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ISO RECOMMENDATION

R 1466

PERFORMANCE REQUIREMENTS

FOR LEVER-OPERATED MANUAL SWITCHES FOR AIRCRAFT

1st EDITION

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BRIEF HISTORY

The ISO Recommendation R 1466, *Performance requirements for lever-operated manual switches 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. 1466, which was circulated to all the ISO Member Bodies for enquiry in March 1968. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Australia	Italy	Thailand
Belgium	Netherlands	Turkey
Brazil	New Zealand	U.A.R.
Canada	Poland	United Kingdom
Czechoslovakia	Portugal	U.S.S.R.
France	South Africa, Rep. of	Yugoslavia
India	Spain	
Israel	Switzerland	

No Member Body opposed the approval of the Draft.

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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PERFORMANCE REQUIREMENTS

FOR LEVER-OPERATED MANUAL SWITCHES FOR AIRCRAFT

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1. SCOPE

This ISO Recommendation states performance requirements for two classes of single-hole fixing, lever-operated manual switches for use in nominal 28 V d.c. and 115/200 V three-phase, 400 Hz a.c. systems in aircraft.

Class 1 switches are sealed and are suitable for higher altitude and temperature conditions than are Class 2 switches, which are sealed only at the lever entry.

2. DESIGN REQUIREMENTS

2.1 The switch should be suitable for either of the following temperature and altitude classifications :

Class 1 : Suitable for use at altitudes up to 21 400 m, and at temperatures within the range − 40 to + 70 °C, and should not suffer damage or deterioration when subjected to − 65 °C.

Class 2 : Suitable for use at altitudes up to 6100 m and for occasional use at 18 300 m, and at temperatures within the range − 20 to + 55 °C, and should not suffer damage or deterioration when subjected to − 40 °C.

2.2 The switch should be suitable for mounting through the panel from the rear and should operate satisfactorily when mounted in any attitude.

2.3 The switch may be the two- or three-position type, with one or more poles : it may be self-retaining and/or spring return. It should preferably be designed to allow the incorporation of integral locking of the lever in any or all positions.

2.4 The method of operation of the switch should be by means of a single lever, moving in a plane at right angles to the mounting panel. The relationship of the lever positions to the keyways, and the relationship of the terminal numbers to the lever positions should be stated in the individual specification.

2.5 The switch terminals should be identified by number in the sequence shown in the individual specification.

3. DIMENSIONS

The envelope and fixing dimensions for the switch should comply with ISO Recommendation R 493, *Dimensions for single-hole mounting, lever-operated switches for aircraft.*

4. OPERATION

4.1 The switch lever action should be positive and it should not be possible during normal usage for the lever to stay in any position other than a fully operated position. The operation of the switch should not be affected adversely by the speed of the movement of the lever.

4.2 It should not be possible to rotate the lever about its longitudinal axis.

4.3 The angular movement of the lever should be between 18 and 23° nominally from the central position with a tolerance of ± 2°.

4.4 There should be at least at 10° movement of the lever before switching occurs.

4.5 The lever should be capable of withstanding without damage or distortion a force of 90 N applied steadily in the directions stated in clause 9.1.2.

5. CONSTRUCTION

5.1 The lever, including any metal inserts, should be insulated from all live parts.

5.2 The manufacturer should declare the maximum and minimum values of the operating force for each operation appropriate to each type of switch.

The force required to operate the switch should be not less than 4.5 N and not more than 45 N. For each operation of a particular type of switch the maximum force should not exceed the minimum force by more than 100 %.

5.3 Where locking of the lever is provided it should be positive and automatic, and the lock should be released by raising the lever against a spring force of 4.5 to 22.5 N.

5.4 The exposed portion of the switch should have a non-glaring finish.

5.5 The switch should be sealed at the point of entry of the lever to prevent the ingress of liquids or foreign matter. The bodies of Class 1 switches should, in addition, be sealed to the standard required by the test in clause 9.14.

5.6 Terminations should be by screws, each capable of accepting two crimped tag-type terminations of approved design. The terminal threads should preferably be No. 6 UNC or M4 × 0.7. Terminals should have a mechanical strength adequate to satisfy the requirements of clause 9.1.1.

