International Standard 8056/1

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Aircraft — Nickel-chromium and nickel-aluminium thermocouple extension cables — Part 1 : Conductors — General requirements and tests

Aéronefs — Câbles de compensation de couples thermoélectriques en nickel-chrome et en nickel-aluminium — Partie 1 : Conducteurs — Exigences générales et essais

First edition — 1985-04-15

UDC 621.315.55 : 629.7 **Ref. No. ISO 8056/1-1985 (E)**

Descriptors : aircraft, aircraft equipment, thermocouples, electric extension wires, electric conductors, specifications, tests.

Price based on 6 pages

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 8056/1 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*.

Aircraft — Nickel-chromium and nickel-aluminium thermocouple extension cables — Part 1 : Conductors — General requirements and tests

1 Scope and field of application

This part of ISO 8056 specifies the design requirements and tests for the conductors of thermocouple extension cables, using nickel-chromium and nickel-aluminium, for installation in aircraft temperature indicator and control systems.

Methods for determining the thermo-e.m.f. of conductor wires against platinum are given in the annex.

2 References

IEC Publication 564, *D.C. bridges for measuring resistance.*

IPTS 68, *International Practical Temperature Scale of 1968.*

3 Conductor materials

Conductors for use in the construction of thermocouple extension cables for aircraft shall be manufactured from bright, annealed, nickel-chromium (non-magnetic) wires and bright, annealed, nickel-aluminium (magnetic) wires.

They shall comply with the requirements specified in table 1 in terms of d.c. resistance and those in table 2 in terms of thermo-e.m.f. characteristics against platinum over the appropriate temperature range.

Table 3 shows the resistances which have been assumed for nickel-chromium and nickel-aluminium wires in the calculation of d.c. conductor resistances.

A maximum increase in length of 4 %, as a result of stranding, has been assumed for the wires of each conductor.

Each reel or coil of wire to be used in the manufacture of the conductors shall be tested in accordance with 5.1 and 5.2. Finished conductors shall be tested in accordance with 5.3 and 5.4.

Each reel or coil of wire to be used in the manufacture of the conductors shall be tested in accordance with 5.1 and 5.2. Finished conductors shall be tested in accordance with 5.3 and 5.4.

4 Conductor construction

The positive conductor shall consist of stranded, bright, annealed, nickel-chromium alloy wires complying with the requirements of clause 3.

The negative conductor shall consist of stranded, bright, annealed, nickel-aluminium alloy wires complying with the requirements of clause 3.

Joints in single wires shall be welded, brazed or silver-soldered, but the complete conductor shall not be joined. There shall be no kinks, broken wires or other irregularities in the conductors.

5 Tests

5.1 Thermo-electric tests on conductor wires

All wires, before stranding, shall be shown to comply with the requirements specified in table 2 with respect to thermo-e.m.f. against platinum[1] over the range of temperature appropriate to the cable under manufacture.

Measurements shall be made on sample lengths taken from both ends of each reel or coil of wire. A method of direct comparison against platinum, as described in clause A.1, shall be used where single samples are to be tested. Where large numbers of samples are to be tested, a differential method, as described in clause A.2, using substandards of nickel-chromium and nickel-aluminium as appropriate, may be employed. The substandards used shall have known, traceable thermo-electric characteristics against platinum. In the event of a dispute, the direct comparison method shall take precedence.

1) Platinum with a temperature coefficient of resistance not greater than 0,003 925 ± 3 ppm.

5.2 Tests to determine the magnetic significance of conductor wires

Each wire, before stranding, shall be checked with a magnet to determine its magnetic significance. Nickel-chromium wires shall be non-magnetic. Nickel-aluminium wires shall be magnetic.

5.3 Thermo-electric tests on conductors of finished cables

A sample length shall be cut from one end of each reel or coil of finished cable. The thermo-electric characteristic against platinum of the conductor shall be checked differentially by the method using a substandard, as described in clause A.2, over the temperature range of the cable. This characteristic shall comply with the requirements specified in table 2.

5.4 Conductor resistance tests

Each length of finished cable shall be checked for resistance at 20 ± 1 °C by means of a suitable bridge, as described in IEC Publication 564, of accuracy class no larger than 0,5. Suitable precautions shall be taken to eliminate the effects of parasitic e.m.f.'s. The appropriate limits of resistance are given in table 1.

