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MILITARY SPECIFICATION

LIGHTING, INTEGRAL, RED, AIRCRAFT INSTRUMENT, GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

- * 1.1 This specification covers the general requirements for a 5-volt incandescent or 115 volt electroluminescent illuminating system for red integrally lighted aircraft instruments. This specification defines the requirements and test procedure applicable to the lighting system for aircraft instruments when referenced in an instrument specification.

2. APPLICABLE DOCUMENTS

- 2.1 The following documents, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein:

* SPECIFICATIONS

Military

MIL-C-14806	Coating, Reflection Reducing, for Instrument Cover Glass and Lighting Wedges
MIL-C-25050	Colors, Aeronautical Lights and Lighting Equipment, General Requirements for
MIL-C-81774	Control Panel, Aircraft, General Requirements for

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Engineering Specifications and Standards Department (Code 93), Naval Air Engineering Center, Lakehurst, NJ 08733, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 6220

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* STANDARDS

Federal

FED-STD-595 Colors

Military

MS24367 Lamp, Incandescent, Miniature Integral Lighting

MS24515 Lamp, Sub-Miniature

MS25237 Lamp, Incandescent, Single Contact Midget Flanged Base (T-1-3/4 Bulb)

MS27569 Lamp, Incandescent, Miniature Integral Lighting, T-1-3/4 Size

MS27570 Lamp, Incandescent, Miniature Integral Lighting, T-1-1/4 Size

MS27571 Lamp, Incandescent, Miniature Integral Lighting, T-1 Size

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 General. The requirements of this specification are applicable as the lighting system requirements of the applicable instrument specification. (See 4.2)

3.2 Materials. Materials used in the lighting systems shall be of the type to withstand the service, functional and environmental conditions specified by the applicable instrument specification.

3.3 Design and construction.

* 3.3.1 Design. The lighting system shall be so designed that the lighted portion of the display will be held to the minimum required to achieve the optimum presentation of information. Light emitted from the edge of a coverglass or wedge, or both, and light emitted from around the dial (halo-effect) shall not be visible when viewed from any point on a 36-inch line determined by the intersection of a plane parallel to and 18 inches from the front surface of the instrument coverglass and a horizontal plane 12 inches above the geometric center of the instrument coverglass (See Figure 1). The middle of the line shall be the point determined by the intersection of the 36-inch line and a vertical plane perpendicular to the instrument coverglass and passing through the geometric center of the display (See Figure 1).

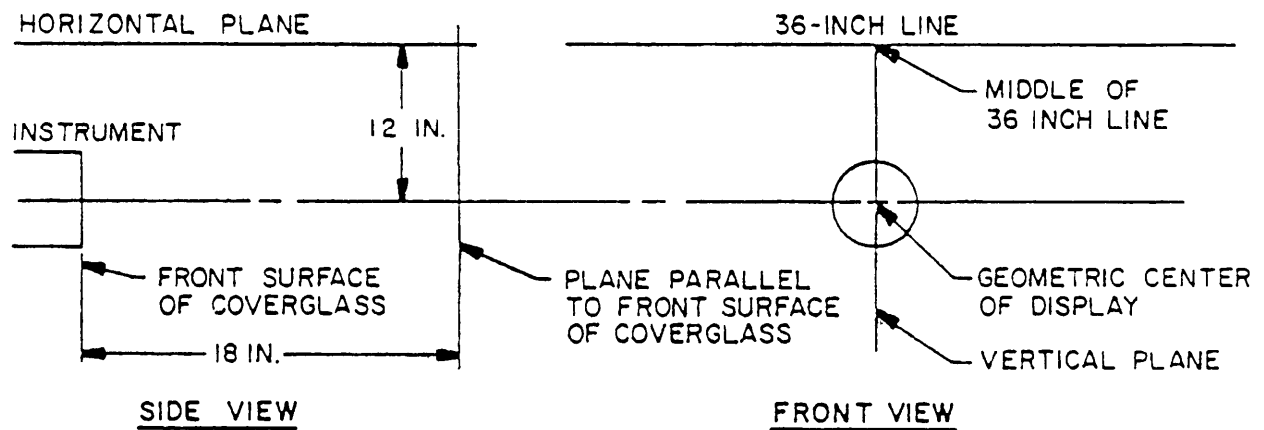


FIGURE 1.

