INTERNATIONAL STANDARD

ISO 4141-1

First edition
1998-02-01

Road vehicles — Multicore connecting cables —

Part 1:
Test methods and requirements for basic performance sheathed cables

Véhicules routiers — Câbles de raccordement multiconducteurs —

Partie 1: Méthodes d'essai et exigences pour les câbles gainés à performance de base

Reference number
ISO 4141-1:1998(E)

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.

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.

International Standard ISO 4141-1 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

Together with ISO 4141-2 and ISO 4141-3, this first edition of ISO 4141-1 cancels and replaces ISO 4141:1988, which has been technically revised.

ISO 4141 consists of the following parts, under the general title *Road vehicles – Multicore connecting cables*:

— *Part 1: Test methods and requirements for basic performance sheathed cables*

— *Part 2: Test methods and requirements for high performance sheathed cables*

— *Part 3: Construction, dimensions and marking of unscreened sheathed low-voltage cables*

— *Part 4: Test methods and requirements for coiled cable assemblies*

Annex A forms an integral part of this part of ISO 4141. Annex B is for information only.

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet central@iso.ch
X.400 c=ch; a=400net; p=iso; o=isocs; s=central

Printed in Switzerland

Road vehicles — Multicore connecting cables —

Part 1:
Test methods and requirements for basic performance sheathed cables

1 Scope

This part of ISO 4141 specifies the test methods and requirements for basic performance multicore sheathed cables for the connection of towing and towed vehicles, suitable for a temperature range of – 40 °C to + 85 °C.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 4141. At the time of publication, the editions indicated were valid. All Standards are subject to revision, and parties to agreements based on this part of ISO 4141 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1431-1:1989, *Rubber, vulcanized or thermoplastic — Resistance to ozone cracking — Part 1: Static strain test.*

ISO 1817:–[1)], *Rubber, vulcanized — Determination of the effect of liquids.*

ISO 4141-3:1998, *Road vehicles — Multicore connecting cables — Part 3: Construction, dimensions and marking of unscreened sheathed low-voltage cables.*

ISO 4892-1:1994, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance.*

ISO 4892-2:1994, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc sources.*

ISO 6722-1:1996, *Road vehicles — Unscreened low-tension cables — Part 1: Test methods.*

ISO 6722-2:1996, *Road vehicles — Unscreened low-tension cables — Part 2: Requirements.*

IEC 811-1-1:1993, *Insulating and sheathing of electrical cables, common test methods — Part 1: Methods for general application — Section 1: Measurement of thickness and overall dimensions — Tests for determining the mechanical properties.*

IEC 811-2-1:1993, *Insulating and sheathing of electrical cables, common test methods — Part 2: Methods specific to elastomeric compounds. Section 1: Ozone resistance test, hot set test, mineral oil immersion test.*

3 Test temperature

All tests unless otherwise stated shall be performed at (23 ± 5) °C.

---

1) To be published. (Revision of ISO 1817:1985)

4 Tests and requirements

4.1 Single cores

The single cores of multicore sheathed cables shall comply with ISO 6722-2 and shall meet the requirements in 4.2 and 4.3. Single core identification shall conform to ISO 4141-3.

4.2 Continuity and withstand voltage

4.2.1 Test

Check the continuity of each single core and perform a withstand voltage test on a cable as delivered and on the test samples after the tests specified in 4.13, 4.14, 4.15, 4.18 and 4.20. For the withstand voltage test, apply a test voltage of 3 kV r.m.s. at a frequency of 50 Hz or 60 Hz for 1 min, between each conductor and the remaining conductors connected together.

4.2.2 Requirement

Breakdown shall not occur.

4.3 Capacitance test

4.3.1 Test

Lay up cores for data transmission separately from the remaining cores, and subject them to the three different capacitance measurements (measurements A, B and C in figure 1), as follows, using a standard capacitance measuring device with alternating current and a frequency of 1 kHz:

— C_a: capacitance between the conductor of core a[2] and ground[3] (result of measurement A);

— C_b: capacitance between the conductor of core b[2] and ground[3] (result of measurement B);

— C_{ab}: capacitance between the conductor of core a[2] and core b[2]:

the result of measurement C is a capacitance C_c, which is equal to $C_a + \frac{C_{ab} \times C_b}{C_{ab} + C_b}$.

