INTERNATIONAL STANDARD

ISO 8031

Third edition
2009-10-15

Rubber and plastics hoses and hose assemblies — Determination of electrical resistance and conductivity

Tuyaux et flexibles en caoutchouc et en plastique — Détermination de la résistance et de la conductivité électriques

Reference number
ISO 8031:2009(E)

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Published in Switzerland

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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 8031 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 1, *Hoses (rubber and plastics)*.

This third edition cancels and replaces the second edition (ISO 8031:1993), which has been technically revised (for details, see the Introduction).

Introduction

This edition of ISO 8031 addresses the problems encountered in field testing and during product acceptance tests in a production facility in following the test procedures specified in the previous edition (ISO 8031:1993) and a more practical approach is suggested. Also, a test procedure for determining electrical continuity between the end fittings of a hose assembly without actually measuring the resistance has been introduced. This test is frequently carried out in the field and in the factory when the product standard does not require the exact electrical resistance to be measured, but only requires verification of electric conductivity between both metal end fittings.

Special test methods to determine the electrical resistance through the hose wall (now required in some product standards for hoses used in explosive atmospheres) have been added.

Some test methods which have been standard practice in the hose industry for some time have now been included, as have several new methods to determine the ability of a hose assembly (with metal end fittings) to dissipate static electric charges when the metal end fitting is connected to earth. A total of four new explanatory sketches are included. The hose and hose assembly product standard applicable will have to specify which method is most suitable for the purpose of verification of the required property.

Annex A, an amended version of informative Annex A, “Recommended terminology and limits for electrical resistance”, in ISO 8330:2007, has been included.

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Rubber and plastics hoses and hose assemblies — Determination of electrical resistance and conductivity

1 Scope

This International Standard specifies electrical test methods for rubber and plastics hoses, tubing and hose assemblies to determine the resistance of conductive, antistatic and non-conductive hoses and the electrical continuity or discontinuity between metal end fittings.

NOTE All the test methods described for rubber hoses in this International Standard can also be applied to plastics hoses.

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 2878, *Rubber — Antistatic and conductive products — Determination of electrical resistance*

ISO 8330, *Rubber and plastics hoses and hose assemblies — Vocabulary*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8330 apply.

4 Measurement of resistance of conductive, antistatic and non-conductive hoses

4.1 General

Rubber hoses may have a conducting lining only or a conducting cover only, or may be manufactured from conducting rubber compounds throughout. A method of test is specified for each of the three possible types of construction.

4.2 Apparatus

The following apparatus is required and shall be basically as described in ISO 2878.

4.2.1 Test instruments

4.2.1.1 To determine the resistance of conductive, antistatic and non-conductive hose[1)], the test should preferably be made with an instrument specifically designed for measuring insulation resistance, having a nominal open-circuit voltage of 500 V d.c., or with any other instrument known to give comparable results. The instrument shall be sufficiently accurate to determine the resistance to within ± 10 % unless specified otherwise. During the test, not more than 3 W shall be dissipated in the specimen, to prevent erroneous results due to effects of temperature. The power dissipated shall be determined by the square of the open-circuit voltage divided by the measured resistance.

The resistance values obtained will vary with the applied voltage, and errors may occur when low test voltages are involved. In cases of dispute, the voltage applied to the test piece shall be not less than 40 V, except where this conflicts with the requirement not to dissipate more than 3 W in the test piece.

4.2.1.2 For tests requiring the measurement of the electrical continuity between end fittings or through continuous internal or external bonded wires, the instrument used shall be an ohmmeter sufficiently accurate to determine the resistance to within ± 10 %.

4.2.1.3 For tests where, according to the product standard, determination of the electrical continuity between the end fittings of a hose assembly is required, without measurement of the actual electrical resistance, a 4,5 V battery in combination with a 4 V (0,3 A) test lamp can be used.

4.2.1.4 For determination of the electrical resistance through the hose wall (required by some hose product standards for hoses used in explosive atmospheres), the instrument used shall be an ohmmeter with a capacity of 10^{12} Ω and the measurement shall be made at 500 V d.c. The instrument shall be sufficiently accurate to determine the resistance between the lining and the cover as measured through the hose wall to within ± 5 %.

4.2.2 Electrodes and contacts

4.2.2.1 General

For tests conducted in a laboratory, the equipment described below shall be used. For field tests, and for routine tests and product acceptance tests in a manufacturer's plant, this equipment is not practical, and alternatives may be used as described in 4.6.1, 4.7.1.2 and 4.7.2.3.

Electrodes shall be formed on the surface as bands $\left(25^{+2}_{-1}\right)$ mm wide around the circumference by means of a conductive silver lacquer, colloidal graphite or a conductive liquid.

When a conductive liquid is used, the electrode contact area shall be completely wetted and shall remain so until the end of the test. Unless otherwise specified, the conductive liquid shall consist of

— 800 parts by mass of anhydrous poly(ethylene glycol) of relative molecular mass 600;

— 200 parts by mass of water;

— 1 part by mass of wetting agent;

— 10 parts by mass of potassium chloride.

1) See ISO 8330 and Annex A of this International Standard for details of construction.

When a conductive silver lacquer or colloidal graphite is used, the surface resistance between any two points on a sample of the dried film shall not exceed 100 Ω.