5.7 The terminal arrangement should be such that wiring access is still provided when the switches are mounted in rows at minimum spacing. Means should be provided to avoid accidental contact or short-circuiting between adjacent terminals or cable lugs.

The switches should be suitable for close mounting and should not constitute an electrical hazard if the side faces of adjacent switches touch one another.

5.8 The switch should be mounted by means of a threaded bush, with a locating keyway in the plane of movement of the lever, suitable for use with the panel mounting hole specified in ISO Recommendation R 493, *Dimensions for single-hole mounting lever-operated switches for aircraft.* Two hexagon mounting nuts, one locating washer and one internal shakeproof washer should be provided with each switch.

5.9 The switch should be so constructed that it is suitable for performing at least 50 000 operations at maximum rated current and voltage.

5.10 The switch contacts, including common internal connections, should be self-wiping on all switched contact positions. Springs should be of the compression type.

5.11 The lever mechanism should incorporate a positive contact opening action in order to assist in breaking a tack weld.

5.12 The appropriate contacts only should operate when the lever is suddenly released from a spring-loaded position.

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6. VOLTAGE AND CURRENT RATINGS

6.1 Voltage

The switch should be suitable for operating in nominal 28 V d.c. and 115/200 V three-phase, 400 Hz a.c. systems having the characteristics described in ISO Recommendation R 1540,* *Characteristics of aircraft electrical power systems.* In addition, the switch should be suitable for use at voltages down to 4 V d.c. or a.c.

6.2 Current

The switch should perform at least 50 000 operations and should be suitable for any one of the following nominal current ratings :

resistive load	15 A
inductive load	10 A
tungsten filament lamp load (28 V d.c.)	7.5 A
tungsten filament lamp load (200 V a.c.)	2.5 A

6.3 In addition, unless otherwise declared, the switch should be suitable for operation at 100 mA resistive load at voltages down to 4 V.

The inductance loads should be as follows :

28 V d.c. – 10 A, 40 mH

115/200 V a.c. – 10 A, 0.75 to 0.80 power factor, lagging.

7. ENVIRONMENT

The switch should comply with the requirements of ISO Recommendation R . . .,** *Environmental and operational conditions of aircraft equipment,* including vibration, acceleration, crash-landing, climatic and, for Class 2 switches, explosion-proofness. They should not support mould growth and Class 1 switches should not deteriorate even after storage for long periods in the tropics.

8. TESTS

8.1 Except where specific details are listed below, tests should be in accordance with the practice and requirements of relevant national specifications for aircraft switches.

Evidence should be available to the purchaser that switches identical to those supplied as covered by this ISO Recommendation have satisfactorily passed type tests conducted in accordance with section 9. In order that a consistent standard of quality be maintained, the manufacturer should conduct production routine tests and production quality tests, the minimum requirements for which are indicated in sections 10 and 11.

8.2 All tests referring to a.c. voltages relate to 200 V (line to line) for multi-pole switches, and to 115 V (phase) for single-pole switches.

All electrical tests should be performed with the switch connected on each side with cable of a cross-section compatible with the required current. Except for the test in clause 9.9 each cable should be attached to the switch using a crimped termination of approved design and at least 915 mm in length.

8.3 Unless otherwise stated, the tests should be made at a temperature of 15 to 30 °C, pressure of 700 to 800 mmHg, and at a relative humidity not exceeding 90 %.

8.4 A cycle of operation should consist of movement of the lever from one extreme position to the other and return to the original position. Levers of switches of the spring-return type should be allowed to return to the biased position without hindrance or assistance from the operating device. The times spent in each position should be approximately equal.

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* At present Draft ISO Recommendation.

** To be prepared.

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9. TYPE TESTS

Type tests should be made on switches which have previously passed the production tests. For the purposes of this ISO Recommendation, switches of single-pole, double-pole, three-pole and four-pole construction are considered as basic types of switch. Each basic type of switch should be subjected to type tests in accordance with a schedule to be agreed with the relevant Approving Authority. It is not intended that variants of a basic type of switch should be subjected to all of the tests : the extent of the type tests on such switches should be agreed between the manufacturer and the Approving Authority. Specified type tests may be required by the Approving Authority to be repeated after the introduction of a major modification.