From this value, the capacity C_{ab} can be calculated as follows:

$$C_{ab} = \frac{C_b \left(C_c - C_a\right)}{C_b + C_a - C_c}.$$

4.3.2 Requirements

Cores for data transmission shall have a capacitance of 50 pF/m maximum between the data cores and a capacitance of 100 pF/m maximum between each data core and ground.

NOTE — These values are based on the worst case assumption of a cable length of 40 m. If this value is exceeded and/or when installation may increase the capacitance, this is to be taken into consideration.

4.4 Lay length

4.4.1 Test

Fasten the test sample at its ends. Measure the length of five lays.

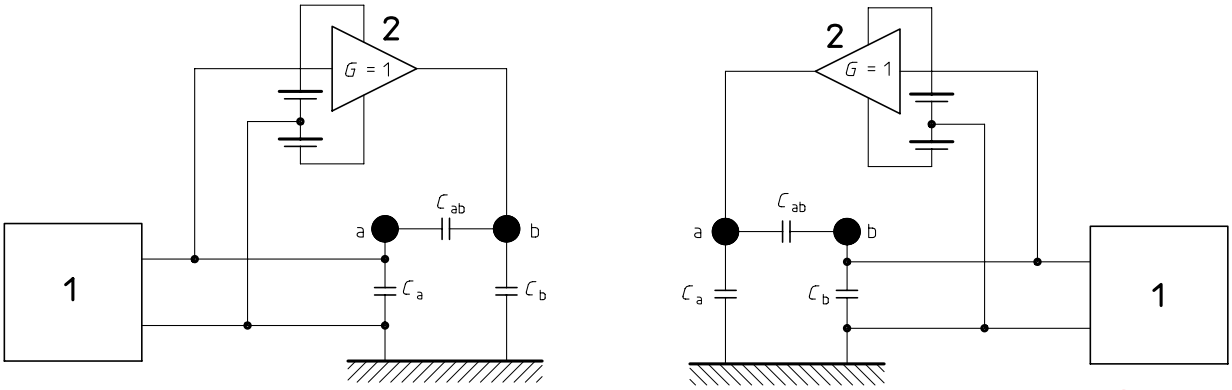
4.4.2 Requirement

The length measured shall not exceed 250 mm.

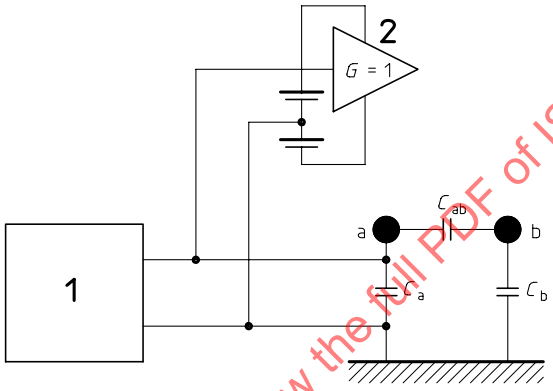
---

2) Cores a and b are cores for data transmission of the connecting cable, i.e. cores 6 and 7 of the "EBS" cable, and cores 14 and 15 of the "24-15" cable: see ISO 7638-1 and ISO 7638-2, and ISO 12098, respectively.

3) "Ground" is described as all other cores of the cable connected in parallel.



a) Measurement A (C_a) **b) Measurement B** (C_b)



c) Measurement C

Key

1 C meter

2 Auxiliary amplifier

NOTE — The auxiliary amplifier (high impedance input, low impedance output, gain G =1) sets the potential of the conductor a equal to that of the conductor b, so that the influence of $C_{ab} + C_b$ (measurement A), and $C_{ab} + C_a$ (measurement B) is eliminated.

Figure 1 — Capacitance measurement methods

4.5 Outside diameter and ovality of the multi-core cable (for round cables)

4.5.1 Test

Determine the maximum and minimum cable outside diameters by taking three sets of measurements at places at least 200 mm apart.

Calculate the ovality, in percent, for each set of measurements by the following equation:

$$\frac{d_{max} - d_{min}}{0{,}5\,(d_{max} + d_{min})} \times 100\ \%$$

where d_{max} and d_{min} are the maximum and minimum cable outside diameters respectively.

