INCH-POUND

MIL-C-53039A(ME)
23 November 1988
SUPERSEDING
MIL-C-53039(ME)
16 April 1984

MILITARY SPECIFICATION

COATING, ALIPHATIC POLYURETHANE, SINGLE COMPONENT, CHEMICAL AGENT RESISTANT

This specification is approved for use within the USA Belvoir Research, Development and Engineering Center, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers both camouflage and noncamouflage, one component chemical agent resistant, aliphatic polyurethane coating for use as a finish coat on military combat equipment. The coating is lead and chromate (hexavalent) free and has maximum of 420 gm/liter (3.5 lbs/gallon) volatile organic compounds.

1.2 Classification.

1.2.1 Colors. The coating shall be of the following colors as specified (see 6.2).

Aircraft Black 37038	Black 37030	Green 383, 34094
Aircraft Gray 36300	Brown 383, 30051	Interior Aircraft Black 37031
Aircraft Green 34031	Dark Green 34082	Interior Aircraft Gray 36231
Aircraft Insignia Blue 35044	Dark Sandstone 33510	Olive Drab 34088
Aircraft Red 31136	Earth Yellow 33245	Sand 33303
Aircraft White 37875	Field Drab 33105	Tan 686, 33446
Aircraft Yellow 33538		

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: USA Belvoir Research, Development, and Engineering Center, ATTN: STRBE-TSE, Fort Belvoir, VA 22060-5606 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 8010

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2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

TT-B-1325	- Beads (Glass Spheres); Retro-Reflective.
TT-C-490	- Cleaning Methods and Pretreatment of Ferrous Surfaces for Organic Coatings.
TT-S-735	- Standard Test Fluids, Hydrocarbon.
TT-T-291	- Thinner: Paint, Volatile Mineral Spirits (Petroleum Spirits).
PPP-P-1892	- Paint, Varnish, Lacquer and Related Materials: Packaging, Packing and Marking of.

MILITARY

MIL-L-2104	- Lubricating Oil, Internal Combustion Engine, Heavy-Duty.
MIL-P-23377	- Primer Coating, Epoxy-Polyamide, Chemical and Solvent Resistant.
MIL-P-52192	- Primer Coating, Epoxy.
MIL-P-53022	- Primer, Epoxy, Corrosion Inhibiting, Lead and Chromate Free.
MIL-P-53030	- Primer Coating, Epoxy, Water Reducible, Lead and Chromate Free.
MIL-T-81772	- Thinner, Aliphatic Polyurethane Coating.
MIL-P-85582	- Primer Coatings: Epoxy, VOC Compliant, Chemical and Solvent Resistant.

STANDARDS

FEDERAL

FED-STD-141	- Paint, Varnish, Lacquer and Related Materials; Methods of Inspection, Sampling and Testing.
FED-STD-313	- Preparation and Submission of Material Safety Data Sheets.
FED-STD-595	- Colors.

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MILITARY

MIL-STD-129	- Marking for Shipment and Storage.
MIL-STD-147	- Palletized Unit Loads.
MIL-STD-45662	- Calibration System Requirements.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN; NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.1.2 Other Government documents, and publications. The following other Government documents, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those in effect on the date of the solicitation.

DEPARTMENT OF TRANSPORTATION (DOT)

49 CFR, 171-178 Hazardous Materials Regulations.

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

29 CFR, 1910.144 Safety Color Code for Marking Physical Hazards.
29 CFR, 1910.145 Specifications for Accident Prevention Signs and Tags.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, DC 20402.)

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 476	- Titanium Dioxide Pigments, Specification for.
D 523	- Specular Gloss, Standard Test Method for.
D 562	- Consistency of Paints Using the Stormer Viscosimeter, Method of Test for.
D 659	- Resistance to Chalking of Exterior Paints, Evaluating Degree of.
D 768	- Yellow Iron Oxide, Hydrated.
D 1014	- Conducting Exterior Exposure Test of Paints on Steel, Standard Method of.
D 1210	- Fineness of Dispersion of Pigment - Vehicle Systems, Standard Practice for.
D 1308	- Effect of Household Chemical on Clear and Pigmented Organic Finishes, Standard Method of Test for.
D 1849	- Package Stability of Paint, Standard Test Method for.
D 3335	- Test for Low Concentration of Lead, Cadmium and Cobalt in Paint by Atomic Absorption Spectroscopy.

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D 3960 - Determining Volatile Organic Content (VOC) of Paints and Related Coatings, Standard Practice for.
E 97 - Directional Reflectance Factor 45-Deg 0-Deg, of Opaque Specimens by Broad - Band Filter Reflectometry, Test Method for.
E 308 - Spectrophotometry and Description of Color in CIE 1931 System, Standard Recommended Practice for.
G 26 - Operating Light- and Water-Exposure Apparatus (Xenon-Arc type) for Exposure of Nonmetallic Materials, Recommended Practice for.

(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 Association, Inc., Traffic Department, 1616 P Street, N.W. Washington, DC 20036.)

UNIFORM CLASSIFICATION COMMITTEE, AGENT

Uniform Freight Classification

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

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

RULE 1107 - Manufactured Metal Parts and Products Coatings.

(Application for copies should be addressed to the South Coast Air Quality Management District, 9150 E. Flair Drive, El Monte, CA 91731.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. The coating furnished under this specification shall be a product which is qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.2.1 and 6.4). Any change in the

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formulation of a qualified product will necessitate its requalificaiton. The material supplied under contract shall be identical, within manufacturing tolerances, to the products receiving qualification.

3.2 Materials. The materials used in the coatings shall be as specified herein. Materials not specified shall be selected by the contractor and shall be subject to all provisions of this specification.

3.3 Color and spectral reflectance. All colors listed in 1.2.1 shall impart to the substrate the required spectral reflectance properties in the visible (380-700 nanometers) and near infrared (700-900 nanometers) spectral regions under Standard Illuminent C tested as specified in 4.3.2.

3.3.1 Camouflage. Camouflage colors are those for which there are nemerical requirements for chromaticity in table I and color chips are available from the preparing activity (see 6.6). The color shall fall within 2.0 National Bureau of Standards (NBS) units of the values listed when calculated using the average brightness of the range specified. Figures 4 through 16 may be used as approximate guidelines to the chromaticity limits for the appropriate color. In addition, Dark Green 34082 and Green 383, 34094 shall meet the spectral reflectance limits listed in table III and plotted in figure 12.

3.3.2 Aircraft camouflage. Aircraft camouflage colors are those for which there is only a maximum infrared reflectane requirement. Aircraft Gray 36300, Aircraft Green 34031, Interior Aircraft Black 37031 and Dark Sandstone 33510 shall visually match chips furnished by the preparing activity (see 6.4) and meet the infrared reflectance requirements of table I when tested as specified in 4.3.11.

3.3.3 Other colors. All other colors listed in 1.2.1 shall visually match the appropriate chip from FED-STD-595.

TABLE I. Color and reflectance requirements.

Color	Brightness (Y)	Chromaticity x	Chromaticity y	Infrared[1/] Min.	Infrared[1/] Max.	Allowable[2] Ratio
Dark Green 34082	0.071 - .091	0.339	0.390	-	60.0	5.2
Green 383, 34094	0.063 - .083	0.328	0.365	-	60.0	5.2
Field Drab 33105	0.093 - .117	0.390	0.383	25.0	35.0	-
Earth Yellow 33245	0.228 - .263	0.420	0.395	30.0	40.0	-
Sand 33303	0.284 - .323	0.360	0.366	55.0	65.0	-
Brown 383 30051	0.060 - .080	0.357	0.342	8.0	20.0	-
Black 37030	0.030 - .041	0.310	0.315	0.0	15.0	-

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TABLE I. Color and reflectance requirements. (Cont'd)

Color	Brightness (Y)	Chromaticity x	Chromaticity y	Infrared[1/] Min.	Infrared[1/] Max.	Allowable[2] Ratio
Aircraft Green 34031	-	-	-	-	7.0	-
Tan 686, 33446	0.360 - 0.400	0.368	0.364	40.0	50.0	-
Interior Aircraft Black 37031	-	-	-	-	7.0	-
Aircraft Gray 36300	-	-	-	-	15.0	-
Dark Sandstone 33510	-	-	-	-	45.0	-

1/ See table II or 4.3.11.
2/ The ratio is calculated by dividing the average infrared reflectance by the average red region reflectance.

TABLE II. Selected Ordinates for determining infrared and red reflectance values from spectrophotometric curves.

Magenta Red Region Nanometers	Infrared Region Nanometers		
620.0	714.0	769.0	816.0
626.0	725.0	773.0	821.0
638.0	730.0	777.0	826.0
645.0	737.0	783.0	831.0
649.0	742.0	787.0	836.0
652.0	747.0	793.0	842.0
653.0	751.0	797.0	848.0
655.0	756.0	802.0	855.0
658.0	760.0	807.0	862.0
663.0	764.0	811.0	873.0

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TABLE III. Spectral reflectance limits for Dark Green 34082 and Green 383, 34094.

Wavelength	% Reflectance		Wavelength	% Reflectance	
Nanometers	Max.	Min.	Nanometers	Max.	Min.
600	10.2	-	760	59.5	40.0
610	9.8	-	770	61.5	42.0
620	9.8	-	780	-	42.0
630	9.8	-	790	-	42.0
640	9.5	-	800	-	42.0
650	9.5	-	810	-	42.0
660	10.0	-	820	-	42.0
670	10.5	4.0	830	-	42.0
680	13.0	5.8	840	-	42.0
690	21.5	8.5	850	-	42.0
700	28.0	11.0	860	-	42.0
710	35.8	15.0	870	-	42.0
720	41.0	19.0	880	-	42.0
730	48.5	25.0	890	-	42.0
740	51.8	30.0	900	-	42.0
750	56.0	36.3			

3.4 Composition. The material shall be furnished as a single package, and shall consist of a aliphatic polyisocyanate prepolymer combined with volatile solvents, pigments, extenders and additives.

3.4.1 Pigment. The pigments listed in table IV, or any combination thereof, shall make up the primary hiding pigmentation for the colors specified. Iron oxides used as hiding pigments shall be of synthetic origins and not naturally occurring. The titanium dioxide shall be a rutile, chalk resistant type conforming to ASTM D 476, type III or IV. If other tinting pigments are used to match the spectral characteristics, these additional pigments must have good color stability. No lead or chromate (hexavalent) pigments shall be used and antimony sulfide shall be absent. The extender pigments shall be siliceous matter and shall not exceed the amounts specified in table VI based on the manufacturer's statement of composition. Glass beads for Interior Aircraft Black 37031 shall conform to TT-B-1325, type I, grade B and shall conform to the amount specified in table VI.

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TABLE IV. Pigmentation.

Dark Green, 34082 Green 383, 34094	Acid insoluble green pigment predominately composed of cobalt, zinc, and chromium oxides with other oxides permitted, carbazole dioxazine violet, iron oxides, chromium oxide, light stable organic yellow and orange, zinc/magnesium ferrite or other mixed metal oxides.
Field Drab 33105 Brown 383, 30051 Earth Yellow 33245 Sand 33303 Tan 686, 33446 Dark Sandstone 33510	Chromium oxide, titanium dioxide, carbon black, carbazole dioxazine violet, iron oxides, zinc/magnesium ferrite or other mixed metal oxides.
Aircraft Green 34031 Olive Drab 34088	Iron oxides, carbon black, zinc/magnesium ferrites or other mixed metal oxides.
Black 37030 Aircraft Black 37038 Interior Aircraft Black 37031	Carbon black, iron oxides.
Aircraft White 37875	Titanium dioxide.
Aircraft Red 31136	Titanium dioxide, light stable organic red.
Aircraft Gray 36300 Interior Aircraft Gray 36231	Titanium dioxide, carbon black, iron oxides.
Aircraft Insignia Blue 35044	Copper phthalocyanine blue, carbon or lampblack, black iron oxide, titanium dioxide.

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3.4.2 Nonvolatile vehicle. The nonvolatile vehicle shall be a hydroxyl terminated prepolymer reacted with an aliphatic polyisocyanate. The IR spectrum of the partially cured resin shall show the presence of aliphatic polyisocyanates (for example figure 1) and shall contain no aromatic polyisocyanates when determined as stated in 4.3.5.

3.4.3 Volatile organic compounds (VOC). When tested as in 4.3.6 the VOC limit shall not exceed 420 gms/liter (3.5 lbs/gallon) as defined in Rule 1107 SCAQMD.

3.5 Quantitative requirements. The coating shall conform to the quantitative requirements of table V when tested as specified in 4.3.

TABLE V. Coating requirements.

Characteristic	Min.	Max.
Chromate, hexavalent	Negative	
Lead content, percent	-	0.06
Pigment, antimony sulfide	Negative	
Coarse particles and skin (retained No. 325 mesh sieve), percent by weight of pigment	-	1.0
Viscosity, Krebs-Stormer, K.U.	65	80
Fineness of grind for camouflage and Dark Sandstone 33510		
Hegman	3	-
ASTM Microns	-	60
Interior Aircraft Black 37031		
Hegman		0
ASTM Microns	100	
Aircraft Green 34031		
Hegman	0	2
ASTM Microns	75	100
Other colors.		
Hegman	4	-
ASTM Microns	-	50
Hiding power (contrast ratio)		
Aircraft Red 31136	.94	-
Aircraft White 37875	.92	-
Other colors	.98	-
Drying time		
Set to touch, minutes	5	30
Dry hard, hours	-	3
Dry through, hours	-	4
Specular gloss for Dark Sandstone 33510, Sand 33303, Earth Yellow 33245 and Tan 686, 33446.		
60 degree	- -	1.5
85 degree	-	4.0

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TABLE V. Coating requirements. (Continued)

Characteristic	Min.	Max.
Other camouflage colors.		
60 degree	-	1.0
85 degree	-	3.5
Aircraft Green 34031 and Interior Aircraft Black 37031.		
60 degree	-	0.5
85 degree	-	1.0
Other colors.		
60 degree	-	3.0
85 degree	-	8.0

3.5.1 Specific quantitative requirements. Each color shall conform to its specific requirement in table VI when tested as specified in 4.3.1.1. Total solids, pigment solids and vehicle solids are calculated as percent by weight. Extender pigment is percent by weight of pigment.

