

Specification for

General requirements for mechanical and electromechanical aircraft indicators

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Committees responsible

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- Civil Aviation Authority (Airworthiness Division)
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- Ministry of Defence
- Society of British Aerospace Companies Limited

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Foreword

This revision of BS 2G 101:1975 has been prepared under the direction of the Aerospace Standards Committee to align the general requirements for aircraft indicators with ISO 268:1980 published by the International Organization for Standardization (ISO). The general requirements stipulated are for use in conjunction with G series British Standards for specific aircraft indicator types. As in the case of previous editions, the requirements of this standard will not be applied retrospectively.

Imperial units are used in this standard to maintain compatibility with existing aircraft practice; metric dimensions are given in parentheses.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 20, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This British Standard specifies 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 and the relevant requirements of BS 3G 100.

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

NOTE 1 The titles of the publications referred to in this standard are listed on the inside back cover.

NOTE 2 The latest revision of an aerospace standard is indicated by a prefix number.

2 Cases

2.1 The finished indicator cases shall be of the types given in Table 1, unless specified otherwise in the contract or order.

Table 1 — Types of indicator case

Type	Figure
Flangeless round	Figure 1 and Figure 2
Flangeless square and rectangular	Figure 3 and Figure 5
Flangeless square 2 in (50.8 mm)	Figure 4

2.2 The mounting details for the front area of the indicator case and mounting shall comply with Figure 1 to Figure 5 as appropriate (see Table 1).

NOTE 1 To allow physical interchangeability of panel indicators, a range of preferred mounting dimensions has been established.

NOTE 2 The individual specification for the indicator, referred to in this Part of BS 3G 101 as “the individual specification”, states all the dimensions for the case.

NOTE 3 Information on panel cutouts is given for each type.

NOTE 4 The two methods of mounting most commonly used are as follows.

a) Clamp mounting, with the indicator secured in the operating position by a clamp mounted on the rear face of the indicator panel. For this arrangement access to the rear of the panel is not required when the indicator is fixed, as the clamp arrangement is operated from the front of the panel. The clamp method of mounting is also used by circular and square indicators.

It is particularly important with this type of indicator to ensure that the surface around which the clamp fits is of uniform dimension and of adequate strength to retain rigidity of mounting.

b) Clamp mounting, with mooring plate and/or optional adaptor plate as shown in Figure 6, Figure 7 and Figure 8.

2.3 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.

2.4 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 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.

2.5 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 BS 3G 100-2, and to tests for resistance to other fluids, as required by the individual specification.

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

2.7 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 (1 000 mbar) above that of the interior to 20 kPa (200 mbar) below that of the interior, and there shall be no interference between the moving elements and the cover glass during and after the application of pressure.

NOTE Indicators should not present a hazard due to implosion or explosion.

2.8 Where an indicator is vented to the surrounding atmosphere, the vent shall not affect the performance of the indicator. It shall be screened to prevent the ingress of sand and dust. The vent shall be protected against inadvertent closure and located at approximately the lowest point connecting with the interior when the indicator is in the normal position.

2.9 Hermetically sealed instruments shall be used only where essential for performance lifting requirements.

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

3 Connections

3.1 Pressure connections

3.1.1 Where an indicator has more than one pressure connector, the connectors shall be of different sizes.

3.1.2 The tapped holes of the pitot and static connections shall be indelibly identified.

3.1.3 Where indicators are supplied without adaptors, the female recesses shall comply with the following requirements.

- a) Recesses for pitot connections shall be in accordance with Figure 9.
- b) Recesses for static connections shall be in accordance with Figure 10.
- c) Recesses for connections to pressure-measuring indicators other than pitotstatic instruments shall be in accordance with Figure 9.
- d) The connections shall be unobstructed to a depth as given in Figure 9 and Figure 10.
- e) The connections shall be securely attached to the case and shall be capable of withstanding a torque of 200 lbf·in (22.6 N·m) when mounted on the panel. For test purposes the case shall be mounted on a suitable plate. The plate shall be firmly clamped and the torque gradually applied to the connections.

NOTE The boss shown in Figure 9 and Figure 10 is to provide clearance when banjo fittings are used; it should be omitted or modified if so required by the individual specification.

3.2 Electrical connections

3.2.1 It shall be impossible for a multi-pin electrical connector used on an indicator to be mated incorrectly with the complementary cable-mounted connector.

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

4 Mounting attitude

4.1 The indicator shall be suitable for mounting in any attitude, and shall comply with the accuracy requirements in any attitude. Any limitations on mounting attitudes shall be declared by the manufacturer.

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

5 Indicator movements

5.1 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 indicator does not affect the accuracy of indication.

5.2 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.

5.3 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 the maximum and/or below the minimum scale graduations respectively, but shall be such that the direction from which the display is deflected is still apparent.

5.4 Indicators shall accurately and smoothly follow changes of input at rates of change up to maximum conditions defined in the individual specification.

5.5 Pointer oscillations and display fluctuations which result from environmental conditions or noisy input information shall be suppressed.

5.6 Indicator movements shall not be damaged or deranged by sudden or extreme changes of input information which are experienced at switch-on or during ground tests.

5.7 The indicator shall be designed to have minimum power consumption.

NOTE It should be a design aim not to exceed 0.30 W/in³ (18.3 kW/m³) or 0.20 W/in² (0.31 kW/m²) of external surface area. Heat dissipation should be measured for the maximum duty cycle during normal operation, including integral lighting.

6 Presentation

6.1 General

6.1.1 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.

6.1.2 The design and purpose of the display shall be clear and unambiguous and such that it cannot 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, means shall be provided to prevent ambiguity. Single channel, concentric, multi-pointer displays (for example, three-pointer altimeters) shall be avoided.

