

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION

R 1468

METHODS OF TEST

FOR GENERAL PURPOSE ELECTRICAL CABLES

WITH ALUMINIUM OR ALUMINIUM ALLOY CONDUCTORS

FOR AIRCRAFT

1st EDITION

July 1970

COPYRIGHT RESERVED

The copyright of ISO Recommendations and ISO Standards belongs to ISO Member Bodies. Reproduction of these documents, in any country, may be authorized therefore only by the national standards organization of that country, being a member of ISO.

For each individual country the only valid standard is the national standard of that country.

Printed in Switzerland

Also issued in French and Russian. Copies to be obtained through the national standards organizations.

STANDARDSISO.COM : Click to view the full PDF of ISO/R 1468:1970

BRIEF HISTORY

The ISO Recommendation R 1468, *Methods of test for general purpose electrical cables with aluminium or aluminium alloy conductors for aircraft*, was drawn up by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, the Secretariat of which is held by the British Standards Institution (BSI).

Work on this question led to the adoption of Draft ISO Recommendation No. 1468 which was circulated to all the ISO Member Bodies for enquiry in December 1967. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Belgium
Canada
Israel
Italy
Japan

Netherlands
New Zealand
Poland
Spain
Switzerland

Turkey
U.A.R.
United Kingdom

The following Member Bodies opposed the approval of the Draft :

France
U.S.S.R.

This Draft ISO Recommendation was then submitted by correspondence to the ISO Council which decided to accept it as an ISO RECOMMENDATION.

CONTENTS

	Page
1. Scope	5
I. Type tests only	5
2. Resistance to typical aircraft fluids	5
3. Ageing in air at high temperature, followed by a bend test at room temperature and an insulation test while immersed in water	6
4. Flexibility test at room temperature	7
5. Bend test at low temperature	7
6. Surface creepage test whilst immersed in salt water	8
7. Heat test	8
8. Test for emission of smoke	8
9. Test of physical properties of insulation material	9
10. Abrasion test	9
II. Type and production routine tests	9
11. Conductor resistance tests	9
12. Insulation tests	9
III. Type and production quality tests	10
13. Flammability tests	10
14. Tensile and elongation tests on conductors	10
15. Test of physical properties of insulation material	10
Annex A : Preparation of the test pieces for elongation at break test	11
Annex B : Abrasion testing machine	12

METHODS OF TEST
FOR GENERAL PURPOSE ELECTRICAL CABLES
WITH ALUMINIUM OR ALUMINIUM ALLOY CONDUCTORS
FOR AIRCRAFT

1. SCOPE

- 1.1 This ISO Recommendation describes the methods of tests suitable for establishing the compliance of general purpose electrical cables with aluminium or aluminium alloy conductors for aircraft with the performance requirements stated in ISO Recommendation R 1076, *General purpose electrical cables with aluminium or aluminium alloy conductors for aircraft*. It is intended for use as a basis for specifying tests in the relevant national specifications where the national type approving authorities consider that existing tests are inadequate.

The tests are classified as follows :

- I. Type tests only.
- II. Type and production routine tests.
- III. Type and production quality tests.

- 1.2 Requirements differing from those of ISO Recommendation R 634, *Methods of test for general purpose electrical cables with copper conductors for aircraft*, are marked ‡.

I. TYPE TESTS ONLY**2. RESISTANCE TO TYPICAL AIRCRAFT FLUIDS**

- 2.1 The object of this test is to check that the cable will not be affected, in such a way as to cause failure in service or undue difficulties in servicing, by any of the fluids with which it is likely to come into contact on modern aircraft.
- 2.2 Separate cable samples should be bent into a loop of a diameter approximately fourteen times the overall diameter of the cable and immersed each in one of the following fluids, with the ends clear of the fluid, for not less than 20 hours, at a temperature such as is likely to be experienced in service for the particular fluid :
- (a) aviation fuels;
 - (b) lubricating oils (including ester-based oils);
 - (c) hydraulic fluids (including ester-based hydraulic fluids);
 - (d) de-icing fluids.
- 2.3 After immersion, the samples should be wiped, straightened and cooled to a temperature of $20 \pm 5^{\circ}\text{C}$, and then subjected to a bend of 360° round a mandrel having a diameter of not more than fourteen times the overall diameter of the cable. After this treatment, the diameter of the cable should not have increased by more than 5 %. There should be no cracking, splitting or other deterioration of the outer coverings and the samples should withstand a voltage test of 1500 V r.m.s. and a frequency of any value from 25 to 100 Hz inclusive, for at least 1 minute without breakdown in water. The potential should be applied between the conductor and the water, and should be increased at a uniform rate from 0 to 1500 V within a period of 30 seconds.
- It is also possible to rate the fluid resistance of insulation on the basis of the percentage of cable weight increase.