Clean metal contacts shall be applied to the electrodes so that the contact area is approximately the same size as, but no greater than, the electrodes, except where otherwise stated.

In the case of hoses of less than 50 mm bore, it is difficult to apply the conducting liquid accurately to the hose bore, and it is preferable to use a brass plug of external diameter equal to or greater than the hose internal diameter (ID), coated with conducting liquid and then pushed 25 mm into the hose.

4.2.2.2 Special electrodes and contacts

The following special electrodes and contacts shall be used for the determination of the electrical resistance through the hose wall, and other test methods:

a) Outer electrode: a copper sheet-metal band, of standard width 25 mm, clamped around the outer hose wall (see Figure 1).

b) Inner electrode:

   1) For hoses of less than 50 mm bore size, it is recommended that a tight-fitting brass plug (solid for small bore sizes and hollow for larger sizes), of minimum length 2 × the pitch of the helical wire(s) (for hoses incorporating helical wires) or 0,5 × ID (for hoses without helical wires), be used.

   2) For hoses of more than 50 mm bore size, it is recommended that an adjustable copper sheet-metal band, tightly fitting the bore of the hose (expanded against the lining by spring action), of minimum width 25 mm, be used.

c) Contacts for connecting the electrodes to the ohmmeter should preferably be soldered or brazed to the electrodes to minimize resistance between ohmmeter and electrode (see Figure 1).

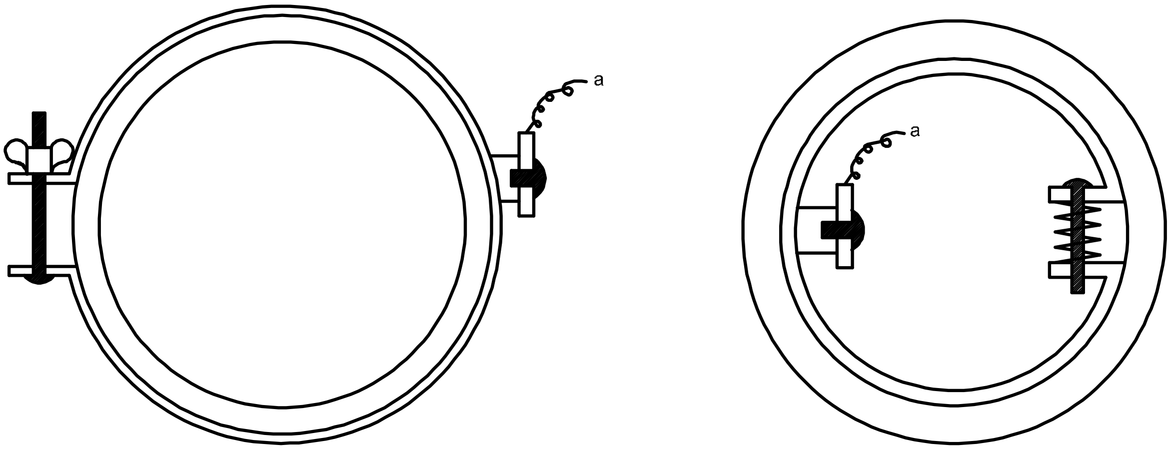
d) Alternative to b): a 25-mm-wide conducting foam plug completely wetted with a suitable conductive liquid (see 4.2.2.1) of outside diameter slightly larger than the inside diameter of the hose to ensure a snug fit with good electric contact with the hose lining and connected to a suitable insulated conductor (see Figure 3, items 1 and 3). This electrode is recommended for use with hoses with corrugated linings or linings which are less flexible than rubber (i.e. PTFE).

e) In order to establish good electrical contact with the cover of a corrugated hose, it is recommended that a conducting foam strip 25 mm wide, completely wetted in suitable conductive liquid (see 4.2.2.1), be placed round the full outside circumference of the hose, underneath the electrode described in item a) above.

4.3 Preparation and cleaning for the test

The surfaces of the hose or test piece shall be clean. If necessary, they may be cleaned by rubbing with fuller's earth (magnesium aluminium silicate) and water, washing with distilled water and allowing to dry. Do not use organic materials which attack the rubber or cause it to swell, and do not buff or abrade the test surfaces.

The surface of the hose shall not become deformed either during the application of the contacts or during the test. When using test pieces, the supports shall be outside the test length. When testing a long length of hose, the hose shall be uncoiled and laid straight on polyethylene or another insulating material. Care shall be taken to ensure that the hose is insulated from any leakage path along the length of hose.



a) **Outer electrode for all sizes**

b) **Inner electrode for bore sizes** > 50 mm

[a] To ohmmeter.

Figure 1 — Examples of inner and outer electrodes as described in 4.2.2.2

4.4 Conditioning

Normally, the articles shall be conditioned for at least 16 h under one of the following sets of standard conditions:

(23 ± 2) °C and (50 ± 5) % relative humidity;

(27 ± 2) °C and (65 ± 5) % relative humidity.

However, where very long lengths of hose are being tested, it is permissible, by agreement between supplier and customer, to use the conditions prevailing in the factory, warehouse or laboratory, provided that the relative humidity is not greater than 70 %. For testing in the field and for routine and product acceptance tests in a manufacturer's factory of short lengths of hose and hose assemblies, this applies as well.