9.1 Mechanical strength tests

9.1.1 *Strength of terminals.* All terminals should be subjected for not less than 1 minute to

(*a*) a pull of 45 N in each of the following directions :

- parallel to the long axis of the terminal screw;
- at right angles to the long axis of the terminal screw;

(*b*) a torque of 1.8 N·m applied to the terminal screw.

9.1.2 *Strength of lever.* A force of 90 N should be applied for not less than 1 minute to the lever under each of the following conditions, during which the switch should be connected electrically to check contact operation :

(*a*) perpendicular to the lever axis and parallel to the line of lever travel at each end position of the lever;

(*b*) perpendicular to the plane of travel in both directions throughout the entire range of lever travel;

(*c*) coaxial with the lever axis toward and away from the switch body throughout the entire range of lever travel;

(*d*) for locked lever switches, perpendicular to the lever axis in the plane of travel and in the direction to cause operation. The lever should remain in the locked position.

For the tests in (*a*), (*b*) and (*c*) the load should be applied at 3 mm from the tip of the lever.

9.1.3 *Strength of panel mounting bush.* A tightening torque of 3.6 N·m should be applied for not less than 1 minute to the mounting nut with the switch mounted in a panel and located by means of the locating washer and keyway.

9.1.4 The switch should not be damaged or distorted as a result of the tests defined in clauses 9.1.1 to 9.1.3, immediately following which it should

(*a*) satisfy the requirements of the insulation resistance test (see clause 9.5);

(*b*) perform satisfactorily 10 cycles of operation at 28 V d.c.;

(*c*) satisfy the requirements of the lever bush sealing test (see clause 9.13).

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9.2 Operating force test

The force necessary for the operation of the switch to all operating positions should be determined. The force should be applied at 3 mm from the tip of the lever and at right angles to the lever axis. The test should be repeated three times in each lever direction. The forces to operate and, if appropriate, to unlock the lever should be within the declared limits.

9.3 Mechanical endurance tests

Two switches should each be subjected to 100 000 cycles of no-load operation as follows, at a rate between 20 and 30 cycles per minute for two-position switches and between 10 and 15 cycles per minute for three-position switches :

Class 1

(*a*) 80 000 cycles at + 20 ± 5 °C

(*b*) 10 000 cycles at + 70 ± 2 °C

(*c*) 10 000 cycles at − 40 ± 2 °C

Class 2

(*a*) 80 000 cycles at + 20 ± 5 °C

(*b*) 10 000 cycles at + 55 ± 2 °C

(*c*) 10 000 cycles at − 20 ± 2 °C

NOTE. – For spring-return switches return from the momentarily actuated position is to be accomplished solely by the internal mechanism of the switch without hindrance or assistance by the operating device. When testing other types of switch the operating device is not to impart a load to the switch lever in any fixed position of the lever.

Following these tests, the switches should satisfy the requirements of the voltage drop and insulation resistance tests described in clauses 9.4 and 9.5 and there should be no mechanical breakage, malfunction, or deterioration of the lever seal, when tested in accordance with clauses 9.1, 9.2 and 9.13.

9.4 Voltage drop test

With 15 A d.c. flowing through the contacts, the voltage drop across the switch terminals should be measured and should not exceed 100 mV. With the exception of spring-return switches, no force should be applied to the lever during this test.

9.5 High voltage and insulation tests

The switch, mounted on a metal plate, should be subjected to the tests defined in clauses 9.5.1 and 9.5.2.

9.5.1 *High voltage test.* A test voltage of 1500 V r.m.s. 50 Hz should be applied for not less than 5 seconds between

(*a*) each terminal and all others not connected to it, with the lever in each position;

(*b*) all terminals connected together and the metal mounting plate and any exposed metallic parts with the lever in each position.

The voltage should be increased and decreased gradually.

9.5.2 *Insulation resistance test.* Immediately following the tests defined in clause 9.5.1 the insulation resistance should be measured at a potential of 500 V d.c. between the points specified in clause 9.5.1 (*a*) and (*b*) and should not be less than 100 MΩ.

