INTERNATIONAL STANDARD 2100

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Tests for aircraft electrical plug and socket connectors

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

International Standard ISO 2100 was drawn up by Technical Committee ISO/TC 20, *Aircraft and space vehicles.*

It was approved in March 1971 by the Member Bodies of the following countries :

Austria	India	South Africa, Rep. of
Belgium	Israel	Spain
Canada	Italy	Thailand
Czechoslovakia	Japan	Turkey
Egypt, Arab Rep. of	Netherlands	United Kingdom
France	New Zealand	U.S.A.

The Member Body of the following country expressed disapproval of the document on technical grounds :

Germany

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Tests for aircraft electrical plug and socket connectors

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the test requirements referred to in ISO 1949, *Design requirements for aircraft electrical plug and socket connectors*[1], and should be read in conjunction with that Standard.

2 TEST DETAILS

The tests shall comply with the details given in the table on the following pages.

1) At present at the stage of draft.

<table>
<tr><th>Test No.</th><th>Title of test</th><th>Test procedure</th><th>Required test results</th></tr>
<tr><td>1</td><td>Engagement and disengagement forces</td><td>Mount fixed items in the normal manner.

Fully engage and disengage the correct mating item in the normal manner. Measure the forces of engagement and disengagement.</td><td>The forces shall lie within the limits previously declared by the manufacturer.</td></tr>
<tr><td>2</td><td>Contact potential difference</td><td>Fully engage the components and pass the test current [see test No. 2 b)] through all contacts until stable conditions obtain. Measure the potential difference of the specimens to be monitored between the extreme ends of the cable. The potential difference is to be determined as in 11.3 of ISO 1949.</td><td></td></tr>
<tr><td>2 a)</td><td>Light current</td><td>The test current is not to exceed 50 mA. The open circuit voltage of the source is not to exceed 20 mV d.c. or a.c. peak at a frequency not exceeding 2 kHz. When d.c. is used the measurement is to be repeated with the current reversed, the potential difference being the mean of the two measurements.</td><td>The potential difference shall not exceed the following values :
<table><tr><th>Contact size</th><th>mV/A</th></tr><tr><td>20 and smaller</td><td>2,5</td></tr><tr><td>16</td><td>2,0</td></tr><tr><td>12</td><td>1,5</td></tr></table></td></tr>
<tr><td>2 b)</td><td>Rated current</td><td>The test current is to be the d.c. rated current in accordance with an agreed bunch rating for the cable used. The open circuit voltage of the source is not to exceed 2,5 V.</td><td>The potential difference shall not exceed the following values :
<table><tr><th>Contact size</th><th>mV/A</th></tr><tr><td>20 and smaller</td><td>2,5</td></tr><tr><td>16</td><td>2,0</td></tr><tr><td>12</td><td>1,5</td></tr></table></td></tr>
<tr><td>3</td><td>Insulation resistance
(at 500 V d.c. for 1 min)</td><td>Mount the unmated specimen normally. Measure the insulation resistance using 500 V d.c. applied for 1 min between each contact being tested (see 11.3 of ISO 1949) and all others connected together and to the housing and mounting plate. Connect all other contacts to the mounting plate during the test. The cable connected to the contact under test may be separated from the remainder of the bunch.</td><td>The values shall be not less than 5 GΩ.</td></tr>
</table>

<table>
<tr><th>Test No.</th><th>Title of test</th><th>Test procedure</th><th>Required test results</th></tr>
<tr><td>4</td><td>Shell continuity</td><td>Using a d.c. voltage source, the open circuit voltage of which does not exceed 2,5 V, pass a current of 1 A from the cable accessory on one side, through the engaged plug and socket, to the cable accessory on the opposite side. Measure the potential drop between the extremities of both cable accessories.</td><td>The value shall not exceed 12,5 mV.</td></tr>
<tr><td>5</td><td>Sealing

Non-hermetic

Hermetic</td><td>The tests described below for non-hermetic connectors are to be conducted at the declared minimum temperature ± 5 °C, at normal temperature, and also at the declared maximum temperature ± 5 °C.