4.5 Procedure for hoses with conducting lining (on full hose length)

Apply suitable electrodes as specified in 4.2.2 on the inside surface at each end of the hose. The edge of the electrode band shall be coincident with the end of the hose. When using a conductive liquid, care shall be taken to avoid creating a leakage path between the lining and the reinforcement or cover of the hose.

Apply the metal contacts to the electrodes.

Apply the test voltage and measure the resistance (5 ± 1) s after the application of the voltage.

For field tests and routine and product acceptance tests in the factory, the equipment specified in 4.2.2.1 is too complicated and impractical. Instead, clean copper or brass contacts at least 100 mm^2 in area, shaped to fit the inside surface of the hose lining and held in position manually, can be used. Alternatively, suitable electrodes as described in 4.2.2.2 can be used.

4.6 Procedure for hoses with conducting cover

4.6.1 Method for full hose lengths

Apply electrodes as specified in 4.2.2.1 on the outside surface at each end of the hose.

Apply the metal contacts.

Apply the test voltage and measure the resistance (5 ± 1) s after the application of the voltage.

For field tests and routine and product acceptance tests in the factory, the equipment specified in 4.2.2.1 is too complicated and impractical. Instead, clean copper or brass contacts at least 100 mm^2 in area, shaped to fit the outside surface of the hose cover and held in position manually, can be used. Alternatively, suitable electrodes as described in 4.2.2.2 can be used.

4.6.2 Method for test pieces as tested in the laboratory

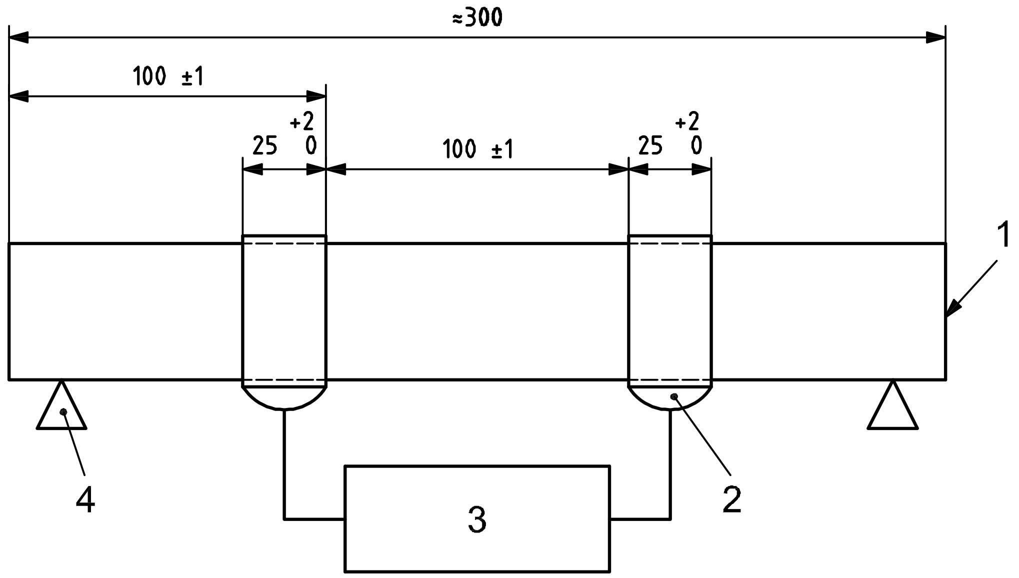
4.6.2.1 Test pieces

Prepare the test pieces by cutting five lengths of hose approximately 300 mm long from samples taken at random from a production run. Condition the test pieces in accordance with 4.4.

Position electrodes as specified in 4.2.2.1 symmetrically along the test piece so that the distance between their nearest edges is (100 ± 1) mm (see Figure 2).

Ensure that contact is maintained with the electrodes around the circumference and that the contact pieces are sufficiently long for the two free ends to be held securely by a tensioning clip (see Figure 2) such that the fit of the electrodes is as tight as possible, consistent with the means employed.

Dimensions in millimetres



Key

1 test piece

2 metallic foil contact pieces wrapped around conducting electrodes and held by clips

3 500 V d.c. insulation tester

4 insulated support or clamp

Figure 2 — Electrodes and contacts for testing as described in 4.6.2.1

4.6.2.2 Test procedure

Place the test piece on blocks of polyethylene, or other insulating material, to provide a resistance of greater than $10^{11}\ \Omega$ between the test piece and the surface on which the blocks are supported. Ensure that the leads from the instrument do not touch each other, the hose or any part except the terminal to which each is connected. Connect the leads from the test instrument to the appropriate contact piece.

Apply the test voltage and measure the resistance (5 ± 1) s after the application of the voltage.

Avoid breathing on the test surfaces and thus creating condensation that may lead to inaccuracies.

4.7 Procedure for hoses with conducting compounds throughout

4.7.1 Method for hoses up to 6 m in length

4.7.1.1 Apply suitable electrodes as specified in 4.2.2.1 on the inside surface at one end of the hose (end A) and on the outside surface at the other end (end B).

Apply the metal contacts to the electrodes.

Apply the test voltage and measure the resistance (5 ± 1) s after the application of the voltage.

