

MIL-L-3891B  
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SUPERSEDING  
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MILITARY SPECIFICATION  
LUMINESCENT MATERIAL AND EQUIPMENT  
(NONRADIOACTIVE)

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

1. SCOPE

1.1 Scope. This specification covers two types of photo-luminescent materials for operational military uses in various forms, shapes, colors, and sizes.

1.2 Classification.

1.2.1 Luminescent material. Nonradioactive luminescent material shall be of the following types, forms, shapes, colors and sizes as specified (see 6.2):

Types:

- P - Phosphorescent (see Table I).
- F - Fluorescent.

Forms:

- 1 - Liquid or paste.
- 2 - Rigid plastic backed.
- 3 - Flexible plastic backed.
- 4 - Cloth.
- 5 - Tape.

Shapes:

- Rectangular sheets.
- Disks.
- Irregular shapes or markings.

FSC 9390

**MIL-L-3891B****Colors:**

Type F materials with daylight color ranging between white and greenish-yellow.

Type F materials with the following colors after irradiation:

Blue.	Orange.
Green.	Yellow.
Red.	

Sizes: As specified (see 6.2).

1.2.2 Equipment. When specified (see 6.2), special lighting or illuminating equipment shall be furnished for the activation of phosphorescent and fluorescent material and shall be of one type, as specified herein.

**2. APPLICABLE DOCUMENTS**

2.1 The following documents of the 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****Federal**

TT-N-95	- Naptha; Aliphatic.
TT-X-916	- Xylene (for Use in Organic Coatings).
UJ-P-268	- Paper, Kraft, Wrapping.
CCC-D-950	- Dyeing and After Treating Processes for Cotton Cloths.
PPP-B-566	- Boxes, Folding, Paperboard.
PPP-B-601	- Boxes, Wood, Cleated-Flywood.
PPP-B-636	- Boxes, Shipping, Fiberboard.
PPP-B-676	- Boxes, Set-Up.
PPP-C-96	- Cans, Metal, 28 Gage and Lighter.

**Military**

MIL-P-116	- Preservation-Packaging, Methods of.
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**STANDARDS****Federal**

FED. STD. No. 141	- Paint, Varnish, Lacquer, and Related Materials; Methods of Inspection, Sampling, and Testing.
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Military

- MIL-STD-105                   - Sampling Procedures and Tables for  
                                  Inspection by Attributes.
- MIL-STD-129                  - Marking for Shipment and Storage.

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

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- G 26 - Operating Light- and Water-Exposure Apparatus (Xenon-Arc Type )  
for Exposure of Nonmetallic Materials.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

## NATIONAL MOTOR FREIGHT TRAFFIC ASSOCIATION, INC., AGENT

National Motor Freight Classification.

(Application for copies should be addressed to the American Trucking Associations, Inc., ATTN: Tariff Order Section, 1616 P Street, NW, Washington, DC 20036.)

## UNIFORM CLASSIFICATION COMMITTEE, AGENT

Uniform Freight Classification.

(Application for copies should be addressed to the Uniform Classification Committee, ATTN: Tariff Publishing Officer, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606.)

## 3. REQUIREMENTS

3.1 Description.

3.1.1 Luminescent material. Luminescent materials covered by this specification are limited to those which emit light only as a result of excitation by exposure to an external source of radiant energy. This

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specification does not cover luminescent substances which give off light either spontaneously as a result of radioactivity or chemical action, or as a result of friction, the passage of an electric current or exposure to cathode rays. The character of the light source shall be as specified (see 6.2).

**3.1.2 Phosphorescent material.** Phosphorescent material covered by this specification is a material which, after exposure to a source of radiant energy in the visible spectral range for an appreciable period of time (6 to 8 hours) after excitation of the material has ceased. Accordingly, this type of material (which may be represented by calcium sulphide) may be used for applications requiring a minimum luminance for an extended period (overnight), that is, where prolonged observation is required but not until the observer has become somewhat dark adapted.

**3.1.3 Fluorescent material.** Fluorescent material covered by this specification is a material which emits visible energy during the period while exposed to a source of radiant energy, and will cease to emit this energy almost immediately after excitation of the material has ceased. Fluorescent materials are available in a variety of colors (see 1.2.1, colors, Type F).

**3.2 Material.** Material shall be as specified herein. Material not specified shall be selected by the supplier and shall be subjected to all provisions of this specification.

**3.3 Uniformity.** The material, as supplied (or applied according to the manufacturer's instructions), shall be uniform in appearance, both by reflected light and by its own luminance. The effect of weathering shall be uniform. There shall be no streaks or spots, visible graduations of color, or cracking or pitting after weathering when tested as specified in 4.4.3.2.

**3.4 Flammability.** Luminescent material shall have flame resistance such that when prepared and tested as specified in 4.4.3.3 the specimen shall not burn over its entire exposed area, and shall not continue burning more than 3 seconds after the applied flame is removed.

**3.5 Toxicity.** The supplier shall furnish evidence that the luminescent materials supplied are nontoxic to humans during application, provided that precautions are taken according to procedures to be specified by the supplier. Such evidence shall be subject to approval by the contracting officer (see 6.6). These precautions shall be clearly stated on the label.

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3.6 Temperature deformation. The material shall show no physical deformation, or change, and shall exhibit no softening or flow characteristics that would impair the serviceability when subjected for 24 hours to a temperature of  $50^{\circ} \pm 1^{\circ} \text{ C}$  ( $122^{\circ} \pm 2^{\circ} \text{ F}$ ).

3.7 Low temperature. The materials shall not crack, peel, or flake due to expansion of the base material caused by rapid temperature changes between  $-40^{\circ}$  to  $49^{\circ} \text{ C}$  ( $-40^{\circ}$  to  $120^{\circ} \text{ F}$ ). When luminescent tape is required, it shall be mounted on or applied to a painted sheet steel backing or to a suitable backing specified by the manufacturer.

3.8 Humidity. The material shall adhere to the base surface after prolonged exposure to a humidity of not less than 90 percent as specified in 4.4.3.6. Previous to testing, tape shall be applied to a painted sheet steel backing or to a suitable backing specified by the manufacturer.

3.9 Adhesiveness. The material, other than liquid or paste form, shall be furnished either with pressure sensitive adhesive backing or with plain nonadhesive backing, as specified (see 6.2).

3.9.1 Adhesive backing (where required).

3.9.1.1 General. The adhesive shall be pressure sensitive and of such a nature that it will adhere uniformly to smooth dry surfaces, including the surface of the luminescent material itself, painted steel, and wood. The adhesive shall adhere firmly to the backing and it shall not pull away from the backing when tape is unrolled. A tear strip shall be provided if necessary for the particular adhesive used.

3.9.1.2 Adhesive backing weathering. No loosening, lifting, peeling, or other signs of unsuitability shall occur during the weathering tests specified in 4.4.3.2.

3.9.1.3 Application. The adhesive shall be suitable for application of the material at any temperature from  $10^{\circ}$  to  $49^{\circ} \text{ C}$  ( $50^{\circ}$  to  $120^{\circ} \text{ F}$ ).

