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MILITARY SPECIFICATION

LIGHTING, INSTRUMENT, INTEGRAL, WHITE GENERAL SPECIFICATION FOR

1. SCOPE

1.1 This specification covers the general requirements for a 5.0V illuminating system for integrally white-lighted aircraft instruments using incandescent lamps as the light source.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

Military

MIL-C-675	Coating of Glass Optical Elements (Anti-reflection)
MIL-C-14806	Coating, Reflection Reducing, for Instrument Cover Glasses and Lighting Wedges

STANDARDS

Federal

FED-STD-595	Colors

Military

MS21376	Lamp Sub Miniature Helium Retardant Flange Base, T-1 Size
MS24367	Lamp, Incandescent - Miniature Integral Lighting
MS24515	Lamp - Sub Miniature
MS25237	Lamp, Incandescent, T-1 3/4 Bulb, Midget Flange Base
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

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(Copies of documents required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Qualification or preproduction. Qualification or preproduction provisions shall be as specified in the applicable instrument specification.

3.2 Materials. The instrument lighting system shall be of materials that will enable it to withstand the service, functional, and environmental conditions specified by the applicable instrument specification.

3.3 Design and construction. The lighting system shall be contained within the instrument case. A minimum of two lamps shall be used for each instrument. The lighting system shall not interfere with the visibility of any portion of the dial or scale. No one portion of the display shall depend upon one lamp for its illumination. The lighting system shall in no way interfere with correct operation of the instrument.

3.3.1 Coverglass. The instrument coverglass and any other transparent element between the coverglass and dial shall be coated with a reflection reducing film in accordance with MIL-C-675 or MIL-C-14806 as specified in the applicable instrument specification.

3.3.2 Lamps. When any portion of helium is used in the filling medium of the instrument, only MS21376, MS27569, MS27570-8515AS15, MS27570-1191AS15, MS27571-6809AS15, or MS27571-6808AS15 lamps may be used. If helium is not used or if a non-hermetically sealed case is used, the MS25237-328AS10, MS24367-715AS15, MS24367-713AS15, MS24515-718AS15 lamps may be used in addition to the above lamps. Any lamp selected shall be used throughout the system.

3.3.2.1 Lamp location. Lamps may be accessible either from the outside of the instrument or contained within the instrument case. Where practicable, lamps shall be removable without opening the case. In-flight replacement will not be required. Where applicable instrument specification required hermetic sealing, lamps need not be contained within the seal.

3.3.2.2 Lamp circuit. The lamp circuit shall be designed to operate from a 5.0V 400-Hz power system. All lamps shall be connected in parallel. In all applications, the circuit shall terminate in two pins which shall be used solely for the lamp circuit. Resistors or transformers shall not be used within the instrument to change to voltage applied to the lamp terminals. (Wiring between the two lighting terminals on the connector and the lamp socket or terminals shall be of sufficient size to prevent any appreciable voltage drop in the wiring.)

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3.3.2.2.1 Dielectric. The lamp circuit shall withstand 500V plus twice the lamp circuit design voltage at 60 Hz for one minute under the conditions specified in 4.5.7.

3.3.3 Life and reliability. The lighting system shall be designed for a life of 1,000 hours or for the period required by the applicable instrument specification, whichever is greater. Reliability shall be in accordance with the applicable detail specification.

3.3.4 Color. The color of the white portions of the indicator display with 4.50 ±0.050V applied to the lighting terminals shall be x = 0.440 ±0.020 and y = 0.405 ±0.020 when measured as specified herein.

3.3.5 Brightness. When 4.50 ±0.050V are applied to the lighting terminals, the light intensity and distribution shall be as follows:

a. White areas: 1.00 ±0.50 foot-lambert. The average of all readings taken in the white areas shall be 1.00 ±0.30 foot-lamberts.

b. Gray area: 0.60 ±0.30 foot-lambert.

c. Black areas: 0.05 ±0.03 foot-lambert when reflected light (wedge and ring lighting) is used and 0.04 ±0.02 foot-lambert for refracted light (back lighting).

d. Pointers, lubber lines, command bars, miniature airplane symbols deviation bars, and other similar reference marks:
1.20 ±0.50 foot-lambert. The average brightness of all of the (pointer) readings shall be 0.10 to 0.50 foot-lamberts higher than the average brightness of the (dial) white areas.

e. Red areas: 1.00 ±0.50 foot-lambert.

