INTERNATIONAL STANDARD 1466

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

Lever-operated manual switches for aircraft — Performance requirements

First edition — 1973-09-15

UDC 629.7.064.5 : 621-316.542.1 : 620.1

Ref. No. ISO 1466-1973 (E)

Descriptors : aircraft, aircraft equipment, switches, design, dimensions, ratings, tests.

Price based on 8 pages

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.

Prior to 1972, the results of the work of the Technical Committees were published as ISO Recommendations; these documents are now in the process of being transformed into International Standards. As part of this process, International Standard ISO 1466 replaces ISO Recommendation R 1466-1970 drawn up by Technical Committee ISO/TC 20, *Aircraft and space vehicles*.

The Member Bodies of the following countries approved the Recommendation :

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

No Member Body expressed disapproval of the Recommendation.

Printed in Switzerland

Lever-operated manual switches for aircraft — Performance requirements

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies 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 REFERENCES

ISO/R 224, *Standard form of declaration of performance of aircraft electrical equipment.*

ISO/R 493, *Dimensions for single-hole mounting, lever-operated switches for aircraft.*

ISO 1540, *Aircraft electrical power systems — Characteristics.* [1)]

ISO . . . , *Aircraft equipment — Environmental and operational conditions.* [2)]

3 DESIGN REQUIREMENTS

3.1 The switch shall 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 6 100 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.

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

3.3 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.

3.4 The method of operation of the switch shall 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 shall be stated in the individual specification.

3.5 The switch terminals shall be identified by number in the sequence shown in the individual specification.

4 DIMENSIONS

The envelope and fixing dimensions for the switch shall comply with ISO/R 493.

5 OPERATION

5.1 The switch lever action shall be positive and it shall 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 shall not be affected adversely by the speed of the movement of the lever.

5.2 It shall not be possible to rotate the lever about its longitudinal axis.

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

1) At present at the stage of draft.

2) In preparation.

5.4 There shall be at least a 10° movement of the lever before switching occurs.

5.5 The lever shall be capable of withstanding without damage or distortion a force of 90 N applied steadily in the directions stated in 10.1.2.

6 CONSTRUCTION

6.1 The lever, including any metal inserts, shall be insulated from all live parts.

6.2 The manufacturer shall 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 shall 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 shall not exceed the minimum force by more than 100 %.

6.3 Where locking of the lever is provided it shall be positive and automatic, and the lock shall be released by raising the lever against a spring force of 4,5 to 22,5 N.

6.4 The exposed portion of the switch shall have a non-glaring finish.

6.5 The switch shall 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 shall, in addition, be sealed to the standard required by the test in 10.14.

6.6 Terminations shall be by screws, each capable of accepting two crimped tag-type terminations of approved design. The terminal threads shall be M4 X 0,7 or No. 6 UNC. Terminals shall have a mechanical strength adequate to satisfy the requirements of 10.1.1.

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

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

6.8 The switch shall 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/R 493. Two hexagon mounting nuts, one locating washer and one internal shakeproof washer shall be provided with each switch.

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

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

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

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

7 VOLTAGE AND CURRENT RATINGS

7.1 Voltage

The switch shall 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 1540. In addition, the switch shall be suitable for use at voltages down to 4 V d.c. or a.c.

7.2 Current

The switch shall perform at least 50 000 operations and shall 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

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

The inductance loads shall 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.

8 ENVIRONMENT

The switch shall comply with the requirements of ISO . . . , including vibration, acceleration, crash-landing, climatic and, for Class 2 switches, explosion-proofness. They shall not support mould growth and Class 1 switches shall not deteriorate even after storage for long periods in the tropics.

9 TESTS

9.1 Except where specific details are listed below, tests shall be in accordance with the practice and requirements of relevant national specifications for aircraft switches. Evidence shall be available to the purchaser that switches identical to those supplied as covered by this International Standard have satisfactorily passed type tests conducted in accordance with clause 10. In order that a consistent standard of quality be maintained, the manufacturer shall conduct production routine tests and production quality tests, the minimum requirements for which are indicated in clauses 11 and 12.

9.2 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 shall 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 10.9 each cable shall be attached to the switch using a crimped termination of approved design and at least 915 mm in length.

9.3 Unless otherwise stated, the test shall be made at a temperature between 15 and 30 °C, pressure of 93 to 106 kPa (933 to 1 060 mbar), and at a relative humidity not exceeding 90 %.

9.4 A cycle of operation shall 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 shall be allowed to return to the biased position without hindrance or assistance from the operating device. The times spent in each position shall be approximately equal.

