International Standard 268

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Aircraft — Mechanical and electromechanical indicators — General requirements

Aéronefs — Instruments de bord mécaniques et électromécaniques — Caractéristiques générales

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Foreword

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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 268 was developed by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, and was circulated to the member bodies in January 1978.

It has been approved by the member bodies of the following countries :

Australia	Germany, F. R.	Spain
Austria	India	Sweden
Belgium	Italy	Turkey
Brazil	Japan	United Kingdom
Canada	Mexico	USA
Chile	Poland	USSR
Czechoslovakia	Romania	Yugoslavia
France	South Africa, Rep. of	

The member body of the following country expressed disapproval of the document on technical grounds :

Netherlands

This International Standard cancels and replaces ISO Recommendation R 268-1962, of which it constitutes a technical revision.

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Aircraft — Mechanical and electromechanical indicators — General requirements

1 Scope and field of application

This International Standard states the requirements which are generally applicable to mechanical and electromechanical indicators for use in aircraft. It is to be read in conjunction with specifications for individual indicators.

For the purpose of this International Standard, an indicator is regarded as a unit primarily concerned with the visual display of information.

2 References

ISO 2655, *Environmental tests for aircraft equipment — Part 2.5 : Waterproofness.*

IEC Publication 68-2-17, *Basic environmental testing procedures — Part 2.1 : Test Q : Sealing.*

3 Cases for indicators

3.1 The size and type of the finished indicator case shall be declared by the manufacturer in sufficient detail to facilitate subsequent installation.

3.2 Any limitation in the use of a mounting for which the indicator has been declared shall be stated by the manufacturer. During vibration and acceleration testing the declared mounting shall be used.

3.3 An indicator case with electrical connections shall be earthed through a connector terminal pin or bonding point. Unless otherwise required by the individual specification, no internal electrical circuit, excluding low voltage internal lighting circuits, shall be returned via this case/earth bonding connection. The current-carrying capacity of the case earthing wire shall be greater than the current-carrying capacity of the associated airframe wiring.

3.4 The design and construction of the indicator case shall be such that the indicator's specified performance is unaffected when the indicator, installed in accordance with the relevant declarations, is subjected to the test for drip-proof equipment in accordance with ISO 2655, and to tests for resistance to other fluids, as required by the individual specification.

3.5 The legibility of the indicator shall not be significantly affected by any misting inside the glass under the conditions of use for which it is declared.

3.6 A hermetically-sealed indicator shall withstand the sealing test specified in IEC Publication 68-2-17.

3.7 If a pressure-measuring indicator is vented to the surrounding atmosphere, the vent shall not affect the performance of the indicator. It shall be suitably screened to prevent the ingress of dust and sand. Preferably, the vent should be protected against inadvertent closure and located at approximately the lowest point connecting with the interior when the indicator is in the normal position.

3.8 An indicator required by the individual specification to have an airtight or pressure-resisting case shall be capable of withstanding, without damage or leakage greater than that permitted by the individual specification, external pressures from 100 kPa[1] (1 000 mbar) above that of the interior to 20 kPa (200 mbar) below that of the interior, and there shall be no interference between the pointer and the cover glass during and after the application of pressure.

3.9 The sealing of the indicator shall not preclude easy access to its interior for servicing purposes.

1) 1 kPa = 1 kN/m^2

4 Connections

4.1 Pressure connections

4.1.1 If the indicator has more than one pressure connector, the design of the connectors shall be such as to make incorrect fitting impossible.

4.1.2 Pitot (total pressure) and static pressure connections shall be indelibly identified.

4.2 Electrical connections

4.2.1 It shall be impossible for a multi-pin electrical connector used by an indicator to be mated incorrectly with the complimentary cable-mounted connector.

4.2.2 If an indicator has more than one multi-pin electrical connector, the design of the connectors shall be such as to make incorrect connections impossible.

5 Mounting attitude

5.1 Preferably, the indicator should be suitable for mounting in any attitude; the specified accuracy requirements being maintained in any attitude. Any limitations of mounting attitudes shall be declared by the manufacturer.

5.2 The individual specification shall state the normal mounting attitude at which the indicator is to be calibrated.

6 Indicator movements

6.1 Indicator movements shall be securely fixed to the body of the indicator in such a manner that any distortion by connection or mounting of the latter does not affect the accuracy of indication.

6.2 The design of an indicator and the form of its input information shall ensure that each value of the input parameter results in a unique indicator reading (for example, two-speed synchros have been made to avoid ambiguity in the display and transmission of altitude information).

6.3 Stops shall be fitted to indicator movements where otherwise the display would be able to move beyond the end of the scale to positions that result in erroneous readings. These stops shall be operative above or below the maximum and minimum scale graduations respectively, but shall be such that the direction from which the display is deflected is still apparent.

6.4 The design of indicator movements shall be based on the following general principles :

6.4.1 Indicators shall accurately and smoothly follow changes of input and emergency conditions.

6.4.2 The sensitivity and accuracy of displayed information shall be compatible with the needs of flightcrews.

6.4.3 Measures shall be taken to suppress pointer oscillations and display fluctuations which may result from environmental conditions or noisy input information.

