MIL-E-16663A(OS)
9 July 1974
SUPERSEDING
MIL-E-16663 (BuOrd)
2 December 1952

MILITARY SPECIFICATION

ENAMEL, SEMI-GLOSS, (FOR METAL SURFACES OF AMMUNITION AND AMMUNITION CONTAINERS)

This specification is approved for use by all departments and agencies of the Department of Defense.

1. SCOPE

1.1 **Scope.** This specification covers semi-gloss enamels for production line application by brushing, spraying or dipping. This specification meets Air Pollution Regulations (Rule 66).

1.2 **Classification.** Enamels covered by this specification shall be of the following types and classes as specified (see 6.2).

Type I - Air drying
  Class 1 - Rapid drying
  Class 2 - Flash drying

Type II - Baking

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issues in effect on date of invitation for bids or request for proposals form a part of this specification to the extent specified herein.

FSC 8010

SPECIFICATIONS

Federal

P-D-680	Dry Cleaning Solvent
QQ-S-698	Steel, Sheet and Strip, Low-carbon
TT-B-846	n-Butyl Alcohol
TT-P-143	Paint, Varnish, Lacquer and Related Materials; General Specification for Packaging, Packing and Marking
TT-T-548	Toluene

STANDARDS

Federal

FED-STD-141	Paint, Varnish, Lacquer, and Related Materials; Methods of Inspection, Sampling and Testing
FED-STD-595	Colors

Military

MIL-STD-129	Marking for Shipment and Storage

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

3. REQUIREMENTS

3.1 **Color.** The color of the enamel shall be as specified in the contract or order (see 6.2). When tested as in 4.4.3, it shall match the standard color chip in FED-STD-595, except the gloss of color numbers 10371, 36118, and 36231 shall be disregarded.

3.2 **Composition.**

3.2.1 **Pigments.** The enamel shall consist of suitable opaque pigments together with necessary tinting pigments. Any extenders used shall be acid insoluble siliceous or silicated type.

3.2.2 **Vehicle.** The vehicle shall be a phthalic-alkyd resin conforming to the requirements of table I modified with synthetic resins or drying oils together with the necessary driers and volatile solvents to meet the requirements of this specification. Rosin or rosin derivatives shall not be used.

3.2.3 **Volatile content.** The volatile content shall conform to the following requirements by volume when tested as in 4.4.4.

a. Solvents having an olefinic or cyclo-olefinic type of unsaturation: 5 percent maximum.

b. A combination of aromatic compounds with eight or more carbon atoms to the molecule except ethyl benzene: 8 percent maximum.

c. A combination of ethyl benzene, ketones having branched hydrocarbon structures or toluene: 20 percent maximum.

d. Total of a + b + c: 20 percent maximum.

3.3 **Quantitative requirements.** The coating shall conform to the quantitative requirements specified in tables I and II.

Table I

GENERAL QUANTITATIVE REQUIREMENTS

Characteristics	Minimum	Maximum
Phthalic anhydride, percent by weight of vehicle solids		
Type I, Class 1, and Type II	26	35
Type I, Class 2	18	26
Calcium oxide, percent by weight of pigment	–	1.5
Rosins and rosin derivatives		
Water, percent by weight of enamel	–	1.0
Coarse particles and skins, percent by weight of pigment	–	1.0
60 degree specular gloss	25	40
Viscosity:		
Package, Krebs Units	70	78
Reduced, No. 4 Ford Cups, seconds	17	25
Fineness of grind	4	–
Drying time:		
Air-drying, Type I		
Set to touch, minutes		
Class 1	–	20
Class 2	–	6
Dry hard, minutes		
Class 1	–	30
Class 2	–	20
Full hardness, hours		
Class 1	–	16
Class 2	–	48
Baking, Type II		
Dry hard at 250° ± 5° F or equivalent heat treatment, minutes	–	18
Free from after tack, after baking and then air drying, hours	–	8

Table II

SPECIFIC QUANTITATIVE REQUIREMENTS

Color	FED-STD-595 Color No.	Solids, percent by weight of enamel		Extenders, percent by weight of total pigments	Pigment volume, percent of total solids volume	Contrast ratio
		Total solids	Vehicle solids			
		Min.	Min.	Max.	Max.	Min.
Buff	10371	60	35	30	42	98
Red	21136	50	35	30	42	88
Orange	22246	60	35	30	42	88
Yellow	23538	60	35	30	42	92
Olive drab	24087	60	35	30	42	98
Green	24108	60	35	30	42	98
Medium blue	25109	60	35	30	42	98
Light blue	25193	60	35	30	42	98
Ocean gray	36118	60	35	30	42	98
Slate	26132	60	35	30	42	98
Blue gray	36231	60	35	30	42	98
Black	27038	50	35	30	42	98
Purple	27144	60	35	30	42	98
White	27875	60	35	30	42	88

3.4 Qualitative requirements.

3.4.1 **Condition in container.** When tested as in 4.4.7 the enamel shall be free from grit, seeds, skins, lumps, abnormal thickening, or livering and shall show no more pigment settling or caking than can be readily reincorporated to a smooth homogeneous state.