Table 1 — Details of nickel-chromium and nickel-aluminium conductors

Conductor			Conductors of				Nominal diameter of conductor
			nickel-chromium [Ni-Cr(+)]		nickel-aluminium [Ni-Al(−)]		
Size		Number and diameter of wires	D. C. resistances at 20 °C				
			max.	min.	max.	min.	
mm²	AWG[1)]	mm	Ω/1 000 m	Ω/1 000 m	Ω/1 000 m	Ω/1 000 m	mm
0,4	22	19/0,15	2 364	1 956	932	771	0,75
0,6	20	19/0,2	1 330	1 100	524	434	1,00
1,0	18	19/0,25	851	705	336	278	1,25
1,2	16	19/0,3	591	489	234	193	1,50
2,0	14	37/0,25	437	362	172	143	1,75
3,0	12	37/0,32	267	220	106	86	2,20
5,0	10	61/0,32	162	133	64	52	2,85

1) American Wire Gauge.

Table 2 — Thermo-electric characteristics of nickel-chromium and nickel-aluminium conductors against platinum

Temperature	Conductors of			
	nickel-chromium (Ni-Cr)		nickel-aluminium (Ni-Al)	
	Thermo-e.m.f. against platinum			
	max.	min.	max.	min.
°C	mV	mV	mV	mV
− 100	− 2,287	− 2,167	1,386	1,266
− 50	− 1,271	− 1,151	0,738	0,618
0	0,060	− 0,060	0,060	− 0,060
50	1,413	1,293	− 0,730	− 0,610
100	2,873	2,753	− 1,342	− 1,222
150	4,418	4,298	− 1,839	− 1,719
200	6,029	5,909	− 2,228	− 2,108
250	7,689	7,569	− 2,463	− 2,583
300	9,382	9,262	− 2,945	− 2,825

Table 3 — D.C. resistances of nickel-chromium and nickel-aluminium wires

Wire diameter	Conductors of			
	nickel-chromium (Ni-Cr)		nickel-aluminium (Ni-Al)	
	D.C. resistances			
	max.	min.	max.	min.
mm	Ω/m	Ω/m	Ω/m	Ω/m
0,32	9,487	8,162	3,742	3,221
0,30	10,793	9,287	4,258	3,664
0,25	15,54	13,38	6,132	5,276
0,20	24,30	20,90	9,581	8,245
0,15	43,18	37,16	17,03	14,65

Annex

Methods for determining thermo-e.m.f. of conductor wires against platinum

A.1 E.M.F. measurement by method of direct comparison against platinum[1]

(see figure 1)

A.1.1 Sampling

A sample length (approximately 1 m) shall be cut from the outer end of each reel or coil of the conductor. In the case of previously untested single wires, a second sample shall be cut from the inner end of each reel. The cut lengths and the reels from which they are taken shall be marked for future reference.

A.1.2 Junction formation

Each test sample shall be paired with a piece of platinum[1] wire of similar length. If there is insulation present, 100 mm shall be removed from both ends of the sample. A sound electrical junction shall be formed between the pair at one end (variable temperature junction). The junction shall include all the wires of each conductor and be as short in length as possible. Its effective diameter shall not exceed the sum of the diameters of the joined conductors by more than 50 %. Similar junctions shall be formed between the free ends of the pair and a pair of copper leads, drawn from an homogeneous source, for connection to a measuring instrument (reference junctions).

A.1.3 Reference temperature

Each reference junction shall be immersed in an isothermal medium, maintained at a temperature of 0 ± 0,1 °C, the ultimate thermal stability of which is demonstrably unperturbed by the immersion. The depth of immersion shall be not less than 80 mm.

A calibrated thermometer, traceable to 0 °C (as defined on IPTS 68) within ± 0,1 °C, shall be used to monitor the reference temperature during the test.

A.1.4 Test temperature

The variable temperature junction shall be immersed in an isothermal medium, maintained at the required test temperature, the ultimate thermal stability of which is unperturbed by the immersion. The depth of immersion shall be not less than 80 mm.

A calibrated thermometer, traceable to appropriate points on IPTS 68 to an uncertainty no greater than ± 0,2 °C, shall be positioned in the medium so that the temperature gradient between its sensing head and the test junction is demonstrably negligible. The heat loss along the thermometer shall be insignificant. The ultimate thermal stability of the medium shall be not less than ± 0,1 °C/min.