10 TYPE TESTS

Type tests shall be made on switches which have previously passed the production tests. For the purposes of this International Standard, switches of single-pole, double-pole, three-pole and four-pole construction are considered as basic types of switch. Each basic type of switch shall 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 shall be subjected to all of the tests : the extent of the type tests on such switches shall 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.

10.1 Mechanical strength tests

10.1.1 *Strength of terminations*

All terminations shall be subjected for not less than 1 min 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.

10.1.2 *Strength of lever*

A force of 90 N shall be applied for not less than 1 min to the lever under each of the following conditions, during which the switch shall 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 shall remain in the locked position.

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

10.1.3 *Strength of panel mounting bush*

A tightening torque of 3,6 N·m shall be applied for not less than 1 min to the mounting nut with the switch mounted in a panel and located by means of the locating washer and key-way.

10.1.4 The switch shall not be damaged or distorted as a result of the tests defined in 10.1.1 to 10.1.3, immediately following which it shall

a) satisfy the requirements of the insulation resistance test (see 10.5);

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

c) satisfy the requirements of the lever bush sealing test (see 10.13).

10.2 Operating forces test

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

10.3 Mechanical endurance tests

Two switches shall 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 shall satisfy the requirements of the voltage drop and insulation resistance tests described in 10.4 and 10.5 and there shall be no mechanical breakage, malfunction, or deterioration of the lever seal, when tested in accordance with 10.1, 10.2 and 10.13.

10.4 Voltage drop test

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

10.5 High voltage and insulation tests

The switch, mounted on a metal plate, shall be subjected to the tests defined in 10.5.1 and 10.5.2.

10.5.1 *High voltage test*

A test voltage of 1 500 V r.m.s. 50 Hz shall be applied for not less than 5 s 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.

10.5.2 *Insulation resistance test*

Immediately following the tests defined in 10.5.1 the insulation resistance shall be measured at a potential of 500 V d.c. between the points specified in 10.5.1 a) and b) and shall not be less than 100 MΩ.

10.6 Temperature rise test

10.6.1 The switch, suspended in still air, shall carry 15 A d.c. until steady conditions are reached. The temperature or temperature rise of any external part of the switch shall not exceed the figures stated in 10.6.2 and 10.6.3 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) shall not exceed 55 °C. For multi-pole switches the temperature shall be measured with all normally closed poles carrying rated current.

10.6.2 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 shall not exceed 100 °C at maximum ambient temperature.

10.6.3 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, shall not exceed 20 °C. If such a part is made from metal the temperature rise shall not exceed 10 °C.

10.7 Electrical endurance tests[1)]

10.7.1 Twelve switches shall 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) 1 000 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 6 100 m;

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

1) See Note in 10.3.

During the tests the sample switches shall 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

10.7.2 Two switches shall each be subjected to 50 000 cycles of operation as follows at the rate specified in 10.7.1, carrying a 100 mA resistive load at 2 to 4 V d.c. The voltage drop measured between terminals at this current shall be checked every thousand cycles, and shall 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 6 100 m.

10.7.3 Following the tests defined in 10.7.1 and 10.7.2, the switches shall be subjected to the insulation resistance test defined in 10.5. There shall be no mechanical breakage or damage to the switch mechanism.

10.8 Overload test

10.8.1 The switch shall be subjected to 50 cycles of operation at the appropriate rate specified in 10.7.1, controlling 200 % resistive current at 28 V d.c.

10.8.2 The switch shall be subjected to 50 cycles of operation at the appropriate rate specified in 10.7.1, controlling 200 % resistive current at 115/200 V a.c.

10.9 Short-circuit test

10.9.1 Switches shall be subjected to the following short-circuit tests in a circuit equivalent to that shown in the figure. The circuit shall 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.

10.9.2 *Closed circuit test*

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

10.9.3 *Making circuit*

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

For the tests defined in 10.9.2 and 10.9.3, the contacts shall not weld or stick and there shall be no mechanical damage to the switch. After the tests the voltage drop across the contacts shall be measured in accordance with 10.4 and shall not exceed 150 mV.

10.10 Vibration test

10.10.1 The switch shall be subjected to the appropriate vibration tests described in ISO . . . .

10.10.2 The resonance tests shall 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 shall not close during the tests, and the voltage drop across closed contacts shall not exceed 150 mV, oscillographic methods being used to check compliance with this requirement.

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

10.10.4 At the conclusion of the tests the switch shall satisfy the requirements of the high voltage and insulation resistance tests described in 10.5.