- * 3.3.2 Construction. The lighting system shall be so constructed that the light sources are contained within the instrument enclosure. The coverglass, when used as part of the lighting system, shall not interfere with the visibility of any portion of the dial or scale (for incandescent lighting a minimum of two (2) lamps shall be used for each instrument). No one portion of the indicia shall depend solely on one incandescent lamp for its illumination. No portion of the illuminated display shall be decreased by more than 60 percent of its original brightness when a lamp is deenergized or fails in service. The lighting system shall be built to last the normal life of the instrument and shall in no way interfere with the correct operation of the instrument. Otherwise, the method best suited for the instrument involved may be used, provided it meets the requirements specified herein.
- * 3.3.3 Coverglass and wedges. All surfaces of the instrument coverglass and any other transparent element between the coverglass and dial, such as a lighting wedge shall be treated with a reflection reducing coating conforming to MIL-C-14806. For wedge assemblies, alignment marks shall be placed on the edge of the wedge-coverglass to facilitate alignment of the coverglass with the bezel.

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- * 3.3.4 Lamps. When any helium is used in the filling medium of an hermetically sealed instrument, only MS27569, MS27570-8515AS15, or MS27571-6809AS15 lamps shall be used. If helium is not used or if a non-hermetically sealed case is used then MS25237-328AS10, MS24367-715AS15 or MS24515-718AS15 lamps may be used. For any one instrument the same type of lamp shall be used. If an electroluminescent light source is chosen, a lamp capable of providing 100 hours of life to half of initial brightness shall be used. Initial brightness shall be defined as that brightness measured after an initial period of 100 hours.
- * 3.3.5 Lamp location. Where practicable lamps shall be replaceable without opening the instrument case or using tools. Replacement units shall not protrude beyond the surface of the instrument case. In-flight replacement is not intended. Where the applicable instrument specification requires hermetic sealing, the lamps need not be contained within the seal.
- * 3.3.6 Lamp circuit. Unless otherwise specified by the procuring activity, the lamp circuit shall be designed to operate from a $5.00 \pm 0.10V$ or a $115 \pm 2V$, 400 ± 20 Hz power source. All lamps shall be connected in parallel. The lamp circuit may use a ground return within the instrument except in applications where a case ground return would be harmful to the correct operation of the instrument. In all applications, the lamp circuit shall terminate in two pins used solely for the lamp circuit. When a case ground return is used, the case grounded portion of the lighting system shall be clearly marked on the instrument wiring diagram to insure proper connection to the grounded side of the power supply. Externally adjustable resistors may be used to balance lighting between instruments.
- * 3.3.6.1 Dielectric. The lamp circuit shall be able to withstand 500V plus twice the lamp circuit design voltage of 400 Hz for one minute between each terminal and ground and between the lighting terminals with lamps removed. If the lamp circuit uses a ground return, this requirement shall be compiled with before the circuit is connected to ground.
- 3.3.6.2 Electric connector. Unless otherwise specified by the procuring activity, the electrical circuit for the lighting system shall terminate in the electric connector used for other electrical terminals to the indicator. In the event the instrument does not require an electric connector except for the lighting circuit, a connector suitable for attachment to the plug assembly shall be as specified in the detail specification. A suitable cap shall be provided to protect the connector during shipment and storage. Unless otherwise specified by the procuring activity, the connector shall be located on the back of the instrument case. A mating connector plug assembly with approximately 3 feet of wire attached to the lighting terminals shall be furnished for qualification or preproduction test purposes.