A.1.5 Precautions

The test arrangement shall be such that there is no electrical contact between the conductors except at the junctions and via the measuring instrument. There shall be no electrical contact between any part of the circuit and any external conductor except the measuring instrument.

A.1.6 Thermo-e.m.f. test

When the thermometer indicates that the system has stabilized at the required temperature, the magnitude and polarity of the e.m.f. appearing between the copper leads shall be measured on a suitable instrument having an uncertainty of not more than ± 0,005 mV. The measurement will normally entail a reversal of connections to the instrument, in which case the magnitude of the e.m.f. is decided by taking the arithmetic mean of the two readings. In determining the polarity of the e.m.f., the platinum limb shall be taken as reference.

The result shall be recorded against the reference number of the reel or coil.

The estimated uncertainty of measurement for this method of thermo-e.m.f. determination shall be ± 0,02 mV at all test temperatures.

A.2 E.M.F. measurement by method using a substandard (see figure 2)

A.2.1 Sampling

A sample length (approximately 1 m) shall be cut from the outer end of each reel or coil of the conductor. In the case of previously untested single wires, a second sample shall be cut from the inner end of each reel. The cut lengths and the reels or coils from which they are taken shall be marked for future reference.

A.2.2 Substandard

A substandard conductor, made from the same nominal material as the test sample, shall be established. The thermoelectric characteristic of the substandard against platinum[1] at points on IPTS 68, over the requisite temperature range, shall be known to an uncertainty no greater than ± 0,2 °C. A certificate showing the traceability of the substandard shall be held.

1) Platinum with a temperature coefficient of resistance not greater than 0,003 925 ± 3 ppm.

A.2.3 Junction formation

The test sample shall be paired with a piece of substandard conductor of approximately similar length. If there is insulation present, 100 mm shall be removed from both ends of each conductor. A sound electrical junction shall be formed between the pair at one end (variable temperature junction). The junction shall include all the wires of each conductor and be as short in length as possible. Its effective diameter shall not exceed the sum of the diameters of the joined conductors by more than 50 %. Similar junctions shall be formed between the free ends of the pair and a pair of copper leads, drawn from an homogeneous source, for connection to a measuring instrument (reference junctions).

A.2.4 Reference temperature

Each reference junction shall be immersed in an isothermal medium, maintained at a temperature of 0 ± 0,1 °C, the ultimate thermal stability of which is demonstrably unperturbed by the immersion. The depth of immersion shall be not less than 80 mm.

A calibrated thermometer, traceable to 0 °C (as defined on IPTS 68) within ± 0,1 °C, shall be used to monitor the reference temperature during the test.

A.2.5 Test temperature

The variable temperature junction shall be immersed in an isothermal medium, maintained at the required test temperature, the ultimate thermal stability of which is unperturbed by the immersion. The depth of immersion shall be not less than 80 mm.

A calibrated thermometer, traceable to appropriate points on IPTS 68 to an uncertainty no greater than ± 1 °C, shall be positioned in the medium so that the temperature gradient between its sensing head and the variable temperature junction is demonstrably negligible. The heat loss along the thermometer shall be insignificant. The ultimate thermal stability of the medium shall be not less than ± 1 °C/min.

A.2.6 Precautions

The test arrangement shall be such that there is no electrical contact between the conductors except at the junctions and via the measuring instrument. There shall be no electrical contact between any part of the circuit and any external conductor except the measuring instrument.

A.2.7 Thermo-e.m.f. test

When the thermometer indicates that the system has stabilized at the required temperature, the magnitude and polarity of the e.m.f. appearing between the copper leads shall be measured on a suitable instrument having an uncertainty of not more than ± 0,005 mV. The measurement will normally entail a reversal of connections to the instrument, in which case the magnitude of the e.m.f. is decided by taking the arithmetic mean of the two readings. In determining the polarity of the e.m.f., the substandard limb shall be taken as reference, i.e. the copper lead associated with the substandard limb shall be connected to the negative terminal of the instrument.

The measured value, which is the difference in potential between the test piece and the substandard, shall be added algebraically to the known thermo-e.m.f. value for the substandard (against platinum[1]) at the test temperature) and the result shall be recorded against the reference number of the reel or coil.