3.9.1.4 Adhesion. When tested as specified in 4.4.3.7, the samples shall peel at a rate of not faster than 10 cm in 2 minutes.

3.10 Shelf life. After 30 days of shelf storage in the original package from the date of delivery at the test laboratory, materials shall conform to this specification (see 4.4.3.9 and 6.3).

3.11 Phosphorescent (Type P).

3.11.1 Liquid or paste form (for application by brush or spatula).

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**3.11.1.1 Phosphorescent luminance.** Phosphorescent material shall have a luminance of not less than that specified in Table I, at the times indicated, when tested in accordance with 4.4.3.1.1.4. A sample 58 square centimeters (9 square inches), shall be visible to a dark-adapted person after the sample had not been exposed to any light for 8 hours.

**TABLE I.**

Minimum Luminance of Phosphorescent Material (Type P).				
Equivalent microlamberts ( $\mu\text{L}$ ) at specified interval after end of excitation				
Sample Color	2 minutes	30 minutes	1 hour	3 hours
Yellow	20 $\mu\text{L}$	0.4 $\mu\text{L}$	0.12 $\mu\text{L}$	0.02 $\mu\text{L}$
Blue	2.8 $\mu\text{L}$	0.15 $\mu\text{L}$	0.07 $\mu\text{L}$	0.02 $\mu\text{L}$

**3.11.1.2 Phosphorescent weathering.** The maximum decrease in luminance of the phosphorescent material after being subjected to 40 hours in the salt spray (fog) test and to 40 hours in the accelerated weathering (open arc or Xenon apparatus) shall not be greater than 40 percent.

**3.11.1.3 Phosphorescent mixing.** The material shall be furnished ready-mixed with all the necessary ingredients.

**3.11.1.4 Accessory equipment.** All equipment necessary for the proper application of the liquid or paste, including all brushes which are required, shall be furnished with the material.

**3.11.1.5 Instructions.** Full instructions for the application and drying of the product, for the preparation of surfaces prior to application, and for the protection of the finished surfaces shall be furnished by the supplier.

**3.11.1.5.1 Protective coating.** After application, it shall be possible to coat the material with a transparent adhering compound for mechanical protective purposes. The supplier shall supply, as part of the instructions, complete information concerning the lacquers or other materials best suited for application over the luminescent material.

3.11.1.6 Drying time. The liquid or paste form material shall set to touch in not less than 1/2 hour nor more than 2 hours and shall dry hard within 8 hours at a temperature of  $23^{\circ} \pm 1^{\circ} \text{ C}$  ( $73.5^{\circ} \pm 2^{\circ} \text{ F}$ ), and a relative humidity of  $50 \pm 4$  percent.

3.11.1.7 Phosphorescent primer. When applicable, a suitable primer shall be provided which shall remain acid-free upon aging, shall be free of heavy metals such as lead and iron, and shall not quench or react with the luminescent coat.

3.11.1.8 Phosphorescent hiding power. Luminescent material in the liquid or paste form shall have hiding power such that 1 gallon will produce a completely luminescent area of not less than 9.29 square meters (100 square feet) when applied over a primed surface.

### 3.11.2 Rigid plastic backed form.

3.11.2.1 Rigid plastic (Type P) luminance. The material shall conform to 3.11.1.1.

3.11.2.2 Rigid plastic (Type P) weathering. The phosphorescent material shall conform to 3.11.1.2 and the backing shall remain in a serviceable condition and shall show no signs of cracking or separation from the phosphorescent material.

3.11.2.3 Backing. The backing material shall retain its shape without distortion, bending, warping, curling, softening, or flow, when subjected after mounting to acid fumes and humidity of not less than 90 percent atmospheric conditions at temperatures up to  $65^{\circ} \pm 3^{\circ} \text{ C}$  ( $149^{\circ} \pm 5^{\circ} \text{ F}$ ), regardless of the manner of mounting. The backing shall have a minimum useful life equal to or greater than that of the phosphorescent material.

### 3.11.3 Flexible plastic backed form.

3.11.3.1 Flexible plastic (Type P) luminance. The material shall conform to 3.11.1.1.

3.11.3.2 Flexible plastic (Type P) weathering. The phosphorescent material shall conform to 3.11.1.2. The backing shall remain in a serviceable condition and shall show no signs of cracking, hazing, discoloration or separation from the phosphorescent material.

3.11.3.3 Phosphorescent plastic material. The plastic material into which the phosphorescent material is incorporated or which covers the phosphorescent material shall retain its shape without distortion, bending,

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warping, curling, softening, or flow, when subjected to acid fumes and humidity of not less than 75 percent atmospheric conditions at temperatures up to  $65^{\circ} + 3^{\circ} \text{ C}$  ( $149^{\circ} + 5^{\circ} \text{ F}$ ), regardless of the manner of mounting. The plastic material shall have a minimum useful life equal to or greater than that of the phosphorescent material.

#### 3.11.4 Cloth form.

3.11.4.1 Cloth (Type P) luminance. The material shall conform to 3.11.1.1.

3.11.4.2 Cloth (Type P) weathering. The phosphorescent material shall conform to 3.11.1.2. The backing shall remain in serviceable condition, shall show no signs of deterioration such as raveling or fraying, and shall exhibit no signs of separation from the phosphorescent material.

3.11.4.3 Cloth (Type P) backing. The cloth backing shall be of cloth, moisture and fungus resistant, and shall have a minimum useful life equal to or greater than that of the phosphorescent material. The material used to provide the fungus resistance shall be no more toxic than the copper 8-quinolinolate specified in CCC-D-950, inhibitor (e).

#### 3.11.5 Tape form.

3.11.5.1 Tape (Type P) luminance. The material shall conform to 3.11.1.1.

3.11.5.2 Tape (Type P) weathering. The phosphorescent material shall conform to 3.11.1.2. The tape backing shall remain in serviceable condition and shall show no signs of deterioration or separation from the phosphorescent material.

3.11.5.3 Tape (Type P) backing. The tape backing shall be moisture and fungus resistant, and shall have a minimum useful life equal to or greater than that of the phosphorescent material. The material used to provide the fungus resistance shall be copper 8-quinolinolate or equal, as specified in CCC-D-950, inhibitor (e).

3.11.5.4 Tape (Type P) flexibility. The minimum radius of curvature, to which the finished tape may be applied without cracking, separation of layers, or other damage, shall be not greater than 12.7 mm (1/2 inch).

3.11.5.5 Size. Unless otherwise specified (see 6.2), tape shall be furnished in rolls 10.2 cm (4 inches) wide and 9.14 meters (10 yards) long.

#### 3.12 Fluorescent (Type F).

3.12.1 Liquid or paste form (for application by brush or spatula).

### 3.12.1.1 Fluorescent luminance.

3.12.1.1.1 Installation. Where the material is to be furnished as part of an installation and where an ultra-violet light source will also be required, the luminance of the material when irradiated by that source under the conditions of actual installation shall be not less than 25 equivalent microlamberts.

