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MIL-F-21241(NOrd)
4 December 1958
SUPERSEDING
NAVORD OS 1650B
8 October 1948

MILITARY SPECIFICATION

FILTERS, COLOR, FINISHED (FOR OPTICAL INSTRUMENTS)

1. SCOPE

1.1 Scope. This specification covers finished color filters for use in optical instruments. It is not intended to cover polarizing filters.

1.2 Classification. Filters shall be of the following types, colors, and grades, as specified (see 6.2):

Types:
- Type I – Solid glass.
- Type II – Laminated.

Colors:
- Red.
- Yellow.
- Aircraft neutral.
- Light neutral.
- Dark neutral.
- Searchlight neutral.

Grades:
- Grade A – Adequate for use near the focal plane of an eyepiece.
- Grade BT – Adequate for use near a telescope objective lens.
- Grade BR – Adequate for use near a rangefinder objective lens.
- Grade C – Adequate for use at unit magnification, or with the unaided eye.

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.

SPECIFICATIONS

FEDERAL

L-P-406	Plastics, organic: General Specifications, Test Methods.
PPP-B-591	Boxes, Fiberboard, Wood-Cleated
PPP-B-601	Boxes, Wood, Cleated Plywood

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PPP-B-621	Boxes, Wood, Nailed and Lock-Corner
PPP-B-636	Boxes, Fiber

MILITARY

MIL-P-116	Preservation, Methods of
MIL-B-131	Barrier Material; Water Vaporproof, Flexible
MIL-B-10377	Boxes, Veneer, Paper, Covered
MIL-L-10547	Liners, Case

STANDARDS

MILITARY

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

DRAWINGS

BUREAU OF ORDNANCE

List of drawings and drawings called for on the applicable schedule or contract or order (see 6.2).

PUBLICATIONS

BUREAU OF ORDNANCE

OP 400	General Instructions for the Design, Manufacture, and Inspection of Naval Ordnance Equipment.

(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 Preproduction sample. Unless otherwise specified in the contract or order (see 6.2), a preproduction sample is required (see 4.3.1) for each type, color, grade, and size filter called for in the contract or order. Samples shall be manufactured using the methods, procedures, and plant location proposed for the production lot. Samples shall be inspected as specified under 4.4.4.1, such inspection being for the purpose of determining that the manufacturer's production process will produce filters that will meet the requirements of this specification. Costs of preproduction inspection of filters failing to meet all requirements of this specification shall be borne by the contractor.

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3.2 Material and construction. Type I filters shall consist of a single homogenous plate of stable, non-hygroscopic glass. Type II filters shall consist of a single sheet of colored plastic bonded between two plates of colorless, stable, non-hygroscopic glass. Filters differing in construction as specified above will be considered for procurement by the procuring activity. Approval by the procuring activity must be obtained for such difference in construction before submittal of bids.

3.3 Shape and dimensions. The shape and dimensions of filters shall be as specified on the applicable drawings.

3.4 Color.

3.4.1 Comparison standards (standard filters).

3.4.1.1 Filter sets. For each color of production filters required by the contract or order, the contractor shall furnish the Government inspector a set of four filters, except as provided for in 3.4.1.5, as color comparison standards. The color requirements of each set of standard filters shall be the same as the color requirements specified herein for the production filters that each set of standard filters represents. The spectral transmittance curves of a set of filters shall be similar in every respect consistent with specified values. Two filters of each set shall have a luminous transmittance equal to the maximum value that any filter of a particular color of production filters furnished under a contract will have and the other two filters shall have the minimum value that any production filter will have (see 6.3).

3.4.1.2 Data. Each standard filter, except searchlight-neutral filters, shall be accompanied by a table or curve of its spectral transmittance, its luminous transmittance value, and its chromaticity coordinates "x" and "y". Unless otherwise specified in the contract or order (see 6.2), each searchlight-neutral standard filter shall be accompanied only by its luminous transmittance value.

3.4.1.3 Size and quality. Standard filters shall be circular with a diameter of 40 ± 2 milimeters. The thickness of standard filters shall be not less than two nor more than five millimeters, the actual thickness between these limits being such as to obtain the transmittance limits specified herein. The optical quality of standard filters shall be that of Grade A filters specified herein.

3.4.1.4 Marking. Each set of standard filters and accompanying data shall be forwarded by the Government inspector to the procuring activity or its testing agency, as may be directed by the procuring activity, for approval as color standards. Upon approval, each standard filter shall be permanently scribed by the testing agency to show its luminous transmittance value, the manufacturer, the testing agency, and date of approval. The marking shall be placed around the margin of one of the polished surfaces and shall extend in toward the center not more than three millimeters.

3.4.1.5 Disposition. From each set of standard filters approved for use, one light and one dark filter shall be retained by the procuring activity or its testing agency and the remaining two filters shall be returned to the Government inspector. Upon completion of a contract, the Government inspector shall return his standard filters to the contractor. Sets of standard filters approved for use for any contract may be used for subsequent contracts without additional tests, provided the filters are satisfactory for use as color comparison standards. It is the contractor's responsibility to detect and report in his bid, any change in the transmittance values that may have occurred due to aging or other causes.

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3.4.2 Production filters.

