

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION R 1220

METHODS OF TEST
FOR HEAT-RESISTING (190 °C) ELECTRICAL CABLES
WITH COPPER CONDUCTORS FOR AIRCRAFT

1st EDITION

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BRIEF HISTORY

The ISO Recommendation R 1220, *Methods of test for heat-resisting (190 °C) electrical cables with copper 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. 1144 which was circulated to all the ISO Member Bodies for enquiry in December 1966. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Argentina	Israel	Thailand
Belgium	Italy	Turkey
Brazil	Netherlands	U.A.R.
Canada	Spain	United Kingdom
France	Switzerland	Yugoslavia

The following Member Bodies opposed the approval of the Draft :

Germany
U.S.A.

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

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METHODS OF TEST
FOR HEAT-RESISTING (190 °C) ELECTRICAL CABLES
WITH COPPER CONDUCTORS FOR AIRCRAFT

1. SCOPE

This ISO Recommendation gives details of tests suitable for establishing the compliance of heat-resisting (190 °C) electrical cables with copper conductors for aircraft in accordance with ISO Recommendation R 1075, *Performance requirements for heat-resisting (190 °C) electrical cables with copper conductors for aircraft*.

It is intended for use as a basis for specifying tests in the relevant national specifications where the national 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. TYPE TESTS ONLY**2. VOLTAGE TEST AT HIGH TEMPERATURE**

- 2.1 The object of this test is to check that the cable is able to withstand voltages expected in service even when at a high temperature and the insulation is in a mechanically strained condition.
- 2.2 Five turns of cable should be wound on, and retained in close contact with, a metal mandrel, the diameter of which is ten times the maximum specified diameter of the cable for sizes 22 to 10 and fifteen times the diameter of the cable for sizes 8 to 0000.
- 2.3 The assembly should be placed in an air oven, the temperature of which should be raised slowly to 200 ± 5 °C. After 168 hours at this temperature, a voltage of 1500 V (r.m.s.) should be applied between the conductor and the mandrel. The cable should withstand this voltage for 30 minutes without signs of electrical failure.

3. AGEING IN AIR AT HIGH TEMPERATURE FOLLOWED BY AN INSULATION TEST WHILE IMMERSSED IN WATER

- 3.1 The object of this test is to check that there is no cracking of the outer coverings of the cable 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.
- 3.2 Two specimens of cable should be bent into U loops each with an internal diameter ten times the maximum specified diameter of the cable for sizes 22 to 10 and fifteen times the diameter of the cable for sizes 8 and larger. The specimens should then be placed in an air oven at 200 ± 5 °C for 168 hours. At the conclusion of this period the specimens should be removed from the oven and should show no signs of splitting or cracking. Discolouration of the cable should not be deemed a failure but the printing and phase identification on the cable should remain legible.
- 3.3 The specimens should then be immersed in water at 20 ± 5 °C for 5 minutes with the ends protruding 100 mm (4 in) above the surface and, while thus immersed, they should withstand without breakdown 1500 V (r.m.s.) applied gradually and maintained for 1 minute between the conductor and the water.

4. SURFACE CREEPAGE TEST

- 4.1 The object of this test is to check that there shall be no significant current leakage at the terminations of the cables even under moist conditions where wicking might occur.
- 4.2 A 450 mm (18 in) length of cable should have both ends prepared by cutting back the outer coverings leaving the primary insulation exposed for a length of 25 mm (1 in). The outer braid and tape should then be trimmed back exposing any other braid for a length of 6 mm (0.25 in). An electrode should be formed in contact with both braids by applying copper wire as a close helix covering each braid for a distance of 6 mm (0.25 in). The specimen should then be bent into a U loop and immersed in water at a temperature of 20 ± 5 °C so that the surface of the water is 38 mm (1.5 in) below each wire electrode. After 24 hours immersion, the insulation resistance between the water and the wire electrodes connected together should be measured after 1 minute's electrification at a potential of 1000 V d.c. The value should be not less than 5 M Ω .