3.12.1.1.2 Tungsten illumination. When irradiated by tungsten illumination as specified in 4.4.3.1.2, the luminance of the material shall be not less than 25 equivalent microlamberts.

3.12.1.2 Fluorescent weathering. The material shall not show reduction more than 50 percent in luminance following weathering for 84 hours when tested as specified in 4.4.3.2.2 without protective coating.

3.12.1.3 Fluorescent mixing. The material shall be furnished ready-mixed with all the necessary ingredients.

3.12.1.4 Accessory equipment. All equipment necessary for the proper application of the liquid or paste, including all brushes which are required, shall be furnished with the material.

3.12.1.5 Instructions. Full instructions for the application and drying of the product, for the preparation of surfaces prior to application, and for the protection of the finished surfaces shall be furnished by the supplier.

3.12.1.6 Drying time. The liquid or paste form material shall set to touch in not less than 1/2 hour nor more than 2 hours, and shall dry hard within 8 hours at a temperature of  $23^{\circ} \pm 1^{\circ} \text{C}$  ( $73.5 \pm 2^{\circ} \text{F}$ ) and a relative humidity of  $50 \pm 4$  percent.

3.12.1.7 Primer. A suitable primer shall be provided, when necessary or desirable, which shall remain acid-free upon aging, shall be free of heavy metals such as lead or iron, and shall not react with the fluorescent coat.

3.12.1.8 Protective coating. After application, it shall be possible to coat the material with a transparent adhering compound for mechanical protective purposes. The supplier shall supply, as a part of the instructions, complete information concerning the lacquers or other materials best suited for application over the fluorescent material.

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3.12.1.9 Fluorescent hiding power. Fluorescent material in the liquid or paste form shall have a hiding power such that 1 gallon will produce a completely fluorescent area of not less than 9.29 square meters (100 square feet) when applied over a primed surface.

3.12.2 Rigid plastic backed form.

3.12.2.1 Rigid plastic (Type F) luminance. The material shall conform to 3.12.1.1.

3.12.2.2 Rigid plastic (Type F) weathering. The material shall conform to 3.12.1.2.

3.12.2.3 Rigid plastic (Type F) backing. The backing material shall retain its shape without distortion, bending, warping, curling, softening, or flow, when subjected after mounting to acid fumes and humidity of not less than 75 percent atmospheric conditions at temperatures up to  $65^{\circ} \pm 2^{\circ} \text{C}$  ( $149^{\circ} \pm 3^{\circ} \text{F}$ ), regardless of the manner of mounting. The backing shall have a minimum useful life equal to or greater than that of the fluorescent material.

3.12.3 Flexible plastic backed form.

3.12.3.1 Flexible plastic (Type F) luminance. The material shall conform to 3.12.1.1.

3.12.3.2 Flexible plastic (Type F) weathering. The material shall not show a reduction of more than 10 percent in luminance following weathering for 150 hours when tested as specified in 4.4.3.2.2.

3.12.3.3 Fluorescent plastic material. The plastic material into which the fluorescent material is incorporated or which covers the fluorescent material shall retain its shape without distortion, bending, warping, curling, softening, or flow, when subjected to acid fumes and humidity of not less than 75 percent atmospheric conditions at  $65^{\circ} \pm 2^{\circ} \text{C}$  ( $149^{\circ} \pm 3^{\circ} \text{F}$ ), regardless of the manner of mounting. The plastic material shall have a minimum useful life equal to or greater than that of the fluorescent material.

3.12.4 Cloth form.

3.12.4.1 Cloth (Type F) luminance. The material shall conform to 3.12.1.1.

3.12.4.2 Cloth (Type F) weathering. The material shall conform to 3.12.1.2.

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3.12.4.3 Cloth (Type F) backing. The cloth backing shall be of cloth, moisture and fungus resistant, and shall have a minimum useful life equal to or greater than that of the fluorescent material. The material used to provide the fungus resistance shall be inhibitor (e) of CCC-D-950. There shall be no fungus growth when tested as specified in 4.4.3.12.

3.12.4.4 Size. Size of cloth shall be as specified (see 6.2).

3.12.5 Tape form.

3.12.5.1 Tape (Type F) luminance. The material shall conform to 3.12.1.1.

3.12.5.2 Tape (Type F) weathering. The material shall conform to 3.12.1.2.

3.12.5.3 Tape (Type F) backing. The tape backing shall be moisture and fungus resistant, and shall have a minimum useful life equal to or greater than that of the fluorescent material. The material used to provide the fungus resistance shall be inhibitor (e) of CCC-D-950. There shall be no fungus growth when tested as specified in 4.4.3.12.

3.12.5.4 Flexibility. The material shall conform to 3.11.5.4.

3.12.5.5 Size. Size of tape shall be as specified (see 6.2).

3.13 Ultra-violet light equipment. Equipment furnished for the irradiation of fluorescent materials shall be capable, when used in conjunction with a filter similar to Corning No. 5860, 3.75 mm thick, or its equivalent, of producing ultra-violet radiation within the wave-length limits of 3260 and 4020 Angstrom units. The equipment shall be capable of being operated at the voltage and frequency specified (see 6.2). Complete instructions shall be furnished for each complete equipment and shall contain, as a minimum, the following information:

- (a) General description.
- (b) Complete instructions for care, operation, and maintenance.
- (c) Parts identification by style, model, or catalog number.
- (d) Complete wiring diagram.
- (e) Manufacturer's name or symbol.
- (f) Manufacturer's type or model number.
- (g) Rated current and voltage.

3.14 Workmanship. The workmanship shall be such that the materials shall have no defects which may detrimentally affect the suitability of the material for its intended use. The material shall be manufactured by such processes as to assure compliance with the requirements of this specification.

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**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 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 this specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

**4.1.1 Component and material inspection.** The supplier is responsible for insuring that components and materials used are manufactured, examined, and tested in accordance with referenced specifications and standards.

**4.2 Classification of inspections.** Inspections shall be classified as follows:

- (a) Quality conformance inspection (see 4.3).
- (b) Inspection of preparation for delivery (see 4.5).

**4.3 Quality conformance inspection.**

**4.3.1 Sampling.** Sampling for examination and tests shall be in accordance with MIL-STD-105.

**4.3.2 Examination.** Samples selected in accordance with 4.3.1 shall be examined as specified in 4.4.1. AQL shall be 2.5 percent defective.

**4.3.3 Tests.** Samples selected in accordance with 4.3.1 shall be tested as specified in 4.4.2.

**4.4 Inspection procedure.**

**4.4.1 Examination.** The unit of product for examination shall be one packaged roll, sheet, or bottle. Examination shall be made on an unwound roll for the following defects:

- 101. Any visible imperfection affecting appearance or serviceability.
- 102. Ragged edges.
- 103. Dirty or discolored.
- 104. Cracked or blistered.
- 105. Peeled or chipped.
- 106. Hole, cut, tear, or sharp creases.
- 107. Irregularly wound.
- 108. Color not as specified.
- 109. Does not correspond to color range specified.
- 110. Width of roll not as specified.