4.7.1.2 Repeat the test, applying the electrodes to the outside surface at end A and to the inside surface at end B.

For field tests and routine and product acceptance tests in the factory, the equipment specified in 4.2.2.1 is too complicated and impractical. Instead, clean copper or brass contacts at least 100 mm^2 in area, one shaped to fit the inside surface of the lining, the other shaped to fit the outside surface of the cover, and held in position manually, can be used. Alternatively, suitable electrodes as described in 4.2.2.2 can be used.

4.7.2 Method for hoses over 6 m in length

4.7.2.1 Apply suitable electrodes as specified in 4.2.2.1 on the inside surface at a minimum distance of 50 mm from one end of the hose and on the outside surface at distances of 3 m and 6 m from the same end.

Apply the metal contacts to the inside electrode and to the outside electrode at 3 m from the inside electrode.

Apply the test voltage and measure the resistance (5 ± 1) s after the application of the voltage.

4.7.2.2 Repeat the test between the inside electrode and the outside electrode at 6 m from the inside electrode. The difference between these resistance values shall be regarded as the resistance for 3 m of the hose.

4.7.2.3 Repeat the tests at the other end of the hose length.

For field tests and routine and product acceptance tests in the factory, the equipment specified in 4.2.2.1 is too complicated and impractical. Instead, clean copper or brass contacts at least 100 mm^2 in area, one shaped to fit the inside surface of the lining, the other shaped to fit the outside surface of the cover, and held in position manually, can be used. Alternatively, suitable electrodes as described in 4.2.2.2 can be used.

NOTE The purpose of this test is not only to measure and compare the resistance of the end 3 m of hose but to ensure that the homogeneity of the hose construction is maintained throughout manufacture. This test is normally performed as part of type testing.

4.8 Hose assemblies fitted with metal end fittings

4.8.1 When it is required that the resistance of a hose assembly be measured, the leads of the test instrument shall be attached directly to the metal end fittings.

4.8.2 Some hoses, especially thermoplastics hoses, have conductive layers within the hose construction. These hoses shall be tested as assemblies made with fittings and assembly techniques specified by the hose and fitting manufacturer.

4.9 Test procedure to determine the electrical resistance through the wall of hoses and hose assemblies

4.9.1 General

This test is usually carried out as a type test only. It is required by some hose product standards for hoses used in an explosive atmosphere. The test is carried out only when required by the hose product standard and only when hoses are specially ordered for use in an explosive atmosphere. It is not considered to be a standard or routine test.

4.9.2 Test procedure for hoses (without end fittings)

4.9.2.1 Preparation for the test

Prepare the test pieces by cutting five lengths of hose approximately 300 mm long from samples taken at random from a production run.

Use an ohmmeter with a capacity of at least $10^{10}\ \Omega$ and make the measurement at 500 V d.c.

The instrument shall be sufficiently accurate to determine the resistance between the lining and cover, measured through the hose wall, to within ± 5 %.

4.9.2.2 Electrodes and contacts

For the outer electrode, see 4.2.2.1. For hoses with corrugated covers, a wetted conducting foam strip underneath the electrode is recommended to ensure good contact over the entire electrode surface.

For the use of conductive liquid or conductive silver laquer or colloidal graphite, see 4.2.2.1.

The inner electrode shall consist of tap water with an electrical conductivity of at least 10^{-4} S/m.

4.9.2.3 Preparation and cleaning for test

The surfaces of the test piece shall be clean. If necessary, they may be cleaned by rubbing with fuller's earth (magnesium aluminium silicate) and water, washing with distilled water and allowing to dry. Do not use organic materials which attack the material of the test piece or cause it to swell, and do not buff or abrade the test surfaces.

The surface of the test piece shall not become deformed either during the application of the contacts or during the test. Care shall be taken to ensure that the test piece is insulated from any electrical leakage path along its length.

4.9.2.4 Conditioning

See 4.4.

4.9.2.5 Test procedure

The test shall be carried out within 30 min with the test piece in the vertical position on blocks of polyethylene or another insulating material. First seal one end of the test piece with a plug of insulating material and mount the test piece vertically with the plugged end pointing down. Then fill the test piece with tap water (see 4.9.2.2) to a level 20 mm above the outer electrode. Check that there is no leakage.

Apply clean, reliable metal contacts to the outer electrode and the tap water inside. Then connect the ohmmeter to the inner and outer electrodes.

Apply the test voltage and measure the resistance (5 ± 1) s after application of the voltage.

Avoid breathing on the surfaces and thus creating condensation that may lead to inaccuracies. Also avoid any conductive or semi-conductive connection between the individual hose layers at either end of the test piece.

Calculate the electrical resistance R, in ohms, through the hose by multiplying the measured electrical resistance R_m, in ohms, by a conversion factor ID/25 (where ID is the internal hose diameter in millimetres):

$$R = R_\mathrm{m} \times \mathrm{ID}/25$$

NOTE ID/25 is a conversion factor for the standard square surface area.

4.9.3 Test procedure for hose assemblies with metallic end fittings but without an internal wire helix in contact with the end fittings

4.9.3.1 Electrodes and contacts

Use two outer electrodes, as follows:

a) one of the metallic end fittings that will be connected to earth in service;

b) the outer electrode described in 4.2.2.1 and shown in Figure 1 for measuring the electrical resistance between the outer cover and end fitting.