4.5.2 Requirement

Each diameter measured and ovality calculated shall be within the dimensional limits specified in ISO 4141-3.

4.6 Thickness of the sheath

4.6.1 Test

Strip three test samples from the cable to be tested from places at least 1 m apart. A test sample consists of a thin slice of the complete sheath, cut with a suitable device (sharp knife, razor-blade, etc.) perpendicular to the core axis. If core marking causes indentation of the sheath, the first test sample shall be taken through this indentation.

Measure the complete sheath thickness at its thinnest portion perpendicular to the cable axis.

4.6.2 Requirement

Each value measured shall not be less than the minimum wall thickness as specified in ISO 4141-3.

4.7 Visual appearance

On visual examination, the sheath shall be smooth, even and free from surface imperfections such as lumps, voids, particles, or other contamination.

4.8 Durability of the sheath marking

4.8.1 Test

NOTE — The following test only applies if marking is required.

Prepare three test samples of at least 300 mm length and apply the test fluids listed below:

— sample 1: test fuel C in accordance with ISO 1817;

— sample 2: oil No. 1 in accordance with ISO 1817;

— sample 3: DOT 4 braking fluid[4)].

After 15 s, place the sample in a hot air-oven with natural draught at (50 ± 2) °C for 48 h. Then pull each sample twice between two pieces of felt (approximate dimensions 50 mm x 50 mm) without dressing, having a minimum wool content of 75%, and with a packing density of 0,171 g/cm^3 to 0,191 g/cm^3. Carry out this operation so that the sheath marking is wiped at a speed of approximately 100 mm/s over a length of 200 mm. Apply a force of (10 ± 1) N while pulling the test samples through the felt. Replace the felt after 10 test applications.

4.8.2 Requirement

The marking shall remain legible.

4.9 Resistance of the sheath to fluids

4.9.1 Test

Verify the material specifications by checking the guaranteed material features of the material manufacturer, in particular in relation to the following:

— resistance to base (5% KOH, 25% K_2CO_3, 70% H_2O);

— resistance to liquid B specified in ISO 1817;

---

4) Test fluid in preparation for inclusion in an Amendment to ISO 1817.

— resistance to lubricating oil No. 1 specified in ISO 1817;

— resistance to liquid F specified in ISO 1817;

— resistance to lubricating grease specified in ISO 1817.

4.9.2 Requirement

The sheath material shall be resistant to the products specified in 4.9.1.

4.10 Stripping of the sheath

It shall be possible to remove at least 100 mm of the sheath, cleanly and without difficulty, by a method agreed on by the manufacturer and user, without causing damage to the inner cores.

4.11 Shrinkage by heat of the sheath

4.11.1 Test

Perform the test specified in ISO 6722-1, but with a sample length of 200 mm. Condition the sheath for 15 min at (150 ± 2) °C.

4.11.2 Requirement

The sheath of the sample shall not shrink by more than 4% in length.

4.12 Pressure at high temperature

4.12.1 Test

Take two samples of 100 mm length each from two places at least 1 m apart.

Cut a strip from each of the samples. If the sheath shows ridges caused by the individual cores, cut the strip in the direction of the ridges so that it contains at least one groove throughout its length.

Support the strips by a metal pin. If the sheath shows ridges, the pin diameter shall be approximately equal to the core diameter; if the sheath shows no ridges, the pin diameter shall be approximately equal to the inner diameter of the sheath.

Place the strips and the metal support pins with the apparatus shown in figure 2 in a heating cabinet at a temperature of (85 ± 2) °C for 16 h. Then arrange them as shown in figure 2 so that the pin supports the sheath, the pin lying in the groove, if any, of the sample, and with the blade pressing against the outer surface of the sheath with the following force F, in newtons:

$$F = 0{,}8\sqrt{(2De - e^2)}$$

where

D is the maximum specified outside diameter, in millimetres;

e is the minimum specified sheath thickness, in millimetres.