6.4.4 Indicator movements shall neither be damaged nor deranged by sudden or extreme changes of input information that are experienced at switch-on or during ground tests.

7 Presentation

7.1 General

7.1.1 The indicator shall present the required information concisely and with a degree of precision compatible with the indication required and with the sensitivity of the movement. The data presented shall be prime, that is, no further operation upon it shall be necessary apart from simple factoring. The units in which information is presented shall comply with the requirements of the individual specification.

7.1.2 The design and purpose of the display shall be clear and unambiguous and such that it cannot resonably be confused with other types of display likely to be used with it. In particular, for scales in excess of 360° with a single pointer, suitable means shall be provided to prevent ambiguity. Single channel, concentric, multi-pointer displays (for example, 3-pointer altimeters) should be avoided.

7.1.3 Indicators shall be designed so that parallax effects and tunnel (marking) effects do not interfere with reading of the indicator, to the degree of precision appropriate to the function(s) being displayed, when viewed from angles up to 40° to a perpendicular axis through the centre of the display face.

7.1.4 Manufacturers name, symbol or part number or other information not essential to the function(s) being displayed shall be unobstrusive if marked on dialfaces or instrument bezels.

7.1.5 If a display has both a pointer and counter presentation, care shall be taken to reduce masking of the counters by the pointer to a minimum.

7.1.6 If the indicator is luminous, the treated area shall be kept to a minimum compatible with ease of reading. (See 10.2.2.)

7.2 Scales and counters

7.2.1 Figures and graduations shall be restricted to the minimum number compatible with the accuracy of reading required. Markings shall be white on a black background unless markings or areas of other colours are required, in which case the colour specification shall be agreed with the individual manufacturer. All coatings used shall have a mat finish.

7.2.2 For circular scale displays, the values shall increase in a clockwise direction. For strip (straight scale) displays, the values shall increase from bottom to top or from left to right.

7.2.3 Where necessary to achieve the required reading accuracy over a certain part of the scale, non-linear scales may be employed provided that linear visual interpolation does not reduce the reading accuracy below the required system accuracy. Unless otherwise declared by the manufacturer, indicators with non-linear or individually-calibrated scales and having the same part number shall be designed so that the scale numbers and divisions of the working range are in geometrically similar positions. Over those parts of the scale which are operationally important, graduations shall represent equal increments of the indicated quantity and visual interpolation shall be possible. The tolerances governing these general requirements shall be as given in the individual specification.

7.2.4 Sufficient scale numerals shall be marked on the dial to avoid or reduce the misreading by a complete scale division. These numerals, located against major scale markings, shall increase in single units, in twos, in fives or in decimal equivalents, except where for operational reasons (for example, the take-off range of airspeed indicators) it is necessary to have a higher discrimination and the individual specification requires alternative increments.

7.2.5 The preferred smallest scale interval which is marked but has no numeral against it shall represent one, or two or five units, or any decimal factor of such units.

7.2.6 If a rotating drum digital display is incorporated in the presentation, the higher digit shall appear above the lower digit, that is the digits shall move downwards for increasing values. Counter indicators shall be provided with a means of ensuring that a complete number is always visible and of identifying the direction of increase or decrease of the value indicated, either by the provision of an aperture large enough for adjacent numeral(s) to be seen or by other means.

7.3 Pointers and settable indices

7.3.1 The shape and size of pointers shall be such as to enable the indication to be readily appreciated to meet required operational conditions. Where speed of reading is essential, it is preferable that the tip of the pointer should be finished square and be the same width as major scale marks. Where accuracy of reading is essential, the end shall be pointed, the included angle at the tip being not greater than 45°.

7.3.2 The pointer tip shall extend to, but not obscure, the shortest scale divisions, and the pointer shall be, as far as practicable, in the same plane as the scale in order to minimize parallax effects.

7.3.3 The colour of the main pointer shall be white unless other colours are required by the individual specification.

7.3.4 If settable indices or limit pointers are incorporated, they shall be of conspicuous colour pattern so that they are easily recognizable and cannot be confused with the main indication. It shall not be possible, under any conditions, for the index or limit pointer to foul the main pointer(s) or any part of the main display(s).

7.3.5 The design of main pointer, settable indices and limit pointers shall be such that pointer coincidence is clearly defined.

7.3.6 Except where otherwise permitted by the individual specification, the direction of movement of the controls operating indices or pointers shall be clockwise or forward for increasing values of the controlled parameter.

7.4 Failure warning indication

7.4.1 Where possible, a failure indication shall be provided on the face of the indicator whenever the information displayed is incorrect or unreliable. The failure indication shall be a distinctive warning flag which, where practicable, shall obscure the failed information, or a light, or a combination of both. Indications of an oscillating or flickering nature shall not be used.