TABLE VI. Specific quantitative requirements.

Color	Total solids (Min.)	Vehicle solids (Min.)	Pigment solids (Min.)	Extender pigments Max.)
Dark Green 34082	65	31	33	60
Green 383, 34094	65	31	33	60
Field Drab 33105	65	31	30	67
Earth Yellow 33245	65	31	30	67
Sand 33303	65	31	30	67
Brown 383, 30051	65	31	30	67
Black 37030	65	31	30	83
Aircraft Green 34031	65	31	28	70
Interior Aircraft Black 37031	65	31	27	78 1/
Olive Drab 34088	65	31	30	67
Tan 686, 33446	65	31	30	67
Dark Sandstone 33510	65	31	30	67
Aircraft White 37875	65	25	34	52
Aircraft Red 31136	65	31	27	75
Aircraft Black 37038	65	31	27	85
Aircraft Gary 36300	65	31	32	62
Aircraft Insignia Blue 35044	65	31	16	88
Interior Aircraft Gray 36231	65	31	32	62

1/ 19-20 percent of total pigment is glass beads.

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3.6 Qualitative requirements.

3.6.1 Condition in container. When tested as specified in 4.3.12, the coating shall be free form grit, seeds, skins, abnormal thickening or livering in a freshly opened container and shall show no more pigment settling or caking than can be easily and completely reincorporated to a smooth homogeneous state.

3.6.2 Storage stability.

3.6.2.1 Accelerated storage stability. After testing as in 4.3.13.1, the coating shall meet all the requirements of the specification and have a maximum viscosity increase of 90 Ku's per amendment 1 changes. There shall be no curdling or hard dry caking and any sedimentation shall easily mix back into a smooth homogeneous state.

3.6.2.2 Full container storage stability. A full quart can shall show no skinning, livering, curdling, hard dry caking nor tough gummy sediment when tested as specified in 4.3.13.2. It shall remix readily to a smooth homogeneous state, shall have a maximum viscosity increase of 90 Ku's per amendment 1 changes and shall meet all other requirements of this specification.

3.6.3 Spraying properties. When tested as specified in 4.3.14, the coating shall spray satisfactorily in all respects and shall show no running, sagging, or streaking. The coating should not spray dry and the dried film shall show no dusting, mottling, color separation or other film irregularities or defects and shall present a smooth (except Aircraft Green 34031 and Interior Aircraft Black 37031) lusterless finish free from seediness.

3.6.4 Brushing properties. The coating shall brush satisfactorily and shall dry to a smooth, uniform film, free from seeds, runs, sags, or streaks when tested as specified in 4.3.15.

3.6.5 Flexibility. A film of the coating tested as specified in 4.3.16 shall withstand bending without cracking or flaking.

3.6.6 Recoatability. When tested as specified in 4.3.17, recoating of a dried film shall produce no lifting, softening, or other film irregularity.

3.6.7 Water resistance. A film of the coating tested as specified in 4.3.18 shall show no blistering or wrinkling and no more than a slight whitening or softening immediately upon removal from the water. After 2 hours air drying the portion of the panel that was immersed shall meet the specification requirements in regard to adhesion, hardness, color and gloss from the portion that was not immersed.

3.6.8 Hydrocarbon resistance. A film of the coating tested as specified in 4.3.19 shall show no blistering or wrinkling when examined immediately after removal from the hydrocarbon test fluid. When examined 2 hours after removal, there shall be no excessive softening, whitening, or dulling. After 24 hours drying, the panel which was immersed shall meet the specification requirements in

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regard to hardness, adhesion, and general appearance when compared to a panel prepared at the same time but not immersed and shall have no more than a 0.5 gloss unit increase over the original 60 degree and 85 degree specular gloss.

3.6.9 Acid resistance. For Dark Green 34082, and Green 383, 34094, a film of the coating tested as specified in 4.3.20 shall have no blistering and show no change from the original color.

3.6.10 Polish resistance (except Interior Aircraft Black 37031). A film of the coating tested as specified in 4.3.21 shall have a maximum 85 degree specular gloss of 12 for all colors except Aircraft Green 34031. Aircraft Green 34031 shall have a maximum 85 degree gloss of 5.

3.6.11 Accelerated weathering. Samples of aircraft colors and Olive Drab 34088 tested as specified in 4.3.22 for 300 hours shall show no cracking, chalking, loss of adhesion, and shall meet the color, 60 and 85 degree gloss requirements of the specification. Camouflage colors tested as specified in 4.3.22 for 300 hours shall show no cracking, chalking, loss of adhesion, or increase in the 60 and 85 degree gloss and the color change shall be less than 2.5 NBS units. In addition, the camouflage colors after accelerated weathering shall remain within 2.5 NBS units of the value specified in table I at the average of the allowable brightness range. The infrared reflectance and allowable ratio shall remain within those limits originally specified.

3.6.12 DS2 resistance. A film of the coating when tested as specified in 4.3.23 shall show no blistering, wrinkling, or film softening when examined immediately after washing with warm water. After drying, there shall be a maximum color change of 2.5 NBS units when comparing a portion of the untested panel to that of the tested area.

3.6.13 Chemical agent resistance. A film of the coating tested as specified in 4.3.24 shall desorb a maximum of 40 micrograms of agent GD and 180 micrograms of agent HD.

3.6.14 Weather resistance. Films of the coating tested as specified in 4.3.25 shall show no checking, cracking, or appreciable film deterioration. There shall be no more than light chalking (see ASTM D 659). The color shall show no excessive change in value and chroma and no change in hue. After removal of any chalking which has occurred, the original color shall be substantially restored and the washed area shall show no more than slight fading or darkening.

3.6.15 Exclusion of toxic solvents. The product shall contain no benzene, chlorinated compounds or ethylene based glycol ethers and their acetates.

3.7 Material Safety Data Sheet (MSDS). A MSDS shall be prepared in accordance with FED-STD-313 for the aliphatic polyurethane coating. The contractor will overpack a copy of the MSDS with each shipment of material (see 6.5).

3.8 User instruction marking. In addition to the markings specified in 5.3.1 and 5.3.2, all containers shall be legibly marked or labeled with the following:

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Caution: The Surgeon General requires airline respirators to be used unless air sampling shows exposure to be below standards, then either chemical cartridge respirators or airline respirators are required. Avoid contact with skin and eyes. Use with adequate ventilation. For other safety and disposal recommendations refer to the Material Safety Data Sheet. Keep container tightly closed. This coating is very water sensitive and caution must be taken to insure that water or high humidity do not come in contact with the coating at any time during reduction, application or drying. If necessary for spray application, use only urethane grade thinner for reduction. MATERIAL SHOULD BE USED WITHIN 8 HOURS AFTER REDUCTION.

NOTE: If 1,1,1,trichloroethane is used in reduction, do not use spray equipment containing any aluminum components.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may utilize his own or any other facilities suitable for the performance of inspection requirements specified herein, unless disapproved by the Government. The contractor shall certify that their Test, Measurement and Diagnostic Equipment (TMDE) is calibrated in accordance with MIL-STD-45662. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to the prescribed requirements.

4.1.1 Sampling, inspection, and testing. Unless otherwise specified, sampling, inspection and testing shall be in accordance with section 1000 of FED-STD-141.

4.1.2 Material Safety Data Sheet. Material Safety Data Sheets must be in compliance with the requirements of FED-STD-313 (see 3.7).

4.2 Classification of inspection. Testing under this specification shall be for the following:

a. Qualification (see 4.2.1 and 6.4).
b. Acceptance of individual lots (see 4.2.2).
c. Acceptance for use as component on end item (see 4.2.3).
d. Validation of spectral reflectance characteristics (see 4.2.4).
e. Inspection of packaging (see 4.4).

4.2.1 Qualification tests. Qualification testing shall consist of tests for all requirements specified in section 3.

4.2.2 Acceptance tests. Acceptance testing of individual lots shall consist of the following tests: COndition in container, hiding power, total solids, infrared reflectance, viscosity, fineness or grind, specular gloss, drying time, color and spectral reflectance, spraying properties, and mixing properties as specified in sections 3 and 4.

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4.2.3 Conformance tests. When approved by the cognizant activity, acceptance of lots for use as a component on an end item shall be based on conformance with specified requirements for the following characteristics:

Color - spectral reflectance
Fineness of grind
60 degree gloss
85 degree gloss
Acid resistance
Hydrocarbon fluid resistance
Water resistance

4.2.4 Validaiton. (Except aircraft colors Red 31136, Blue 35044, Interior Gray 36231, Black 37038, White 37875, Yellow 33538, Interior Black 37031, Dark Sandstone 33510, and Olive Drab 34088). The contracting officer shall require that a pint sample from each production lot be forwarded to the Commander, US Army Belvoir Research and Development, and Engineering Center, ATTN: STRBE-VO, Fort Belvoir, VA 22060-5606, for validation of spectral reflectance characteristics.

4.3 Test methods.

4.3.1 Test conditions. The routine testing condition shall be in accordance with section 9 of FED-STD-141 or in accordanc with the appropriate ASTM method except as otherwise specified herein. Failure of any test result to fall within the ranges specified in 3.3, 3.4, 3.5, 3.6, and 3.7 shall constitute failure of the applicable test.

4.3.1.1 Test procedures. The following tests (see table VII) shall be conducted in accordance with FED-STD-141 or ASTM as specified herein. The right is reserved to make any additional test deemed necessary to determine that the coating meets the requirements of this specificaiton.

4.3.1.2 Test panels. Except as otherwise specified, steel test panels shall be pretreated with a zinc phosphate coating conforming to TT-C-490, type I.

TABLE VII. Index.

Item	Application method in FED-STD-141	Applicable ASTM Test Method	Test Paragraph	Requirements Paragraph
Color and spectral reflectance	6241	E 308	4.3.2	3.3
Total solids	-	-	4.3.3	Table VI
Pigment analysis	4021	-	4.3.4	Tables IV, VI and 3.4.1
Titanium dioxide	-	D 476, III	-	3.4.1
Chromate, Hexavalent	-	-	4.3.4.1	Table V
Lead content	-	-	4.3.4.2	Table V

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TABLE VII. Index. (Cont'd)

Item	Application method in FED-STD-141	Applicable ASTM Test Method	Test Paragraph	Requirements Paragraph
Antimony sulfide	-	-	4.3.4.3	Table V
Vehicle solids	-	-	4.3.4	Table VI
Nonvolatile vehicle	-	-	4.3.5	3.4.2
Coarse particles and skins	4092	-	-	Table V
Volatile organic compounds	-	D 3960	4.3.6	3.4.3
Viscosity				
Krebs-Stormer	-	D 562	-	Table V
Hiding-power (contrast ratio)	-	D 2805	4.3.7	Table V
Fineness of grind	-	D 1210	4.3.8	Table V
Drying time	4061	-	4.3.9	Table V
Specular gloss	-	D 523	4.3.10	Table V
Infrared reflectance				
Camouflage colors	6241	-	4.3.2	Table I
Noncamouflage colors	6242	-	4.3.11	Table I
Condition in container	3011	-	4.3.12	3.6.1
Storage stability, accelerated	-	-	4.3.13.1	3.6.2.1
Storage stability, full container	-	D 1849	4.3.13.2	3.6.2.1
Spraying properties	4331/2131	-	4.3.14	3.6.3
Brushing properties	4321	-	4.3.15	3.6.4
Flexibility	6221	-	4.3.16	3.6.5
Recoatability	-	-	4.3.17	3.6.6
Water resistance	-	D 1308, Sec. 6.4	4.3.18	3.6.7
Hydrocarbon resistance	-	D 1308, Sec. 6.4	4.3.19	3.6.8
Acid resistance	-	-	4.3.20	3.6.9
Polish resistance	2021	-	4.3.21	3.6.10
Accelerated weathering	-	G 26	4.3.22	3.6.11
DS2 resistance	-	-	4.3.23	3.6.12
Chemical agent resistance	-	-	4.3.24	3.6.13
Weather resistance	-	D 1014	4.3.25	3.6.14
Toxic solvents	-	-	-	3.6.15

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4.3.2 Color and spectral reflectance. Prepare 4 drawdowns of the coating on black and white Morest cards to a dry film thickness of 0.002 ±0.0002 inches. Dry for 48 hours as specified in 4.3.1. Measurements shall be made over the black portion of the Morest card. For camouflage colors, determine the color from the spectral reflectance curves using the recording spectrophotometer method in accordance with ASTM E 308. Determine infrared reflectance in accordance with method 6241 of FED-STD-141. For aircraft camouflage colors compare the color as specified in 3.3.2 and determine the infrared reflectance as specified in 4.3.11. For all other colors, compare colors specified in 3.3.3. Nonconformance to 3.3 shall constitute failure of this test.