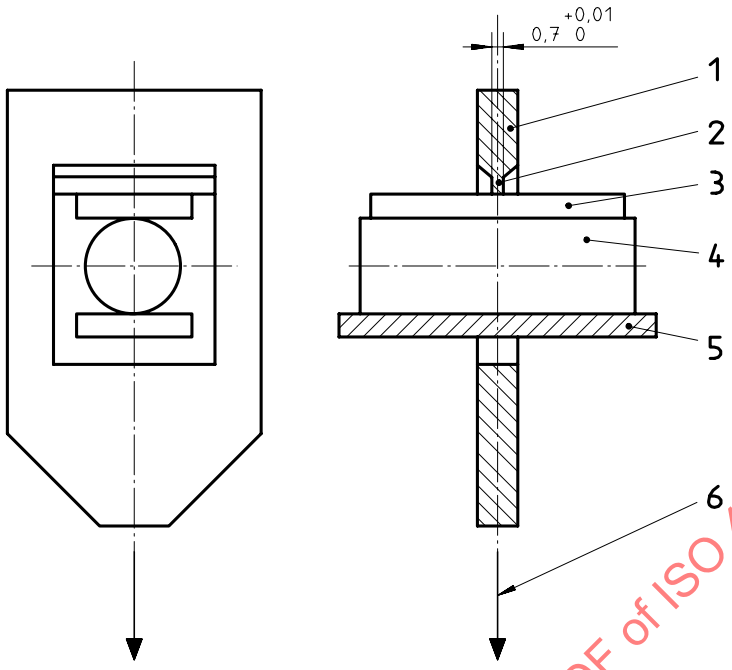
NOTE — The coefficient 0,8 is expressed in newtons per millimetre.

Apply the force in a direction perpendicular to the axis of the pin with the blade also perpendicular to the axis of the pin.

Maintain the apparatus, with the samples in position, in this condition in the heating cabinet for 4 h. Remove the samples from the apparatus and cool them, within 10 s, by immersion in cold water.

Measure the thickness of the sheath immediately, at the point of impression and at points about 10 mm to either side of the impression, by means of a measuring microscope.

Dimensions in millimetres



Key

1 Test frame
2 Blade
3 Test strip
4 Pin
5 Support
6 Force

Figure 2 —Test apparatus for pressure at high temperature

4.12.2 Requirements

The thickness within the area of the impression shall not be less than 40% of the mean of the thicknesses at the other two measuring points.

The sheath shall not rupture.

4.13 Impact at low temperature

4.13.1 Test

Take three test samples of 150 mm min. in length from places at least 1 m apart from the cable to be tested.

Perform the impact test on the middle of the test samples using the apparatus shown in figure 3, using a hammer the mass of which is 500 g.

Place the test apparatus, positioned on a pad of sponge rubber of 40 mm thickness, together with the test samples, in a refrigerator at a temperature of (-15 ± 2) °C for at least 4 h. At the end of this period, place each test sample in turn in a position as shown in figure 4, with its minor axis perpendicular to the steel base. Then allow the hammer to fall from a height of 100 mm.

After the test, allow the test samples to regain a room temperature of (23 ± 5) °C and examine them visually.

4.13.2 Requirement

The test samples shall show no sign of fracture or cracking to the sheath.

If the test samples meet this requirement, perform the test specified in 4.2.

4.14 Bending at low temperature

4.14.1 Test

Take two test samples of 300 mm length from the cable to be tested from places at least 1 m apart and condition them together with a metallic mandrel of 80 mm diameter in a freezing chamber at (- 40 ± 2) °C for 4 h.

After conditioning, bend the samples 180° around the mandrel. The bending shall take place within 5 s in the freezing chamber.

Then allow the test samples to regain a room temperature of (23 ± 5) °C and examine them visually.

4.14.2 Requirement

The test samples shall show no signs of fracture or cracking to the sheath.

If the test samples meet this requirement, perform the test specified in 4.2.

