with the stoppers. Leave the test pieces for 24 h ± 30 min at 21 °C ± 2 °C.

At the end of this period, remove one of the stoppers and pour the contents into the beaker (A.3.3). Remove the other stopper and hang the hose or tubing vertically over the beaker. By means of the filter funnel (A.3.1), rinse the inside of the hose or tubing with five portions each of 20 cm^3 of liquid C.

Filter the entire contents of the beaker through the previously weighed sintered-glass filter (A.3.7), using a small amount of clean liquid C to rinse out the beaker. Collect the filtrate in a previously weighed evaporating dish (A.3.2). Dry the filter in the oven (A.3.5) at 85 °C ± 5 °C until a constant mass is obtained.

Calculate the total mass of insoluble matter.

Place the evaporating dish and its contents on the fuel evaporator (A.3.4) under the extraction hood and evaporate the liquid to dryness. Dry the residue in the oven at 85 °C ± 5 °C until a constant mass is obtained.

Calculate the total mass of soluble material extracted by liquid C.

Keep the dried residue in the evaporating dish under the extraction hood at 21 °C ± 5 °C for a minimum of 16 h then dissolve the residue in 30 cm^3 of methanol (A.3.9) at the same temperature. Filter the solution through the sintered-glass filter into the second pre-weighed evaporating dish. Rinse the first dish with 10 cm^3 of fresh methanol and filter as before. Rinse and filter once more.

Place the second evaporating dish containing the filtered solution on the fuel evaporator under the extraction hood and evaporate all the methanol. Dry the residue in the oven at 85 °C ± 5 °C until constant mass is attained.

Calculate, in g/m^2, the mass of waxy extractables dissolved by the methanol per unit internal surface area.

Annex B
(normative)

Resistance of tubing to tearing

B.1 Scope

This annex specifies the conditions governing tear resistance tests using a test piece taken from tubing in which the ratio of the internal to the external diameter is 0,5 or less.

B.2 Principle

With aid of a tensometer, measurements are taken to indicate the force required to propagate a tear initiated in the test piece.

B.3 Apparatus

B.3.1 **Knife**, carefully ground, or **razor blade**.

B.3.2 **Tensometer**, with the following features:

a) a device for recording load and cross-head movement;

b) a constant cross-head movement of 100 mm/min ± 10 mm/min;

c) grips capable of securing the test piece without damage or slippage.

B.3.3 **Wall-thickness gauge**, such as a comparator or thread counter.

B.4 Test pieces

B.4.1 Shape and dimensions

Each test piece shall be of the shape and dimensions shown in Figure B.1.

B.4.2 Preparation

Using a knife or razor blade (B.3.1), cut a length of 80 mm ± 1 mm from the tubing. Starting at one end, slice the piece in half longitudinally over a distance of 30 mm ± 1 mm. Continue the slit on one side only, following the section marked by the points A, B, C and D in Figure B.1.

Dimensions in millimetres

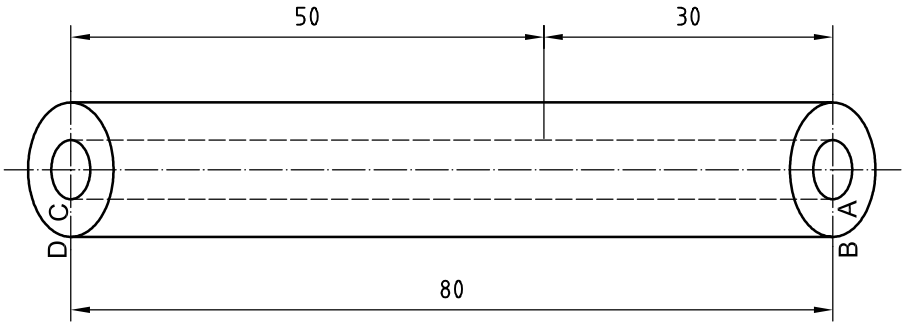


Figure B.1 — Shape and dimensions of the test piece

B.4.3 Number

A minimum of three test pieces shall be tested.

B.4.4 Conditioning

Condition each test piece in accordance with ISO 23529.

B.5 Procedure

Using the wall-thickness gauge (B.3.3), measure the wall thickness of each test piece.

Mount a test piece in the grips (see Figure B.2)

Adjust the load scale and apply a tensile force until the test piece tears along its length.

Repeat for the remaining test pieces.