4.3.3 Total solids. Place a portion of the thoroughly mixed sample in a dropping bottle and weigh to the nearest one-tenth mg. Weigh a 60 mm aluminum dish with fourth decimal accuracy. Transfer a small sample that does not exceed 0.3 g to the dish; determine its exact weight by loss of weight of the bottle. Dissolve the sample in 2 mL of A.C.S. reagent grade acetone and dry in a gravity convection oven at 110 ±5 °C (230 ±9 °F) for 30 minutes. Upon cooling, re-weigh the dish to the nearest one-tenth mg. From the weight of the residue in the dish and the weight of the sample taken, calculate the percent nonvolatile or volatile as required. Check for compliance with table VI.

4.3.4 Pigment analysis. Extract the pigment as in method 4021 of FED-STD-141 using extraction mixture C. Calculate the percent pigment (TP) and, using the value for total solids (TS) obtained in 4.3.3, calculate the vehicle solids (VS) content as TS-TP. Check for compliance with table VI. Determine the percent extender pigment content from the statement of composition. Run the acid insoluble by method 5271 of FED-STD-141. In the case of the camouflage green colors, the acid insoluble should show the presence of the insoluble green pigment and silica. Check for compliance with tables IV and VI and 3.4.1.

4.3.4.1 Hexavalent chromium (Cr^{6+} must be absent).

a. Reagents:

1. 25 percent aqueous KOH.

b. Procedure:

1. Add 5 mL of 25 percent AQ. KOH to 1/2g of the extracted pigment contained in a 15 mL centrifuge tube.
2. Agitate by shaking the tube for a few minutes then centrifuge.
3. The supernatant liquid should be colorless. A yellow color indicates presence of chromate. Nonconformance to the requirement in 3.4.1 and table IV shall constitute failure of this test.

4.3.4.2 Lead content.

4.3.4.2.1 Determination of lead by atomic absorption spectroscopy. Determine percent of lead in accordance with ASTM D 3335. Nonconformance to table IV shall constitute failure of this test.

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4.3.4.2.2 Determination of lead by X-ray emission spectrometric analysis (alternate method).

4.3.4.2.2.1 Test panel preparation. Using 100 grams of a known lead free coating, prepare standard aliquots containing 0.000, 0.03, 0.06, and 0.09 percent lead metal, based on a total nonvolatile paint, by adding calculated amounts of lead napthenate of a known lead content. Thoroughly mix the aliquots to incorporate the lead and draw down the standards and mixed coating to be tested on duplicate black and white Morest cards using a 0.0020-inch (0.004-inch gap clearance) film applicator. Dry for 48 hours at a temperature of 23 ±1.1 °C (73.4 ±2 °F), a relative humidity off 50 ±4 percent, and under dust free conditions. Cut the drawdowns into a suitable size and shape to fit the sample holder of the x-ray fluorescence spectrometer.

4.3.4.2.2.2 X-ray analytical procedure. Lead content shall be determined using an x-ray fluorescence spectrometer capable of determining lead content at a minimum level of 0.03 percent by weight of the total nonvolatile paint. The parameters of angle, crystal, pulse height selection, counting time, collimator, x-ray tube, voltage amperage, shall be established for a wave length dispersive fluorescence spectrometer according to conventional x-ray analytical procedures. The analytical line Pb L-alpha or Pb L-beta shall be used. To calibrate, place the known standards in the x-ray unit and measure the count rates of lead, lead background and the Compton scattered background from the x-ray tube. The ratio R, of net lead intensity and Compton scattered background is calculated as follows:

$$R = \frac{I_{Pb} - \dfrac{(I_{Pb}\ \text{Background I} + I_{Pb}\ \text{Background II})}{2}}{I_{\text{Compton Line}}}$$

Where I = gross intensity and the background is taken on each side of the Pb line.

Establish a lead calibration curve using these results. Determine the lead content of the test paint using the above procedure and calibration curve. When using an energy dispersive fluorescence spectrometer, it shall be set up in accordance with the manufacturer's manual. Nonconformance to table IV constitute failure of this test.

4.3.4.3 Antimony sulfide. Add 25 mL of 50 percent ammonium hydroxide to about 2 grams of pigment in a 50 mL erlenmeyer flask. With agitation, saturate the mixture with hydrogen sulfide for about 1 minute. Filter through coarse paper into 100 mL beaker. Do not wash residue. Slowly and with stirring, add 6 N HCL to the filtrate until it is acidic. Formation of a yellow-brown precipitate indicates that antimony was in the original pigment mixture. A milky white precipitate of sulfur will form in the absence of Sb_2S_3. Nonconformance to table V shall constitute failure of this test.

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4.3.5 Nonvolatile vehicle. Centrifuge a 1:1 mixture of methyl isobutyl ketone and paint at 12,000 rpm for 10 minutes. Evaporate a film of the vehicle on a sodium chloride plate at 105 °C (221 °F) for 5 minutes. Scan the infrared spectrum from 2.5 to 15 micrometers. Check for compliance with 3.4.2. Nonconformance to 3.4.2 shall constitute failure of this test.

4.3.6 Volatile organic compounds (VOC) determination. Determine the VOC content in accordance with ASTM D 3960. Check for compliance with 3.4.3. Nonconformance to 3.4.3 shall constitute failure of this test.

4.3.7 Hiding power (contrast ratio). Prepare a drawdown as specified in 4.3.2 with a dry film thickness of 0.009-0.0011 inch. Verify the film thickness in the area in which the reflectance is measured. Determine the reflectance using the daylight reflectance factor of ASTM E 97 over the black and white portion of the card and record the values as R_B and R_W respectively. Calculate the hiding power by R_B/R_W and check for compliance with table V. Nonconformance to table V shall constitute failure of this test.

4.3.8 Fineness of grind. Determine fineness of grind according to ASTM D 1210. Check for compliance to table V. Nonconformance to table V shall constitute failure of this test.

4.3.9 Drying time. Draw down the coating to a dry film thickness of 0.001 ±0.0001 inches. Determine the drying in accordance with method 4061 of FED-STD-141. Check for compliance with table V. Nonconformance to table V shall constitute failure of this test.

4.3.10 Specular gloss. Draw down the coating to a dry film thickness of 0.001 ±0.0001 inches. Test for 60 degree gloss and 85 degree gloss (sheen) as specified in ASTM D 523. Check for compliance with table V. Nonconformance to table V shall constitute failure of this test.

4.3.11 Infrared reflectance. (Aircraft Gray 36300, Aircraft Green 34031; Interior Aircraft Black 37031 and Dark Sandstone 33510.) Determine the infrared reflectance on the black portion of the drawdown made in 4.3.2. Determine the infrared reflectance for Aircraft Gray 36300 and Dark Sandstone 33510 at 1500 nanometers using a spectrophotometer which is capable of measuring the total diffuse reflectance. Determine the infrared reflectance for Aircraft Green 34031 and Interior Aircraft Black 37031 in accordance with method 6242 of FED-STD-141 using a Wratten 87 filter. Nonconformance to table I shall constitute failure of this test.

4.3.12 Condition in container. Determine package condition in accordance with method 3011 of FED-STD-141 and observe for compliance with 3.6.1. On qualification testing, determine pigment settling by proceeding as in method 3011 of FED-STD-141 but do not stir. Reseal and then agitate the can for 3 minutes on a paint shaker.[1/] On reexamination of the contents, the disclosure of any gel bodies or undispersed pigment indicates unsatisfactory settling properties. Nonconformance to 3.6.1 shall constitute failure of this test.

1/ An apparatus of this type, powered by a 1/4 hp motor, operates at a rate of 1350 shakes per minute and is manufactured by Red Devil Tools, Irvington, NJ.

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4.3.13 Storage stability.

4.3.13.1 Accelerated storage stability. Fill an epoxy lined pint container with the coating and determine the viscosity in accordance with ASTM D 562. Tightly seal the container and place sample in a preheated oven for 7 days at 60 ±1 °C (140 ±1.8 °F). Allow to cool to room temperature and examine the contents. Nonconformance to 3.6.2.1 shall constitute failure of this test.

4.3.13.2 Full container storage stability. Allow a full pint can to stand undisturbed for 12 months in accordance with ASTM D 1849. Examine the contents for skinning. Reseal and agitate the can for 5 minutes on a paint shaker. Reexamine and evaluate for pigment settling as specified in 4.3.12. Determine viscosity and other applicable tests for compliance with 3.6.2.2. Nonconformance to 3.6.2.2 shall constitute failure of this test.

4.3.14 Spraying properties. If reduction is necessary for spray application, and air pollution regulations are not in effect, reduce 4 parts by volume of the coating with one part by volume of thinner conforming to MIL-T-81772, type 1. If it is necessary to reduce for spraying and the 3.5 lb/gallon VOC requirement is in effect, reduce 4 parts by volume of the coating with one part by volume of 1,1,1 trichlorothane (Dow Chlorothene SM[2/] or equivalent) or follow manufacturer's instructions. Spray the coating on a solvent cleaned steel panel to a dry film thickness between 0.0009 and 0.0011 inch and observe for spraying properties in accordance with method 4331 of FED-STD-141 for compliance with 3.6.3. Observe reduced coating in 7 hours and determine if spraying properties are satisfactory. For referee test use automatic application per method 2131 of FED-STD-141. Nonconformance with 3.6.3 shall constitute failure of this test.

4.3.15 Brushing properties. Apply the coating using a 2-1/2 inch brush in accordance with method 4321 of FED-STD-141. The packaged coating may be reduced as in 4.3.14 if needed. Check for compliance with 3.6.4. Nonconformance to 3.6.4 shall constitute failure of this test.

4.3.16 Flexibility. Spray the coating to a dry film thickness of 0.001 ±0.0001 inches on a No. 31 gage (0.0107 inch) cold rolled, luster finish steel panel prepared as in procedure B, phosphoric acid etched, method 2011 of FED-STD-141. Age the film in a horizontal position for 72 hours then bake for 96 hours at 105 ±5 °C (221 ±9 °F). Determine flexibility, over a 1/4 inch mandrel in accordance with method 6221 of FED-STD-141. Nonconformance to 3.6.5 shall constitute failure of this test.

4.3.17 Recoating. Prepare two solvent cleaned 4 by 12 inch steel panels and spray with coating to a dry film thickness of 0.0009 to 0.0011 inch. Apply a second coat of paint to one panel after 2 hours air drying and a second coat to the other after 24 hours. Examine for lifting, softening, and evidence of other film irregularity. Nonconformance to 3.6.6 shall constitute failure of this test.

2/ Chlorothene SM - Dow Chemical Company, 2020 Dow Center, Midland, MI 48640.

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4.3.18 Water resistance. Prepare a steel panel pretreated as specified in 4.3.1.2. Spray the coating to a dry film thickness of 0.0009 to 0.0011 inches and air dry for 168 hours. Coat all exposed unpainted metal surfaces with wax or suitable protective coating and immerse in water at 23 ±2 °C (73.4 ±3.6 °F) for 168 hours as in ASTM D 1308, section 6.4. At the end of the test period remove and examine for compliance with 3.6.7. Nonconformance of 3.6.7 shall constitute failure of this test.

4.3.19 Hydrocarbon resistance. Prepare a film of the coating as in 4.3.18. Air dry the specimen for 168 hours and then immerse for 168 hours at 23 ±2 °C (73.4 ±3.6 °F) in a hydrocarbon fluid conforming to TT-S-735, type III as in ASTM D 1308, section 6.4. At the end of the test or period remove and examine for compliance with 3.6.8. Nonconformance of 3.6.8 shall constitute failure of this test.

4.3.20 Acid resistance (for Green 383, 34094 and Dark Green 34082 only). Using the film prepared in 4.3.9, place a 3 to 5 mL spot of a 10 percent by volume acetic acid solution on the surface of the coating. Cover with an appropriate size watch glass and allow to stand for 1 hour. Rinse with water thoroughly, allow to dry, and examine for blistering and color change for compliance with 3.6.9. Nonconformance of 3.6.9 shall constitute failure of this test.

4.3.21 Polish resistance. (Except Interior Aircraft Black 37031).

4.3.21.1 Test apparatus. The apparatus[3/] shall consist of an electrically operated straightline, reciprocating washability and abrasion machine with an abrasion boat attachment. The abrasion boat shall approximate 3-1/2 by 2-1/8 inches at the base and weigh 4-1/2 pounds including added weights. The abrasion boat shall have a spindle located at each end to retain the roll of polishing cloth and vertical pin by which it is attached to the driving cord. A cotton canton flannel cloth, 1-3/4 inches wide, shall be attached to the spindles for this test. The length of the stroke shall approximate 13 inches. The speed shall approximate 37 cycles (74 strokes per minute).

4.3.21.2 Polishing medium. The polishing medium shall consist of the following by weight:

50 parts synthetic yellow iron oxide (ASTM D 768).
100 parts SAE-10 engine oil conforming to MIL-L-2104.

4.3.21.3 Test procedure.

4.3.21.3.1 Test procedure (a). Draw down a 2-inch wide film of the coating with 0.002-inch (0.004-inch gap clearance) doctor blade on a 6- by 17-inch glass panel prepared and cleaned as in method 2021 of FED-STD-141. Air dry the specimen for 168 hours and then apply a 0.002-inch film of the polishing medium over the coating areas of the test specimen.

3/ An apparatus of this type powered by a 1/3 hp explosion-proof motor, is manufactured by the Gardner Laboratories, Inc., Bethesda, Maryland.