5. BEND TEST AT LOW TEMPERATURE

- 5.1 The purpose of this test is to check that no constituent of the cable will crack under conditions of severe flexing at temperatures down to -55 °C. The test is not necessarily applicable to cables having an overall diameter of 8.8 mm (0.345 in) or larger.
- 5.2 The specimen of the cable at least 300 mm (12 in) long, should be stored in air at a temperature of -55 ± 1 °C for a period of 6 hours, immediately after which it should be wound on a mandrel. The mandrels used in the test should be of metal and should be allowed to cool to the specified temperature with the cable. The diameter of the mandrel should be ten times the maximum specified diameter of the cable. The rate of winding should be uniform at approximately one complete turn each second. A revolving mandrel should be used.
- 5.3 After 1 minute, and with the cable still on the mandrel, there should be no signs, to normal vision, of cracking of the component parts.

6. HEAT TEST

- 6.1 The object of this test is to check that adjacent cables do not adhere when heated to the maximum temperature likely to be experienced in service.
- 6.2 Two cable samples should be made into the form of a twisted pair 300 mm (12 in) long, the lay being approximately ten times the maximum specified diameter of the cable. The sample should be stored in an air oven at a temperature of 200 ± 5 °C for 1 hour. During this period the cables should not emit excessive fumes. At the end of the hour the cable should be removed from the oven and allowed to cool to a temperature of 20 ± 5 °C. It should then be possible to separate both parts of the sample without damage to their surfaces.

7. FLEXIBILITY TEST AT ROOM TEMPERATURE

- 7.1 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.
- 7.2 A specimen of the complete cable should be wound on a mandrel at a temperature of 20 ± 5 °C under a tensile load of
- 22.25 N (5 lbf) for cables of sizes 22 to 4,
 - 44.5 N (10 lbf) for cables of sizes 2 and 1,
 - 89.0 N (20 lbf) for cables of sizes 0 to 0000,
- into a close helix, the internal diameter of which is three times the maximum specified diameter of the cable for sizes 22 to 10 and six times the maximum specified diameter of the cable for sizes 8 to 0000.
- 7.3 The complete tests should comprise five test cycles, each cycle consisting of the winding of the cables 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 upon rewinding. No part of the cable should show signs, to normal vision, of damage after this test.

8. ABRASION TEST

- 8.1 The abrasive ribbon used in the test is of the greatest importance as the test results can only be compared if the ribbons used are new and of essentially the same characteristics. For this reason it is recommended that the tapes and weights used in the test should be as specified in the relevant national specification.
- 8.2 A sample of cable should be clamped in the abrasion test apparatus described in Annex A 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 sample should be moved 76 mm (3 in) towards one of the clamps and rotated through 90° in the same direction.

9. SIMULATED INSTALLATION TEST

- 9.1 The purpose of this test is to check that the outer covering of the cable will not ruck back, and that the printed identification remains legible when the cable is passed through a rubber grommet.
- 9.2 A 914 mm (36 in) length of single core cable should be passed three times through a hole in a sheet of rubber 19 mm (0.75 in) thick, having a hardness* of 52 to 60° IHRD. The diameter of the hole should be as given in Table 1.

TABLE 1

Cable size	Hole size	
	Mean overall diameter of cable mm	less in
22 to 14	0.25	0.010
12 to 10	0.38	0.015
8 to 1	0.51	0.020
0 to 0000	0.64	0.025

The sample should be drawn through the hole three times, the same end being used as the leading end each time. The outer covering should not ruck back more than 6,35 mm (0.25 in) and the identification should be recognizable. A trace of castor oil may be applied to the cable to act as a lubricant during this test.

* See ISO Recommendation R 48, *Determination of hardness of vulcanized rubbers* (2nd edition - 1968).

II. TYPE AND PRODUCTION ROUTINE TESTS

10. CONDUCTOR RESISTANCE TEST

The maximum values should be in accordance with ISO Recommendation R 470, *Dimensions and conductor resistance of heat-resisting (190 °C) electrical cables with copper conductors for aircraft*.

11. INSULATION TESTS

The cable should be subjected to insulation tests in accordance with clause 9 (b) of ISO Recommendation R 1075, *Performance requirements for heat-resisting (190 °C) electrical cables with copper conductors for aircraft*.

III. TYPE AND PRODUCTION QUALITY TESTS

12. ELECTRICAL TESTS

The cable should be subjected to electrical tests in accordance with section 10 of ISO Recommendation R 1075.