The brightness of other colors and the selection of colors shall be governed by their relative brightness in daylight and shall be subject to the approval of the procuring activity. When no other guidance is available, the brightness of these other colored areas shall be 1.0 ±0.50 foot-lambert.

3.3.6 Stray light. The lighting system shall be so housed as to prevent the leakage of stray light and to shield all lamp filaments from direct view.

3.3.7 Light leakage. The lighting system shall in no way restrict the visibility of any graduations, numerals, pointers, or other specific markings.

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3.3.8 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 herein.

3.4 Indicia. The presentation may be combination of white, black, and gray as specified in the applicable instrument specification. Unless otherwise specified in the applicable instrument specification, the colors shall conform to Table I.

Table I. Colors

Color	Color No. as listed in FED-STD-595
White	37875
Black	37038
Gray	36440

3.5 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 five 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 is the brightness of the black portions of the instrument scales.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. 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.

4.2 Classification of tests. The inspection and testing of systems shall be classified as follows:

a. Qualification or preproduction tests as specified in the applicable instrument specification.

b. Quality conformance tests.

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4.3 Test conditions

4.3.1 Standard atmospheric conditions. Unless otherwise specified, tests shall be conducted at an atmospheric pressure of 22 to 32 inches Hg, at a temperature of 25° ±10°C, and at a relative humidity of 80 percent or less.

4.3.2 Environmental conditions. The tests specified in 4.5, with the exception of 4.5.4 and 4.5.7, shall be performed after completion of the environmental tests required by the applicable instrument specification. Where possible, the brightness and color tests shall be performed after each environmental test specified in the applicable instrument specification. The tests shall be conducted in the sequence specified under 4.5.

4.4 Quality conformance tests. Quality conformance tests shall consist of:

a. Individual tests

b. Sampling tests.

4.4.1 Individual tests. Each lighting system shall be subjected to the following tests as described under 4.5:

a. Examination of product.

b. Operation.

4.4.2 Sampling tests.

4.4.2.1 Sampling plan A. One system shall be selected at random from each 100 or less produced on the contract or order and subjected to the following tests as described under 4.5:

a. Individual tests.

b. Light.

4.4.2.2 Sampling plan B. Unless otherwise specified (see 6.2), two systems shall be selected at random from the first ten produced on the contract or order and subjected to the following test as described under 4.5:

a. Sampling plan A tests.

b. Life and reliability.

c. Contrast.

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d. Lamp circuit.

e. Dielectric.

4.4.3 Rejection and retest. When one system selected from a production run fails to meet the specification, no systems still on hand or later produced will be accepted until the extent and cause of failure are determined and appropriately corrected. The contractor shall explain to the Government representative the cause of failure and the action taken to preclude recurrence. After correction, all tests shall be repeated.

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

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

4.5. Test methods

4.5.1 Examination of product. The lighting system shall be examined to determine compliance with the requirements that can be checked visually.

4.5.1.1 Light leakage. The instrument shall be checked to assure conformance to 3.3.7. Light or reflections emitted from the edge of a coverglass or from around the dial or between openings in counters and warning flags shall not be visible when viewed from any point on a 36-inch line. The line shall be 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.

4.5.2 Operation. the lighting system shall be excited with 5.0V and examined to determine that all lamps function properly.

4.5.3 Lamp circuit. The instrument shall be opened and the lamp circuit checked as follows. The examination shall be made prior to sealing.

a. Determine if lamps are connected in parallel.

b. Determine if the lighting circuit is connected as indicated on the wiring diagram.

c. Determine if any resistances are used to drop the input voltage to the lamps, or if any transformers are used to vary the voltage to the lamp terminals.

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d. Determine if at least two lamps are used.

e. Determine if any portion of the display depends solely upon one lamp for its illumination. Not more than 70 percent of the brightness on any portion of the display shall be illuminated by one lamp.