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3.3.7 Color. All the light emitted by the lamps shall be converted to aviation red as specified in MIL-C-25050, except that the color shall not be paler or yellower than the Instrument Panel Lighting Limit Filter National Bureau of Standards (NBS) No. 3215.

- * 3.3.8 Brightness. When $5.00 \pm 0.10V$ or $115 \pm 2V$, 400 ± 20 Hz are applied to the lighting terminals, whichever is applicable, the light intensity and the light distribution of the lighting system shall be such that the brightness of the presentation shall conform to Table I. For any single display, the average brightness of the pointer and lubber lines shall always be greater than the average of the display markings. In no case shall the brightness of the pointer and lubber line exceed 1.7 foot-lamberts.

TABLE I. Photometric Brightness

Daylight Color	Incandescent Lighting System Brightness (Foot-Lamberts)	Electroluminescent Lighting System Brightness (Foot-Lamberts)
White - (Markings)....	1.0 ± 0.5	0.5 ± 0.2
White - (Pointer and Lubber Lines)	1.2 ± 0.5	0.5 ± 0.2
<u>Transilluminated</u>		
Gray - (Background)....	0.6 ± 0.3	0.2 ± 0.1
Black - (Background)	0.04 ± 0.2	0.02 ± 0.01

- * 3.3.9 Stray light. The lighting system shall be so housed as to prevent the leakage of stray light and to shield from direct view all lamp filaments. The brightness of any point on a white piece of paper conforming in shape to the outer edge of, and perpendicular to, the coverglass shall not exceed 1.50 foot-lamberts in the lower half of the instrument and 0.20 foot-lambert in the upper half of the instrument. The upper half and lower half of the instrument are separated by a horizontal plane containing the instrument centerline when the instrument face is in the vertical upright position. Where the instrument coverglass is square or rectangular, a sheet of white paper shall be placed perpendicular to the coverglass and on any line parallel to the top edge of the coverglass. The brightness of any point looking down on the paper shall not exceed 1.50 foot-lamberts and on any point looking up on the paper shall not exceed 0.20 foot-lambert. The sheet of white paper used in the above measurements shall be neutral, diffusing, and have a reflectance of 85 ± 5 percent. The measurement of stray light shall be made at a point 0.5 inch in front of the instrument coverglass.

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- * 3.3.10 Dial visibility. The lighting system shall in no way restrict the visibility of any graduations, numerals, pointers, and other specific markings, when viewed from the line defined in 3.3.1.
- * 3.3.11 Knobs and lettering. Unless otherwise specified in the applicable instrument specification, all indicia associated with instrument knob positions and all lettering on the instrument face shall be illuminated. The brightness range shall be as specified in MIL-C-81774.
- 3.3.12 Indicia. The presentation may be any combination of white, black, or gray, as specified in the applicable instrument specification. Unless otherwise specified in the applicable instrument specification, the colors shall conform to Table II.

TABLE II. Colors

Color	FED-STD-595
White	37875
Black	37038
Gray	36440

3.3.13 Contrast. Contrast between the white and black portions of the indicator scale shall be 12 or greater. Contrast between the gray and black portions of the indicator scale shall be 5 or greater. Contrast "C" is defined as:

$$C = \frac{B_2 - B_1}{B_1}$$

Where B_2 is the brightness of the gray or white and B_1 the brightness of the black portions of the instrument scale.

Contrast measurements shall be made under uniform, diffuse illumination. For contrast qualification and preproduction tests, one sample of all portions of the presentation behind the coverglass (dials, pointers, tapes, counters, etc.) shall be furnished.

4. QUALITY ASSURANCE PROVISIONS

4.1 Contractors responsibility. The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

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- * 4.2 Classification of tests. All the tests specified in Test Methods (4.5) constitute the lighting system requirements of the qualification or first article tests, whichever is applicable, and acceptance tests of the applicable instrument specification.