3.4.2.1 Spectral and luminous transmittances, general requirements. The spectral transmittance curves of the filters of a particular color shall be similar in every respect, consistent with transmittance values specified herein, to those of the approved set of standard filters of that color. The luminous transmittance value of each filter of a particular color shall lie between the maximum (light) and minimum (dark) luminous transmittance values of the approved set of standard filters of that color.

3.4.2.2 Red filters.

3.4.2.2.1 Spectral transmittance. The short wave length spectral transmittance for red filters shall be as follows:

Not over 1-percent at 540 millimicrons and shorter wave lengths.
Not over 5-percent at 570 millimicrons.
Not over 10-percent at 580 millimicrons.
Not over 30-percent at 590 millimicrons.

The long wave length spectral transmittance shall be such that the luminous transmittance value specified in 3.4.2.2.2 will be met.

3.4.2.2.2 Luminous transmittance. The luminous transmittance for red filters shall be not less than 8-percent.

3.4.2.3 Yellow filters.

3.4.2.3.1 Spectral transmittance. The short wave length spectral transmittance for yellow filters shall be as follows:

Not over 1-percent at 480 millimicrons and shorter wave lengths.
Not over 3-percent at 500 millimicrons.
Not over 8-percent at 510 millimicrons.
Not over 20-percent at 520 millimicrons.

The long wave length spectral transmittance shall be such that the luminous transmittance value specified in 3.4.2.3.2 will be met.

3.4.2.3.2 Luminous transmittance. The luminous transmittance for yellow filters shall be not less than 50-percent.

3.4.2.4 Neutral filters, except searchlight neutral.

3.4.2.4.1 Chromaticities. Aircraft neutral, light neutral, and dark neutral filters shall appear substantially neutral in color and shall have chromaticities meeting the requirements as expressed by the following algebraic expressions (see 6.3). The x-value shall be not greater than $0.759 - 1.056y$ nor less than $0.368 - 0.184y$. The y–value shall be not less than $0.134 + 0.589x$ nor greater than $0.719 - 0.947x$. These limits are shown graphically by the heavy lines in Figure 1.

3.4.2.4.2 Chromaticity deviation. Neutral filters having excitation purities of 10-percent or less but whose chromaticities do not lie within the limits specified in 3.4.2.4.1 will be considered for procurement by the procuring activity. Approval by the procuring activity must be obtained for such filters before submittal of bids. The limits for the chromaticities of these filters are shown by the dotted lines in Figure 1.

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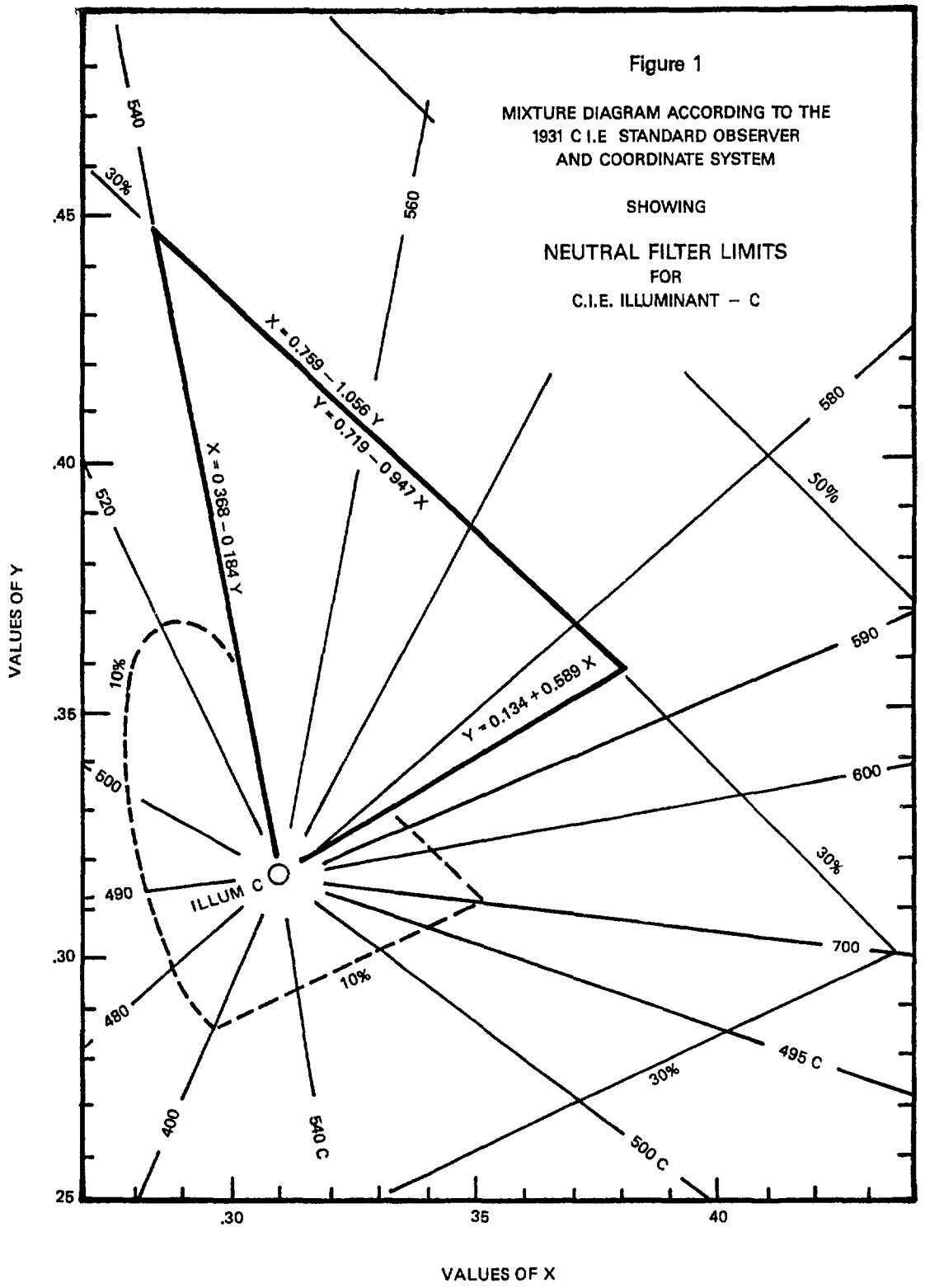