4.5.4 Life and reliability. The lighting system shall be subjected to a life test with 5.0 ±0.05V 400 Hz applied to the lighting terminals. The duration of the test shall be 1,000 hours or for a period equal to the life test time required by the applicable instrument specification, whichever is greater. Wherever possible, this test shall be performed concurrently with the reliability or life test, or both, of the instrument specification. The power supplied to the lighting circuit shall be interrupted every 57 minutes for a period of three minutes. Measurement of color and brightness shall be made prior to and after this test. When this test is run as part of the reliability test, the brightness and color shall be monitored each 500 hours of testing and 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.

4.5.5 Light (calibration and measurement of brightness and color of white lighted indicators). Light tests shall be made with 4.50 ±0.050V applied to the lighting terminals. All measurements shall be in complete darkness and with the axis of the photometer perpendicular to the coverglass.

4.5.5.1 Equipment. Equipment required for the light test shall be as follows:

a. Photo Research Corporation model UB 1/2 Spectra Brightness Spot Meter, or approved equivalent.

b. Microspectar lens.

c. Filter holder between meter and lens.

d. External foot-lambert meter (internal impedance must match photometer).

e. Regulated power supply, 1 percent accuracy (regulating voltage to the indicator).

f. All voltmeters used shall be accurate to with in ±1/2 percent of the specified voltage (AC voltmeters should provide readings that are independent of wave form of the applied voltage).

g. Lamp and opal glass combination calibrated by the National Bureau of Standards (NBS) for 2,854°K (or applicable specified color temperature). This is the color temperature of the light emitted by the opal glass.

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h. the following constants shall be determined:

$$C_1 = 1.0984 \frac{Y}{R}$$

$$C_2 = 0.3556 \frac{Y}{R}$$

C_1 and C_2 are determined by solving the following equations simultaneously:

$$0.4476 = \frac{RC_1}{Y+RC_1+BC_2}$$

$$0.4076 = \frac{Y}{Y+RC_1+BC_2}$$

4.5.5.2.1 Color correction graph. Known light sources shall be determined by taking spectral analysis data and computing the true x and y coordinates for a NBS combination of 2360°K light source and filter which yield color coordinate limits as specified herein. A minimum of the four corners of the specified limits plus an intermediate point on each side of the square area encompassing the specified limits shall be used for calibration of the photometer. Once it is determined through calibration what the photometer reads when measuring the known sources of white light, a new polygon shall be determined by connecting the points as read by straight lines. This shall be the new tolerance for that photometer. Any readings falling outside these limits shall be cause for rejection of the instrument lighting. The changing of any component in the photometer that would affect the calibration shall necessitate recalibration. See figure 1 for an example of this calibration procedure.

4.5.5.3 Color measurements. Color measurements shall be made as follows:

a. Apply 4.5 ±0.05V to the instrument under test

b. Focus the photometer visually on the numeral indicia pointer or areas to be measured.

c. Insure that while readings are being taken, the 0.015 inch diameter circle does not move off its desired setting. record the Y (foot-lamberts), R, and B readings with the photometer axis perpendicular to the instrument to be measured.