Dimensions in millimetres

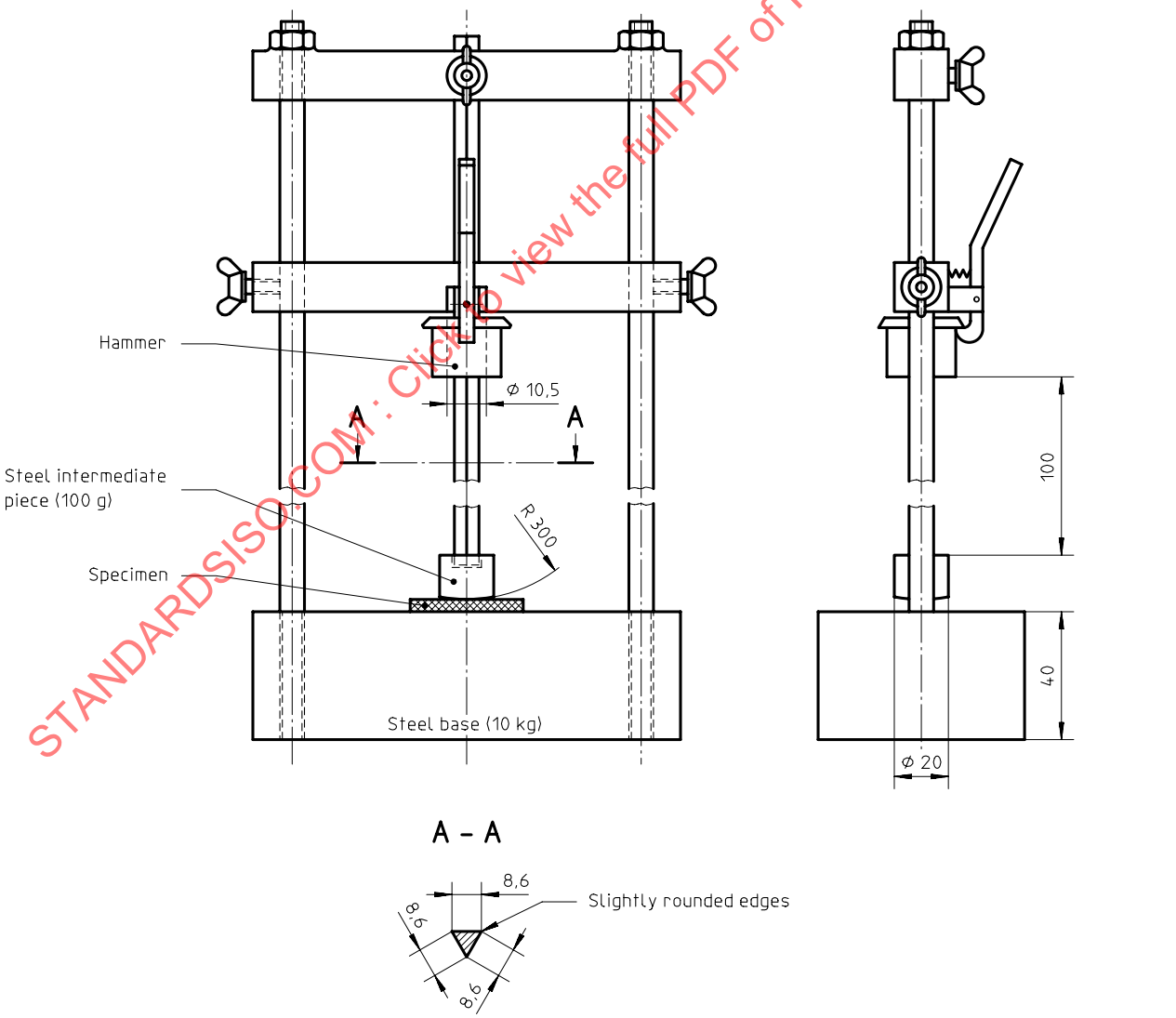


Figure 3 — Test apparatus for impact at low temperature

4.15 Cyclic bending

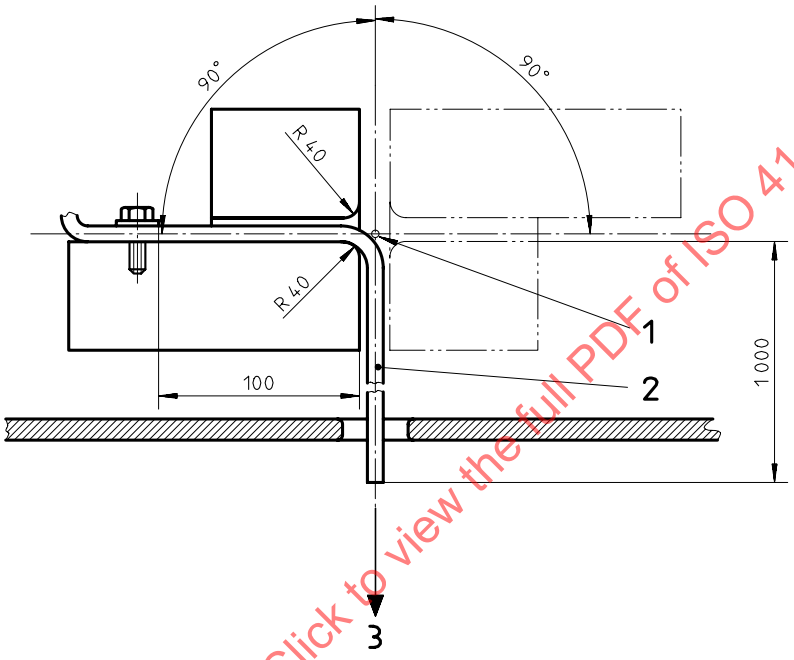
4.15.1 Test

Perform the test with a suitable bending machine such as that shown in figure 4.

Suspend the cables to be tested vertically hanging fixed at one end, with the other end subjected to a force of 50 N. Bend them over a radius of 40 mm and allow the fixing to pivot to an angle of 90° to either side of the vertical, at a frequency of 0,25 cycles per second, for 5 000 cycles.

Monitor core resistance throughout the entire test period.

Dimensions in millimetres



Key

1 Pivot
2 Cable
3 Force

Figure 4 — Test apparatus for cyclic bending

4.15.2 Requirements

No conductor shall break during the test. The samples when inspected visually shall show no signs of fracture or cracking to the sheath.

If the test samples meet this requirement, perform the test specified in 4.2.

4.16 Resistance to flame propagation

4.16.1 Test

Use the test apparatus specified in ISO 6722-1:1996, 12.2.

Suspend the test samples in a room free of draughts and expose them for 15 s to the tip of the test flame inner cone as shown in figure 5.

4.16.2 Requirement

Any combustion flame of the sheath material shall extinguish itself within 70 s after withdrawal from the burner flame.

4.17 **Artificial weathering** (where applicable)

4.17.1 Test

Take 10 test samples from the sheath for a tensile test in accordance with IEC 811-1-1.

Expose five of the test samples to ultraviolet radiation with the xenon arc lamp in accordance with ISO 4892-1 and ISO 4892-2 for 750 h at (55 ± 3) °C. Carry out the test with water spray cycles (5 min water spray and 25 min dry interval, or 12 min and 180 min respectively) at a relative humidity of (50 ± 5) % for the dry intervals.

NOTE — The preferred test device is the xenon arc test cabinet. Other cabinets using other light sources, e.g. open flame carbon arc (see [2]), are acceptable by agreement between the cable manufacturer and the user.

After removing them from the test cabinet, let the samples regain a temperature of (23 ± 5) °C and then subject them to the tensile test in accordance with IEC 811-1-1, together with the remaining five samples.