4.4.2 Tests. Tests shall be in accordance with Table II. The sample unit shall be one roll, sheet, or bottle.

4.4.3 Inspection test procedures.

4.4.3.1 Luminance. The luminance of luminescent materials shall be determined by photoptically corrected photometers or by visual comparison methods. The visual comparison method consists of matching the luminance of a standard field with the luminescent surface under test. The luminance of the standard field shall be capable of being varied at will and shall be produced using a tungsten lamp operated at 2042 K color temperature (see 6.8 and 6.9).

4.4.3.1.1 Luminance measurement of Type P material.

4.4.3.1.1.1 Test equipment. The test equipment shall consist of a photomultiplier photometer or a photometer similar to Figure 1 or 2, and a tungsten projection lamp operating at a rated voltage of 115 volts, alternating current (a.c.). The lamp shall be 150 watts and shall furnish 100 foot-candles at a distance of 45 cm (17-11/16 inches).

4.4.3.1.1.2 Type P test specimens. When supplied in liquid or paste form, test specimens of at least 58 square centimeters (9 square inches), shall be prepared in accordance with the manufacturer's instructions by applying the luminescent material to either a painted sheet steel backing or to a suitable backing specified by the manufacturer. When supplied in plastic, tape or cloth form, the test specimens shall have an area of at least 58 square centimeters (9 square inches).

4.4.3.1.1.3 Luminance test procedure. The test specimens, after having been kept in complete darkness for a period of not less than 24 hours prior to test, shall be irradiated for 1 minute by an illumination of 100 foot-candles when the material is in rigid or flexible plastic backed, cloth or tape form and for 5 minutes if in liquid or paste form. Specimens shall be irradiated by exposure to a 150-watt General Electric Type CEW (or equivalent) projection lamp operated 115 volts a.c. After irradiation, luminance readings shall be made 2 minutes after exposure and thereafter at the end of 30, 60, and 180 minutes. Reading shall be made by an observer whose eyes have been dark-adapted for a period of at least 30 minutes and in an area where ambient temperature is 21° to 24° C (70° to 75° F). The inability of observer to make readings shall constitute failure of this test.

4.4.3.1.1.4 Low luminance measurements (Type P). For these luminance measurements visual photometer similar to those shown on Figures 1 and 2

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or a photomultiplier photometer shall be used. When a visual photometer is used, it shall have an optical field subtending at the eye an angle of at least 8 degrees, and unless otherwise specified (see 6.2), shall have the approval of either the National Bureau of Standards or the Naval Research Laboratory. The photomultiplier photometer shall be calibrated against a radioactive self-luminous marker or a standard lamp source, both having current calibrations traceable to the National Bureau of Standards. The color of the marker shall not be different from the test sample except when using a photomultiplier photometer corrected for photoptic vision. Nonconformance to requirements in 3.11.1.1 shall constitute failure of this test.

4.4.3.1.2 Luminance measurements of Type F material. Test equipment, test specimens, conditioning, and test procedures, where applicable, shall be as specified in 4.4.3.1.1 for phosphorescent materials, with the exception of the excitation lamp which shall be a miniature blacklight fluorescent lamp (G. E. MF5000 or equivalent) in combination with a Corning 5860 filter or equivalent of sufficient thickness so that the combination has a spectral distribution that contains no radiation below 330 nanometers and none above 420 nanometers with the principle radiation being around 365 nanometers. The intensity of the excitation of the lamp on the specimen is controlled by the lamp to specimen distance, which is determined by means of a calibrated reference plaque for fluorescent materials. The luminance shall be measured at an angle of 40 degrees to the plane of the sample. The plaque shall be placed in the specimen position and the lamp to plaque distance varied until the luminance is equal to that of the calibrated value of the plaques. These plaques are available for loan upon application to the Warner Robins Air Logistics Center, WRALC/META, Robins Air Force Base, Georgia 31093 (Autovon 468-3236 Aug 1974). Luminance values shall be reported in equivalent microlamberts. Nonconformance to 3.12.1.1.1 shall constitute failure of this test.

4.4.3.2 Weathering. The weathering tests of luminescent materials shall be conducted in accordance with the following paragraphs, unless otherwise specified (see 6.2).

4.4.3.2.1 Weathering of Type P material.

4.4.3.2.1.1 Test apparatus. The test apparatus shall be as required in FED. STD. No. 141, Method 6061, Salt spray (Fog) Test (5 percent salt) and Accelerated Weathering Open Arc Apparatus Method 6151, or Xenon Apparatus specified in ASTM G 26, Type BH.

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4.4.3.2.1.2 Test procedure. The test procedure shall be as specified in FED. STD. No. 141, Methods 6061 and 6151, or ASTM G 26, Type BH for Xenon weathermeter, with the specimens being conditioned for 40 hours in each method. Nonconformance to 3.3, 3.9.1.2 and 3.11.1.2 shall constitute failure of this test.

#### 4.4.3.2.2 Weathering of Type F materials.

4.4.3.2.2.1 Weathering test equipment. The test equipment used shall be a National-Accelerated Weathering Unit, Model X-I-A, Atlas Weathermeter or Atlas Xenon Weathermeter, Model 600 WR, or equivalent.

4.4.3.2.2.2 Weathering test procedure. The samples shall be fitted on the rack. On each revolution of the rack each sample shall receive a bath of tap water from continuously operating spray nozzles. A carbon arc taking approximately 70 amperes shall subject the samples to intense ultra-violet radiation at a distance of 47.6 cm (18-3/4 inches). Panels of "Corex D" or equivalent glass shall surround the arc to cut off the ultra-violet range of the spectrum below a wave length of 2,700 Angstrom units. A supplementary blower shall be used, if necessary, to maintain the samples at an ambient temperature of approximately 49° C (120° F). Xenon test procedures are in ASTM G 26, Type BH. Nonconformance to 3.3, 3.9.1.2 and 3.11.1.2 shall constitute failure of this test.

#### 4.4.3.3 Flammability.

4.4.3.3.1 Flammability test equipment. The test equipment shall consist of a Bunsen or Tirril gas burner, having a tube of 9.5 mm (3/8 inch) inside diameter, and with the air supply completely shut off, adjusted to give a luminous flame 3.8 cm (1-1/2 inches) long, enclosed in a sheet-metal shield 30.5 cm (12 inches) wide, 30.5 cm (12 inches) deep, and 76.2 cm (30 inches) high, open at the top, and provided with a vertical sliding glass front. Sufficient room shall be left at the bottom of the front to allow manipulation of the gas burner used in igniting the specimen. A clamp shall be provided to suspend the specimen vertically from its upper end, approximately in the center of the apparatus.