9.6 Temperature rise test

9.6.1 The switch, suspended in still air, should carry 15 A d.c. until steady conditions are reached. The temperature or temperature rise of any external part of the switch should not exceed the figures stated in clauses 9.6.2 and 9.6.3 below. The temperature rise in the attached cable (measured with a suitable thermocouple at the surface of the conductor beneath the insulation at the point 25 mm from the end of the insulation) should not exceed 55 °C. For multi-pole switches the temperature should be measured with all normally closed poles carrying rated current.

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9.6.2 The temperature of any component part of the switch which may normally be accessible to, or inadvertently touched by, occupants of the aircraft under operating conditions should not exceed 100 °C at maximum ambient temperature.

9.6.3 The temperature rise of any part which is necessarily handled and which is made from, or covered with, material which is a poor thermal conductor, should not exceed 20 °C. If such a part is made from metal the temperature rise should not exceed 10 °C.

9.7 Electrical endurance tests*

9.7.1 Twelve switches should each be subjected to at least 50 000 cycles of operation as follows, at a rate between 10 and 12 cycles per minute for two-position switches and between 5 and 6 cycles per minute for three-position switches, voltage drop at rated current being checked every thousand cycles and not to exceed 150 mV between terminals.

Class 1

(*a*) 25 000 cycles at sea level;

(*b*) 24 000 cycles at a pressure corresponding to an altitude of 11 000 m;

(*c*) 1000 cycles at a pressure corresponding to an altitude of 21 400 m.

Class 2

(*a*) 25 000 cycles at sea level;

(*b*) 24 990 cycles at a pressure corresponding to an altitude of 6100 m;

(*c*) 10 operations at a pressure corresponding to an altitude of 18 300 m.

During the tests the sample switches should carry loads as follows :

Number of samples	Load (100 %)
2	d.c. resistive
2	a.c. resistive
2	d.c. inductive
2	a.c. inductive
2	d.c. lamp
2	a.c. lamp

9.7.2 Two switches should each be subjected to 50 000 cycles of operation as follows at the rate specified in clause 9.7.1, carrying a 100 mA resistive load at 2 to 4 V d.c. The voltage drop measured between terminals at this current should be checked every thousand cycles, and should not exceed 2 mV per set of contacts, or 4 mV per two sets of contacts in series :

(*a*) 25 000 cycles at sea level;

(*b*) 25 000 cycles at a pressure corresponding to an altitude of 6100 m.

9.7.3 Following the tests defined in clauses 9.7.1 and 9.7.2, the switches should be subjected to the insulation resistance test defined in clause 9.5. There should be no mechanical breakage or damage to the switch mechanism.

* See Note in clause 9.3.

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9.8 Overload test

9.8.1 The switch should be subjected to 50 cycles of operation at the appropriate rate specified in clause 9.7.1, controlling 200 % resistive current at 28 V d.c.

9.8.2 The switch should be subjected to 50 cycles of operation at the appropriate rate specified in clause 9.7.1, controlling 200 % resistive current at 115/200 V a.c.

9.9 Short-circuit test

9.9.1 Switches should be subjected to the following short-circuit tests in a circuit equivalent to that shown in the Figure, page 15. The circuit should be adjusted to provide a current of sixty times the rated resistive current at 28 V d.c. with the selector switch in the calibrate position. For three-position switches, a separate switch may be used for testing each operating position.

9.9.2 *Closed circuit test.* The switch under test should be inserted in the test circuit with its contacts closed, the selector switch set to test, and the circuit-breaker closed. The control switch should then be closed to initiate the fault current and held closed until the circuit-breaker clears the fault. The fault current should be applied five times with a minimum interval of 2 minutes between each test.

9.9.3 *Making circuit.* The switch under test should be inserted in the circuit with its contacts open, the selector switch set to test, and the circuit-breaker closed. The switch under test should then be closed to initiate the fault current and held closed until the circuit-breaker clears the fault. The switch should then be opened on no-load.

For the tests defined in clauses 9.9.2 and 9.9.3, the contacts should not weld or stick and there should be no mechanical damage to the switch. After the tests the voltage drop across the contacts should be measured in accordance with clause 9.4 and should not exceed 150 mV.