Figure 1

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3.4.2.4.3 Luminous transmittance. The luminous transmittance of aircraft neutral, light neutral, and dark neutral filters shall be as follows:

Aircraft neutral – Not less than 10-percent nor more than 15-percent.
Light neutral – Not less than 2-percent nor more than 4-percent.
Dark neutral – Not less than 0.15-percent nor more than 0.30-percent.

3.4.2.5 Searchlight neutral filters. The chromaticity of searchlight neutral filters shall be such that the sun or high intensity carbon arc, when viewed through the filter, will appear substantially unchanged in color. The luminous transmittance shall be not less than 0.003 nor more than 0.008-percent. These limits correspond to optical densities of 4.52 and 4.10 respectively.

3.5 Optical quality.

3.5.1 General optical quality requirements. Each filter shall be free of surface and internal defects to the extent that the optical quality requirements below will be met. The surfaces of each filter shall have such polish and parallelism that the optical quality requirements below will be met. Surface defects include scratches, pits, digs, and holes due to exposed bubbles. Internal defects include bubbles, seeds, stones, cords, striae, light and dark areas, and strain in the glass. Additional defects in Type II filters include dark inclusions of foreign matter in the plastic sheet or bonding material and small uncolored or differently colored areas.

3.5.2 Grade A filters.

3.5.2.1 Defect zones. The area of each filter shall be divided into three zones by the periphery of the filter and two imaginary circles concentric with the periphery. The zones shall be designated as the inner, intermediate, and outer zones. The imaginary circle bounding the inner zone shall have a radius equal to one half the radius of the filter and the imaginary circle bounding the intermediate zone shall have a radius equal to three fourths the radius of the filter.

3.5.2.1.1 Allowable defects by zones. The inner zone shall be entirely free from visible surface and internal defects. The intermediate zone shall not contain any defects having a maximum dimension over 0.1-millimeter, any defects separated be less than 10 millimeters, or more than two defects. The outer zone shall not contain any defect having a maximum dimension over 0.2 millimeter, except cords and striae, or more than a total of five defects. Cords and striae shall not extend in from the filter edge more than one-eighth of the filter radius or a distance of 2.5 millimeters, whichever distance is smaller.

3.5.2.2 Definition. The definition of a telescope of applicable magnification shall not be impaired in any manner when the filter is tested as described in 4.4.4.3.4.2.2.

3.5.2.3 Deviation. The deviation at normal incidence shall not exceed 3-1/2 minutes of arc.

3.5.3 Grade BT filters.

3.5.3.1 Surface and internal defects. There shall be no surface or internal defects visible over the entire area of the filter when the filter is examined as described in 4.4.4 3.4.3.1.

3.5.3.2 Definition, parallax, and resolution. The definition of a telescope of applicable magnification shall not be impaired in any manner when the filter is tested as described in 4.4.4.3.4.3.2. In addition, no visible parallax between the target image and the telescope crossline shall be introduced under the conditions of the test. The limit of resolution shall not exceed the applicable value when the filter is tested as described in 4.4.4.3.4.3.2.

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3.5.3.3 Deviation. The deviation at normal incidence shall not exceed 10 seconds of arc.

3.5.4 Grade BR filters.

3.5.4.1 Surface and internal defects. There shall be no surface or internal defects visible over the entire area of the filter when the filter is examined as described in 4.4.4.3.4.4.1.

3.5.4.2 Definition, parallax, and resolution. The definition of a telescope of applicable magnification shall not be impaired in any manner when the filter is tested as described in 4.4.4.3.4.4.2. In addition, no visible parallax, between the target image and the telescope crossline, shall be introduced under the conditions of the test. The limit of resolution shall not exceed the applicable value when the filter is tested as described in 4.4.4.3.4.4.2.

3.5.4.3 Deviation. The deviation at normal incidence shall not exceed 10 seconds of arc.

3.5.5 Grade C filters.

3.5.5.1. Surface and internal defects. No surface or internal defect shall be visible when the filter is examined as described in 4.4.4.3.4.5.1.

3.5.5.2 Lens Power. In any area 5 millimeters in diameter situated in any portion of the filter exclusive of the marginal area within 1-millimeter of the edge, the positive or negative lens power in any meridian shall not exceed 1/16-diopter, and the difference in lens power in any 2 meridians shall not exceed 1/16-diopter.