3. AGEING IN AIR AT HIGH TEMPERATURE, FOLLOWED BY A BEND TEST AT ROOM TEMPERATURE AND AN INSULATION TEST WHILE IMMERSSED IN WATER

3.1 Object of the test

The object of this test is to check that there is no cracking of the outer coverings of the cable during bending after heating and that the cable will not break down electrically due to displacement of the conductor resulting from deformation of the insulation at high temperature with the conductor under a tensile load. In addition, the test is designed to check that there is no deterioration of the conductor surface as a result of the insulation having been aged at a high temperature.

3.2 Ageing in air oven

A test piece of cable at least 610 mm (24 in) long, having the insulation removed for 25 mm (1 in) at each end, should be bent at least 180° round a cylindrical mandrel of diameter as specified in the Table below. The conductor should be loaded in such a manner that the portion of the insulation compound between the conductor and the mandrel is under compression while the conductor has attached at each end the load specified in the Table. These conditions should be maintained for a period of 120 hours in an air oven at a constant temperature of $120 \pm 2^\circ\text{C}$. On removal from the air oven, the test piece should be cooled to between 20 and 25°C within a period of 1 hour. When cooled, the cable should be freed from the load, removed from the mandrel and straightened. The test piece should then be subjected successively to the tests mentioned in clauses 3.3 and 3.4, and subsequently the insulation should be removed from the test piece and the conductor examined. It should show no signs of corrosion.

TABLE - Diameters of mandrels and test loads for bend tests

Cable		Cable size	Maximum diameter of mandrel				Test load			
Nominal conductor area			Bend test*		Bend test at low temperature**		Bend test*		Bend test at low temperature**	
mm ²	in ²		mm	in	mm	in	daN	lbf	daN	lbf
8.5	0.013	8	254	10	152	6	1.3	3	2.2	5
14.3	0.0222	6	254	10	254	10	2.7	6	4.4	10
21.5	0.0331	4	254	10	254	10	2.7	6	4.4	10
34.4	0.0532	2	254	10	457	18	2.7	6	6.7	15
43.0	0.0666	1	254	10	457	18	2.7	6	6.7	15
54.5	0.0845	0	254	10	457	18	4.4	10	8.9	20
70.0	0.108	00	254	10	457	18	4.4	10	11.1	25
86.0	0.132	000	254	10	457	18	4.4	10	13.3	30
109.0	0.169	0000	254	10	457	18	4.4	10	13.3	30

* See clauses 3.2 and 3.3.

** See clause 5.3, method B.

3.3 Bend test at room temperature

At a temperature maintained between 20 and 25°C one end of the test piece should be secured to the mandrel and the other end to the load specified in the Table. The mandrel should be rotated until the full length of the test piece is wrapped round the mandrel and is under the specified tensile load with adjoining turns in contact with each other. The mandrel should then be rotated in the reverse direction until the full length of the surface of the cable which was outside during the first wrapping is now next to the mandrel. This procedure should be repeated until two bends in each direction have been formed in the same section of the cable. There should be no cracking or puckering of the outer coverings of the finished cable as a result of this test.