For the inner electrode, use a 25-mm-wide removable conducting foam plug wetted with a conductive liquid as described in 4.2.2.1 and securely fitted to the end of a 250-mm-long insulated electrode, as shown in Figure 3. The outside diameter of the plug shall be sufficiently large to ensure a snug fit in the bore of the hose and good electrical contact.

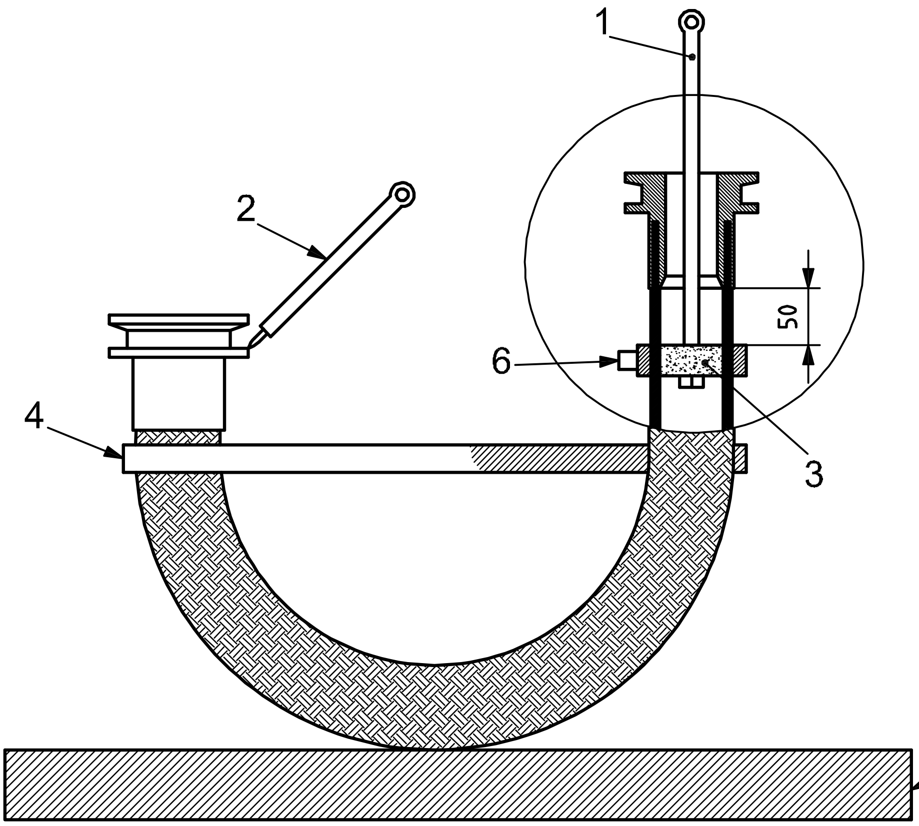
4.9.3.2 Preparation and cleaning for test

The test piece shall consist of a hose fitted, at each end, with an end fitting of the same type as that supplied with the assembly for service in explosive environments and attached by the same method as stated in the design specification for the assembly. The surfaces of the test piece shall be clean. If necessary, clean them in accordance with 4.3.

4.9.3.3 Conditioning

See 4.4.

Dimensions in millimetres



Key

1 insulated electrode extending down into the hose bore

2 electrode connecting with the outside of the metallic fitting

3 25-mm-wide conducting foam plug completely wetted with a suitable conductive liquid (plug outside diameter to be larger than hose bore to ensure a tight fit)

4 a non-conductive strap may be used to hold the hose assembly in a “U” shape when this is required for ease of measurement (alternatively, the assembly may be placed in an unbent horizontal position when this is considered more suitable)

5 non-conductive surface to support the assembly (either held in a “U” shape or in an unbent horizontal position)

6 extra outer electrode as described in 4.2.2.1 and shown in Figure 1

Figure 3 — Hose assembly wall resistance measurement as described in 4.9.3, using a wetted conductive foam plug as the inner electrode

4.9.3.4 Test procedure

4.9.3.4.1 Place the assembly either in the position shown in Figure 3 or laid out horizontally in a straight position on a suitable non-conductive surface of sufficient length and thickness to ensure complete isolation from earth.

Apply the outer and inner electrodes as specified in 4.9.3.1. Ensure that the inner, wetted electrode (conductive foam plug) fits tightly in the bore of the hose, especially in the case of hoses with a corrugated bore.

Place the third electrode (the outer electrode shown in Figure 1) over the outside hose cover directly opposite the inner electrode in the bore, ensuring good electrical contact by applying conductive liquid, colloidal graphite or silver laquer (as specified in 4.2.2.1) or, as an alternative for hoses with corrugated covers, a 25-mm-wide strip of wetted conductive foam wrapped around the outside cover, held in place by the third electrode.

Apply the metal contacts to the electrodes and ensure there is very little or no electrical resistance between the contact and the electrode.

4.9.3.4.2 Connect the ohmmeter to the inner electrode at one end of the hose assembly and to the end fitting at the other end. For an example of a test arrangement, see Figure 3.

Apply the test voltage (500 V d.c.) and measure the resistance (5 ± 1) s after application of the voltage.