4.3 Tests. The lighting system tests shall consist of the individual and sampling tests of this specification.

- * 4.3.1 Individual tests. Each instrument lighting system shall be subjected to the following tests:

- a. Examination of product (4.5.1)
- b. Operation (4.5.2)

4.3.2 Sampling tests.

- * 4.3.2.1 Sampling plan A. One instrument selected at random from each lot of 100 or less produced on the contract or order shall be subjected to the following tests:

- a. Individual tests (4.3.1)
- b. Light (4.5.3)

- * 4.3.2.2 Sampling plan B. Unless otherwise specified, two instruments selected at random from the first 10 items of the contract or order shall be subjected to the following tests:

- a. Sampling plan A (4.3.2.1)
- b. Contrast (4.5.4)
- c. Lamp circuit (4.5.5)
- d. Dielectric (4.5.6)
- e. Life (4.5.7)

- * 4.3.3 Rejection and retest. When one item selected from a production run fails to meet the requirements of the specification, no items still on hand or later produced will be accepted until the extent and cause of failure are determined and corrected.

4.3.3.1 Individual tests may continue. For operational reasons, individual tests may be continued pending the investigation of a sampling test failure. But final acceptance of items on hand or later produced will not be made until it is determined that items meet all the requirements of this specification.

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4.3.4 Defects in items already accepted. The investigation of a test failure could indicate that defects may exist in items already accepted. If so, the contractor shall fully advise the procuring activity of all defects likely to be found and methods of correcting them.

4.4 Test conditions.

4.4.1 Atmospheric conditions. Unless otherwise specified, tests required by this specification shall be made at atmospheric pressure of 28 to 32 in. Hg, a temperature of $25^{\circ} \pm 10^{\circ}\text{C}$, and a relative humidity of 80 percent or less.

4.4.2 Environmental conditions. Wherever possible, those tests specified in Test Methods shall be performed after the environmental tests required by the applicable instrument specification.

4.4.3 Test sequence. The lighting system shall be subjected to tests in the sequence specified in Test Methods.

4.5 Test methods.

4.5.1 Examination of product. The lighting system shall be examined carefully to determine conformance to Section 3 requirements that can be checked visually.

4.5.1.1 Indicia. The instrument shall be checked visually to assure conformance to Section 3 requirements.

4.5.1.2 Dial visibility. The instrument shall be checked to assure conformance to Section 3 requirements.

4.5.2 Operation. The lighting system shall be energized with $5.00 \pm 0.10\text{V}$ or $115 \pm 2\text{V}$, $400 \pm 20\text{ Hz}$ power, whichever is applicable, and examined to ascertain that all the lamps in the system function.

4.5.3 Light. Tests shall be made with $5.0 \pm 0.10\text{V}$ or $115 \pm 2\text{V}$, $400 \pm 20\text{ Hz}$, whichever is applicable, applied to the lighting terminals. All measurements required shall be made in such a way that the axis of the brightness meter is perpendicular to the surface being measured. The brightness photometer shall be calibrated with NBS Filter No. 3215 and a $2,854^{\circ}\text{K}$ source. All measurements shall be made in complete dark surroundings.

4.5.3.1 Color. The brightness photometer shall be placed sufficiently far from the test instrument that several numerals, lettering, and indicia are included with the photometer test field. A reading (R_1) shall then be taken. One NBS Filter No. 3215 shall then be placed in

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the optical path between the instrument markings and the photometer. A second reading (R_2) shall then be taken. The ratio of R_2 divided by R_1 shall be not less than 0.97 times the ratio of R_4 divided by R_3 , where R_3 is the brightness reading of a luminance standard at 2,854°K with a filter No. 3215 between it and the photometer and where R_4 is the brightness reading of the luminance standard with two Filters No. 3215 between it and the photometer. The photometer shall give a ratio of R_4 divided by R_3 equal to or less than 0.82 to be considered as suitable for this measurement of color.