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4.3.21.3.2 Test procedure (b). Condition the flannel cloth by drawing down a 2-inch-wide film of the polishing medium with a 0.0020-inch (0.0040-inch gap clearance) doctor blade on a 6- by 17-inch glass panel. Clamp the glass panel on the abrasion apparatus so the film is centered with the polishing stroke, and run the apparatus for 10 cycles (20 strokes). Use a new flannel cloth for each test.

4.3.21.3.3 Test procedure (c). Remove the glass panel used to condition the flannel cloth and replace with the specimen test panel from 4.3.21.3.1. Run the apparatus for 100 cycles (200 strokes). Remove the panel, rinse with thinner conforming to TT-T-291, grade 1 and wash with a soft sponge or cloth using yellow laundry soap and water. Dry thoroughly, determine gloss and sheen of the area in the center of the panel as in 4.3.10, and check for compliance with 3.6.10. Nonconformance to 3.6.10 shall constitute failure of this test.

4.3.22 Accelerated weathering. Prepare four tin plate panels to 0.0020 ±0.0002 inch dry film thickness of the coating and air-dry for 72 hours. Three panels are to be tested and one retained as a control. Determine the color and infrared reflectance as in 4.3.2 and measure the 60 and 85 degree gloss. Expose the panel for 300 hours to accelerated weathering in accordance with ASTM G 26 method A, type BH. Measure the 60 and 85 degree gloss and determine the color and inferred reflectance of the exposed film. Examine the panel for chalking by rubbing with a piece of velvet or cheese cloth. Check for compliance with 3.6.11. Nonconformance to 3.6.11 shall constitute failure of this test.

4.3.23 DS2 resistance. Prepare one 4- by 12-inch panel as specified in 4.3.1.2, except spray the coating to a dry film thickness of 0.0018-inch minimum. Air dry the panel 1 day then bake for 1 day at 105 ±1.1 °C (221 ±2 °F). Allow the panel to return to room temperature and place 2 spots approximately 1.0 mL each of DS2 agent on the panel surface. Do not cover, allow to stand 30 minutes then thoroughly wash with warm water. Examine for compliance with 3.6.12. Nonconformance to 3.6.12 shall constitute failure of this test.

4.3.24 Chemical agent resistance.

4.3.24.1 Panel preparation. Spray eight 3 by 3 inch panels, zinc phosphate pretreated according to TT-C-490, type 1 with epoxy primer conforming to MIL-P-52192, MIL-P-23377, MIL-P-53022, MIL-P-53030 or MIL-P-85582 to a dry film thickness between 0.0009 and 0.0011 inch. Air dry 2 hours and spray the coating to be tested to a dry film thickness between 0.0018 and 0.0022 inch. Air dry the panels 4 days then bake for 3 days at 105 ±1.1 °C (221 ±2 °F).

4.3.24.2 Test conditions. Because the desorption rate of agents from paint is temperature dependent, all agent tests will be conducted at 25 °C. Toxic materials are used in this testing; therefore, all work will be performed in an approved fume hood and using approved personal protective equipment.

4.3.24.3 Test apparatus. In the fume hood, use a short length of tubing to attach an apparatus similar to that shown in figure 2 to a sampling bubbler, (figure 3) filled with 5 milliliters of diethyl phthalate. Connect the outlet of the bubbler to the vacuum line in the hood with a 1 liter per minute critical orifice inserted between the bubbler and the vacuum line. A charcoal trap or canister will be inserted directly before the vacuum line.

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4.3.24.4 Test procedure. Mark a circular 5 square centimeter area in the center of the test panel and place the panel in the fume hood. Completely contaminate the area drop-wise from a microsyringe, spreading the agent with the flat portion of the needle and being careful not to damage the paint. Keep the area wet for 30 minutes by adding more agent as required. After 30 minutes, pick up the panel with tongs, hold it over a toxic waste container, and direct a stream of isopropyl alcohol (reagent grade) onto the surface of the panel to remove any liquid agent remaining. Use about five such rinses from a wash bottle and after the finial rinse, continuously monitor the panel until the alcohol has evaporated. Place the stainless steel permeation cell over the contaminated area, seal with duct seal and start sampling. Draw air into the inlet of the test apparatus, over the contaminated film, and through the bubbler and critical orifice. Any agent vapors emitted are picked up by the air stream and absorbed in the diethyl phthalate in the bubbler. After sampling continuously for 24 hours, analyze the diethyl phthalate for the presence of agent using the methods in the appendix A, or by an appropriate gas chromatographic method (if a gas chromatographic method is used, an absorbent more appropriate then diethyl phthalate must be used in the bubblers). Determine the agent recovered in micrograms for compliance with 3.6.13. Nonconformance to 3.6.13 shall constitute failure of this test.

4.3.25 Weather resistance. Prepare two 4 by 12 inch steel panels as in 4.3.24.1. Place on outdoor exposure for 2 years at an angle of 45 degrees south in the vicinity of Washington, D.C. At the end of this exposure period examine the panels for compliance with 3.6.14. Determine chalking according to ASTM D 659. Wash the panels with a warm soap solution using a soft sponge or cloth, rinse, dry and examine for color change. Nonconformance to 3.6.14 shall constitute failure of this test.

4.4 Inspection of packaging. Inspection of packaging shall be in accordance with PPP-P-1892.

5. PACKAGING

5.1 Preservation. Preservation shall be level A or C as specified (see 6.2).

5.1.1 Unit containers. The unit containers for the coating shall, as specified (see 6.2), be 1-quart or 1-gallon multiple friction plug containers, or 5-gallon lug cover steel pails.

5.1.1.1 Level A. Unit containers of the types and sizes specified in 5.1.1 (see 6.2), shall be in accordance with the level A packaging and packing requirements shown in PPP-P-1892 for pigmented liquid products.

5.1.1.2 Level C. Unit containers of the types and sizes specified in 5.1.1 (see 6.2), shall be those containers normally used for products of this nature providing there will be no interaction chemically or physically with the contents so as to damage the container or alter the strength, quality or purity of the contents. The containers shall comply with the requirements of the National Motor Freight Classification (NMFC), or the Uniform Freight Classification (UFC) and the applicable requirements of the Code of Federal Regulations 49 CFR, Department of Transportation (DOT).

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

5.2.1 Levels A and B. The coating material, in unit containers as specified in 5.1.1, shall be packed in accordance with the level A or B requirements of PPP-P-1892.

5.2.2 Level C. The coating material, in unit containers as specified in 5.1.1, shall be packed in accordance with UFC or NMFC, and applicable Department of Transportation Regulations.

5.2.3 Palletization. When specified (see 6.2), pails or drums shall be palletized in accordance with MIL-STD-147.

5.3 Marking. Each unit container and shipping container shall, as applicable, be marked in accordance with MIL-STD-129.

5.3.1 Additional marking. In addition to any special or identification marking which may be required by the contract or purchase order (see 6.2), each unit container and each shipping container shall be legibly marked as specified in 3.8 in conformance to 29 CFR, 1910.144/145.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This single component polyurethane coating is intended to provide surfaces easily and effectively decontaminated after exposure to liquid chemical agents. It may be used in areas where the maximum VOC level 3.5 lbs/gallon is in force. It is applied over epoxy primers (MIL-P-52192, MIL-P-23377, MIL-P-53022, MIL-P-53030, or MIL-P-85582 depending on the application and substrate). For adequate camouflage properties, it is necessary to apply the coatings to a minimum dry film thickness of 0.0018 inches.

6.2 Acquisition requirements. Acquisition documents shall specify the following:

a. Title, number, and date of the specification.
b. Color of coating required (see 1.2).
c. Date of issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
d. Level of preservation and packing required (see 5.1 and 5.2).
e. Size of containers required (see 5.1.1).
f. When palletization is required (see 5.2.3).
g. Any special marking requirements (see 5.3.1).

6.3 Basis of purchase. The coating covered by this specification should be purchased by volume, the unit being one U.S. liquid gallon of 231 cubic inches at 20 °C (68 °F).

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6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in the applicable qualified products list whether or not such products have actually been so listed by that date. The attention of contractors is called to this requirement and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. After qualification, each production lot batch must be validated. The activity responsible for the qualified products list and validation testing is the US Army Belvoir Research, Development and Engineering Center, ATTN: STRBE-VO, Ft. Belvoir, VA 22060-5606, and information pertaining to qualification and validation of products may be obtained from that activity (see 4.2.1 and 4.2.4).

6.4.1 Qualification extension. Qualification testing shall be performed on the colors listed in the left column of table VIII. Colors approved for qualification will extend to their respective colors listed in the right column after satisfactory extension test program. The extension test program will test for color, infrared reflectance, accelerated weathering for only Aircraft Yellow 33538 and Red 31136, 60 and 85 degree gloss, DS2 resistance, acid resistance, accelerated storage stability and chemical agent resistance. Colors in the right column will be listed on the qualified products list if they satisfy the requirements of the extension test program. A quart sample and necessary paperwork is required for this testing.

TABLE VIII. Qualification and extension colors.

Color Qualified	Additional colors to which approval is extended
Green 383, 34094	Dark Green 34082
Field Drab 33105	Earth Yellow 33245, Dark Sandstone 33510
Sand 33303	Tan 686, 33446
Brown 383, 30051	-
Black 37030	-
Olive Drab 34088	Aircraft Green 34031
Aircraft Gray 36300	Interior Aircraft Gray 36231
Interior Aircraft Black 37031	-
Aircraft White 37875	Aircraft Red 31136, Aircraft Insignia Blue 35044, Aircraft Yellow 33538
Aircraft Black 37038	-

6.5 Material Safety Data Sheet. Contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. The pertinent government mailing addresses for submission of data are listed in appendix B of FED-STD-313.

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6.6 Color difference equation. The correct color difference equation is entitled "Hunter's Revised National Bureau of Standards (NBS) Color Difference Equation." One reference source is "Color in Business, Science and Industry, "(Wiley, NY)."

6.7 Subject term (key word) list.

Camouflage
CARC
Chemical agent resistant coating
Urethane coating

6.8 Changes from previous issue. Asterisks (or vertical lines) are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodian:
Army - ME

Review Activities:
Army - AR, EA, AT, ER, MD, AV, MR

Preparing activity:
Army - ME

Project 8010-A354

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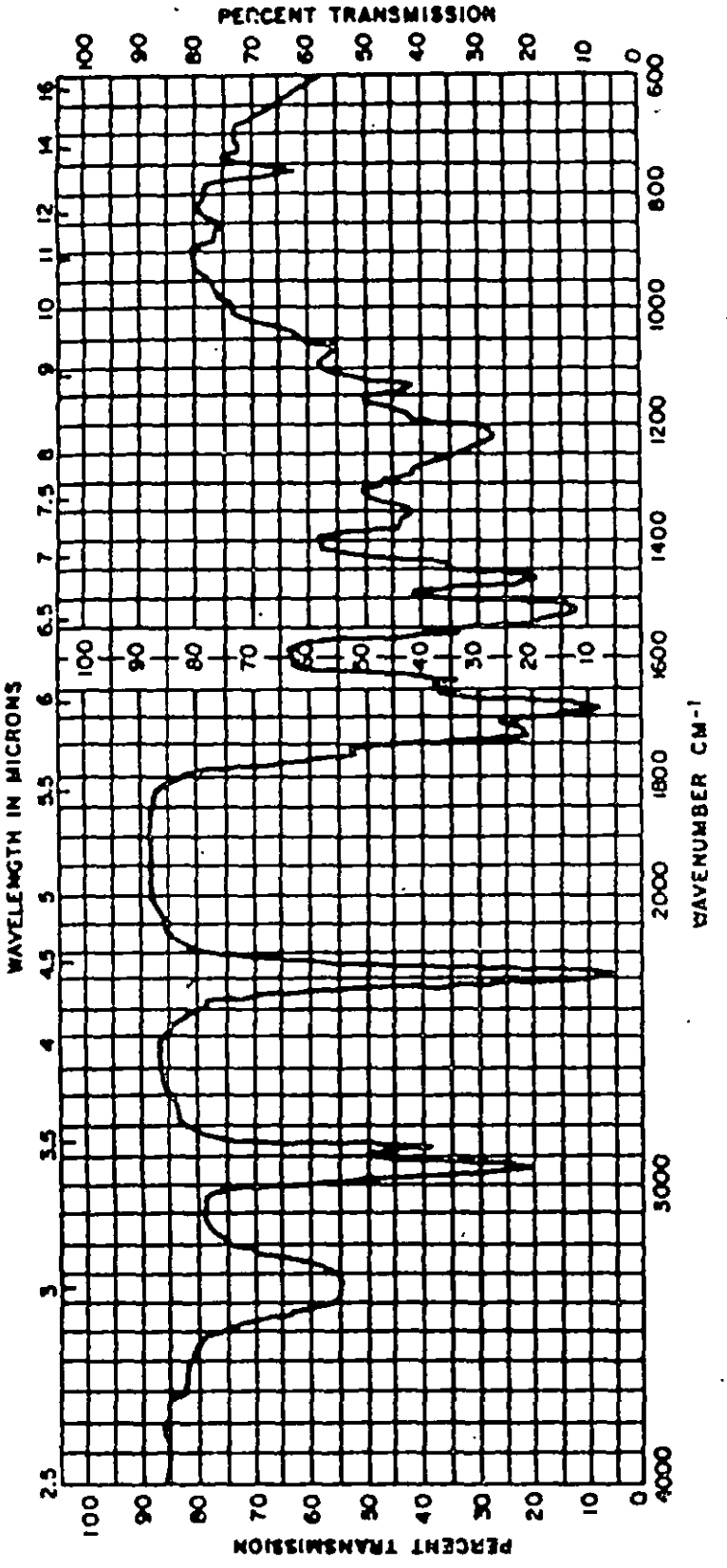

FIGURE I. Infrared spectrum of extracted resin.