10.11 Acceleration test

10.11.1 The switch shall be subjected to the appropriate acceleration tests described in ISO . . . , with the switch contacts in each of the two or three positions, as appropriate. A check shall 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. shall be applied across normally open contacts, and 15 A d.c. shall be passed through closed contacts.

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

10.11.2 The switch shall be subjected to the appropriate crash tests described in ISO . . . , in each of the two or three self-retaining positions.

10.11.3 At the conclusion of the tests the switch shall satisfy the requirements of the insulation resistance test described in 10.5.

10.12 Climatic test

Each class of switch shall be subjected to the appropriate climatic tests specified in ISO . . . .

Three sample switches shall be tested repectively 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 shall 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 shall be left connected to the normally open contacts.

The functioning tests to be performed shall be as follows :

Ten cycles of operation of the switch shall be performed over a period of 1 min. Immediately following this, the voltage drop measured in accordance with clause 10.4 shall not exceed 150 mV.

For the purposes of these tests the declared altitude shall be 21 400 m for Class 1 switches, and 6 100 m for Class 2.

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

10.13 Lever bush sealing test

10.13.1 The switch shall be mounted on a horizontal panel with the threaded bush uppermost and shall 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 shall be operated ten times while wet and carrying 15 A d.c. This cycle of operations shall be repeated five times with a 10 min interval after each cycle.

10.13.2 At the conclusion of the test cycles and after removal of moisture by wiping, the voltage drop measured in accordance with 10.4 shall not exceed 150 mV and the insulation resistance shall be not less than 20 MΩ between terminals and switch ferrule.

10.13.3 Between 2 and 4 h after the conclusion of the tests the switch shall be stripped and examined in accordance with 10.17. There shall be no deterioration of the lever seal, and no signs of moisture inside the switch.

10.14 Switch sealing test[1)]

Class 1 switches shall be subjected to the leakage test described in ISO . . . , 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 10.4, shall not exceed 150 mV and the insulation resistance shall be not less than 20 MΩ between terminals and switch ferrule.

10.15 Resistance to aircraft fluids

Tests shall 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.

10.16 Explosion-proofness

Class 2 switches shall be subjected to the test for explosion-proofness described in ISO . . . .

10.17 Strip examination and report

Upon completion of the type tests each sample switch shall be opened and examined for any signs of excessive wear. A report of the condition of each switch shall be submitted to the Inspecting Authority.

11 PRODUCTION TESTS

11.1 Markings and operation

Each switch shall satisfy the requirements of 5.1 to 5.4 and clause 14.

11.2 Operating force test

Each switch shall satisfy the requirements of the test described in 10.2.

11.3 Voltage drop test

Each switch shall satisfy the requirements of the test described in 10.4.

11.4 High voltage and insulation tests

Each switch shall satisfy the requirements of the tests described in 10.5.

12 QUALITY TESTS

12.1 Selection of samples

Sixteen switches, or 1 % of the batch, whichever is the greater, shall be taken at random from each batch of each basic type of switch manufactured in compliance with this International Standard. The system for batching production shall be agreed between the manufacturer and the purchaser or Inspecting Authority, as appropriate, and declared. The samples shall be taken from switches which have previously been subjected to the production tests specified in Clause 11, and which have passed these tests.

If any sample fails to fulfil the requirements of the tests, the batch shall be segregated and the cause of failure investigated. At the discretion of the Inspecting Authority, further samples may be taken from the batch and tested. If these fail to pass the tests, the batch shall be deemed not to comply with this International Standard.

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

12.2 Electrical endurance test

Each sample switch shall be subjected to electrical endurance tests as described in 10.7.1, carrying a 15 A resistive load at 28 V d.c.

12.3 Vibration test

Each sample switch shall be subjected to resonance tests in accordance with 10.10 followed by 10 h tests at each of any resonant frequencies detected during type tests.

12.4 Lever bush sealing test

Each sample switch shall satisfy the requirements of the test described in 10.13.

12.5 Sealing test

Class 1 switches shall satisfy the requirements of the test described in 10.14.

12.6 Strip examination and report

Each sample switch shall be examined in accordance with 10.17.

13 DECLARATIONS

The declarations made by the manufacturer in accordance with ISO/R 224, shall include

a) classification;

b) the limits of the forces necessary to operate the switch to any position;

c) switch operation relative to lever position and terminal numbering;

d) the system of batching used for quality test sampling.

14 MARKING

In addition to the terminal numbering, the following minimum information shall be clearly and indelibly marked on each switch :

a) national standard number, and classification;

b) manufacturer's name or identification;

c) manufacturer's type number;

d) "15 A res" (res = resistive);

e) "28 V ⎓/200 V ~".