9.10 Vibration test

9.10.1 The switch should be subjected to the appropriate vibration tests described in ISO Recommendation R . . .,* *Environmental and operational conditions of aircraft equipment.*

9.10.2 The resonance tests should be conducted with the switch contacts in each of the two or three positions, as appropriate, with 28 V d.c. applied across normally open contacts and with 15 A d.c. passing through closed contacts. The open contacts should not close during the tests, and the voltage drop across closed contacts should not exceed 150 mV, oscillographic methods being used to check compliance with this requirement.

9.10.3 For equal times during the endurance test (fatigue test) cycles the switch should remain in each of its self-retaining positions. Throughout the test 15 A d.c. should be passed through any closed contact.

9.10.4 At the conclusion of the tests the switch should satisfy the requirements of the high voltage and insulation resistance tests described in clause 9.5.

9.11 Acceleration test

9.11.1 The switch should be subjected to the appropriate acceleration tests described in ISO Recommendation R . . .,* *Environmental and operational conditions of aircraft equipment*, with the switch contacts in each of the two or three positions, as appropriate. A check should be made to verify that there is no inadvertent opening or closing of the contacts during the tests, as indicated by a test lamp or other suitable device. Throughout the test 28 V d.c. should be applied across normally open contacts, and 15 A d.c. should be passed through closed contacts.

The test should be repeated with the switch in each self-retaining position.

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* To be prepared.

9.11.2 The switch should be subjected to the appropriate crash tests described in ISO Recommendation R . . .,* *Environmental and operational conditions of aircraft equipment,* in each of the two or three self-retaining positions.

9.11.3 At the conclusion of the tests the switch should satisfy the requirements of the insulation resistance test described in clause 9.5.

9.12 Climatic test

Each class of switch should be subjected to the appropriate climatic tests specified in ISO Recommendation R . . .*, *Environmental and operational conditions of aircraft equipment.*

Three sample switches should be tested respectively at 4 V d.c., 28 V d.c. and 115/200 V a.c., with contacts closed during the functioning periods, and the circuits should be arranged so that when closed the first sample carries a 100 mA load, and the second and third samples 15 A loads. Except during the functioning tests, the appropriate test potential should be left connected to the normally open contacts.

The functioning tests to be performed should be as follows :

Ten cycles of operation of the switch should be performed over a period of 1 minute. Immediately following this, the voltage drop measured in accordance with clause 9.4 should not exceed 150 mV.

For the purposes of these tests the declared altitude should be 21 400 m for Class 1 switches, and 6100 m for Class 2.

At the conclusion of the test cycles the insulation resistance should be not less than 20 MΩ and after 24 hours at room temperature it should be not less than 100 MΩ.

9.13 Lever bush sealing test

9.13.1 The switch should be mounted on a horizontal panel with the threaded bush uppermost and should have water at a temperature not less than 90 °C poured upon it from a height of 150 to 300 mm above the switch mounting face so that the water may enter the switch lever cavity. The switch should be operated ten times while wet and carrying 15 A d.c. This cycle of operations should be repeated five times with a 10 minute interval after each cycle.

9.13.2 At the conclusion of the test cycles and after removal of moisture by wiping, the voltage drop measured in accordance with clause 9.4 should not exceed 150 mV and the insulation resistance should be not less than 20 MΩ between terminals and switch ferrule.

9.13.3 Between 2 and 4 hours after the conclusion of the tests the switch should be stripped and examined in accordance with clause 9.17. There should be no deterioration of the lever seal, and no signs of moisture inside the switch.

9.14 Switch sealing test**

Class 1 switches should be subjected to the leakage test described in ISO Recommendation R . . .,* *Environmental and operational conditions of aircraft equipment,* with the lever in each self-retaining position.

At the conclusion of the test and after removal of moisture by wiping, the voltage drop, measured in accordance with clause 9.4, should not exceed 150 mV and the insulation resistance should be not less than 20 MΩ between terminals and switch ferrule.

9.15 Resistance to aircraft fluids

Tests should be made to ensure that the materials used in the switches are resistant to the various aircraft fluids, in accordance with the relevant national specification.

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* To be prepared.

** This is a test of the seal in one direction only; test of the seal in both directions may be required for some switches.