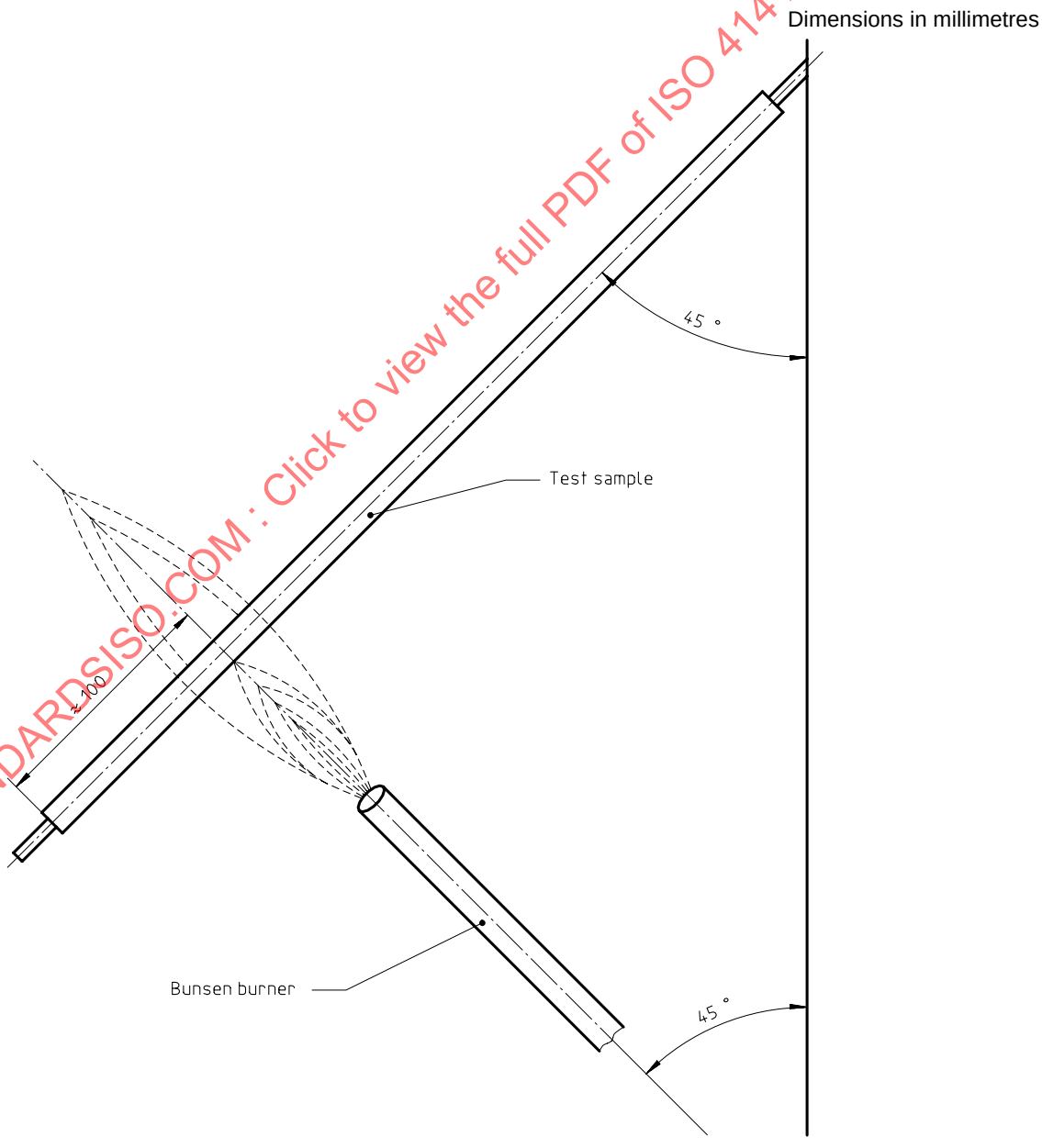


Figure 5 — Test arrangement for resistance to flame propagation

4.17.2 Requirement

After exposure to the artificial weathering, a maximum decrease in resistance to strain of 20% is permitted.

The resistance of the sheath material to artificial weathering shall be stated in a test certificate.

4.18 Abrasion resistance

This test shall be carried out as agreed between manufacturer and user.

4.19 Resistance against ozone

4.19.1 Test

Carry out this test on cable materials that may be affected by ozone. Whenever applicable, test both single cores and complete cables.

Use three test samples of at least 300 mm length of the single core and/or complete cable to be tested and an ozone chamber in accordance with ISO 1431-1 or IEC 811-2-1. Use a mandrel size of diameter (3 ± 0,2) times the outside diameter of the test sample.

NOTE — Aluminium mandrels are preferred since other materials may affect the ozone concentration.

Wind the test samples a minimum of 180° circularly around the mandrel and secure the ends by a suitable clamp. Expose the test samples to an atmosphere containing a mass fraction of $(100 \pm 5) \times 10^{-6}$ of ozone at (65 ± 3) °C for 192 h. After the specified test duration remove the test samples from the test chamber and, while they are still on the mandrels, examine them visually under × 8 magnification for cracks or splits.

4.19.2 Requirement

The test samples shall show no cracks, fractures or other defects. Any defects near the fixing clamps shall be disregarded.

4.20 Short term ageing

4.20.1 Test

Perform the short term ageing test for class A cables as specified in ISO 6722-1, but wind the cable on a mandrel of 60 mm diameter.

After the test, allow the samples to regain a room temperature of (23 ± 5) °C and then examine them visually.

4.20.2 Requirement

The samples shall show no signs of fracture or cracking to the sheath.

If the test samples meet this requirement, perform the test specified in 4.2.