3.5.5.3 Deviation. The deviation at normal incidence shall not exceed 2 minutes of arc.

3.6 Edges. Unless otherwise specified on the applicable drawings, the edges of the filters shall be perpendicular to the surfaces. The edges may be ground or molded. In Type II filters, the two glass plates and the sheet of plastic comprising each filter shall be concentric, and the edge of the plastic sheet shall be within 0.5-millimeter of the edges of the glass plates and shall not extend beyond them. Edge filler may be used up to 0.5-millimeter penetration. Finished filters shall be entirely free from edge separation when examined with the unaided eye.

3.7 Marking.

3.7.1 Grade identification. Each color filter, except "Aircraft neutral" filters, shall be marked to identify its grade with notches traversing the edge of the filter and perpendicular to the filter surfaces. Each notch shall be V-shaped in cross section, and approximately 0.5 millimeter wide and 0.5-millimeter deep. The spacing between adjacent notches shall be 1 to 3 millimeters. The grade identification shall be as follows:

Grade A – One notch
Grade BT – Two notches
Grade C – Three notches
Grade BR – Four notches

On Grade BR filters the nearest grade-identification mark shall be five to ten millimeters from the wedge-indicating mark specified in 3.7.2.

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3.7.2. Wedge indication. The base of the wedge of each Grade BR filter shall be indicated by a line permanently inscribed in and traversing the edge of the filter, perpendicular to the filter surfaces, and terminating at each end with an arrowhead. The circumferential location of the mark shall be such that the deviation component at right angles to the diameter through the mark shall not exceed 1/3-second of arc. For example, for 10-second deviation, 2-degree accuracy in location is required.

3.8 General stability to weathering. The stability shall be such that when the filter is exposed to accelerated weathering conditions in accordance with 4.4.4.1.1, no discoloration, separation, or bubble shall extend more than 2 millimeters in from the edge. In addition, the color of each specimen shall remain essentially uniform over the entire area to within 2 millimeters of the edge, and the spectral transmittance at any wavelength shall not have changed by more than 10-percent of the original value.

3.9 Strength of bonding (Type II filters). The strength of bonding shall be such that when the filter is exposed to variations of temperature in accordance with 4.4.4.1.2, no discoloration, separation, or bubble shall extend more than 2 millimeters in from the edge In addition, the color shall remain essentially uniform over the entire area to within 2 millimeters of the edge, and the luminous transmittance shall not have changed by more than 10-percent of its original value.

3.10 Workmanship. Workmanship shall be of such quality as to produce filters of uniform high quality and as to meet all requirements of the applicable drawings and this specification.

4. QUALITY ASSURANCE PROVISIONS AND TEST REQUIREMENTS

4.1 Unless otherwise specified herein the supplier is responsible for the performance of all inspection requirements prior to submission for Government inspection and acceptance. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. Inspection records of the examinations and tests shall be kept complete and available to the Government as specified in the contract or order.

4.2 Lot. For purposes of sampling a lot shall consist of all the filters of the same type, color, grade, and size made from one melt, pressing, or batch as applicable.

4.3 Sampling.

4.3.1 For preproduction inspection. Unless otherwise specified (see 4.3.1.1), three preproduction sample filters shall be supplied by the contractor for each type, color, grade, and size being purchased. Samples shall be submitted to the Government inspector for preproduction inspection at an activity designated in the contract or order (see 6.2) or by the Bureau of Ordnance Further production of the filters by the contractor prior to the approval of the procuring activity or completion of inspection on the preproduction samples shall be at the contractor's risk. Preproduction samples will become the property of the procuring activity and will not be included in the quantity of filters called for in the contract or order.

Shipping containers shall be marked with the following information:

Title, number, and date of this specification
Applicable drawing number and piece number
Sample for preproduction inspection
Manufacturer's designation
Name of manufacturer
Manufacturer's plant address
Reference (contract number)

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4.3.1.1 Preproduction samples and inspection for a subsequent contract. If a contractor has previously delivered filters in accordance with the requirements of this specification and his product has been found to be satisfactory, the preproduction samples and inspection for any subsequent contract or order for the specific type, color, grade, and size filter previously delivered may be waived at the discretion of the procuring activity (see 6.2).

4.3.2 Sampling for periodic tests (type II filters). From each quantity of 200 or fewer type II filters, a sample shall be selected for the periodic tests of 4.4.4.2. Sampling shall be in accordance with Standard MIL-STD-105, Appendix, Level L6. The Government inspector shall forward the sample to a testing activity designated in the contract or order (see 6.2) or by the Bureau of Ordnance. Failure of one filter of the sample to pass the periodic tests shall be cause for rejection of the quantity represented by the sample and may result in cessation of production as determined by the procuring activity.

Shipping containers of the sample filters shall be marked in accordance with 4.3.1 except that containers shall be marked "Sample for periodic tests" instead of "Sample for preproduction inspection" and in addition shall be marked with the identification of the lot or quantity from which the sample was taken

4.3.3 Sampling for lot acceptance. Unless otherwise specified, and when applicable, the sampling plans and procedures used by the Government inspector in determining the acceptability of filters submitted by a supplier for Government inspection, shall be in accordance with the provisions of Standard MIL-STD-105. The classification of defects shall be provided by the procuring activity. Sampling to determine compliance with spectral transmittance (4.4.4.3.1) shall be in accordance with Standard MIL-STD-105, Appendix, Level L6. One or more defectives in the sample shall be cause for rejection of the lot.