X-4268

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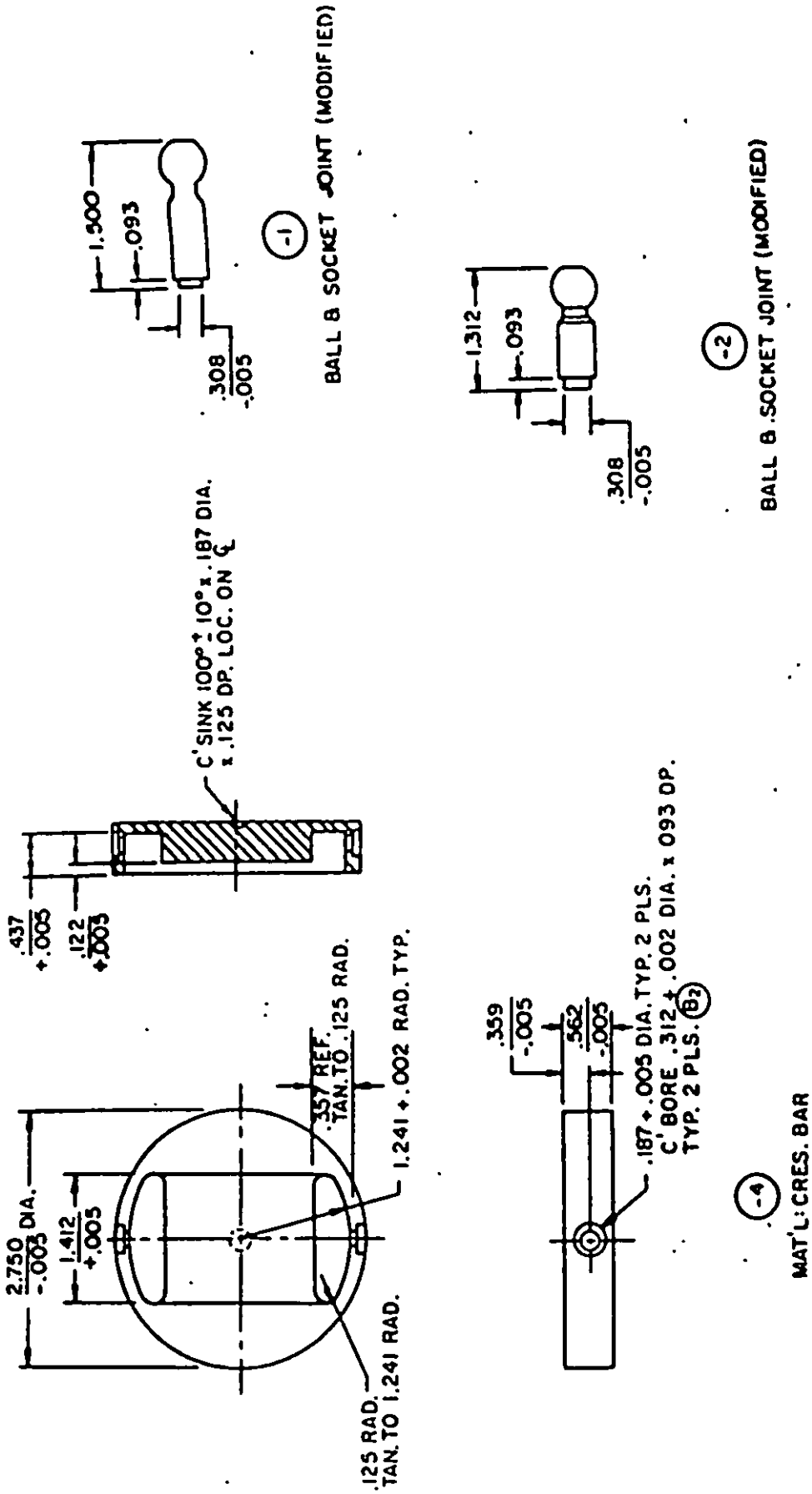

FIGURE 2. Permeation cell.

X-4265

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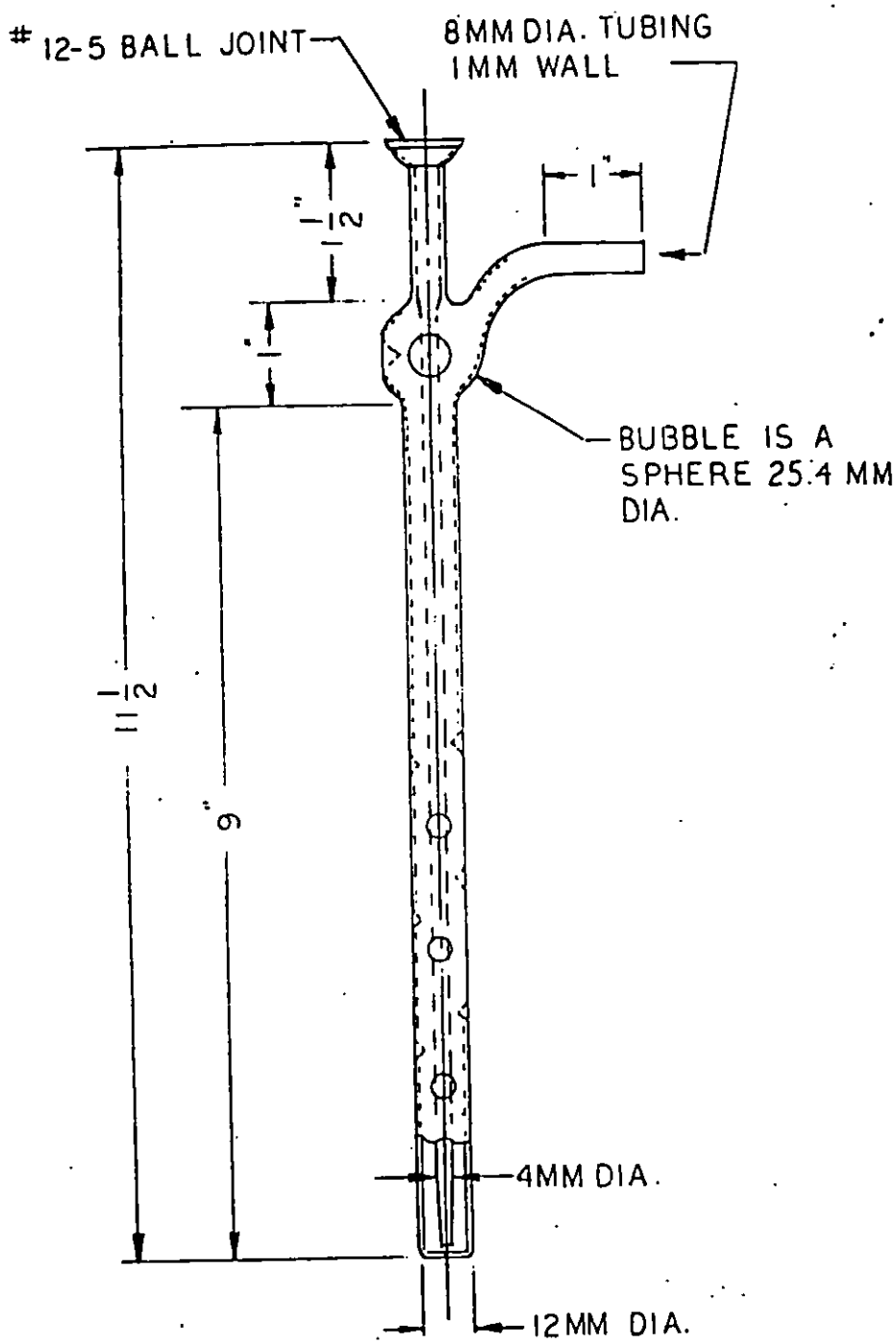

FIGURE 3. Sampling bubbler. X-3685A

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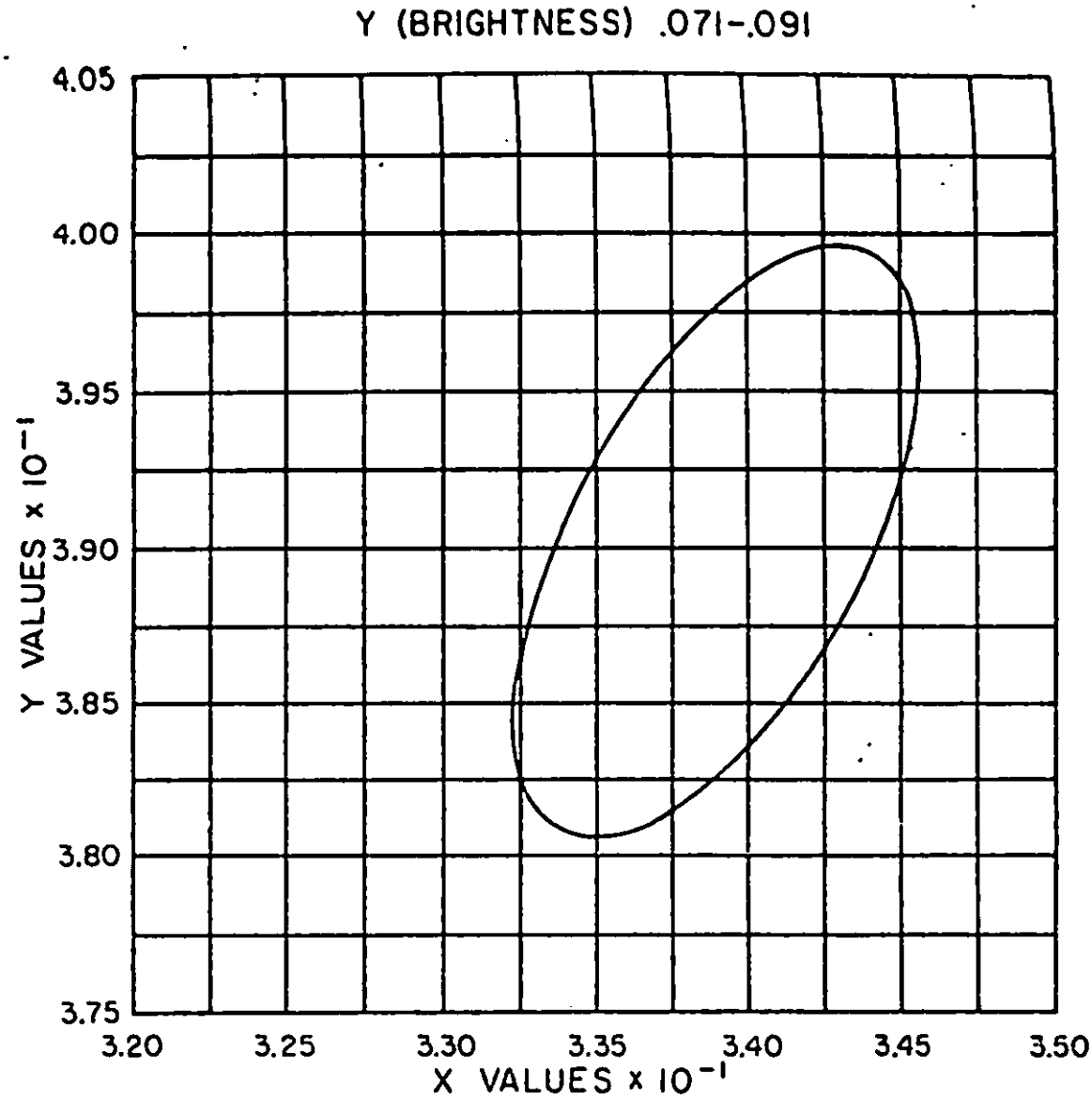

NOTE-COLOR ELLIPSE IS 2.0 NBS UNITS FROM CENTER VALUES.

FIGURE 4. Chromaticity diagram for camouflage paint, color-dark green 34082.