3.4 Insulation test in water

The uninsulated ends of the test piece should be fastened in metallic contact to a metal bar. Care should be taken to avoid fraying the ends of the insulation and protective covering. The distance between two uninsulated ends of the cable should be equal to the diameter of the mandrel specified in the Table. The test piece should be immersed in a 5 % aqueous sodium chloride solution at a temperature of 20 to 25 °C so that the insulation and protective covering protrudes 38 mm (1.5 in) from the surface of the liquid. After immersion for 5 hours, a potential of 1500 V r.m.s. at a frequency at any value from 25 to 100 Hz inclusive should be applied between the conductor and an electrode in contact with the liquid. This voltage should be increased at a uniform rate from 0 to 1500 V within 30 seconds and maintained at 1500 V for a period of 5 minutes without breakdown.

4. FLEXIBILITY TEST AT ROOM TEMPERATURE

- 4.1 The purpose of this test is to check that none of the constituent parts of the cable will crack during the flexing which is likely to be experienced during installation or service.
- 4.2 Before submission to the following test the cable should be maintained for a period of not less than 16 hours in air at a temperature of 20 ± 5 °C and a relative humidity of 75 %.
- 4.3 The test piece of the complete cable should be wound on a mandrel into a close helix of at least three complete turns at a temperature of 20 ± 5 °C under a tensile load of such a value as to ensure that the cable conforms to the mandrel. The mandrel diameter should not be more than three times the maximum specified overall diameter of the cable for cables having overall diameters up to 12.2 mm (0.48 in) and six times the maximum specified overall diameter of the cable for larger cables.
- 4.4 The complete test should comprise five test cycles, each cycle consisting of the winding of the cable on the mandrel, unwinding and rewinding in the reverse direction so that the surface of the cable inside the helix during the first winding is on the outside of the helix on rewinding.
- 4.5 After this treatment no part of the cable should show signs of damage likely to affect the performance of the cable in service. The test pieces should then be subjected to a voltage test of 1500 V r.m.s. and a frequency at any value from 25 to 100 Hz inclusive, for at least 1 minute without breakdown in water.

5. BEND TEST AT LOW TEMPERATURE

- 5.1 The purpose of this test is to check that no constituent parts of the cable will crack under conditions of severe flexing at temperatures down to -30 °C. The test is not necessarily applicable to cables having an overall diameter of 8.8 mm (0.345 in) or larger.
- 5.2 Before submission to the test, the cable should be maintained for a period of not less than 16 hours in air at a temperature of 20 ± 5 °C and a relative humidity of 75 %. The mandrels used in the test should be of metal and should be allowed to cool to the specified temperature with the cable.
- 5.3 Acceptable alternative methods of test are as follows :

Method A

- (a) A test piece of the cable at least 300 mm (12 in) long should be stored in air at a temperature of -30 ± 2 °C for a period of 6 hours, immediately after which it should be wound on a mandrel. The diameter of the mandrel should be ten times the maximum specified diameter of the cable. The rate of bending should be uniform at one complete turn each second. A revolving mandrel should be used.

- (b) After 1 minute and with the cable still on the mandrel there should be no signs to normal vision of cracking of the constituent parts and the sample should withstand without breakdown a voltage test of 1500 V r.m.s. and a frequency at any value from 25 to 100 Hz inclusive for at least 1 minute in water.

Method B

- (a) One end of a test piece of the cable of suitable length should be secured to a mandrel and the other end to a load weight, using a mandrel diameter and weight appropriate to the size of cable, as shown in the Table on page 6. The temperature of the test piece should be lowered to $-55 \pm 1^\circ\text{C}$ at a rate not exceeding 50°C per minute. After having been kept at this temperature for 1 hour, and while still maintaining this temperature, the cable should be wrapped round the mandrel for 180° . The rate of bending should be uniform, and the time to complete the bend of 180° should be 30 seconds. A revolving mandrel should be used.
- (b) The insulation should be removed for a distance of 25 mm (1 in) from each end of the test piece, which should then be subjected to the insulation test described in clause 3.4 with the bent portion submerged.

6. SURFACE CREEPAGE TEST WHILST IMMERSSED IN SALT WATER

A 76 cm (30 in) length of cable should have the insulation removed for 25 mm (1 in) at each end, care being taken not to fray the end of the insulation. The cable should then be immersed in a 5 % aqueous sodium chloride solution at a temperature of $50 \pm 2^\circ\text{C}$ for 24 hours with the ends of the insulation and protective covering protruding 38 mm (1.5 in) above the surface of the solution and with a current-limiting resistance of 75 000 Ω inserted in the circuit. At the end of that period, while the cable is still immersed and at a temperature of $20 \pm 5^\circ\text{C}$, a voltage of 1400 V d.c. should be applied between the conductor and the solution for 1 minute. The leakage current flowing should not exceed 0.2 mA.