Avoid breathing on the test surfaces and thus creating condensation that may lead to inaccuracies. Also avoid any conductive or semi-conductive connection between the individual hose layers at either end of the test piece, apart from the end fittings installed as standard for the design of the hose assembly.

Calculate the electrical resistance through the hose assembly $R_{1,\text{ha}}$, in ohms, by multiplying the measured electrical resistance $R_{1,\text{m}}$, in ohms, by ID/25 (where ID is the internal hose diameter in millimetres):

$$R_{1,\text{ha}} = R_{1,\text{m}} \times \text{ID}/25$$

NOTE ID/25 is a conversion factor for the standard square inside surface area.

4.9.3.4.3 Disconnect the ohmmeter from the inner electrode and connect it to the third electrode, leaving the connection with the end fitting at the other end of the hose assembly intact. Apply the test voltage and measure the resistance (5 ± 1) s after application of the voltage.

Calculate the electrical resistance $R_{2,\text{ha}}$ as in 4.9.3.4.2, but multiply the measured resistance $R_{2,\text{m}}$ by OD/25 (where OD is the outside hose diameter in millimetres):

$$R_{2,\text{ha}} = R_{2,\text{m}} \times \text{OD}/25$$

NOTE OD/25 is a conversion factor for the standard square outside surface area.

5 Measurement of electrical continuity between metal end fittings of hose assemblies

5.1 In certain types of hose construction, electrical continuity is provided between the end fittings by means of a continuous wire or wires bonded to each fitting. When the construction is such that there are internal and external wires, the electrical continuity of both wires shall be established using a suitable ohmmeter as described in 4.2.1.2.

It is essential that the contact resistance between the end fittings and the ohmmeter is minimized.

5.2 When the product standard only requires that the electrical continuity of the two wires be established without actually measuring the electrical resistance of the hose assembly between the end fittings, the equipment described in 4.2.1.3 may be used. A dimly lit lamp is sufficient to indicate satisfactory continuity. It is essential that contact resistance between the end fittings and the battery and lamp is minimized.

6 Measurement of electrical discontinuity of hose assemblies

In certain types of hose containing wire in the construction, it is required that such wire be insulated from the end fittings. In these cases, condition the hose in accordance with 4.4 and measure the resistance between the fittings as described in 4.8. This method shall also be used for hoses without any wire incorporated in the construction.

It is essential that the contact resistance between the end fittings and the ohmmeter is minimized.

7 Measurement of electrical resistance of a hose assembly lining (conductive or static dissipating) or hose assembly cover (conductive or static dissipating) in contact with the metal end fitting

7.1 General

This test is a practical test for determining the ability of a conductive hose assembly (grade Ω as defined in Annex A) to dissipate electrostatic charge when in service.

The hose product standard concerned will specify the requirement for this test when special service conditions apply. The method described is suitable for all types of grade Ω hose assembly with metal end fittings (built-in, swaged, crimped or clamped) but is not suitable for hose assemblies with an internal or external helical metal wire connected to or in electrical contact with the end fitting (i.e. multilayer hoses, etc.).

For practical purposes, the electric resistance of the lining or cover to the end fitting is measured over a distance of 1 m. When necessary, the total resistance to the centre of the hose assembly can be calculated by multiplying the value found over 1 m by the distance to the middle of the assembly.

The test may be carried out either as a type test (with only one end fitting attached) or as a routine test for hose assemblies destined for service in static-charge generating environments (with both end fittings attached and with any length of hose between the fittings).

7.2 Apparatus

7.2.1 Electrodes, on the cover and lining (as shown in Figure 4 and Figure 5), or, alternatively, for hose assembly test pieces with a small or corrugated bore or a lining which is less flexible than rubber (i.e. PTFE), the 25-mm-wide conducting foam plug described in 4.2.2.2, item d), completely wetted in a suitable conductive liquid, may be used when connected to an insulated conductor of sufficient length to make the connection to the insulation tester.

7.2.2 Insulation tester, having a nominal open-circuit voltage of 500 V d.c. (see 4.2.1.1).

7.2.3 Resistance-measuring device (see 4.2.1.4).

7.2.4 Supporting blocks of insulating material (see 4.6.2.2).

7.3 Preparation and cleaning for the test

The cover and lining surfaces making contact with the electrodes (see Figure 4 and Figure 5) shall be clean. If necessary, they may be cleaned and washed as described in 4.3.

7.4 Conditioning

See 4.4.