X-2796A

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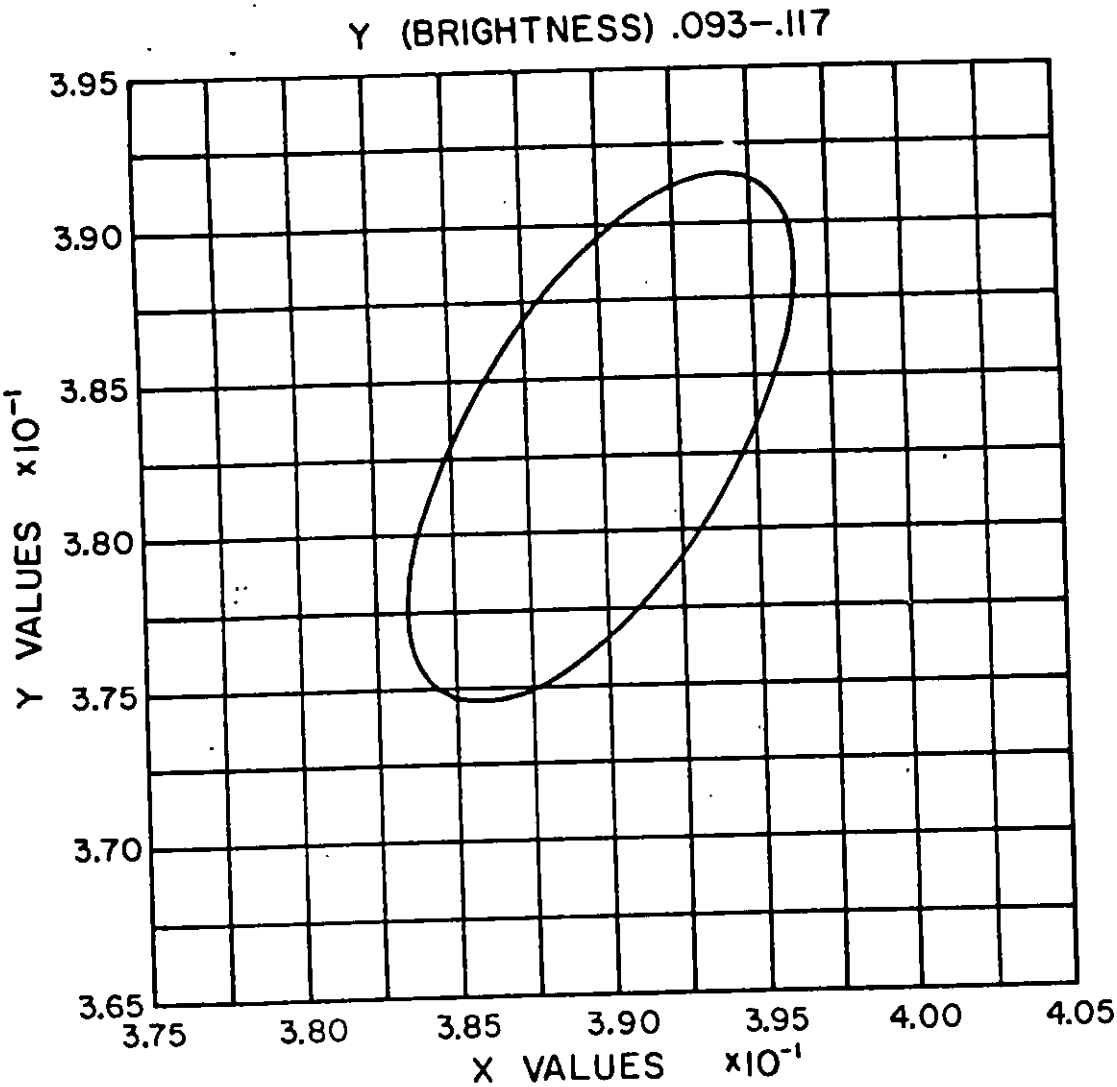

NOTE-COLOR ELLIPSE IS 2.0 NBS UNITS FROM CENTER VALUES.

FIGURE 5. Chromaticity diagram for camouflage paint, color-field drab 33105.

X-2798A

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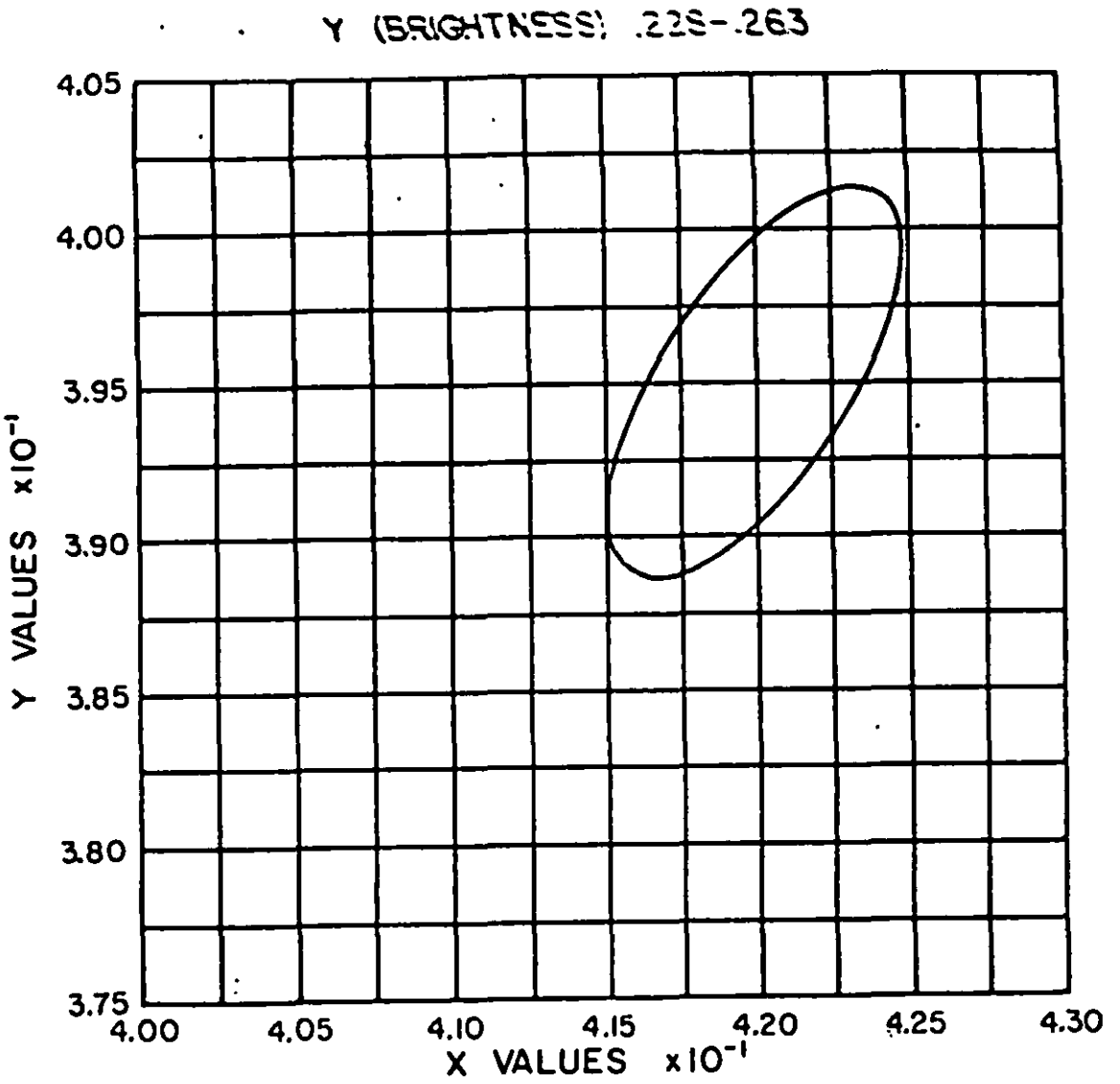

NOTE-COLOR ELLIPSE IS 2.0 NBS UNITS FROM CENTER VALUES.

FIGURE 6. Chromaticity diagram for camouflage paint, color-earth yellow 33245

X-2799A

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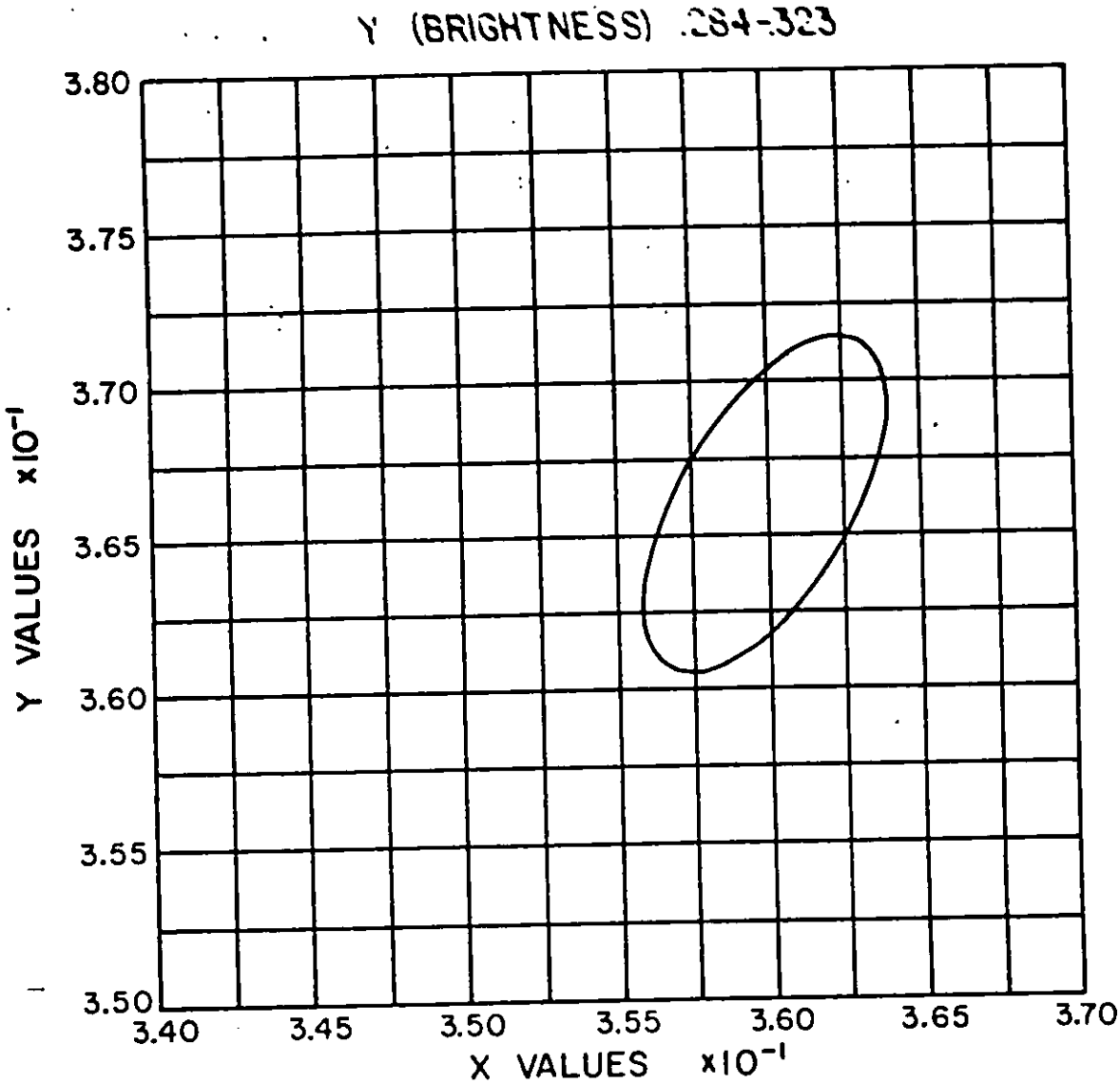

NOTE-COLOR ELLIPSE IS 2.0 NBS UNITS FROM CENTER VALUES.

FIGURE 7. Chromaticity diagram for camouflage paint, color-sand 33303.

X-2800A

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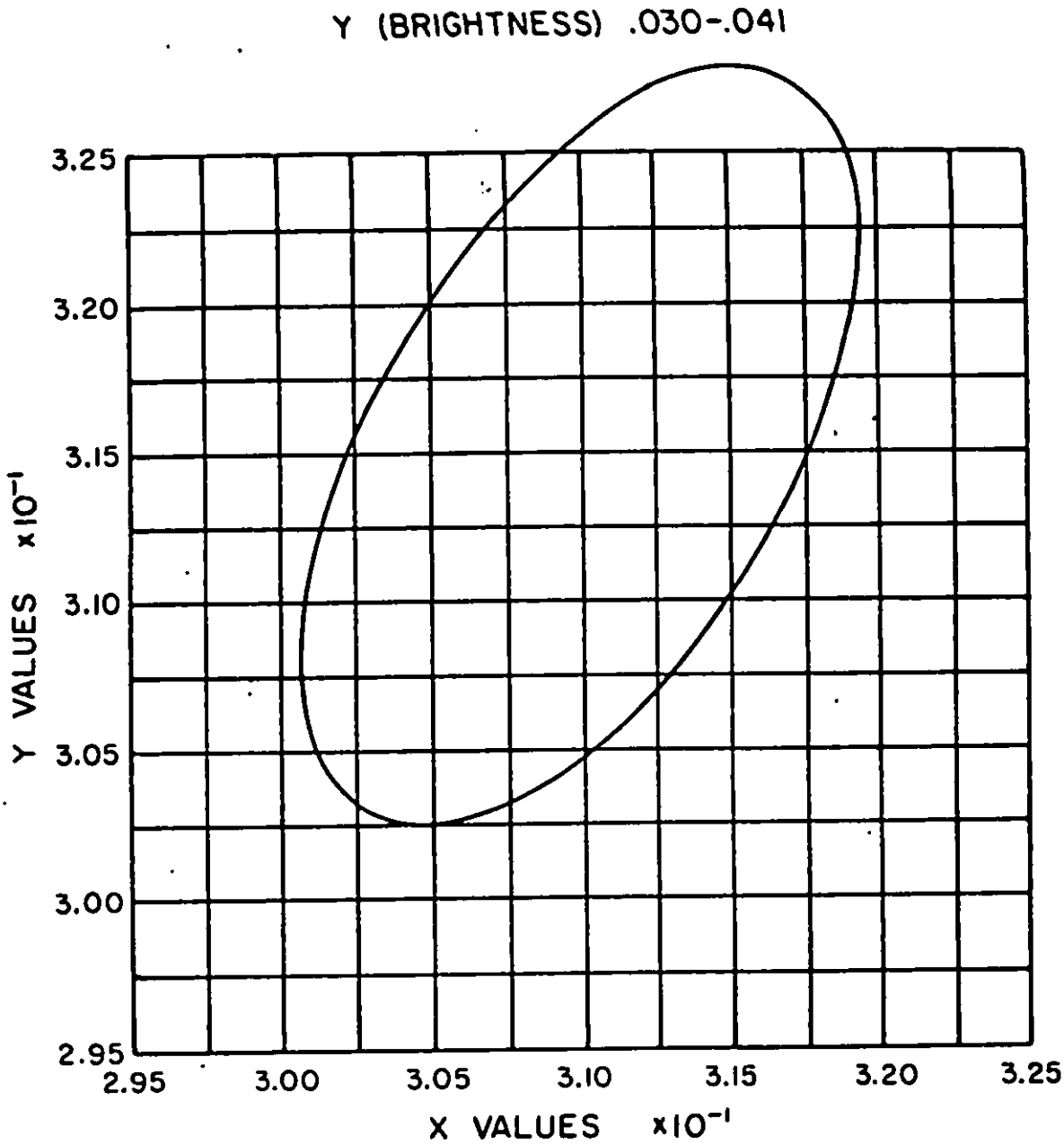

NOTE-COLOR ELLIPSE IS 2.0 NBS UNITS FROM CENTER VALUES.