Hermetic connectors are to be tested at normal temperature only.

Mount Class N connectors on a suitable jig. Mount fixed items in the normal manner but couple free items to a suitable adaptor (for example, a fixed item specially adapted).

Apply a differential pressure of 96,5 to 103 kN/m² in both directions across all seals and measure the air leakage rate.

Mount Class H connectors, in the normal manner (for example soldered or welded in accordance with the manufacturer's instructions), on a sealed container to permit the application of a differential pressure of 96,5 to 103 kN/m² to the connector in both directions. Means satisfactory to the approving authority are to be provided for determining the leakage of pressurized gas through the component.</td><td>

The recorded leakage rate shall not exceed 15 cm³/h expressed at normal temperature and pressure.

The recorded leakage rate shall not exceed 1 X 10⁻⁷ cm³/s.</td></tr>
<tr><td>6

6 a)

6 b)</td><td>Contact holding force

Preconditioning

Holding force</td><td>Six female contacts of each size are to be used for the tests 6 a) and 6 b).

Precondition the test contacts by hand ten times, using a gauge of the maximum permitted contact pin diameter.

Mount the sockets vertically with the mating face on the underside. Gauges A and B, each having a surface finish (0,15 to 0,25 μm) (6 to 10 μin) and of specified mass, are to be inserted in each socket to simulate maximum and minimum diameter pin contacts.</td><td>The female contacts shall retain gauge A and not retain gauge B.

<table>
<tr><th rowspan="2">Contact size</th><th colspan="4">Gauge A</th><th colspan="4">Gauge B</th></tr>
<tr><th>ϕ</th><th>engaged length</th><th>mass g</th><th>mass oz</th><th>ϕ</th><th>engaged length</th><th>mass g</th><th>mass oz</th></tr>
<tr><td>22 and smaller</td><td>min.</td><td>min.</td><td>14</td><td>0.5</td><td>max.</td><td>max.</td><td>113</td><td>4</td></tr>
<tr><td>20</td><td>min.</td><td>min.</td><td>21</td><td>0.75</td><td>max.</td><td>max.</td><td>170</td><td>6</td></tr>
<tr><td>16</td><td>min.</td><td>min.</td><td>57</td><td>2.0</td><td>max.</td><td>max.</td><td>567</td><td>20</td></tr>
<tr><td>12</td><td>min.</td><td>min.</td><td>71</td><td>2.5</td><td>max.</td><td>max.</td><td>850</td><td>30</td></tr>
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</td></tr>
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<table>
<tr><th>Test No.</th><th>Title of test</th><th>Test procedure</th><th>Required test results</th></tr>
<tr><td>7</td><td>Contact retention</td><td>Cable securing devices are to be inoperative for this test.

Remove and insert two widely spaced contacts ten times, using the appropriate tool, then mount the connector with its axis vertical and slowly apply the appropriate axial loads (see table below) to the wires attached to the selected contacts. Apply the load for 5 min.

<table><tr><th rowspan="2">Contact size</th><th colspan="2">Force</th></tr><tr><th>N</th><th>lbf</th></tr><tr><td>22 and smaller</td><td>45</td><td>10</td></tr><tr><td>20</td><td>90</td><td>20</td></tr><tr><td>16</td><td>110</td><td>25</td></tr><tr><td>12</td><td>135</td><td>30</td></tr></table></td><td>Movement of the contacts relative to the insert shall not exceed 0,4 mm (0.015 in) at any time.</td></tr>
<tr><td>7 b)</td><td></td><td>Repeat the procedure described in test 7 a) on two other pin contacts applying the forces in the opposite sense by an approved means.</td><td>Movement of the contacts relative to the insert shall not exceed 0,4 mm (0.015 in) at any time.</td></tr>
<tr><td>7 c)</td><td></td><td>Using the appropriate insertion and removal tools, completely remove from the connector and insert 50 % of the contacts or not less than three contacts in both plugs and sockets.

Measure the force to insert the tool, and the force to extract the tool, wire and contact assembly.</td><td>The insertion force of the tool, with or without a contact fitted, shall not exceed 67 N (15 lbf).