4.4 Inspection.

4.4.1 General procedures. General inspection and test procedures shall be in accordance with Publication OP 400. Lot acceptance inspection shall be conducted at the manufacturer's plant.

4.4.2 Visual and dimensional examination. Filters shall be visually and dimensionally examined for completeness of manufacture, freedom from defects other than optical quality defects, proper item identification, conformance to applicable drawings and specifications, and workmanship.

4.4.3 Cleaning, wrapping, packaging, packing, and marking. Filter containers shall be examined to determine whether or not cleaning, wrapping, packaging, packing, and marking are in accordance with Section 5.

4.4.4 Tests and test procedures.

4.4.4.1 Preproduction tests. The preproduction tests shall consist of the tests in 4.4.4.3.1 through 4.4.4.3.6.2 and the tests of 4.4.4.1.1 and 4.4.4.1.2.

4.4.4.1.1 Stability to weathering. Preproduction filters shall be tested for stability to weathering to determine conformance to 3.8. Measure spectral transmittances. Expose the filters for at least 168 hours (one week) to accelerated weathering under conditions outlined in Method No. 6021 or 6022 of Specification L-P-406. Other means of accelerated weathering may be permitted subject to the approval of the procuring activity. Upon completion of the test examine the filters and remeasure spectral transmittances.

4.4.4.1.2 Strength of bonding (type II filters). Type II preproduction filters shall be tested for strength of bonding to determine conformance to 3.9. Luminous transmittance shall be determined in accordance

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with the procedures of 4.4.4.3.2 prior to conducting this test. Place the filters in an oven and maintain the temperature of the oven at plus 155°F for at least 5 hours. Remove the filters from the oven and allow them to return to room temperature. The filters shall then be placed in a cold chamber and the temperature of the chamber maintained at minus 20°F for at least 16 hours. Remove the filters from the chamber and allow them to return to room temperature. After they have returned to room temperature, the filters shall be examined for conformance to 3.9. Luminous transmittance shall be redetermined in accordance with the procedures of 4.4.4.3.2.

4.4.4.2 Periodic tests (type II filters). Periodic tests shall be performed on type II filters and shall consist of the tests of 4.4 4.1.1 and 4.4.4.1.2

4.4.4.3 Lot acceptance tests.

4.4.4.3.1 Spectral transmittance. Red and yellow filters shall be tested for spectral transmittance to determine conformance to 3.4.2.2.1 and 3.4.2.3.1, respectively. The test shall be made with a spectrophotometer or other suitable spectrophotometric equipment of adequate sensitivity and resolving power.

4.4.4.3.2 Luminous transmittance. Filters shall be tested for luminous transmittance to determine conformance to 3.4.2.2.2, 3.4.2.3.2, 3.4.2.4.3, and 3.4.2.5 as applicable. The test shall consist of comparing the filter under test with the applicable light and dark comparison standards using any suitable photometric means of requisite sensitivity.

4.4.4.3.3 Chromaticities.

4.4.4.3.3.1 Aircraft neutral, light neutral, and dark neutral filters. Aircraft neutral, light neutral, and dark neutral filters shall be tested for chromaticity to determine conformance to 3.4.2.4.1. The test shall be made with a spectrophotometer or other suitable spectrophotometric equipment of adequate sensitivity and resolving power.

4.4.4.3.3.2 Searchlight neutral filters. Searchlight neutral filters shall be tested for chromaticity to determine conformance to 3.4.2.5 as applicable. The test shall consist of viewing the sun or a high intensity carbon arc or other light source of equivalent intensity alternately through the filter under test and the light and dark comparison standards. The coloration of the filter shall lie within the limits established by viewing the same source through the comparison standards

4.4.4.3.4 Optical quality.

4.4.4.3.4.1 Filter test area. Except as specified herein, not less than 95 percent of the total area of the clear aperture of the filters shall be included in the tests

4.4.4.3.4.1.1 Surface and internal defects. Filters shall be examined for surface and internal defects to determine conformance to the requirements of the applicable grade in 3.5. Except as specified herein examination shall be made with the level of illumination high enough to render any and all defects plainly visible. The eyepiece shall be 40 plus or minus 2 millimeter equivalent-focal-length with a minimum apparent field of 45 degrees and shall have a reticle or the image of a reticle in a fixed position at the normal focal plane of the eyepiece. The eyepiece shall be focusable to allow for correction of the observer's eye. The observer's vision shall be fixed on the reticle during these tests.