FIGURE 8. Chromaticity diagram for camouflage paint, color-black 37030.

X-2804A

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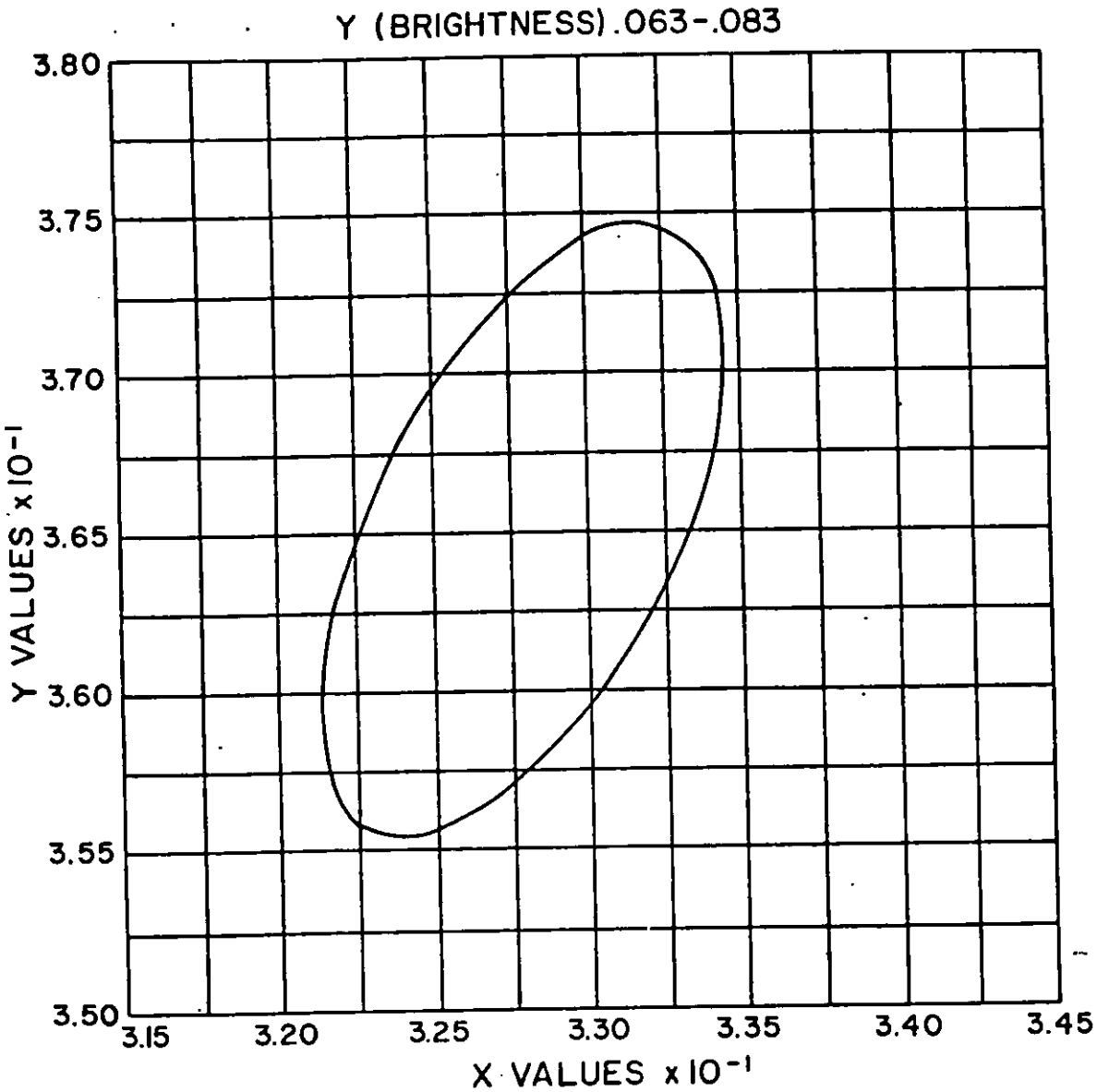

NOTE-COLOR ELLIPSE IS 2.0 NBS UNITS FROM CENTER VALUES.

FIGURE 9. Chromaticity diagram for camouflage paint, color - green 383, 34094.

X-4266A

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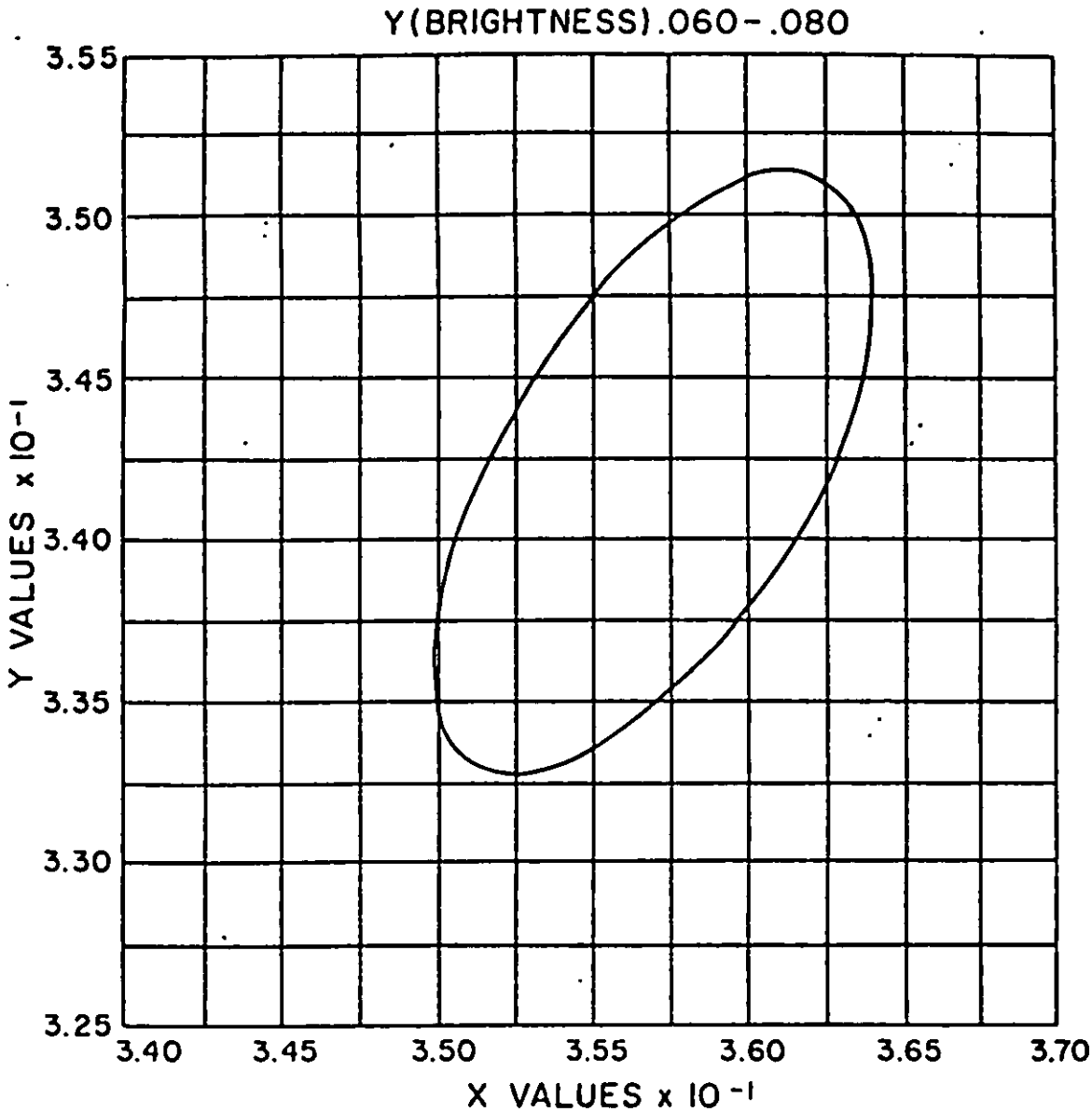

NOTE-COLOR ELLIPSE IS 2.0 NBS UNITS FROM CENTER VALUES.

FIGURE 10. Chromaticity diagram for camouflage paint, color - brown 383, 30051.

X-4267A

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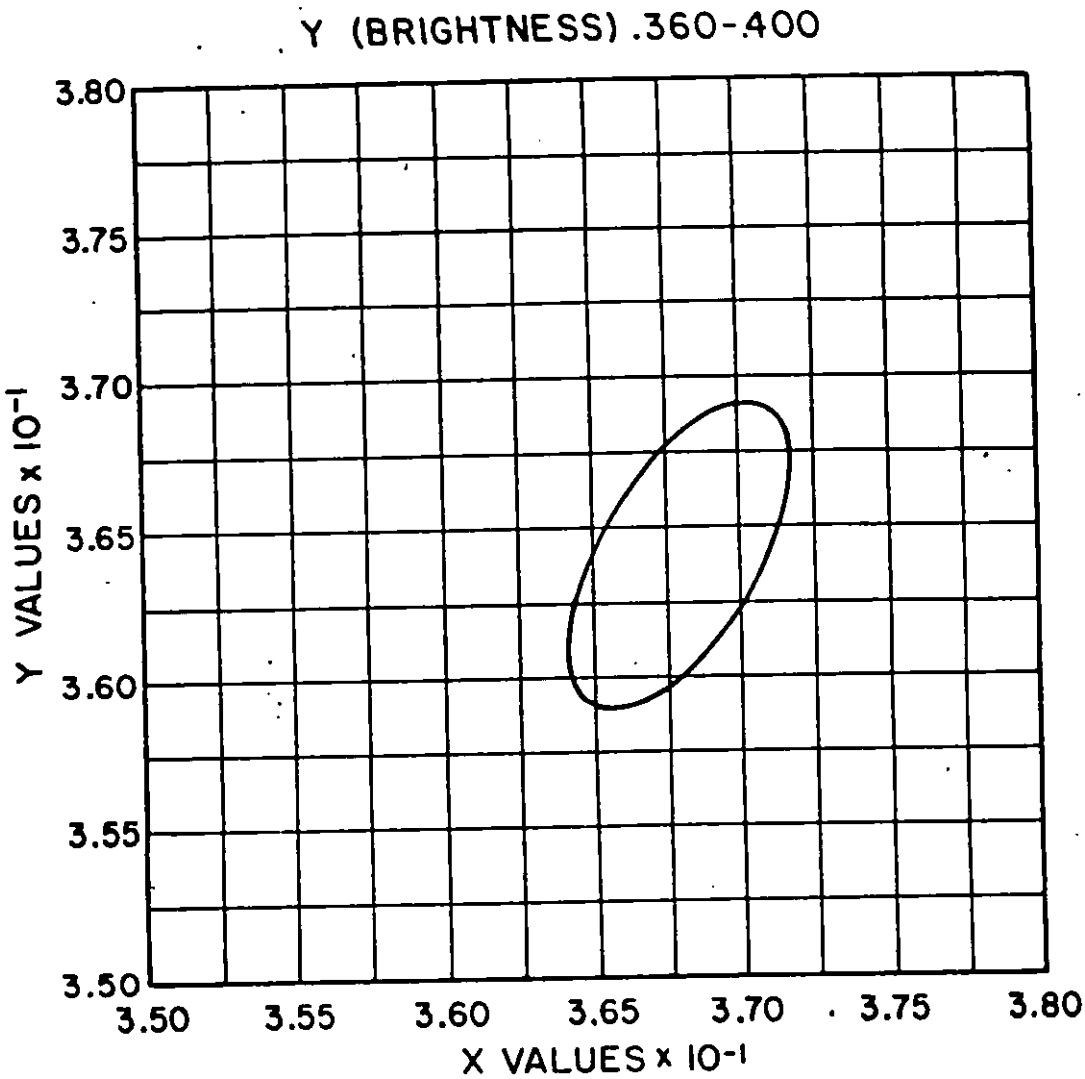

NOTE- COLOR ELLIPSE IS 2.0 NBS UNITS FROM CENTER VALUES.

FIGURE 11. Chromaticity diagram for camouflage paint, color - tan 686, 33446.