4.4.3.3.2 Type F test specimens. Test specimens, when supplied in liquid or paste form, shall be painted sheet steel panels, 7.6 cm by 12.7 cm (3 by 5 inches), prepared as specified in 4.4.3.1.1.2. When supplied in plastic and applied forms, specimens 7.6 cm by 12.7 cm (3 by 5 inches) as furnished by the supplier shall be fastened by suitable means (small screws or adhesive) to the painted sheet steel panel specified herein. When supplied in tape and cloth forms, specimens 7.6 cm by 12.7 cm (3 by 5 inches) shall be applied to the painted sheet steel panels specified herein by means of suitable adhesive or clamps. (Note. In

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preparing the specimens it is important that the lower edges of the luminescent material and the painted sheet steel panel are in close coincidence, and that the complete specimen is thoroughly dried prior to testing.)

4.4.3.3 Flammability test procedure. The test specimens shall be suspended vertically from a clamp covering the upper 12.7 mm (1/2 inch) of length, so adjusted that the lower end is 19 mm (3/4 inch) above the top of the Bunsen burner. The flame shall be applied vertically near the middle of the width of the lower end of the specimen for 12 seconds, then withdrawn, and the duration of the flaming in the specimen noted. Failure of the specimen to extinguish in 5 seconds shall constitute failure of this test.

4.4.3.4 Temperature deformation. Specimens as received shall be suspended vertically in an oven maintained at  $52^{\circ} \pm 1^{\circ} \text{C}$  ( $125^{\circ} \pm 2^{\circ} \text{F}$ ) for 24 hours. After removal from the oven, the specimens shall be examined for defects. For liquid or paste form, specimens shall be prepared as specified in 4.4.3.1.1.2. For forms supplied with adhesive backing, specimens shall be applied to painted sheet steel panels. The specimens shall be visually examined and any deformation shall constitute failure of this test.

4.4.3.5 Low-temperature test. Test specimens which have previously been exposed to the weathering test shall be subjected to the following:

- (a) Specimens shall be vertically positioned in a  $-40^{\circ} \pm 1^{\circ} \text{C}$  ( $140^{\circ} \pm 2^{\circ} \text{F}$ ) chamber for 1 hour.
- (b) Specimens shall be removed from the  $-40^{\circ} \pm 1^{\circ} \text{C}$  ( $-40^{\circ} \pm 2^{\circ} \text{F}$ ) environment and vertically positioned in a  $49^{\circ} \text{C} \pm 1^{\circ} \text{C}$  ( $120^{\circ} \pm 2^{\circ} \text{F}$ ), and 90 percent  $\pm$  2 percent relative humidity chamber for 1 hour.

4.4.3.5.1 Visual examination. After the specimens have been subjected to six consecutive exposures to the above cycle, they shall be examined visually for conformance with 3.7. Nonconformance to the requirements of 3.7 shall constitute failure of this test.

4.4.3.6 Humidity test. Specimens shall be subjected to an environment of  $65.9^{\circ} \pm 1^{\circ} \text{C}$  ( $150^{\circ} \pm 2^{\circ} \text{F}$ ) and 90 percent  $\pm$  2 percent relative humidity for 24 hours. They shall then be subjected to room temperature and ambient relative humidity for the next 24 hours. Three 48-hour cycles of this type shall be performed to determine conformance with 3.8. Nonconformance to 3.8 shall constitute failure of this test.

#### 4.4.3.7 Adhesiveness.

4.4.3.7.1 Test equipment. Test equipment for the adhesive test shall consist of the following items:

- (a) Cleaned float plate glass, 6.4 mm (1/4 inch) thick, by 12.7 cm (5 inches) wide, by 30.5 cm (12 inches) long.
- (b) A 500 gram weight including a means of attaching to the samples.
- (c) A 2.04 Kg (4.5 pound) steel-cored rubber-faced roller. The rubber facing shall have a shore hardness of 70 to 80.
- (d) A timer.
- (e) Scale (metric).
- (f) Sample cutting equipment.
- (g) Glass cleaning solvent shall be of equal volumes of aliphatic naphtha conforming to TT-N-95, Type I and xylene conforming to TT-X-916, Grade A.

4.4.3.7.2 Cleaning the glass plate. Prior to the test the glass plates shall be cleaned with detergent and water and then cleaned a minimum of five times, three times on the test side and two times on the reverse side with the solvent specified in 4.4.3.7.1. The plates shall then be allowed to dry at a room temperature of 21.1° to 23.9° C (70° to 75° F) until all solvent has evaporated. The panels shall then be polished with a clean, lintless cloth (birdseye) to a streakless surface. After the cleaning process, each plate shall be dipped momentarily into distilled water. If the surface of the plate does not retain a continuous film of water for 15 seconds it may be necessary to immerse the plates in methyl alcohol to obtain the break-free water surface. When this is required, immerse the plates in methyl alcohol, remove, and dry at a temperature of between 52° to 93° C (125° to 200° F) and cool to room temperature. Again dip the plates momentarily in distilled water and check for continuous water film on the surface. If the film does not remain continuous for at least 15 seconds the entire cleaning process must be repeated.

Note: It is extremely important that during the entire cleaning process and the test that the surfaces of the glass plate and the adhesive on the samples are not touched by the fingers.

4.4.3.7.3 Adhesive test procedure. Six samples, 2.54 by 22.9 cm (1 by 9 inches) shall be used for this test. The protective backing shall be removed and one end of the sample placed near one end of the glass plate and off to one side so that two samples may be used on one glass plate. The samples shall be carefully mounted on the glass plate so that there are no air bubbles. The last 13 mm (1/2 inch) shall be turned back on itself to provide a double thickness for attaching the

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weights. The samples shall then be rolled three times in each direction at a rate of 2.5 cm (1 inch) per second using the weight of the roller only. The roller is rubber over a steel core with an overall diameter of 8.25 cm (3.25 inches), width of 6.35 cm (2.5 inches) and weighs 2.043 kgm (4.5 pounds). The rubber shall have a shore hardness of 70-80. Each plate shall then be turned over (with the samples on the bottom) and supported above the working surface at each end. The elevation of the glass plate shall be such that the weight will clear the working surface during the entire test. Place a metric scale on top of the glass plate with the zero end 7 or 9 cm from the folded end. Attach the weight to the fold of the sample and time the peeling process from the zero mark on the scale to the 10 cm mark. Nonconformance to 3.9.1.4 shall constitute failure of this test.

**4.4.3.8 Flexibility for tape and cloth forms.** A painted steel mandrel, 2.54 cm (1 inch) in diameter, shall be conditioned to  $10^{\circ}\text{C} \pm 1^{\circ}\text{C}$  ( $50^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ) together with specimens of the tape or cloth 10.2 cm ( $\frac{4}{3}$  inches) wide and 20.3 cm (8 inches) long. After conditioning, the specimens shall be wrapped around the mandrel at a rate of approximately 30 degrees ( $\frac{1}{2}$  radian) per second, care being exercised to maintain temperature equilibrium. After remaining wrapped at  $10^{\circ}\text{C} \pm 1^{\circ}\text{C}$  ( $50^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ) for 10 minutes, the specimens shall be examined closely for cracks and separation of parts, then unrolled, spread out, and reexamined. For adhesively backed materials, the adhesiveness of the material at  $10^{\circ}\text{C} \pm 1^{\circ}\text{C}$  ( $50^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ) shall be noted qualitatively. Upon examination and reexamination, evidence of any cracks or separation of parts shall constitute failure of this test.