The estimated uncertainty of measurement for this method of thermo-e.m.f. determination shall be ± 0,03 mV at all test temperatures.

A.3 General notes

For true characterization of a conductor, the thermo-e.m.f. against platinum should be determined at a number of points (at approximately 50 °C intervals) within the required temperature range. To achieve this, a variable temperature medium or a series of fixed temperature media may be used. For temperature equalization in a medium, the use of a copper block is recommended. This may contain one or more thermowells, but it is pointed out that the greater the distance between the test piece and the standard thermometer, the greater the chance of a thermal gradient becomes. One successful technique is to secure the sensing head of the standard thermometer to the test junction.

The preferred method of junction formation is by an inert process, such as argon arc welding, but other brazing or welding techniques may be used if care is taken to remove any corrosive substances present at the junction as a result of these. Alternatively, twisting, crimping or binding may be used, as long as the junction is sound electrically.

Care shall be taken not to "heat treat" the limbs of the couple and, when a junction-forming technique is used where this becomes a possibility, a sufficient depth of immersion into the isothermal medium shall be allowed to ensure that no heat-treated material lies in the temperature gradient which exists between the test and reference media, i.e. any heat-treated material shall be in the uniform temperature zone of its related isothermal medium.

Where electrical insulation is absent from conductors, this may be applied in the form of a suitable sleeve. At junctions and regions of the conductor lying in a temperature gradient, electrical insulation may be applied in the form of a thin layer of tape, but care shall be taken, where materials known to produce harmful fumes are used, that safe temperatures are not exceeded during the test.

Intimate thermal contact between junctions and the walls of their associated thermowells may be achieved by using a suitably rated silicone oil.

1) Platinum with a temperature coefficient of resistance not greater than 0,003 925 ± 3 ppm.