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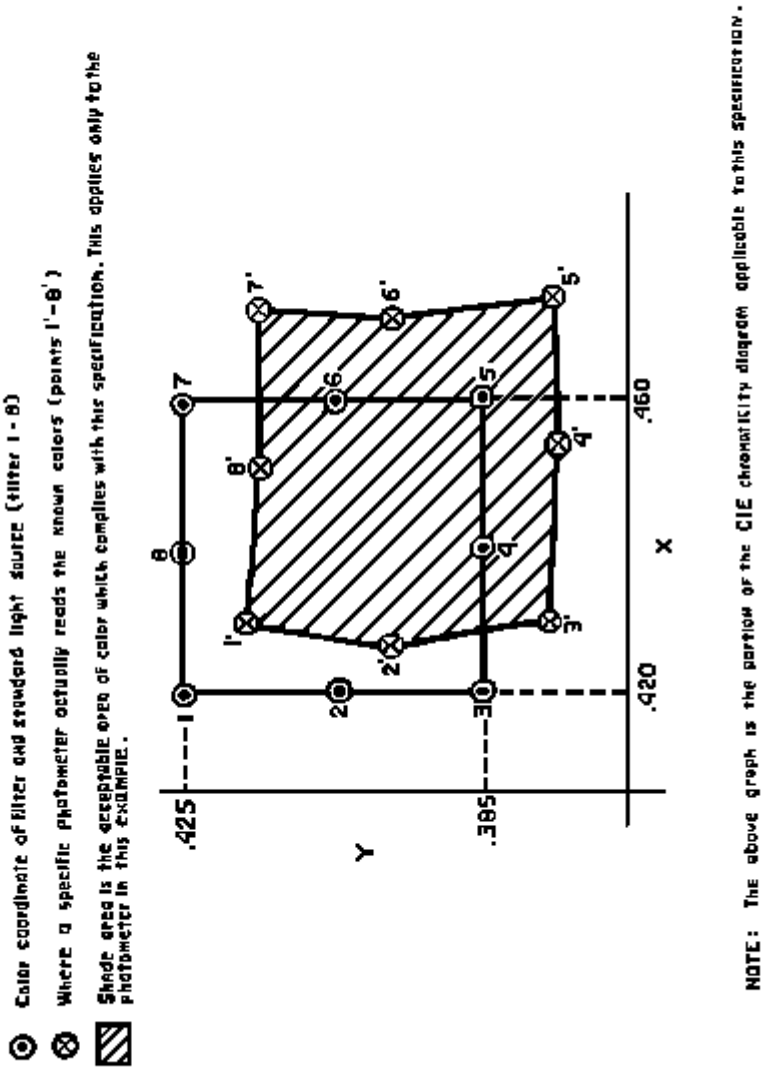

Figure 1. Color Correction Graph

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d. Calculate the chromaticity coordinates of the unknown white light from the following formulas:

$$X = \frac{RC_1}{Y+RC_1+BC_2}$$

$$Y = \frac{Y}{Y+RC_1+BC_2}$$

The values of x and y must fall within the polygon determined in 4.5.5.2.1

4.5.5.4 Brightness. Brightness measurements shall be made as follows:

a. Apply 4.50 ±0.050V

b. Use the specified calibration procedures

c. Turn the filter wheel to the Y (foot-lambert) position and record brightness directly.

Brightness measurements shall be taken of the lighted portion of the indicator. Readings shall fall within the limits required in 3.3.5. Readings of one particular area, such as an indicia, mark, or number, shall be the average of that area. the average of an areas is the arithmetic average of a minimum of three measurements in the area. The magnitude of the actual readings that make up the average shall not exceed a 3 to 1 variation which shall be calculated by dividing the minimum brightness reading in a particular area into the maximum reading in that area. For large areas, such as pointers, several subareas shall be read and reported separately (hub, center, and tip) where each reading is the average of serveral measurements in that subarea.

4.5.5.5 Stray light. The brightness of any point on a sheet of white paper conforming in shape to the outer edge of, and perpendicular to, the coverglass of round instruments shall not exceed 0.20 foot-lambert. Where the instrument bezel is other than round, 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 of any point looking up on the paper shall no exceed 0.20 foot-lambert. The sheet of white paper used in the above measurements shall be neutral, diffusing, and shall have a reflectance of 85 ±5 percent. All measurements shall be made at 4.5 ±0.050V excitation and 0.5 inch in front of the coverglass.

4.5.6 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

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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 reading shall be used to determine conformance to the contrast values specified in 3.5.

4.5.7 Dielectric. For nonhermetically sealed instruments, a voltage of 500V plus twice the lamp circuit design voltage at 60 Hz shall be applied for one minute between each terminal and the case and between the lighting terminals with the lamps removed. If the case is hermetically sealed, 200V at 60 Hz shall be applied between each terminal and the case for one minute. There shall be no insulation breakdown as a result of this test.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, packing, and marking shall be as specified in the applicable detail specification.

6. NOTES

6.1 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this specification

b. When sampling plan B tests will not be conducted (see 4.4.2.2)

6.2 Marginal indicia. The margins of this specification are not marked with an asterisk to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these 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.

6.3 Amendment. Amendments are incorporated into this document.

Custodian:
Air Force - 11

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