**4.4.3.9 Shelf aging.** Unless otherwise specified (see 6.2 and 6.3), material shall be stored. After 30 days of storage the material shall be tested for compliance with 3.10. Nonconformance to 3.10 shall constitute failure of this test.

**4.4.3.10 Color matching.** The color of the material under conditions specified in 4.4.3.2 shall be determined and reported. The method used, shall be color matching. Nonconformance to 4.4.3.1 shall constitute failure of this test.

**4.4.3.11 Test of ultra-violet equipment.** The spectral characteristics of the radiation from ultra-violet equipment furnished under this specification shall be determined by standard spectrophotometric methods. Nonconformance to 3.13 shall constitute failure of this test.

**4.4.3.12 Fungus resistance.** When specified (see 6.2), the luminance material shall be tested for fungus resistance in accordance with FED. STD. No. 141, Method 6271, except that (1) *Aspergillus oryzae*, ATCC 10196 or QM 1273 shall be used as the test organism (see 6.7), (2) test specimens shall be leached before inoculation, (3) the incubation period shall be 7 days, and, (4) the sterile distilled water used in the preparation of the inoculum shall contain 0.005 percent of a nontoxic wetting agent. Nonconformance to 3.12.4.3 or 3.12.5.3 shall constitute failure of this test.

Table II. Inspection Tests

Characteristic	Require- ment par.	Test method	Requirement applicable to		Determi- nation per sample unit	Results rptd. as	Inspec- tion level	AQL
			Ind. Unit	Lot avg.				
Luminance.....	3.11.1.1 3.12.1.1	4.4.3.1	-	X	2	Nearest 0.1 equivalent micro- lambert	L-1	MA
Weathering.....	3.11.1.2 3.12.1.2	4.4.3.2	-	X	2	Nearest 1.0%	L-1	MA
Flexibility.....	3.11.5.4 3.12.5.4	4.4.3.8	X	-	1	Pass or fail (Describe failure)	L-1	6.5
Adhesion.....	3.9.1.4	4.4.3.7	-	X	2	Nearest minute	L-1	MA
Temperature deformation.....	3.6	4.4.3.4	X	-	1	Pass or fail (Describe failure)	L-1	6.5
Low temperature.	3.7	4.4.3.5	X	-	2	Pass or fail (Describe failure)	L-1	6.5
Flammability.....	3.4	4.4.3.3	X	-	1	To nearest second	L-1	6.5
Humidity.....	3.8	4.4.3.6	X	-	1	Pass or fail	L-1	6.5
Shelf life.....	3.10	4.4.3.9				See 6.3.		

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4.5 Inspection of preparation for delivery.4.5.1 Quality conformance inspection of pack.

4.5.1.1 Unit of product. For the purpose of inspection, a completed pack prepared for shipment shall be considered a unit of product.

4.5.1.2 Sampling. Sampling for examination shall be in accordance with MIL-STD-105.

4.5.1.3 Examination. Samples selected in accordance with 4.5.1.2 shall be examined for the following defects. AQL shall be 2.5 percent defective.

- 111. Materials, methods, or containers not as specified for Level A or B. Each incorrect material, method, or container shall be considered one defect.
- 112. Liquid or paste luminescent material and primer not furnished in type of jars or cans specified for Level A or B.
- 113. Lining material for screwcaps not as specified for Level A or B.
- 114. Screwcaps not securely tensioned and sealed as specified for Level A or B.
- 115. Exterior coating and side-seam stripping not accomplished as required for Level A or B.
- 116. Brush bristles not protected as specified for Level A or B.
- 117. Plastic and cloth forms of luminescent material not protected from abrasion as specified for Level A or B.
- 118. Container for tape not provided with a centering device as specified for Level A or B.
- 119. Consolidated packaging not as specified for Level A or B.
- 120. Gross weight exceeds 90.7 kg (200 pounds) for Level A or B.
- 121. Gross weight or size exceeds the limitations of the box specification for Level B.
- 122. Marking missing, illegible, incorrect, or incomplete.

## 5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging. Preservation and packaging shall be Level A, B, or C as specified (see 6.2).

5.1.1 Level A.

5.1.1.1 Liquid or paste luminescent material and primer. Liquid or paste luminescent material and primer shall be furnished in 56.7 or 113.4 grams (2 or 4 ounce) capacity glass bottles or jars or .946 liter (1 quart) capacity metal cans.

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5.1.1.1.1 Glass bottles or jars. The glass containers shall be commercial type bottles or jars with an opening of not less than 7.62 cm (3 inches). The containers shall be closed with a continuous screwcap with nonabsorbent lining material which will remain in the cap when the cap is removed. The lining material shall be resilient or be backed by a resilient material which will not affect or be affected by the packaged product. After filling the container, caps shall have such tension applied as to seal the container against leakage and loosening during shipment, handling and storage. Caps shall be further sealed with cellulose bands or other suitable material in such a manner that will be impossible to remove any luminescent material without destroying the seal.

5.1.1.1.2 Cans. The .946 liter (1 quart) capacity can shall conform to PPP-C-96, Type V, Class 2. Plan B exterior coating and sideseam stripping shall be required.

5.1.1.1.3 Accessory equipment.

5.1.1.1.3.1 Brushes. The brush bristles shall be protected from physical damage and the brushes individually preserved in accordance with MIL-P-116, Method IC-1.

5.1.1.1.3.2 Spatulas. Metal spatulas, if furnished, shall be individually preserved in accordance with MIL-P-116, Method IC-1, using Type P-2 or P-6 preservative on metal surfaces. Wood spatulas shall not require preservation.

5.1.1.2 Plastic and cloth forms of luminescent material. Plastic and cloth forms of luminescent material of like description shall be protected from abrasion with slip sheeting of kraft paper conforming to UU-P-268, type and grade optional, and preserved together in accordance with MIL-P-116, Method IC-2. The container shall be supplier's commercial container or a close-fitting box conforming to PPP-B-566 or PPP-B-676.

5.1.1.3 Tape. Rolls of tape shall be individually preserved in accordance with MIL-P-116, Method IC-2. The container shall be the supplier's commercial container or a close-fitting box conforming to PPP-B-566 or PPP-B-676, and shall have a centering device to prevent shifting of the roll within the box.

5.1.1.4 Instructions. Instructions when furnished as loose sheets shall be individually preserved in accordance with MIL-P-116, Method IC-1, and the required quantity placed in each of the consolidated packaging boxes specified in 5.1.1.5.

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5.1.1.5 Consolidated packaging.

5.1.1.5.1 Liquid or paste luminescent material and primer and spatulas and brushes. Luminescent material and primer in liquid or paste form packaged in 56.7 to 113.4 gram (2 to 4 ounces), or .946 liter (1 quart) containers and the required quantity of brushes and spatulas for each container shall be consolidated packaged together in boxes conforming to PPP-B-636, W6c. Boxes containing glass bottles or jars shall have partitions, vertical fiberboard liners and full size top and bottom pads. Fiberboard separators shall be placed between all layers of unit packages. The cells formed by the partitions and separators shall be of minimum size so that the glass containers shall contact all four sides of the cell. When required to provide protection of glass containers within the cells, additional cushioning shall be affected by the insertion of cellulose wadding or similar material.