7.4.2 The design and presentation of the indication shall be based on the following general principles :

7.4.2.1 The indication shall be easily recognizable by virtue of size, shape and colour.

7.4.2.2 The indication shall not be visible when the relevant part of the instrument is functioning correctly.

7.4.2.3 The indication shall be readily detectable under all operational lighting conditions.

7.4.2.4 If a display is capable of multiple roles simultaneously, separate and easily distinguishable warnings for each role shall be fitted.

7.4.2.5 The indication shall appear in the area of the display where the incorrect information is being displayed.

7.4.2.6 Faulty digital displays shall be sufficiently obscured so that they cannot be read.

7.4.2.7 The indication shall fail safe, that is, it shall be displayed automatically should the warning system itself fail.

7.4.2.8 It shall be impossible for an operator to be able to precancel a warning.

7.4.3 For some applications, an acceptable alternative to the use of a warning flag is the complete withdrawal from view of information known to be incorrect or unreliable. Such an arrangement shall fail safe, that is, the information shall disappear should the warning system itself fail.

7.5 Exceedance warning indication

7.5.1 When required by the individual specification, a warning indication shall be provided on the face of the indicator to attract the attention of flightcrew to a displayed parameter warning,

a) exceeded a critical value, which may correspond to the setting of a limit pointer, or

b) attained a value which is excessively different from that of a second independent display of the same parameter (comparison warning).

NOTE — Exceedance warnings are usually in the form of coloured lights and they are often associated with distinctive visual and aural warnings external to the indicator. The need for exceedance warnings and the form they shall take will be established by the applicable system requirements.

7.5.2 Full cancelling of a warning light shall only be possible if an alternative warning indication remains in view. It shall be impossible for an operator to pre-cancel a warning.

7.5.3 The indication shall be readily detectable under all operational lighting conditions.

7.5.4 The indication shall be fail safe, that is, it shall be displayed automatically should the warning system itself fail.

7.6 Controls

7.6.1 Controls for operational adjustments shall be positioned so that dial marks are not obscured during both adjustment and normal use of the indicator. They shall be designed to avoid inadvertent operation and movement under vibration.

7.6.2 The direction of movement of all controls shall be clockwise, forward or upward for increasing values of the controlled parameter.

7.6.3 If it is necessary for controls to be provided with indications of the sense of movement and the achieved degree of movement, the indications shall be visual (for example, engraved markings) and tactile (for example, mechanical detents) in a position as near as possible to the control.

7.6.4 If rotary switches are fitted to indicators for the selection of operational modes, the angular displacement of the knob for each mode shall be not less than 15° and not more than 90°.

8 Cover glasses and windows

8.1 Cover glasses and windows, when mounted, shall withstand a differential pressure of ± 100 kPa (± 1 000 mbar). The indication shall not be adversely affected by any static electrical charge on the glass. The readability of the indicator shall not be adversely affected by imperfections in the glass under any probable conditions of illumination. The glass shall be anti-reflection coated in accordance with the requirements of the individual specification.

8.2 If transparent plastics sheet is used in an indicator intended for use in ultra-violet lighting, the material shall not fluoresce to such an extent as to affect the indication adversely.

8.3 Toughened safety glass used in cases which have to withstand substantial pressure differences shall comply with the requirements of the individual specification.

8.4 An indicator fitted with a cover glass marked with coloured limit bands or similar markings shall embody design features which ensure a fixed relationship between the glass and indicator dial.

9 Integral lighting

9.1 The integral lighting of the indicator shall comply with the requirements of the individual specification.

9.2 Where practicable, the lamps shall be capable of being replaced without opening the case of the indicator. In-flight replacement of lamps is not required.

10 Luminescent markings

10.1 Brightness

Self-luminous marking shall possess a luminosity of not less than 0,017 cd/m^2 (0,005 foot-lamberts) when measured, not less than one week after application, with an electronic photometer having a spectral response closely matching that of the CIE[1] standard photopic observer.

10.2 Safety requirements

10.2.1 If luminous paints are used for dials, the only radionuclide permitted shall be tritium.

1) Commission internationale de l'éclairage (International Commission on Illumination).

10.2.2 Luminous paint sources and gaseous tritium light sources shall not be directly accessible to touch during normal conditions of use. If necessary, suitable warnings shall be given in the servicing manual.

10.2.3 The mass per unit area of the cover glass or window shall be not less than 50 mg/cm^2.

10.2.4 The total activity of tritiated paint in any instrument shall be not greater than 20 mCi[1)].

11 Self-test

11.1 Where possible, a built-in test capability shall be provided for checking the serviceability of installed servo-driven indicators and related failure warning and exceedance warning systems.

11.2 Test controls need not be mounted on indicators but shall be positioned so that function testing can be readily accomplished.

11.3 Where necessary, measures shall be taken to guard against the inadvertant use of test controls, or inhibit the use of self-test during flight, or protect associated equipment (for example, by the use of interlocks) from any undesirable effects that may result when installed indicators are function tested.

1) 1 mCi = 3,7 × 10^7 Bq = 3,7 × 10^7 s^{-1}

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