4.4.4.3.4.1.2 Definition, parallax, and resolution. Definition, parallax, and resolution tests shall be made by holding the filter in front of the objective of a telescope that has been accurately focused on the target before insertion of the filter and is not refocused during the test. Red filters or filters of sensibly the same color shall be inserted between the eye and the eyepiece when focusing to compensate for chromatic aberration of the telescope. The target for the definition and parallax tests shall be a round, sharply defined disc

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illuminated from the rear by tungsten light having a brightness equivalent to the surface of a commercial 100 watt, 115 volt inside frosted lamp operated at line voltage. The diameter of the disc is not critical. A recommended value is approximately 180 seconds of arc divided by the magnification of the testing telescope. The target for the resolution test shall be of the Foucault resolving-power pattern containing horizontal and vertical black bars upon a white field. The target shall be brightly illuminated by tungsten light without filters. Variation of the target illumination to obtain optimum visual resolution is permitted. The limit of resolution to be met is determined from the following rule; when the diameter of the filter or the diameter of the clear aperture in the case of beveled filters is less than 35 millimeters, the limit of resolution shall be the next whole number above the quotient obtained by dividing 140 seconds of arc by the diameter of the filter or the diameter of the clear aperture, whichever is applicable. When the diameter of the filter or the diameter of the clear aperture in the case of beveled filters is 35 to 70 millimeters, the limit of resolution shall be the next half number above the quotient obtained by dividing 140 seconds of arc by the diameter of the filter or the diameter of the clear aperture, whichever is applicable. Clear aperture is defined as the smaller filter face when one or both edges of the filter are beveled. The aperture of the testing telescope shall be sufficiently large to accommodate the entire clear aperture of the filter.

The targets shall be situated at least 50 meters from the test site or collimated to infinity focus by means of a corrected collimator objective.

4.4.4.3.4.2 Grade A filters.

4.4.4.3.4.2.1 Surface and internal defects. Filters shall be examined for surface and internal defects to determine conformace to 3.5.2 1.1. Examination shall be made by using a 40 millimeter equivalent-focal-length eyepiece with the filter being placed between the eyepiece and the focal plane and within 6 millimeters of the latter.

4.4.4.3.4.2.2 Definition. Filters shall be tested for definition to determine conformance to 3.5.2.2. Filters shall be tested in accordance with the applicable procedures in 4.4.4.3.4.1.2. The magnification of the testing telescope shall be not less than 0.2 of the diameter of the filter or clear aperture, whichever is applicable, measured in millimeters or a value of 6, whichever is greater.

4.4.4.3.4.2.3 Deviation. Filters shall be tested for deviation to determine conformance to 3.5.2.3.

4.4.4.3.4.3 Grade BT filters.

4.4.4.3.4.3.1 Surface and internal defects. Filters shall be examined for surface and internal defects to determine conformance to 3.5.3.1. Examination shall be made by means of a 40 millimeter focal-length eyepiece, with the filter being placed within 12 millimeters of the focal plane on the side opposite the eyepiece

4.4.4.3.4.3.2 Definition, parallax, and resolution. Filters shall be tested for definition, parallax, and resolution to determine conformance to 3.5.3.2. Filters shall be tested in accordance with the procedures in 4.4.4.3.4.1.2. The magnification of the testing telescope shall be not less than 0.8 of the diameter of the filter or clear aperture, whichever is applicable, measured in millimeters.

4.4.4.3.4.3.3 Deviation. Filters shall be tested for deviation to determine conformance to 3.5.3.3.

4.4.4.3.4.4 Grade BR filters.

4.4.4.3.4.4.1 Surface and internal defects. Filters shall be examined for surface and internal defects to determine conformance to 3.5.4.1. Examination shall be made by means of a 40 millimeter focal-length eyepiece with the filter being placed within 30 millimeters of the focal plane on the side opposite the eyepiece.

4.4.4.3.4.4.2 Definition, parallax and resolution. Filters shall be tested for definition, parallax, and resolution to determine conformance to 3.5.4.2. Filters shall be tested in accordance with the procedures in 4.4.4.3.4.1.2.

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The magnification of the testing telescope shall be not less than 0.8 of the diameter of the filter or clear aperture, whichever is applicable, measured in millimeters.

4.4.4.3.4.4.3 Deviation. Filters shall be tested for deviation to determine conformance to 3.5.4.3.

4.4.4.3.4.5 Grade C filters.

4.4.4.3.4.5.1 Surface and internal defects. Filters shall be examined for surface and internal defects to determine conformace to 3.5.5.1. Examination shall be made by viewing through the filter a target consisting of a definite fixation point or pattern on a bright background. The target shall be not less than 10 feet from the filter and shall be viewed with the filter positioned 7 to 9 inches from the eye of the observer. The observer shall have normal vision and accommodation.

4.4.4.3.4.5.2 Lens power. Filters shall be tested for lens power to determine conformance to 3.5.5.2 only if in the test of 4.4.4.3.4.5.1 any portion of the filter, as defined in 3.5.5.2, causes poor definition, weaving, or distortion of the viewed target.

4.4.4.3.4.5.3 Deviation. Filters shall be tested for deviation to determine conformance to 3.5.5.3.

4.4.4.3.5 Edges. The edges of filters shall be examined to determine conformance to 3.6.

4.4.4.3.6 Marking.

4.4.4.3.6.1 Grade identification. Filters shall be examined for grade identification to determine conformance to 3.7.1.

4.4.4.3.6.2 Wedge indication. Grade BR filters shall be examined for proper wedge indication to determine conformance to 3.7.2.