X-4697A

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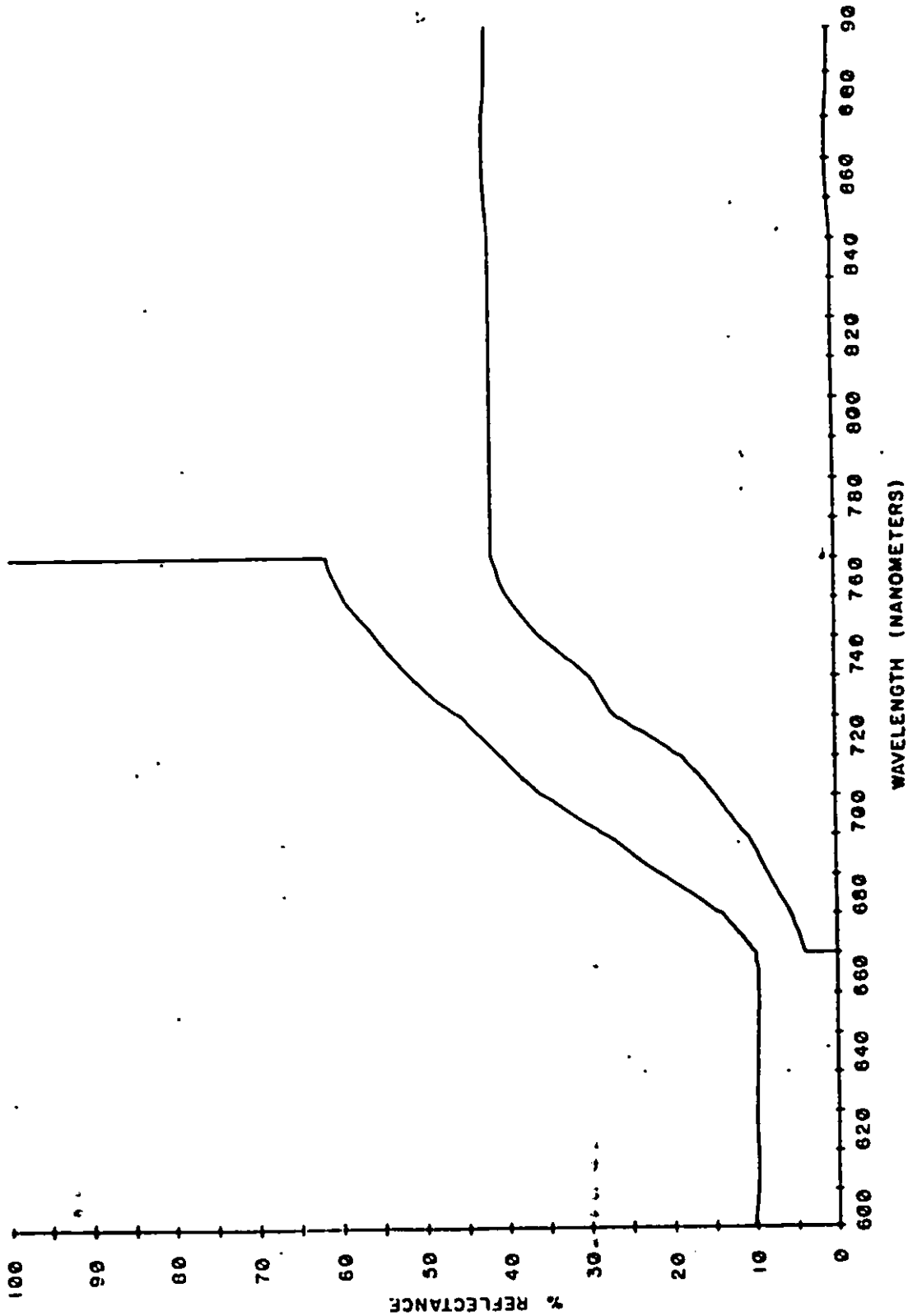

FIGURE 12. SPECTRAL REFLECTANCE LIMITS

X-3013A

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APPENDIX A

METHODS OF ANALYSIS FOR CHEMICAL AGENTS HD AND GD

10. SCOPE

10.1 This appendix contains the detailed methods for the analysis of chemical agents HD (Bis-dichloroethyl sulfide) and GD (pinacolyl methylphosphono-fluoridate).

20. ANALYSIS FOR AGENT HD (BIS-DICHLOROETHYL SULFIDE)

20.1 Reagents.

20.1.1 DB-3 solution. Place 200 mL of 2-methoxy ethanol in a 500 mL volumetric flask. Add 2.0 gm DB-3 [4-(p-nitrobenzyl) pyridine], 0.33 gm phthalic acid, and of 2-methoxy ethanol and mix well. Add 0.5 mL of 6N sodium hydroxide to 50 mL of deionized water (use NaOH low in carbonate) and add to the ethanol solution. A brown color may form but will disappear with thorough mixing. Fill to 500 mL with 2-methoxy ethanol and mix well. Transfer to a brown bottle and store in a refrigerator. This solution is stable for one week if kept cool.

20.1.2 Acetone (CP or reagent grade).

20.1.3 Piperidine.

20.2 Zeroing the Klett-Summerson colorimeter. Turn on the colorimeter being sure the filter is a Klett-Summerson number 54 green (wavelength = 520 - 580 millimicrons). Adjust the potentiometer to zero. Select a clean, unscratched Klett tube, fill with distilled water, and insert into the holder. With the large dial set on zero adjust slit opening so that the potentiometer reads zero. Empty the water from the tube, dry with acetone, and set aside. Use this tube for all future readings.

20.3 Standard curve. Place about 20 mL of diethyl phyhalate in a 50 mL volumetric flask. Weigh into it about 75 milligrams (mg) of HD. Record the exact weight of HD added and dilute to 50 mL with diethyl phthalate. Label the flask "A". Divide the weight of HD added by the 50 mL volume and multiply by 1000 to obtain the concentration in micrograms per milliliter (μ g/mL). Place 20 mL of diethyl phthalate in a second 50 mL volumetric flask. Add 1 mL of solution "A" and fill to the mark with diethyl phthalate. Label this flask "B" and calculate its concentration using the following formula:

$$\text{Concentration of "B"} = \frac{\text{(Volume of "A" used) (concentration of "A")}}{\text{Volume of flask "B"}}$$

Place 50 mL of diethyl phthalate in a 100 mL volumetric flask. Add 4 mL of solution "A" and dilute to mark with diethyl phthalate. Label flask "C" and calculate concentration as shown above. Number 10 Klett tubes 1 through 10. Place 2 mL of diethyl phthalate in each of tubes 1 and 2. Place 0 mL of "B" and 1 mL of diethyl phthalate in each of tubes 3 and 4. Place 1 mL of solution "C"

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and 1 mL of diethyl phthalate in each of tubes 5 and 6. Place 1 mL of "B" and 1 mL of "C" to each of tubes 7 and 8. Place 2 mL of "C" in each of tubes 9 and 10. Place a stirring rod and 5 mL of the DB-3 solution (20.1.1) in each tube and stir well. Place the tubes in a water bath at 100 °C for 10 minutes, remove, and cool to room temperature.[1] Lift the stirring rods free of the liquid but do not remove them from the tubes. Add acetone to the 10 mL mark on each tube making sure the stirring rod remains above the liquid. Stir well. Add 1 mL piperidine, stir well, transfer to the reading tube (20.2) and read within 1 minute on the zeroed Klett-Summerson colorimeter with number 54 filter.[2] Record the Klett readings and average the duplicates. Subtract the average for the blank (1 and 2) from the other averages. Plot the net Klett readings (vertical axis) versus the μ g of agent analyzed (horizontal axis). The result should be a straight line. The slope of this line, net Klett reading μ/g, is used in finding the amount of HD in the bubbler samples.

20.4 Analyzing the bubbler samples. Transfer the contents of the bubbler to a test tube. Place 2 mL of the sample in a Klett tube. Place 2 mL of diethyl phthalate in a separate tube to be used as a blank. Place 2 mL of "B" (see 20.3) in a Klett tube to serve as a check on the procedure. Add a stirring rod and 5 mL of the DB-3 solution (see 20.1.1) to each Klett tube and stir thoroughly. Heat in a water bath at 100 °C for 10 minutes, remove, and cool to room temperature. Lift the stirring rod, dilute to the 10 mL mark with acetone, and stir well. Add 1 mL of piperidine, stir well, transfer to the reading tube (see 20.2) and read on the zeroed Klett-Summerson colorimeter with number 54 filter within 1 minute. Subtract the blank to obtain the net Klett reading; divide by the slope of the standard curve to obtain μ g of HD in the sample.[3] Divide by 2 to obtain μ g/mL and multiply by 5 to obtain μ g of HD collected.

30. ANALYSIS FOR AGENT GD (PINACOLYL METHYLPHOSPHONOFLUORIDATE)

30.1 Reagents.

30.1.1 O-Dianisidine solution. Add 1 gm of o-dianisidine (3,3 -dimethoxybenzidine) to 50 mL of acetone. If the material does not completely dissolve, filter the solution before continuing. Add 200 mL of pure ethanol, mix well, and transfer to a dark bottle. Place this solution in a refrigerator; it is stable for 1 week if kept cool.

30.1.2 Sodium perborate solution. Dissolve 0.1 gm of sodium perborate in 100 mL of deionized water. This may take some time since sodium perborate is not readily soluble in water. Store in a refrigerator; make fresh daily.

1/ The cooling period should be the same for each sample since reaction continues to a degree after heating.
2/ The reading tube should be rinsed with acetone after each reading to avoid cross contamination of the samples.
3/ Klett readings over 500 are not very accurate. In such cases dilute the original sample and make the appropriate changes to the above calculation.

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30.2 Zeroing the Klett-Summerson colorimeter. Proceed as in 20.2 except use a Klett-Summerson number 42 blue filter (wavelength = 400 - 450 millimicrons).

30.3 Standard curve. Place about 20 mL of diethyl phthalate in a 50 mL volumetric flask and weigh into it about 15 mg of GD (pinacolylmethyl phosphonofluoridate). Record the exact weight of GD added. Dilute to the mark with diethyl phthalate and label the flask "A". Divide the weight of GD added by the 50 mL volume and multiply by 1000 to obtain the concentration in μ g/mL. Place 20 mL of diethyl phthalate in a second 50 mL volumetric flask. Add 1 mL of "A" and fill to the mark with diethyl phthalate. Label this flask "B" and calculate its concentration using the following formula:

$$\text{Concentration of "B"} = \frac{\text{(Volume of "A" used) (Concentration of "A")}}{\text{Volume of flask "B"}}$$

Place 20 mL of diethyl phthalate in a third 50 mL volumetric flask and add 5 mL of "A". Dilute to the mark and label "C". Calculate the concentration as shown above. Number 8 Klett tubes 1 through 8. Place 2 mL of diethyl phthalate in each of tubes 3 and 4. Place 2 mL of "B" in each of tubes 5 and 6. Place 1 mL of "C" and 1 mL of diethyl phthalate in each of tubes 7 and 8. Place a stirring rod in each tube, add 2.5 mL of o-dianisidine solution (see 30.1.1) to each tube and stir well. Set a timer to zero. Add 1 mL of sodium perborate solution (see 30.1.2) to Klett tube 1, start timer, and stir well. When the timer reads 1 minute add 1 mL of sodium perborate to Klett tube 2 and stir well. Continue adding 1 mL of sodium perborate to the Klett tubes at 1 minute intervals until all have received the perborate solution. When the timer reads 20 minutes transfer the contents of Klett tube 1 to the reading tube and read immediately on a zeroed Klett-Summerson colorimeter using a number 42 blue filter.[4/] At 21 minutes read the sample in Klett tube 2. Continue reading at 1 minute intervals until all the samples have been read. Average the duplicate reading and subtract the average for the blank (1 and 2) from the other average readings. Plot the net Klett reading (vertical axis) versus the μ g of agent (horizontal axis). The result should be a straight line. The slope of this line, net Klett reading/μ g GF, is used in finding the amount of GD in the bubbler samples.

30.4 Analyzing the bubbler samples. Transfer the contents of the bubbler to a test tube. Place 2 mL of the sample in a Klett tube. Place 2 mL of diethyl phthalate in a separate tube to be used as a blank. Place 2 mL of "B" in a Klett tube to serve as a check on the procedure. Add a stirring rod and 2.5 mL of o-dianisidine solution (see 30.1.1) to each Klett tube and stir well. Set a timer to zero. Add 1 mL of sodium perborate solution (see 30.1.2) to the first Klett tube, stir well, and start the timer. When the timer reads one minute add 1 mL of the sodium perborate solution to the second Klett tube. Continue adding 1 mL of sodium perborate solution at 1 minute intervals until all have received the perborate solution. When the timer reads 20 minutes transfer the contents of the first Klett tube to the reading tube and immediately read on the zeroed Klett-Summerson colorimeter using a number 42 blue filter. At 21 minutes read

4/ Strict attention must be paid to the 20 minutes reaction time; any deviation the will lead to erroneous results.

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sample in the second Klett tube. Continue reading at 1 minute intervals until all the samples have been read. Subtract the blank to obtain the net Klett reading, divide by the slope of the standard curve, net Klett/μ g, to obtain the μ g of GD in the sample. Divide by 2 to obtain μ g/mL and multiply by 5 to obtain μ g of GD collected.

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1. DOCUMENT NUMBER
MIL-C-53039A(ME)

2. DOCUMENT TITLE Coating, Aliphatic Polyurethane, Single Component, Chemical Agent Resistant

3a. NAME OF SUBMITTING ORGANIZATION

b. ADDRESS *(Street, City, State, ZIP Code)*

4. TYPE OF ORGANIZATION *(Mark one)*

- ☐ VENDOR
- ☐ USER
- ☐ MANUFACTURER
- ☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* — Optional

b. WORK TELEPHONE NUMBER *(Include Area Code)* — Optional

c. MAILING ADDRESS *(Street, City, State, ZIP Code)* — Optional

8. DATE OF SUBMISSION *(YYMMDD)*

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