The force necessary to remove the tool, wire and contact assembly shall not exceed 45 N (10 lbf).</td></tr>
<tr><td>8</td><td>Low temperature handling</td><td>Maintain the engaged plugs and sockets at a temperature of − 40 ± 2 °C for a period of at least 2 h. At the conclusion of this period and while the specimen is still at the controlled temperature, disengage the plugs and sockets. Make a visual examination upon return to ambient temperature.</td><td>Separation shall be achieved by hand without recourse to tools. There shall be no sign of damage.</td></tr>
<tr><td>9</td><td>Immersion, low air density (moisture breathing)</td><td>Test plugs and sockets as mated sets. Suitably seal the back of the panel portion of the fixed items (Class H only) against the ingress of moisture. Do not seal the free ends of the cable. Separate individual cable leads as widely as practical.

Immerse the mated plugs and sockets in a container of water to which has been added a quantity of sodium chloride, 5 % by mass, to make the water conductive. Place the container in a suitable chamber with the free ends of the cable terminated inside the chamber but not immersed.</td><td></td></tr>
</table>

Test No.	Title of test	Test procedure	Required test results
9 a)	**Low air density cycle**	Reduce the air pressure inside the chamber to that equivalent to an altitude of 31 000 m and maintain it at this value for 30 min. Then return the chamber to normal atmospheric pressure. Repeat the above procedure twice.	
9 b)	**Insulation resistance**	At the end of the third cycle, and while the connectors are still submerged, subject them to test No. 3 but with the specimens mated.	The value shall be not less than 100 MΩ.
10	**Resistance to fluids**	First expose the specimens for this test while disengaged, for at least 24 h, to ambient conditions of temperature, humidity and pressure within the following limits : Temperature : 15 to 35 °C Humidity : 45 to 75 % Pressure : 860 to 1 060 mbar. For the fluid resistance test use separate specimens for each fluid. The fluid should be at the temperature stated, or at the maximum temperature for the connector, whichever is the lesser. When necessary, a break of not more than 3 days may be made at the end of any cycle. Subject mating specimens to the following treatment : Immerse the disengaged specimens for a period of 15 to 20 min. When grease is specified, liberal smearing over all exposed surfaces of the inserts will suffice. Engage and disengage the specimens immediately after removal from the solvent. The specimens are then to remain disengaged under normal conditions for a period of 15 to 24 h. Then engage the specimens and subject them to the maximum working temperature of the connectors for a period of 7,0 to 7,5 h at the end of which they should be disengaged and engaged. This completes the first cycle. Repeat the above sequence for a further four cycles.	Full engagement shall be achieved by hand without recourse to tools. Full engagement shall be achieved by hand without recourse to tools.

Test No.	Title of test	Test procedure	Required test results
11	**Voltage proof**	Place engaged specimens in an altitude chamber, taking care to separate cable leads as widely as possible. Terminate the connections outside the chamber. Then reduce the pressure within the chamber to the equivalent of an altitude of 31 000 m. Maintain this condition for at least 2 h at the end of which period, while the condition still obtains, apply a test potential of 700 V d.c. or 500 V a.c. (r.m.s.) for a period of 1 min between each contact (see 11.3 of ISO 1949) and all other contacts connected together and to the shell. Then disengage the components and fit them with protective caps (see 7.5 of ISO 1949). Repeat this test.	Leakage current shall not exceed 10 μA.
12	**Vibration**	Specimens for this test should include engaged pairs and disengaged but capped fixed connectors. Secure fixed connectors to the vibration table by their normal mounting arrangement. Secure cables or wires from wired specimens to the table at points not less than 200 mm (8 in) from where they emerge from connectors. Means should be provided for continuously monitoring the resistance of all, or of six engaged contacts, whichever is the lesser, wired in series. The contacts selected are to be the centre contact and others extending radially as widely as possible. Monitor the resistance of the chain continuously while passing a nominal 1 A at an open circuit voltage not exceeding 2,5 V d.c.	
12 a)		Subject the specimens to the vibration resonance search test detailed in ISO . . .[1] for Grade A equipment. In the event of resonance being observed, apply the provision of ISO . . .[1].	During this entire period, no change in resistance shall exceed 10 mΩ for a period of more than 1 μs.
12 b)		At the conclusion of the resonance search test and at the conclusion of any resulting 10 h endurance test (should such be necessary), visually examine the items.	There shall be no mechanical damage or loosening of parts.