5. PREPARATION FOR DELIVERY

5.1 Preservation and Packaging.

5.1.1 Level A.

5.1.1.1 Cleaning. Careful handling and thorough cleaning are emphasized. The cleaning, inspection and wrapping shall be accomplished by qualified technical personnel or under their direct supervision. During and after cleaning, the operator shall wear well-washed white cotton gloves of a suitable type to prevent touching with the bare hand. The working area shall be clean and preferably air conditioned with a temperature between 72 and 78°F and a relative humidity between 35 and 50 percent. The work bench shall be at a convenient height, approximately 36 inches, and equipped with a suitable desk lamp for inspection purposes. The bench top shall be kept clean at all times and covered with clean lens tissue. The cleaning solution shall be as follows:

Orvus Soapy water solution formula

1 gallon of distilled water
2 ounces of ammonium hydroxide
1 ounce of orvus liquid soap or equal. Ph not to exceed 8

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Alcohol solution formula

15 parts of pure grain alcohol
1 part of acetone

Optional (for coloring purposes only; several drops of aniline dye). Cleaning shall be done with a soft clean commercial cloth free from lint and abrasives, or with a cotton swab. The cloth shall be cleaned frequently or renewed often to avoid contamination from handling. The cotton swab shall be prepared by winding cotton, surgical grade, around the end of an orange stick 1/8 inch × 6 inches long. For the initial cleaning, dip a swab in the orvus solution and apply to both sides of the filter element to be cleaned. Holding the element by its edge with the thumb and first finger of one hand, clean off the orvus solution with the cloth held in the other hand. For the final cleaning, dip a swab in the alcohol solution and, holding the element as before, swab the surfaces of the element until all smears, smudges, fingerprints or other foreign matter have been removed.

5.1.1.2 Drying. Filters shall be left to dry by evaporation of the final cleaning solution.

5.1.1.3 Preservative application. No preservative shall be applied.

5.1.1.4 Unit Packaging.

5.1.1.4.1 Wrapping. Immediately after cleaning, each filter shall be neatly wrapped in four or more thicknesses of lens tissue, conforming to Specification UU-P-313, Type I or II. The tissue shall be secured in place with pressure sensitive tape conforming to Specification PPP-T-60.

5.1.1.4.2 Cushioning. Each wrapped filter shall be cushioned on all surfaces and edges with cellulose wadding, Type III, Class A conforming to Specification PPP-C-843, and of the following thickness:

	Filter	Thickness of cushioning
	Weight Ounces	Inches
From:	0 to 3	1/4
	3 to 9	1/2
	9 to 16	3/4

5.1.1.4.3 Packaging. Each tissue wrapped and cushioned filter shall be individually packaged in a close fitting paperboard set-up box conforming to Specification PPP-B-676. Each filter shall be tightly packed to prevent movement within the box. Box shall be held closed with PP-T-60 tape. Boxed filters shall be individually placed in a close fitting bag made from material conforming to Specification MIL-B-131, class 2. Package shall conform with and meet the requirements of method 1A-15X of Specification MIL-P-116.

5.1.1.5 Intermediate packaging. A maximum of 25 filters packaged as described in 5.1.1.4.3 shall be placed in a close-fitting intermediate container conforming to the requirements of Specification PPP-B-636 Type I or Type II class I.

5.1.2 Level B. Not applicable.

5.1.3 Level C. Not applicable.

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5.2 Packing.

5.2.1 Level A. Filters packaged as described in 5.1.1.4.3 or 5.1.1.5 shall be packed in containers conforming to the requirements of Specification PPP-B-636 Type I or Type II class 3: PPP-B-585, class 3; PPP-B-591, overseas type; PPP-B-601, overseas type; or MIL-B-10377 overseas type. Boxes shall be lined with caseliners conforming to Specification MIL-L-10547. Gross weight of a single shipping container shall not exceed 150 pounds or the weight limitation of the container selected.

5.2.2 Level B. Filters packaged as described in 5.1.1.4.3 or 5.1.1.5 shall be packed in containers conforming to the requirements of Specification PPP-B-636 Type I or Type II class 2; PPP-B-585, class 2; PPP-B-591, domestic type; PPP-B-601, domestic type; or MIL-B-10377, domestic type Gross weight of a single shipping container shall not exceed 200 pounds or the weight limitation of the container selected.

5.2.3 Level C. Filters packaged as described in 5.1.1.4.3 or 5.1.1.5 shall be packed to afford protection against damage during direct shipment from the supply source to the first receiving activity for immediate use. Containers shall comply with Consolidated Freight Classification Rules or other common carrier regulations applicable to the mode of transportation.

5.3 Marking. In addition to any special marking required by the contract or order (see 6.2), shipping containers shall be marked in accordance with Standard MIL-STD-129.

6. NOTES

6.1 Intended use. Filters covered by this specification are intended for use on optical instruments as follows:

Grade A - Near the focal plane of an eyepiece
Grade B - Near a telescope objective lens
Grade BR - Near a rangefinder objective lens
Grade C - At unit magnification, or with the unaided eye.

6.2 Ordering data. Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) Types, colors, and grades required (see 1.2).
(c) Lists of drawings and drawings required (see 2.1)
(d) Whether preproduction samples and inspection are required (see 3.1 and 4.3.1.1).
(e) Whether each searchlight-neutral standard filter shall be accompanied by a table or curve of its spectral transmittance and its chromaticity coordinates "x" and "y" (see 3.4.1.2).
(f) Testing activity for preproduction samples or samples for periodic tests if the activity is not designated by the Bureau of Ordnance (see 4.3.1 or 4.3.2).
(g) Levels required in preparation for delivery (see 5.1 and 5.2).
(h) Special marking when required (see 5.3)

6.2.1 The attention of the contracting officer is invited to the Quality Assurance Provisions and options in Specification MIL-P-116.