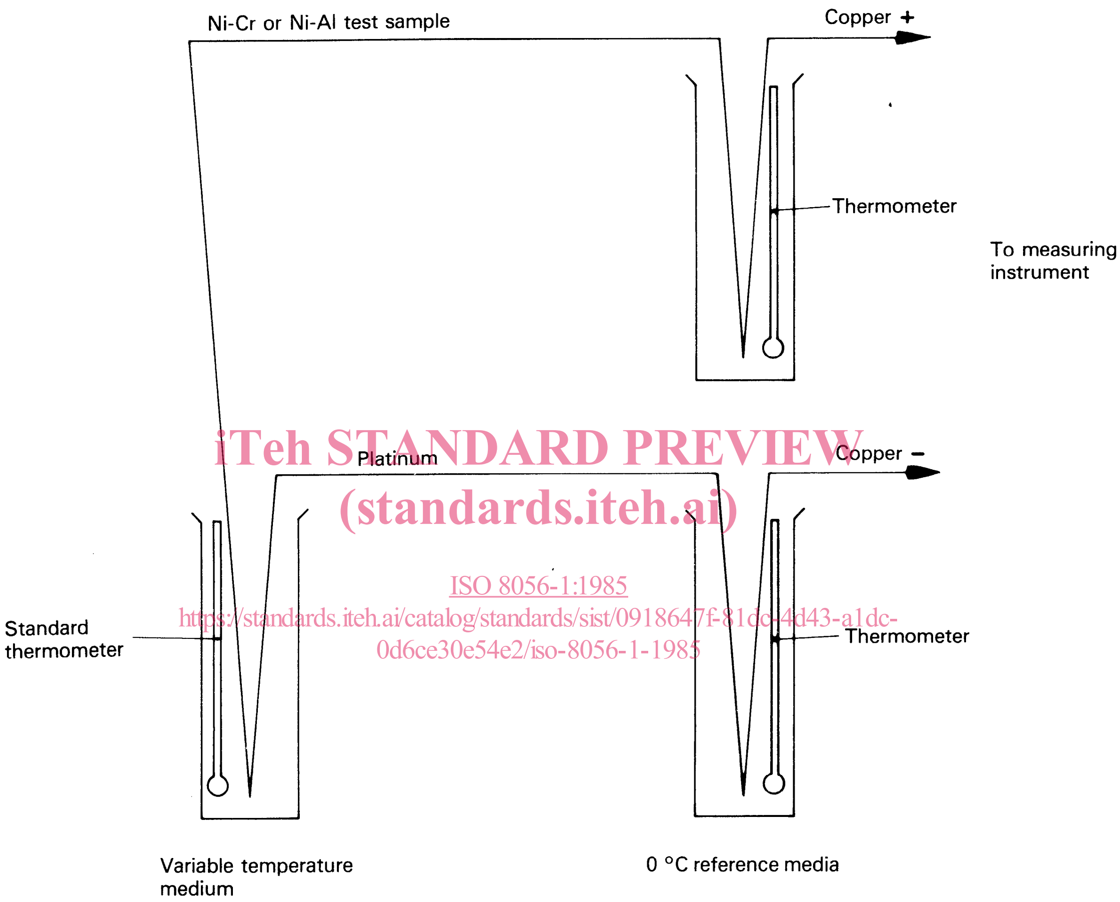

Figure 1 — E.M.F. measurement by method of direct comparison against platinum

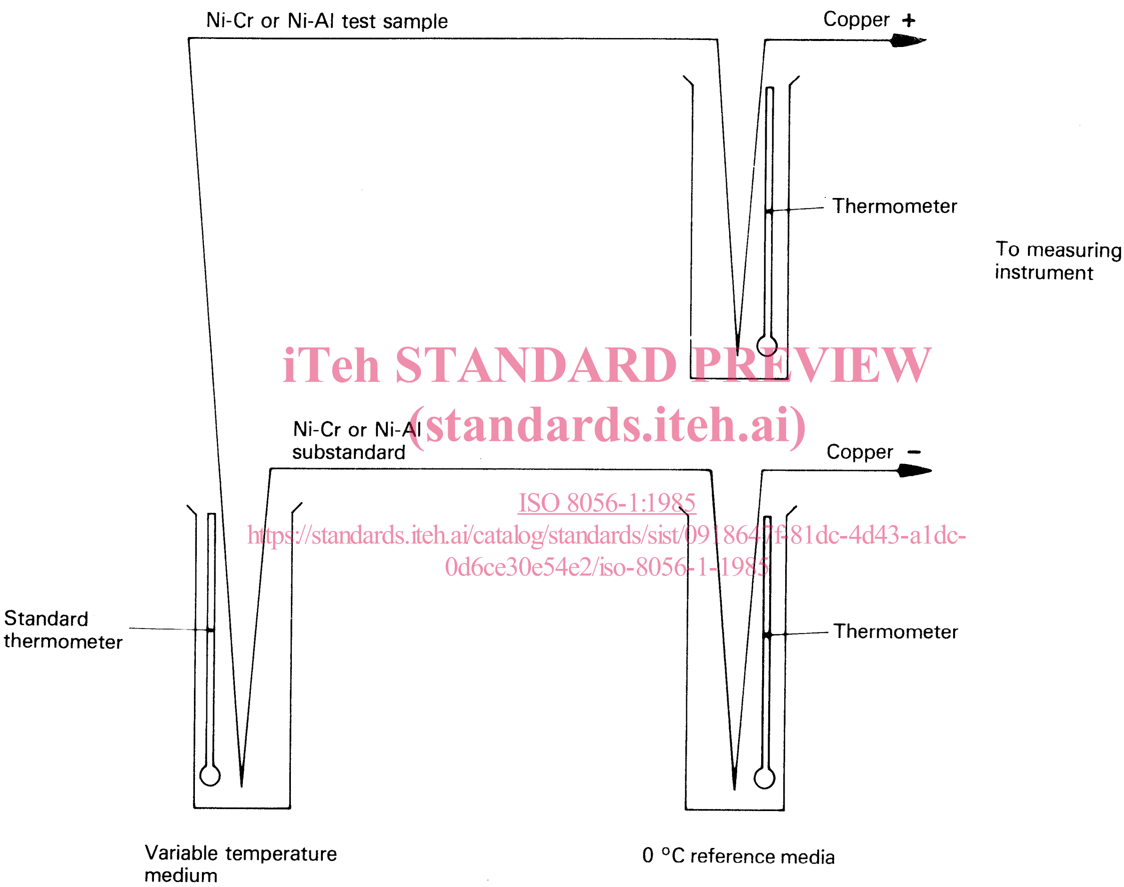

Figure 2 — E.M.F. measurement by method using a substandard