7. HEAT TEST

- 7.1 The purpose of this test is to check that adjacent cables do not adhere when heated to the maximum temperature likely to be experienced in service.
- 7.2 For this test, six samples of cable, each approximately 150 mm (6 in) long, should be laid about a central cable and laced together and maintained at a temperature of 115°C for a period of 1 hour. At the end of that period and after being allowed to cool to a temperature of $20 \pm 5^\circ\text{C}$ the cables should be unlaced and it should then be possible to separate them without sticking occurring between adjacent cables.

8. TEST FOR EMISSION OF SMOKE

- 8.1 The purpose of this test is to check that the finished cable will not give off visible smoke at any temperature up to 110°C .
- 8.2 The test should be conducted in still air at an ambient temperature of 25°C . A test piece of cable approximately 4.5 m (15 ft) long should be so suspended that at least the central 3 m (10 ft) section is horizontal and unsupported. One end of the test piece should be suitably weighted so that no sagging will occur during the test. An electric current should be applied to the cable and the voltage drop measured over the central 3 m (10 ft) portion.

The resistance of the cable should be calculated from the current and voltage values, and the temperature of the conductor determined from the change in resistance. The current should be so adjusted that the conductor temperature stabilizes at $110 \pm 2^\circ\text{C}$. This conductor temperature should be maintained for 1 hour, during which there should be no emission of visible smoke from the test piece when viewed against a matt black background.

9. TEST OF PHYSICAL PROPERTIES OF INSULATION MATERIAL

- 9.1 Eight test pieces of insulation, taken from the finished cable and prepared as described in Annex A, should be aged by placing them in an oven at $113 \pm 2^\circ\text{C}$ and maintaining them at that temperature for a period of 1440 hours. The ventilation rate should be between 3 and 10 air changes per hour. At the conclusion of this period the test pieces should be stored at $23 \pm 1^\circ\text{C}$ for at least 16 hours immediately before being tested for elongation at break. The test should be made at $23 \pm 2^\circ\text{C}$ and the testing machine should have loading grips of the self-tightening type. For a test piece of insulation consisting of a portion of the complete insulation, the rate of traverse of the loading grip should be such that the portion between the gauge marks on the sample is stretched at a rate not exceeding 600 % per minute. For a dumb-bell test piece, the rate of traverse of the loading grip should not exceed 500 mm (20 in) per minute.

On eight tests, the highest and lowest values of elongation at break should be discarded and the average taken of the other six.

- 9.2 Eight tests for elongation at break should also be made on unaged insulation test pieces taken from an adjacent length of the same cable and tested under the conditions given above.
- 9.3 The insulation after ageing should retain at least 70 % of its original elongation measured on the unaged test pieces.

10. ABRASION TEST

- 10.1 The abrasive tape used in the test is of the greatest importance as the test results can only be compared if the tapes used are new and of essentially the same characteristics. It is recommended that the tapes and weights used in the test should be as specified in the relevant national specification.
- 10.2 The test piece should be clamped in the abrasion test apparatus described in Annex B and the appropriate weight applied to the saddle. Starting with a graphite band under the cable, the tape should be drawn across the cable. When the next band passes the cable, the indicator lamp should not light. The test should be made four times and after each test the test piece should be moved 76 mm (3 in) towards one of the clamps and rotated through 90° in a constant direction.

II. TYPE AND PRODUCTION ROUTINE TESTS

† 11. CONDUCTOR RESISTANCE TESTS

The maximum values should be in accordance with ISO Recommendation R 1076, *General purpose electrical cables with aluminium or aluminium alloy conductors for aircraft*.

12. INSULATION TESTS

The cable should be subjected to insulation tests in accordance with section 9, paragraph (b) of ISO Recommendation R 1076.

† See clause 1.2.