13. RESISTANCE TO TYPICAL AIRCRAFT FLUIDS

- 13.1 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.
- 13.2 Separate cable samples should be bent into a loop of approximately six times their overall diameter and immersed one in each of the following fluids, with the ends 38 mm (1.5 in) above the surface of the fluid, for not less than 24 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-base oils);
 - (c) hydraulic fluids (including ester-base hydraulic fluids);
 - (d) de-icing fluids.

At the conclusion of this period each cable should be removed from the fluid, allowed to cool to a temperature of 20 ± 5 °C and wiped twice with a clean cloth.

- 13.3 At the conclusion of this treatment the samples should comply with the following requirements :
- (a) when examined by normal vision there should be no signs of splitting, cracking or other deterioration;
 - (b) when the cable is cut through cleanly at the middle of the immersed portion, there should be no significant shrinkage, looseness or fraying of the outer braid, either at the cut ends or at the outer ends;
 - (c) the primary insulation should not have formed blisters;
 - (d) the protective coverings should show no signs of deterioration;
 - (e) the overall diameter should not have increased by more than 5 %;
 - (f) the cable identification should remain legible.

- 13.4 Three samples of cable 300 mm (12 in) long should have the conductor bared at one end each. A brass ferrule of dimensions appropriate to the size of cable (see Fig. 1) should be slipped over the conductor and pushed up the cable until the insulation and protective covering are fully home in the recessed end of the ferrule. The ferrule should then be secured to the cable by means of a grub screw bearing on the conductor, or by turning back the ends of the strands of the conductor over the ferrule and binding them with wire, or by any other mechanical means that satisfies the Inspector. The ferrule should not, however, be soldered to the end of the conductor.

The end of the cable attached to the ferrule should be immersed to a depth of 101.6 mm (4 in) in kerosene at $120 \pm 2^\circ\text{C}$ for 4 hours.

On removal from the hot kerosene, the samples should be allowed to cool to a temperature of $20 \pm 5^\circ\text{C}$. The outer braid adjacent to the ferrule should show no signs of being loose, frayed or shrunk out of the ferrule, nor at any point should the primary insulation have formed blisters.

14. HEAT CYCLING TEST

- 14.1 The object of this test is to check that kinking of the conductors of the smaller cables will not occur when they are subjected to repeated heating and cooling such as is likely to be experienced in service.

- 14.2 For cables of sizes 22 to 16, a 9 m (30 ft) length of cable should be coiled in a single plane between two flat heat-proof plates, the internal diameter of the coil being not less than 100 mm (4 in). The cable should then be stored in an air oven at $200 \pm 5^\circ\text{C}$ for 2 hours, removed and allowed to cool to a temperature of $20 \pm 5^\circ\text{C}$ for at least 2 hours. This cycle should be repeated four times. Before the first cycle and after the fourth cycle the conductor should be examined radiographically. If there is any significant change in the conductor shape, the cable should be deemed not to comply with this ISO Recommendation.

15. FLAMMABILITY TEST*

- 15.1 Five lengths of cable should be bent into five U loops, the internal diameters of which are six times the maximum specified diameter of the cable. The loops should be immersed, one in each of the fluids listed in clause 13.2, at the appropriate temperature, for 15 minutes with the cable ends out of the liquid. At the conclusion of this period the samples should be removed from the fluid, straightened and wiped with a clean cloth to remove surplus fluid.
- 15.2 Each specimen of the cable should then be supported horizontally in a draught-free chamber and the hottest point of a vertical 76 mm (3 in) non-luminous flame**, with a blue cone 25 mm (1 in) high, should be arranged to impinge on the central portion of the specimen for the time specified in Table 2. During the test no flaming particles should fall from the samples. After the source of the flame has been removed, the cable should meet the following requirements :
- (a) the cable should cease to burn within 25 seconds;
 - (b) the total length burned or charred should not exceed 76 mm (3 in).

TABLE 2

Cable size	Time of flame application seconds
22 to 16	5
14 to 0000	15

* Because of the importance of the cable extinguishing quickly after removal of the flame, this test is preferable to the form of test in which the main criterion is the rate of travel of the flame along the cable and which could lead to the rejection of a cable which although burning rapidly, extinguishes quickly.

** 9.5 mm (0.75 in) Bunsen burner.