4.5.3.2 Brightness. Brightness measurements shall be taken of the lighted portion of the instrument. Readings shall fall within the limits specified in Section 3. Readings of one particular area, such as an indicia, mark or number, shall be the average of that area. Large areas, such as pointers, shall be divided into subareas for brightness readings (e.g., tip, center, and base of the pointer). Readings of brightness which exceed the specified limits when the movable portions of the display are placed in any position within their designed range shall be cause for rejection.

4.5.3.2.1 Brightness measurements. Comparisons of photometric brightness measurements by approved illumination test facilities should take into account tolerances inherent in the light measurement techniques prescribed herein. Where the instrument manufacturer certifies the illumination as being within the limits shown in Table I, then the procuring activity may accept the instrument, provided his approved illumination test facility determines that the reported values of brightness do not exceed the limits specified by more than 20 percent.

4.5.3.3 Stray light. The instrument shall be checked to assure conformance to Section 3 requirements.

4.5.4 Contrast. The illumination for the contrast measurements shall be furnished by uniform, diffused, artificial illumination. Contrast measurements shall be taken with no coverglass or other transparent surface in front of the presentation. Several brightness measurements of the indicia and of the background shall be taken with the axis of the brightness meter perpendicular to the surface being measured. An average of the indicia and background readings shall be used to determine conformance to the contrast values specified in Section 3.

4.5.5 Lamp circuit. The instrument shall be opened and the lamp circuit checked in accordance with Section 3 requirements to determine that:

- a. At least two lamps are used in an incandescent system.
- b. Lamps are connected in parallel.

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c. The lighting circuit is connected as indicated on the wiring diagram.

d. No one portion of the instrument presentation depends solely on one incandescent bulb for its illumination.

e. No resistances or amplifiers are used to change the input voltage to the lamps.

4.5.6 Dielectric. The instrument shall be checked to assure conformance to Section 3 requirements.

- * 4.5.7 Life. The lighting system shall be subjected to a life test with $5.00 \pm 0.10V$ or $115 \pm 2V$, 400 ± 20 Hz, whichever is applicable, applied to the lighting terminals. The duration of the test shall be for 1000 hours or for a period equal to the life test time required by the applicable instrument specification, whichever is greater. Wherever possible, the lighting system life test shall be performed concurrently with the life test of the instrument. During the life test of the instrument lighting system, the power supplied to the lighting circuit shall be interrupted every 57 minutes for a period of 3 minutes.

Following completion of life testing, brightness degradation from initial values shall not exceed 10% of each 1000 hours of life test, unless otherwise specified by the applicable procurement document. Measurement of color and brightness shall be made prior to and after this test. When this test is run as part of a reliability test required by the applicable instrument specification, the brightness and color shall be monitored each 500 hours of testing. Failure of the instrument to meet either the brightness or color requirements shall be counted as a reliability failure of that instrument. Pattern failures (the same type of failure on several instruments) shall require redesign and retesting.

5. PREPARATION FOR DELIVERY

5.1 The requirements of Section 5 are not applicable to this specification.

6. NOTES

6.1 Intended use. The lighting system described herein is intended for use as an integral lighting system for aircraft instruments.

- * 6.2 Test equipment. The following equipment is capable of performing the tests specified in Test Methods:

a. Brightness meter (photometer): Meter shall be accurate within $\pm 5\%$ at all test intensities with a spot aperture smaller than the smallest marking to be measured.

b. Instrument Panel Lighting Filter NBS No. 3215: Supplied only by National Bureau of Standards, Department of Commerce, Washington, D.C.

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6.3 Power supply. Lamps conforming to MS24367, MS24515, MS25227, MS27569, MS27570 and MS27571, shall be operated at $5.00 \pm 0.10V$. The electroluminescent lamps shall be operated at $115 \pm 2V$, 400 ± 20 Hz.

* 6.4 Brightness balance. It is desirable that the relative importance of different elements of a presentation be considered when designing a lighting system, in order that those elements of greater importance will have relatively greater brightness within the specified brightness range.

6.5 The margins of this specification are marked with an asterisk to indicate where changes, deletions, and additions from the previous issue have been made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in those notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

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