6.1.3 Indicators shall be designed so that parallax effects and tunnel (masking) 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.

6.1.4 Manufacturer's name, symbol or part number or other information not essential to the function(s) being displayed shall be unobtrusive if marked on dial faces or instrument bezels.

6.1.5 Where a display has both a pointer and counter presentation, masking of the counters by the pointer shall be kept to a minimum.

6.1.6 Where the indicator is luminous, the treated area shall be kept to a minimum compatible with ease of reading (see 9.3.2).

6.2 Scales and counters

6.2.1 Figures and graduations shall be restricted to the minimum number compatible with the accuracy of reading required. If the purchaser does not state requirements for coloured markings, markings shall be white on black background. All coatings used shall have a matt finish.

NOTE The colour specification for markings or other areas of colour is a matter for agreement between the purchaser and the manufacturer.

6.2.2 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.

6.2.3 Where non-linear scales are used, linear interpolation between graduations shall not result in errors greater than the specified instrument accuracies.

Indicators with individually calibrated scales and having the same part number shall have identical scale numbers and divisions, and the working range shall be geometrically similar.

Over those parts of the scale which are operationally important, graduations shall represent equal increments of indicated quantity.

The tolerances governing these instrument accuracies shall be as given in the individual specification.

6.2.4 Sufficient figures shall be marked on the dial to minimize the possibility of misreading by a whole scale division. Those numerals, located against major scale graduations, shall increase in single units, in twos, in fives or in decimal equivalents.

6.2.5 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 fraction of such units.

6.2.6 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.

6.3 Pointers and indices

6.3.1 The shape and size of pointers shall be such as to enable the indication to be readily appreciated to meet required operational conditions.

NOTE 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°.

6.3.2 The pointer tip shall extend to, but not obscure, the shortest scale divisions.

NOTE The pointer should be, as far as practicable, in the same plane as the scale in order to minimize parallax effects.

6.3.3 If the purchaser does not state requirements for the colour of the main pointer, it shall be white.

NOTE See note to 6.2.1.

6.3.4 Where indices or limit pointers are incorporated, they shall be of conspicuous pattern or shape 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).

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

6.4 Warning indications

6.4.1 Detectability. The warning indications shall be readily detectable under all operational lighting conditions.

6.4.2 Failure warning indication. Where specified for the individual indicator, a failure indication shall be provided on the face of the instrument in the form of a distinctive warning flag, which is to obscure the incorrect information, where permitted by the construction of the indicator.

NOTE Indications of an oscillating or flickering nature should not be used unless required in the individual specification.

Acceptable alternatives to the use of warning flags are as follows:

- a) the complete withdrawal from view of the display information; or
- b) the pointer(s) going off-scale.

The design and presentation of the failure warning indication shall be based on the following.

- 1) The indication shall be easily recognizable by virtue of size, shape and colour.
- 2) The indication shall not be visible when the relevant part of the instrument is functioning correctly.
- 3) Where a display is capable of fulfilling multiple roles simultaneously, separate and easily distinguishable warnings for each role shall be fitted.
- 4) The indication shall appear in the area of the display where the incorrect information is being displayed.
- 5) Faulty digital displays shall be sufficiently obscured so that they cannot be read.

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

7) It shall be impossible for an operator to be able to inhibit the appearances of warning.

6.4.3 Limit warning indication. Where required by the individual specification, a limit warning indication shall be provided on the face of the indicator to attract the attention of the flightcrew to a parameter, when that parameter exceeds or falls below a critical value.

6.4.4 Comparison warning. Where required by the individual specification, a comparison warning signal shall be provided to attract the attention of the flightcrew, when the indicated parameter attains a value which is excessively different from that of a second independent display of the same parameter.

NOTE 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 warnings and the form they take will be established by the applicable system requirements.

6.4.5 Maximum or minimum recording devices. When maximum or minimum recording devices are included on the instrument face their design shall be such as to prevent their being confused with the primary indication.

6.5 Controls

6.5.1 Controls for operational use 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.

6.5.2 The direction of movement of all controls shall be clockwise, forwards or upwards for increasing values of the parameter.

6.5.3 Where 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/or tactile (for example, mechanical detents) in a position as near as possible to the control.

6.5.4 Where more than one control for operating indices or pointers is used, each one shall be marked with a symbol to identify the index or pointer that it operates.

6.5.5 Where 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°.

7 Cover glasses and windows

7.1 Cover glasses and windows, when mounted, shall withstand a differential pressure of ± 100 kPa ($\pm 1\,000$ mbar) without affecting indicator function. 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 BS G 211.

7.2 Where transparent plastics sheet is used in an indicator intended for use under ultraviolet lighting, the material shall not fluoresce to such an extent as to affect the indication adversely.

7.3 Toughened safety glass used in cases which have to withstand substantial pressure differences shall comply with BS 857.

7.4 Indicators fitted with a cover glass marked with coloured limit bands or similar markings shall not be employed unless special design features are embodied which ensure a fixed relationship between the glass and indicator dial.

8 Integral lighting

8.1 The integral lighting of the indicator shall comply with BS G 191 or with the individual specification.

8.2 Where required by the individual specification, the lamps shall be capable of being replaced without opening the case of the indicator.

NOTE In-flight replacement of lamps is not a design requirement.

9 Luminescent and fluorescent markings

9.1 Luminescent brightness

Self-luminous marking shall possess a luminosity of not less than 0.005 foot-lamberts (0.017 cd/m²) when measured not less than one week after application, with an electronic photometer having a spectral response closely matching that of the CIE¹⁾ standard photopic observer.

¹⁾ Commission Internationale de l'Eclairage (International Commission on Illumination).