1) To be prepared.

Test No.	Title of test	Test procedure	Required test results
12 c)		Subject the specimens to the vibration endurance tests detailed in ISO . . .[1] for Grade A equipment but with the following provisions : Of each period specified in ISO . . .[1], 60 % should be under normal conditions, 10 % at approximately the declared minimum temperature and 30 % at approximately the declared maximum temperature. For these tests a stabilizing period of 2 h at the appropriate temperature is to elapse before vibration begins. Contact resistance is to be monitored as in test No. 12. At the conclusion of the endurance tests, examine the items visually. (The method adopted for testing at temperature extremes should be to the satisfaction of the approving authority.)	There shall be no sign of loosening of parts or undue wear which would impair performance.
13	**Thermal shock**	Subject engaged plugs and sockets to five cycles of the following : Place the specimen for not less than 1 h in a chamber maintained at the declared minimum temperature ± 5 °C. Within a period not exceeding 2 min, transfer the specimen to a chamber maintained at the declared maximum temperature ± 5 °C where the specimen should remain for not less than 1 h. At the conclusion of the fifth cycle, allow the specimen to return to normal conditions and then disengage the engaged pair.	There shall be no obvious material deterioration.
14 14 a)	**Endurance at maximum temperature** **Insulation resistance**	Subject engaged plugs and sockets to the declared maximum temperature ± 5 °C for a period of 1 000 h. At the end of this period of 1 000 h and while the specimen is still at maximum temperature, measure the insulation resistance as in test No. 3.	The value shall be not less than 200 MΩ. The plug and socket shall exhibit no obvious material deterioration.

1) To be prepared.

<table>
<tr><th>Test No.</th><th>Title of test</th><th>Test procedure</th><th>Required test results</th></tr>
<tr><td>15</td><td>Resistance to damage by test prod</td><td>Put a standard test prod of nominal pin diameter into the socket contact, while in the insert, to the minimum, mean and maximum declared engagement positions. At each of these depths apply the following appropriate bending moment to the prod about the inserted end and rotate the socket assembly in one direction through 360° so that a uniform force is applied around the inside surface of the contact. Contacts may be locked against rotation.

<table><tr><th rowspan="2">Size</th><th colspan="2">Bending moment ± 10 %</th></tr><tr><th>N·m</th><th>ozf·in</th></tr><tr><td>22 and smaller</td><td>0,014</td><td>2</td></tr><tr><td>20</td><td>0,056</td><td>8</td></tr><tr><td>16 and 12</td><td>0,226</td><td>32</td></tr></table></td><td>NOTE – This is a conditioning procedure before subsequent tests.</td></tr>
<tr><td>16</td><td>Mechanical endurance</td><td>Fully engage and disengage the mating connectors 500 times using the normal means (i.e. coupling devices such as bayonet or screwed coupling rings). The maximum number of engagements per minute should be 15.</td><td>NOTE – This is a conditioning procedure before subsequent tests.</td></tr>
<tr><td>17</td><td>Magnetic interference (only applicable to those types containing ferrous material)</td><td>Specimens for this test are to be fully engaged but should not carry current.

Measure compass safe distance as described in ISO . . .[1].</td><td>Safe distance shall not exceed 127 mm (5 in).</td></tr>
<tr><td>18</td><td>Climatic</td><td>The sample for this test is to include specimens which are disengaged but capped. All leads may be separated as widely as practical.