5.1.1.5.2 Plastic and cloth forms of luminescent material. Plastic and cloth forms of luminescent material packaged as specified in 5.1.1.2 shall be consolidated packaged together in quantities not to exceed the weight limitation of the box in a close-fitting box conforming to PPP-B-636, W6c.

5.1.1.5.3 Tape. Rolls of tape packaged as specified in 5.1.1.3 shall be consolidated packaged together in quantities not to exceed the weight limitation of the box in a close-fitting box conforming to PPP-B-636, W6c.

5.1.2 Level B. Preservation and packaging shall be as specified in 5.1.1 for Level A, except the boxes for consolidated packaging shall be Type CF, Class Domestic, Variety SW, Grade 125.

5.1.3 Level C. Luminescent material and accessories shall be preserved and packaged in a manner to afford protection against deterioration and damage from the supplier to the initial destination.

5.2 Packing. Packing shall be Level A, B, or C as specified (see 6.2).

5.2.1 Level A. Luminescent material and accessories preserved and packaged as specified in 5.1, shall be packed in boxes conforming to PPP-B-601, Overseas Type, style optional. The gross weight shall not exceed 90.7 kg (200 pounds). The box shall be closed and strapped in accordance with the appendix to the box specification.

5.2.2 Level B. Luminescent material and accessories preserved and packaged as specified in 5.1 shall be packed in boxes conforming to PPP-B-636, V3c, style optional. The gross weight or size of each box shall not exceed the limitations of the box specification. Closure and strapping shall be in accordance with the appendix to the box specification.

5.2.3 Level C. Luminescent material and accessories, preserved and packaged as specified in 5.1, shall be packed in fiberboard containers to assure carrier acceptance and safe delivery to destination at lowest rating in compliance with Uniform Freight Classification rules or National Motor Freight Classification rules.

5.3 Marking. Packages and shipping containers shall be marked in accordance with MIL-STD-129; and, in addition, the marking shall include the month and year of manufacture.

## 6. NOTES

### 6.1 Intended use.

6.1.1 Type P. Phosphorescent material is used where it is required to remain luminous after the activating source is removed. Such material is intended for applications to be observed for as long as 8 hours, after the observer has become well dark-adapted. It is not suited for uses requiring observation before the observer has been dark-adapted less than 20 minutes.

6.1.2 Type F. Fluorescent material is intended for nighttime applications requiring constant low intensity localized illumination. Its use requires special ultra-violet lighting equipment and practically requires custom-built installation for the specific application. Fluorescent material also is intended for daylight use where greater luminance and contrast is desired. In this case, sunlight furnishes the ultra-violet. Such materials "reflect" more than 100 percent of the incident visible light due to the conversion of ultra-violet to visible light.

6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Type, form, and color (before and after irradiation) of material required (see 1.2).
- (c) Shapes and sizes required (see 1.2).
- (d) Dimensions of rectangular sheets and diameter of disks (see 1.2).
- (e) When activating equipment is required (see 1.2.2).
- (f) The character of the light source for irradiation of the luminescent material, such as daylight, artificial light (visible) of any particular type, or ultra-violet light (see 3.1.1).

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- (g) Adhesive or nonadhesive backing (see 3.9).
- (h) When size shall be other than as specified (see 3.11.5.5).
- (i) Size of cloth or tape (see 3.12.4.4 and 3.12.5.5).
- (j) Voltage and frequency required for illuminating equipment (see 3.13).
- (k) When approval is not required (see 4.4.3.1.1.4).
- (l) When test shall be other than as specified (see 4.4.3.2).
- (m) When certificate of compliance is acceptable in lieu of test (see 4.4.3.9 and 6.3).
- (n) When the fungus test is required (see 4.4.3.12).
- (o) Level of preservation and packaging and level of packing required (see 5.1 and 5.2). Level B preservation, packaging and packing is intended to provide economical but limited protection and should be specified only when it is determined the luminescent material will be held in covered storage.

6.3 Shelf life. In lieu of testing as specified in 4.4.3.9, a certificate of compliance may be accepted from the supplier.

6.4 Properties. The fluorescent and phosphorescent properties of luminescent material in liquid or paste form depend upon the composition and thickness of the applied film. It is essential that the manufacturer's instructions be followed explicitly in this regard. The life of phosphorescent material will be considerably extended if care is taken to keep it dry. It should not be stored in moist places.

6.5 Color. In specifying color, care should be given to the intended application for the material required. At low levels of illumination the dark adaptation of the eye is affected less by relatively bright red light than by a lower brightness light of any other color. Considering this fact, where a relatively high constant-luminance (fluorescent) material is desired for the illumination of signs, instrument dials, and so forth, while still maintaining the dark adaptation of the eye of the observer, material which fluoresces in the red or orange-red portion of the spectrum should be specified.

6.6 Toxicity. Any questions raised regarding toxicity should be referred to the departmental medical authority. In the case of Army procurement, the Surgeon General will act as advisor to the procurement agency.

6.7 Cultures. Cultures of the organisms used in 4.4.3.12 may be obtained from the American Type Culture Collection, 12301 Parklawn Drive, Rockville, MD 20852, or for service use, from the Mycology Group, Pioneering Research Laboratory, U. S. Army, Natick Laboratories, Natick, MA 01760.

**6.8 Sensitivity.** For ordinary illuminations, the maximum sensitivity of the normal eye occurs in the green region of the visible spectrum. With decreasing illumination the region of maximum sensitivity shifts progressively in the direction of the blue region and the eye becomes progressively more blue sensitive. The values of luminance of phosphorescent materials fall mostly within the range in which this shift in sensitivity is most pronounced. For this reason, dials to be read at the lowest absolute luminance shall emit in the blue-green region of the spectrum.

**6.9 Luminance.** The human eye has the property that the sensitivity curve shifts towards the blue region of the spectrum as the luminance of an observed surface decreases from approximately 100 to 0.5 microlambert. For this reason a special system of photometric units has been adopted by national laboratories throughout the world. This system serves well to evaluate luminance values within this region for all colors of the spectrum. Above 100 microlamberts and below 0.5 microlambert the sensitivity characteristics of the eye remain constant but not equal. The luminance of the material covered by this specification falls within the range from 100 microlamberts down to the threshold value of the eye.

**6.9.1 System.** To establish a useful system of photometric units within this range it has been agreed that the standard source of illumination will be tungsten lamp operating at a color temperature of 2042 K, and that all comparisons of luminance regardless of color, shall be made a perfectly reflecting and diffusing surface illuminated with this 2042 K source. Practically, this can be a surface of MgO or MgCO<sub>3</sub> or some suitable reflecting and diffusing glass surface whose reflection factor is known.