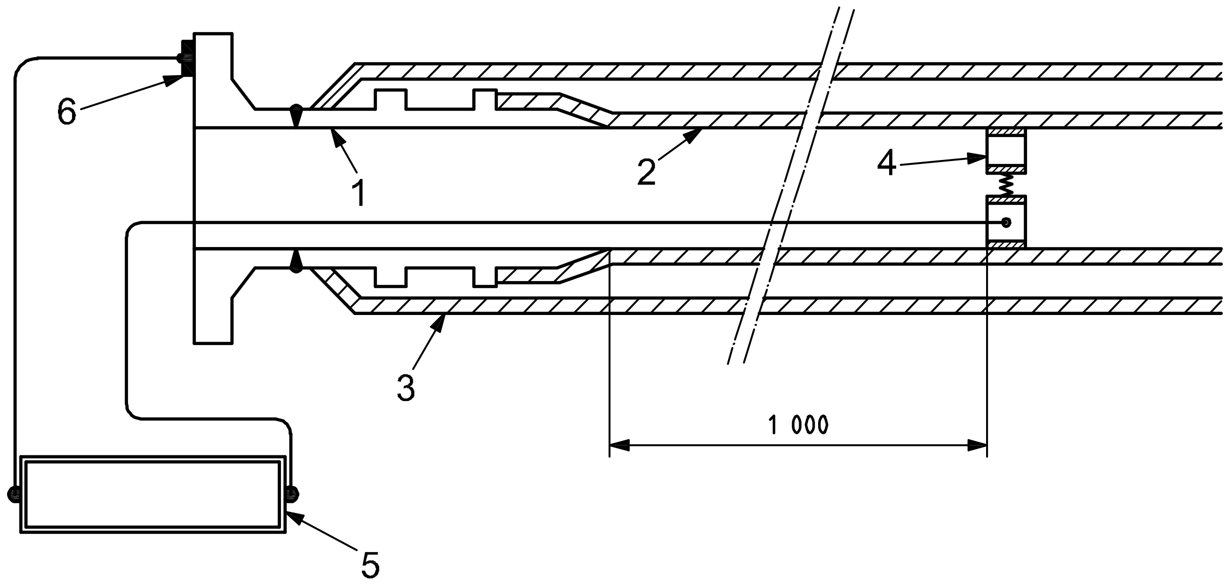
7.5 Test procedure

Support the hose assembly or test piece on suitable supports (see Figure 2) of insulating material (minimum resistance 10^{11} Ω) and apply the electrodes and contacts as shown in Figure 4 (for hose assemblies with a conductive lining) or Figure 5 (for hose assemblies with a conductive cover). For small-bore hose assemblies and assemblies with a corrugated lining, or a lining which is less flexible than rubber (i.e. PTFE), the inner electrode shown in Figure 4 may be replaced by the conductive foam plug (wetted) described in 4.2.2.2, item d), provided it is connected to a well insulated conductor of sufficient length (minimum 1 m + length of end fitting), positioned centrally on insulated supports in the hose assembly bore. The excess conductive liquid in the bore shall be carefully removed by drying to avoid any direct contact between the inner electrode and the end fitting.

Connect the ohmmeter to the electrode (either inner or outer) and the end fitting.

Apply the test voltage and measure the resistance (5 + 1) s after the application of the voltage.

Dimensions in millimetres



Key

1 metal end fitting

2 hose lining

3 hose cover

4 inner electrode with contact (see Figure 1) (when considered easier to apply, the electrode may also be a wetted conductive foam plug as described in 7.2 and 7.5)

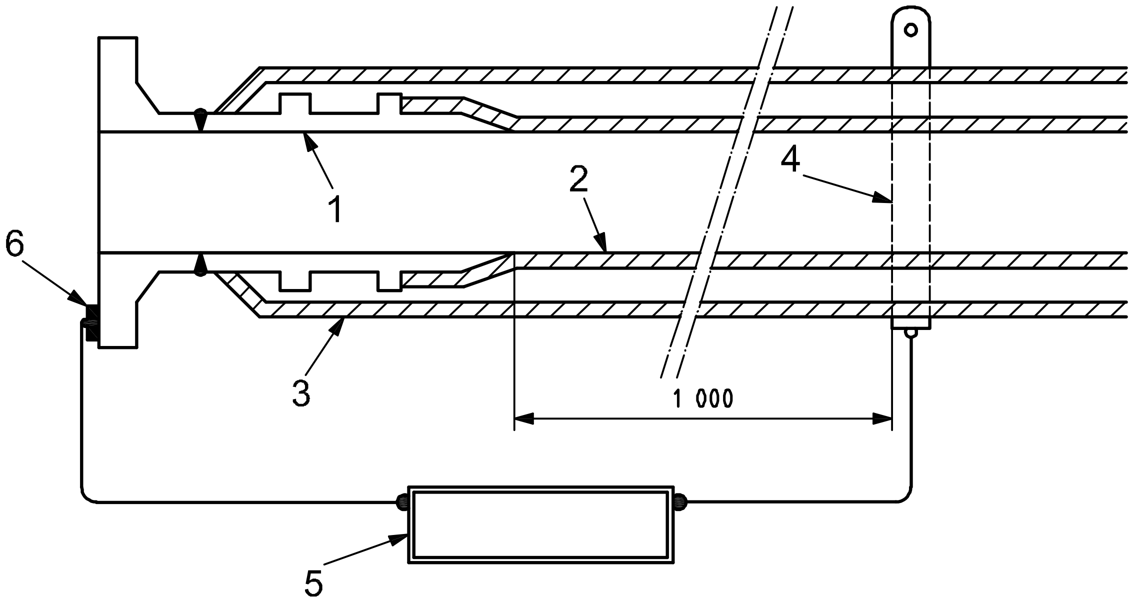
5 500 V d.c. insulation tester

6 contact placed on clean surface of end fitting

NOTE Carcass reinforcement, helical wires and bonding wires (present in some constructions) and other types of end fitting or coupling are not shown, as the purpose of this test is to determine the conductivity between the end fittings and the cover or lining only.