Throughout the climatic tests (except during measurements) odd-numbered contacts are to be connected together, and even-numbered contacts connected together and to the shell. During test 18 b) there should be a potential difference of 350 V d.c. between these two circuits which should be monitored throughout the test.</td><td>There shall be no voltage breakdown during the whole period of the test.</td></tr>
<tr><td>18 a)</td><td>Humidity, temperature and pressure</td><td>Subject the specimens to the combined humidity, temperature and pressure test detailed in ISO . . .[1] for Class 1 equipment. No subsidiary tests are to be applied until the end of the conditioning.</td><td></td></tr>
</table>

1) To be prepared.

Test No.	Title of test	Test procedure	Required test results
18 b)	**Tropical exposure**	Subject the specimens to the tropical exposure test detailed in ISO . . .[1] for Class 1 equipment.	
18 c)	**Fungus growth**	Subject the specimens to the fungus growth test detailed in ISO . . .[1] for Class 1 equipment. At the end of the 28 days remove the items from the test chamber and allow them to recover at normal temperature and pressure within 1,5 to 2,0 h. After removal from the chamber examine the items visually.	There shall be no external deterioration which would affect service use and no mould growth visible to the naked eye.
19	**Acceleration**	Subject the engaged specimens to the acceleration and crash landing tests detailed in ISO . . .[1] for Class 1A equipment.	
19 a)		Monitor continuity of contacts by means of a lamp, during the period of the test.	There shall be no evidence of discontinuity.
19 b)		At the conclusion of the tests, examine the specimens visually.	There shall be no loosening of parts likely to impair service use.
20	**Insert retention** (in shell)		
20 a)	**Torsional**	Render any cable securing device inoperative. Secure the cable loom at a point 150 mm (6 in) from the rear face of the insert. Then rotate the unmated plug or socket through 90°.	There shall be no permanent displacement of the insert.
		Repeat the above test with rotation in the opposite direction.	There shall be no permanent displacement of the insert.
20 b)	**Axial**	For the purposes of this test remove all contacts, filler plugs and cable accessories. Apply the appropriate axial force as stated in the table below, at a rate of approximately 45 N (10 lbf) per second to the mating face of the specimen, and maintain it for at least 1 min.	There shall be no permanent displacement of the insert.

Shell size	Applied axial force	
	N	lbf
8–10–12	132	30
14–16–18	245	55
20–22–24	385	87
28–32–36	410	116

1) To be prepared.

Test No.	Title of test	Test procedure	Required test results
		Repeat the above test but with the load applied to the opposite face.	There shall be no permanent displacement of the insert.
21	**Fireproofness** (applicable to fireproof types only)	Mount the engaged components on a 300 mm (12 in) square vertical steel sheet 0,45 mm (0.018 in; 26 SWG) thick which has been strengthened by a stiffening plate 0,7 mm (0.028 in; 22 SWG) thick extending 6 mm (0.25 in) beyond the profile of the connector. Position two calibrated gas torches, complying with ISO . . .[1], in a horizontal plane, each at 45° to the axis of the plug and on the same (free member) side of the steel sheet so that the components are wholly enveloped in flame, the temperature of which, measured 6,4 mm (0.25 in) from the assembly, is not less than 1 100 °C. Continue this for not less than 20 min. Concurrently, vibrate the assembly continuously at 33 Hz with a minimum amplitude of 1 mm (0.04 in) total excursion 2 mm (0.08 in). All contacts are to be so wired that continuity between engaged contacts, and any breakdown to shell or between any other contacts, is indicated.	All circuits shall function for at least 6 min and no flame occur on the safe side throughout the test.
22	**Salt spray**	The samples for the test are to include engaged specimens and disengaged but capped specimens. Subject the specimens to a salt corrosion test in accordance with ISO . . .[1]. Continue the test for a period of approximately 1,5 h, after which maintain the specimens at a temperature of 35 ± 2 °C and a relative humidity of 90 to 95 % for a period of 7 days.	
22 a)		Repeat the above cycle of treatment three times. At the end of the 28 days, apply the following tests :	
	1) *Visual examination*	Examine the connectors visually.	There shall be no corrosion or deterioration sufficient to impair service use.
	2) *Shell continuity*	As in test No. 4.	The values obtained shall not be greater than 25 mV.
	3) *Engagement and disengagement forces*	As in test No. 1.	As in test No. 1.

1) To be prepared.