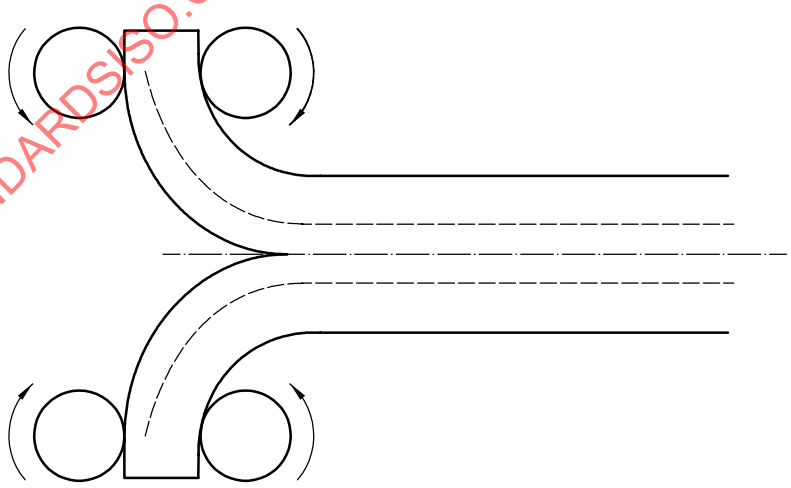


Figure B.2 — Position of the test piece in the grips

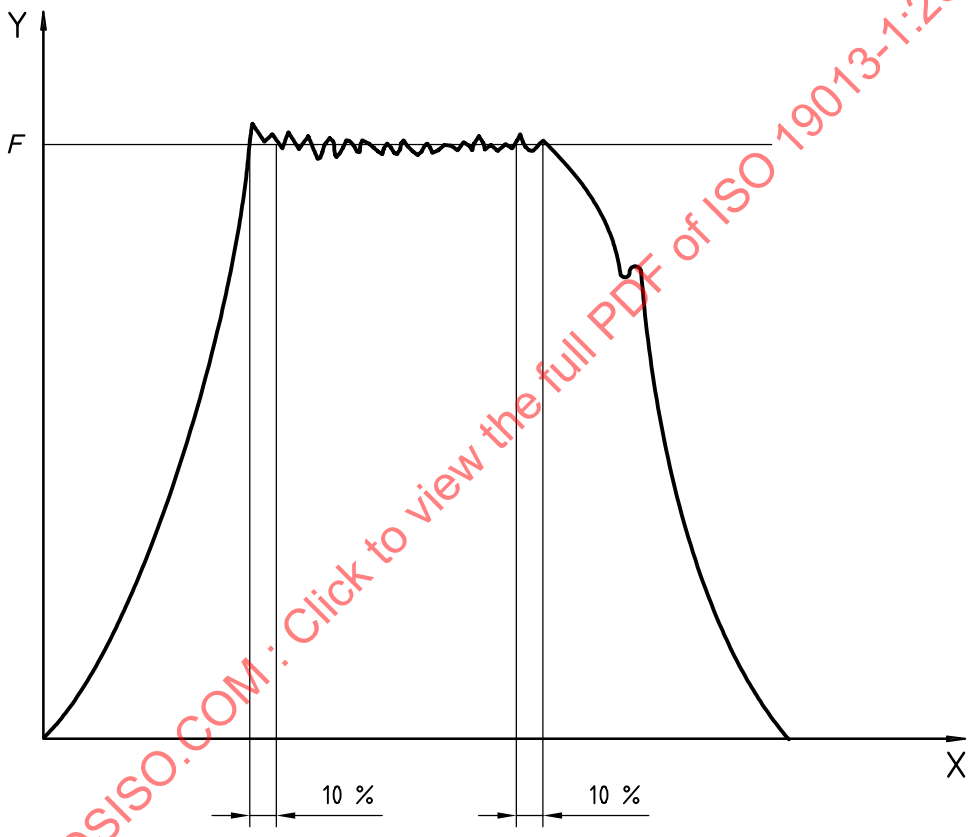
B.6 Expression of results

The load/time graphs will normally resemble that shown in Figure B.3

From each graph, determine, in accordance with ISO 6133, the median peak force required to tear the test piece.

Calculate the tear strength, in kilonewtons per metre, of each test piece by dividing the median peak force, in newtons, for that test piece by the wall thickness, in metres, of the test piece.

Calculate the mean tear strength for all the test pieces tested.



Key

X time

Y load

Figure B.3 — Typical recording obtained during the tear resistance test on tubing

Annex C
(normative)

Method for determining the resistance to surface contamination

Tightly plug the ends of suitable lengths of hose or tubing to enable the adhesion test [Clause 5, test b)], cold flexibility test [Clause 5, test c)] and ozone resistance test [Clause 5, test g)] to be carried out.

Fully immerse each test piece in the specified contaminating fluid for 2 h at 60 °C.

At the end of the immersion period, wipe the fluid from the surface of the hose or tubing and test as required.

Annex D
(normative)

Life-cycle test

D.1 Scope

This annex describes a life-cycle test carried out to ensure that the materials and construction of fuel hoses and tubing will meet the functional requirements of the fuel system when exposed to pressure, vibration and temperature cycles.

D.2 Apparatus

D.2.1 Suitable test chamber, capable of meeting the requirements of SAE J2044:2002, Subclause 6.5. As the test requires the heating of fuel under conditions of flow and pressure, the chamber shall be housed in a suitable explosion-proof facility.

D.3 Procedure

The test shall be conducted in accordance with SAE J2044:2002, Subclause 6.5 (life-cycle test), except the elevated-temperature segment of each cycle shall be carried out at 80 °C for type 1 hoses and tubing, 100 °C for type 2 hoses and tubing and 125 °C for type 3 hoses and tubing.