Figure 4 — Measurement of resistance between hose assembly lining and fitting

Dimensions in millimetres



Key

1 metal end fitting
2 hose lining
3 hose cover
4 outer electrode with contact (see Figure 1)
5 500 V d.c. insulation tester
6 contact placed on clean surface of end fitting

NOTE Carcass reinforcement, helical wires and bonding wires (present in some constructions) and other types of end fitting or coupling are not shown, as the purpose of this test is to determine the conductivity between the end fittings and the cover or lining only.

Figure 5 — Measurement of resistance between hose assembly cover and fitting

8 Test report

The test report shall include items a) to e) and, depending on the requirements specified in the hose product standard, any of the other items listed from f) to o), as appropriate.

a) the hose type and nominal bore;

b) a reference to this International Standard (i.e. ISO 8031:2009);

c) the conditioning and test atmosphere, i.e. the temperature and relative humidity;

d) the distance between the electrodes;

e) the electrode material used;

f) the resistance, in ohms per metre, of the hose lining and the test method used;

g) the resistance, in ohms per metre, of the hose cover, giving the individual readings and the test method used;

h) the resistance, in ohms per metre, of the hose wall from lining to cover, giving the individual readings and the test method used;

i) the resistance, in ohms, of the hose assembly between the couplings and the test method used;

j) whether electrical continuity was established and the test method used (5.1 or 5.2);

k) if electrical discontinuity was established, the insulation resistance, in ohms, obtained;

l) (when required for hoses used in explosive atmospheres) the resistance, in megaohms, measured through the hose wall and the test method used;

m) (when required for hoses used in explosive atmospheres) the calculated resistance, in megaohms, through the hose wall and the test method used;

n) (when required for hose assemblies used in explosive atmospheres) the calculated resistance, in megaohms, through the lining and cover over the entire length of the hose assembly between the lining and cover and one end fitting and the test method used;

o) (for hose assemblies, when required by the hose product standard) the resistance, in megaohms, of 1 m of conductive cover or 1 m of conductive lining in contact with a metal end fitting, measured by the method described in Clause 7 (see Figure 4 and Figure 5).

Annex A
(informative)

Recommended terminology and limits for electrical conductivity and resistance

Construction	Terms		Limits		Test method
	Current description	Recommended new description	Current specification	Recommended new specification	
At least two metallic flexible bonding wires (with or without a metallic helix) (Type M)	Conductive Continuous Electrically bonded	Electrically bonded (Grade M)	$< 10\ \Omega$ per assembly $< 10^2\ \Omega$ per assembly $< 10^5\ \Omega$ per assembly	$< 10^2\ \Omega$ per assembly (between fittings)	ISO 8031
Incorporating conductive rubber or plastics layer(s) (Type Ω) New recommended marking to be specified in hose and hose assembly product standards[a]	Conductive Semi-conductive Antistatic	Conductive (Grade Ω-L, Grade Ω-C, Grade Ω-CL)[a]	$< 10^6\ \Omega$ per assembly $10^3\ \Omega$ to $10^6\ \Omega$ per assembly	$< 10^6\ \Omega$ per assembly[b] (between fittings)	ISO 8031[c]
		Antistatic[d]	$10^3\ \Omega$ to$10^8\ \Omega$ per assembly	$10^3\ \Omega$ to $10^8\ \Omega$ per assembly[d]	
Metallic helix(es) connected to both fittings by means of flexible bonding wires (normally soldered to fitting and helix)	Continuous	Continuous Electrically bonded	No limits (light bulb dimly lit with 4,5 V battery)	$< 10^2\ \Omega$ per assembly (between fittings)	ISO 8031 using ohmmeter (see 5.1) or electric light bulb + battery (see 5.2)
Fittings isolated from metallic helix(es) and from conductive rubber or plastics layer(s)	Insulating Discontinuous	Discontinuous	$> 2{,}5 \times 10^4\ \Omega$ per assembly	$> 2{,}5 \times 10^4\ \Omega$ per assembly	ISO 8031
Incorporating non-metallic helix and non-conducting rubber or plastics layers. When necessary, fittings isolated from rubber layer(s) with a special compound.	Insulating	Insulating	$> 10^6\ \Omega$ per assembly $> 10^8\ \Omega$ per assembly	$> 10^8\ \Omega$ per assembly	ISO 8031

[a] It is recommended that the marking on type Ω hoses indicate the construction of the hose: Ω-L (conductive lining), Ω-C (conductive cover), Ω-CL (conductive cover and lining). This new marking is recommended to inform the hose/hose assembly user about the hose properties.

[b] Fluorocarbon (e.g. PTFE) lined type Ω hoses are not subject to these limits.

[c] The charge-dissipating properties of thermoplastic/fluoropolymer lined hoses with metallic helix wires or a braided metallic-wire reinforcement embedded in the hose wall cannot be checked by measuring the resistance between the end fittings.

[d] This term is mainly for automotive hoses, and is not the preferred term for industrial hose assemblies or fluoropolymer (e.g. PTFE) lined hoses. For both automotive and fluoropolymer (e.g. PTFE) lined hoses, the limits for “antistatic” properties are $10^3\ \Omega$ to $10^8\ \Omega$ per assembly. When necessary, the end fittings can be isolated from the rubber layers by the application of a special compound.

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