**6.9.2 Photometric observers.** The success of this system as measured by the ability of photometric observers to agree in measurements depends upon the observers being well trained in photometric technique. Relatively few Government or commercial laboratories are equipped with measuring devices or experienced personnel to carry out successfully measurements in low luminance photometry. To overcome this difficulty it is suggested that, when necessary, laboratories or commercial establishments use the following procedure. Select a series of three samples from luminescent material in current production over a range of luminance values consistent with the application to be made. Submit these samples to a laboratory qualified to make the necessary certification of luminance. Optical filters should be obtained which match closely in color these calibrated samples. These filters would then be used in the comparison field of a suitable low luminance photometer, thus enabling relatively nonskilled observers to make fairly accurate measurements.

**6.9.2.1 Luminance of diffusing surface.** The luminance of this diffusing surface in equivalent microlamberts is defined by the following equation:

$$L = \frac{ITR}{d^2} \times 10^6$$

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Where:

- I = Intensity of the 2042 K lamp in candles.
- T = Transmission of any attenuator (filter, sector disc, etc.) between lamp and the diffusing surface.
- R = Reflectance of the diffusing surface.
- d = Distance between lamp and diffusing surface in centimeters.

6.10 Explanation of Figure 1. Figure 1 illustrates a special photometer, in which only mechanical means, that is, change of distance and diaphragms, are employed to control the luminance of the comparison field, so that no change in spectral composition is introduced. The exact details of a suitable "wide-angle" photometer are left to the choice of the maker. However, for the guidance of suppliers who are interested in establishing control facilities, Figure 1 is a drawing of the photometer now in use for this purpose by the National Bureau of Standards. Further details of this photometer are as follows:

The box in which the lamp runs on a track is about 10.4 cm (4 inches) square by 55.9 cm (22 inches) long. The luminance of the opal glass,  $S_1$ , depends upon the distance between it and the lamp, L, (an automobile lamp of 32 candle-power nominal rating operated at about 3 amperes). A pointer moves over a distance scale just above the rheostats and knob on the side of the photometer. The luminance of the screen,  $S_2$ , depends upon the brightness of  $S_1$ . At the bottom of the tube on the left there is a semicircular mirror, which forms one-half of the photometric field, while a sample viewed directly forms the other half. A set of diaphragms with holes having areas varying by factors of about 10 has been made and the distance can be varied enough to secure a factor more than 15 to 1 in the square of the distance; accordingly, the instrument presents a wide range of luminosity variation. In use, the lamp, L, is operated at the current necessary to have the light emitted by screen,  $S_2$ , at a color temperature of 2042 K. (A more detailed description is given in National Bureau of Standards Journal, Research 34, 325 (April, 1945), RP1646.)

6.11 The steel-cored rubber roller, 3.25 inches in diameter, 2.5 inches wide, weight of 4.5 pounds and with the rubber having a shore hardness of 70-80 can be purchased from:

Pressure-Sensitive Tape Council  
1201 Waukegan Road  
Glenview, IL 60025.

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Air Force - 84

Review activities:

Army - MI  
DSA - IS, GS

User activities:

Army - EL  
Navy - SA, SH

Preparing activity:

Army - ME

Project No. 9390-0034



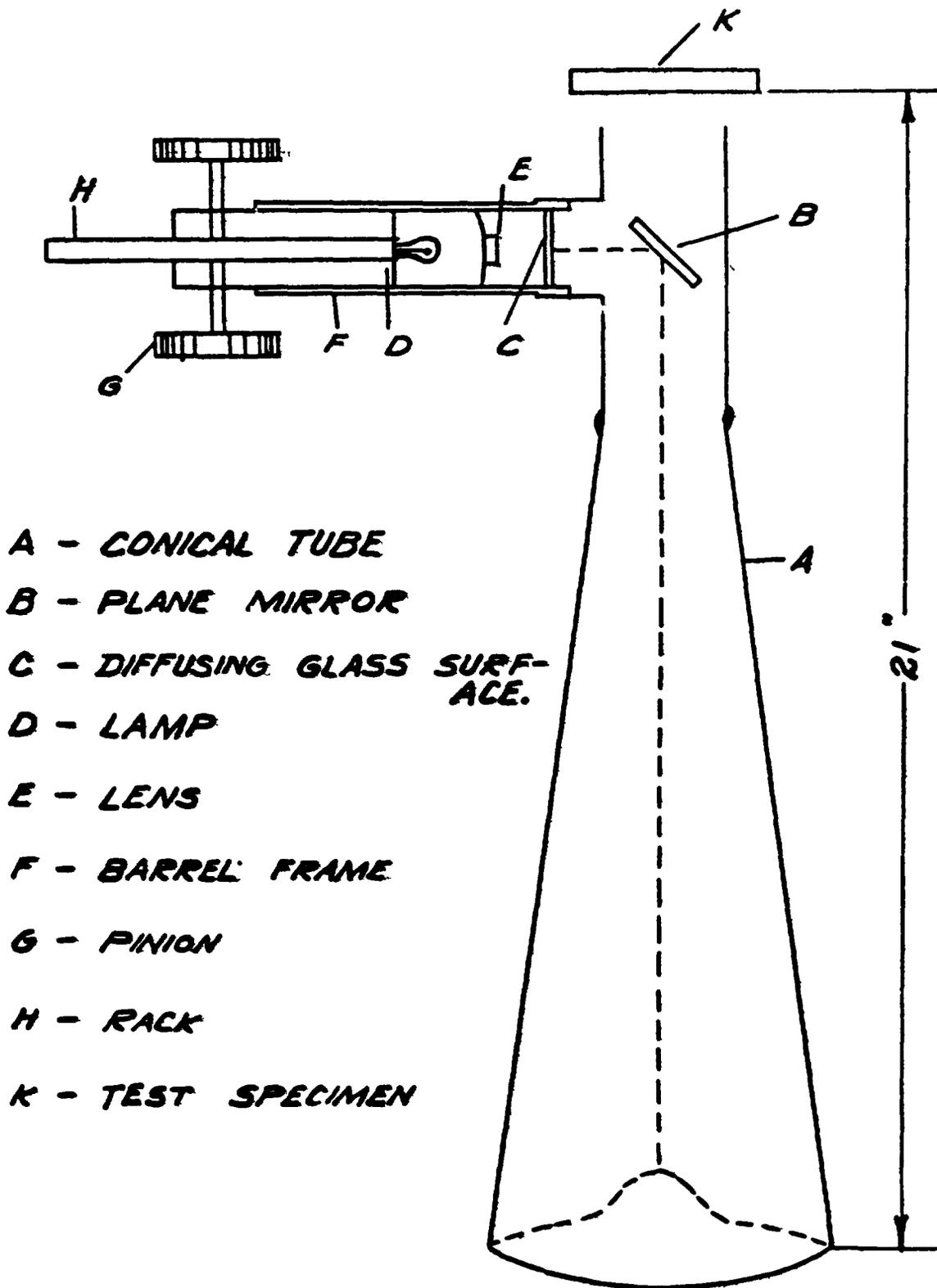


FIGURE 2. Low-luminosity photometer.

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