6.2.2 Criteria for use of proper level of preservation, packaging and packing shall be as follows:

For Level A. This level shall be used for those items which are to be shipped to indeterminate destinations or stored under indeterminate conditions for distribution anywhere.

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For Level B. This level shall be used only when it is definitely known that the item will be held in covered storage in overseas locations for 6 months or less or in domestic locations for an indefinite period.

For Level C. This level shall be used only when it is definitely known that the packaged item is to be shipped to domestic installations for immediate use at the first receiving activity.

6.3 Colorimetric definitions. Reference: The Science of Color, prepared by the Committee on Colorimetry, Optical Society of America; Thomas Y. Crowell, New York, 1953.

6.3.1 System of color designation. The fundamental definitions of the color of neutral filters are expressed in terms of the standard observer and coordinate system adopted by the International Commission on Illumination (also identified as C.I.E. - Commission Internationale de l'Eclairage) at Cambridge, England in 1931. Whenever chromaticity coordinates (x, y, z) appear herein, they relate to this system.

6.3.2 Transmittance. Spectral transmittance is the ratio of transmitted to incident homogenous radiant flux.

6.3.3 Standard Source and observer. Values of luminous transmittance and chromaticity coordinates (x, y) specified herein denote those obtained when the source has the spectral quality of standard Illuminant C and the measuring device has a relative spectral sensitivity of the standard observer, as defined by the International Commission of Illumination. Methods for the computation of luminous transmittance and chromaticity coordinates from spectral data are outlined in Tables I and II. For the purpose of this specification the values obtained by the use of Table I will be considered final. The method of Table II is a simplification of that of Table I, and is applicable in practically all cases except those of neutral filters having relatively high transmission in the red or blue regions of the spectrum.

6.3.4 Filter designs. For the information of parties concerned with the design of filters, existing filter designs are compiled on Bureau of Ordnance Drawing Sk 132263.

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Table I - Weighted-Ordinate Method for Computing Luminous Transmittance and Chromaticity Coordinates from Spectral Data

Wave Length	Trans (T)	$\bar{x}P$	$T\bar{x}P$	$\bar{y}P$	$T\bar{y}P$	$\bar{z}P$	$T\bar{z}P$
400		85		2		404	
10		329		9		1570	
20		1238		37		5949	
30		2997		122		14628	
40		3975		262		19938	
450		3915		443		20638	
60		3362		694		19299	
70		2272		1058		14972	
80		1112		1618		9461	
90		363		2358		5274	
500		52		3401		2864	
10		89		4833		1520	
20		576		6462		712	
30		1523		7934		388	
40		2785		9149		195	
550		4282		9832		86	
60		5880		9841		39	
70		7322		9147		20	
80		8417		7992		16	
90		8984		6627		10	
600		8949		5316		7	
10		8325		4176		2	
20		7070		3153		2	
30		5309		2190			
40		3693		1443			
650		2349		886			
60		1361		504			
70		708		259			
80		369		134			
90		171		62			
700		82		29			
10		39		14			
20		19		6			
30		8		3			
40		4		2			
Sums		98014		99998		117994	

$$\text{Luminous transmittance} = \frac{\Sigma\, T\bar{y}P}{99998}$$

$$X = \frac{\Sigma\, T\bar{x}P}{\Sigma\,(TxP + TyP + TzP)}$$

$$Y = \frac{\Sigma\, T\bar{y}P}{\Sigma\,(TxP + TyP + TzP)}$$

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Table II - Selected-Ordinate Method for Computing Luminous Transmittance and Chromaticity Coordinates from Spectral Data

Ordinate Number		Wave Length	(X)	Wave Length	(Y)	Wave Length	(Z)
1		424 4		465 9		414.1	
2	1/	435.5		489.4		422.2	
3		443 9		500 4		426 3	
4		452 1		508.7		429 4	
5	1/	461.2		515 1		432.0	
6		474 0		520 6		434.3	
7		531 2		525 4		436 5	
8	1/	544 3		529.8		438 6	
9		552.4		533.9		440.6	
10		558.7		537 7		442.5	
11	1/	564 1		541 4		444 4	
12		568.9		544 9		446 3	
13		573 2		548 4		448 2	
14	1/	577.3		551.8		450 1	
15		581.3		555 1		452 1	
16		585.0		558 5		454 0	
17	1/	588.7		561 9		455 9	
18		592 4		565.3		457 9	
19		596 0		568.9		459 9	
20	1/	599 6		572 5		462 0	
21		603 3		576 4		464 1	
22		607.0		580.5		466.3	
23	1/	610.9		584.8		468 7	
24		615 0		589.6		471 4	
25		619.4		594.8		474.3	
26	1/	624.2		600 8		477.7	
27		629 8		607.7		481 8	
28		636 6		616 1		487 2	
29	1/	645 9		627.3		495 2	
30		663 0		647 4		511 2	
Sums							
Factors (30 Ord)			.03268		03333		03938
Factors (10 Ord)1/			09804		10000		11812
Products		X=		Y=		Z=	

Luminous Transmittance = Y

$$X = \frac{X}{X + Y + Z} \qquad Y = \frac{Y}{X + Y + Z}$$

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