3.4.1.1 **Storage stability, partially full container.** A three-quarter filled, closed 8-ounce glass jar of the enamel shall show no skinning when tested as in 4.4.8.

3.4.2 **Dilution stability.** When tested as in 4.4.11 the enamel shall remain stable and uniform showing no precipitation, curdling, or separation. Slight pigment settling shall be permitted. A flow out on glass shall show no seeds or clear areas lacking color.

3.4.3 **Brushing properties.** When tested as in 4.4.12 the enamel shall brush satisfactorily in all respects and shall dry to a smooth, uniform film free from seeds, runs, sags, or streaks.

3.4.4 **Dipping properties.** When tested as in 4.4.13 the enamel shall show satisfactory dipping properties and shall present a smooth appearance, free from sagging, running, or excessive silking.

3.4.5 **Spraying properties.** When tested as in 4.4.14 the enamels shall spray satisfactorily in all respects and shall show no running, sagging, streaking, or blushing. The dried film shall show no dusting, mottling, or color separation, and shall present a smooth finish free from seeds.

3.4.6 **Flexibility.** A film of enamel tested as in 4.4.16 shall withstand bending without cracking or flaking.

3.4.7 **Knife test.** A film of enamel tested as in 4.4.17 shall adhere tightly and not flake, crack, or powder from the metal. The cut shall show beveled edges.

3.4.8 **Dry-cleaning solvent resistance.** A film of enamel tested as in 4.4.18 shall show no wrinkling or blistering immediately after removal of the panel from the solvent. The enamel shall be no more than slightly affected when examined 2 hours after removal. After 24 hours air drying the portion of the panel which was immersed shall be almost indistinguishable with regard to hardness, color, and gloss from a panel prepared at the same time but not immersed.

3.4.9 **Water resistance.** A film of enamel tested as in 4.4.19 shall show no wrinkling or blistering immediately after removal of the panel from the water. The enamel shall be no more than slightly affected when examined 2 hours after removal. After 24 hours air drying the portion of the panel which was immersed shall be almost indistinguishable with regard to hardness, color, and gloss from a panel prepared at the same time but not immersed.

3.4.10 **Accelerated weathering.** A film of enamel tested as in 4.4.20 shall show no cracking or checking and no more than a slight loss of gloss or chalking (No. 8 method 6411 of FED-STD-141). The film shall show no excessive change in chroma and no change in hue.

3.4.11 **Salt spray resistance.** A film of enamel tested as in 4.4.21 shall show no rust creepage or undercutting beyond one-eighth inch from the score mark. At all other points there shall be no rusting or blistering. After 24 hours air drying the film shall not be softer than a panel prepared at the same time but not exposed. After removal of the enamel the metal substrate shall be free from rusting, pitting, or corrosion except on the area immediately adjacent to the score.

3.4.12 **Toxicity.** The enamel shall contain no benzene (benzol), chlorinated compounds, hydrolyzable chlorine derivates, or other ingredients which are deemed toxicologically hazardous under normal conditions of usage.

4. QUALITY ASSURANCE PROVISIONS

4.1 **Responsibility for inspection.** Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 **Sampling, inspection and testing.** Unless otherwise specified, sampling, inspection and testing shall be in accordance with method 1031 of FED-STD-141.

4.3 **Classification of tests.** Testing under this specification shall be for the purpose of acceptance of individual lots.

4.4 **Test methods.**

4.4.1 **Test conditions.** The routine and referee testing conditions shall be in accordance with section 7, FED-STD-141 except as otherwise specified herein.

4.4.2 The following tests of table III shall be conducted in accordance with applicable methods of FED-STD-141 or as required in this specification. The right is reserved to make any additional tests deemed necessary to determine that the enamel meets the requirements of this specification.

Table III
INDEX

Tests	Test Method		
	Applicable method in FED-STD-141	Paragraph of this specification giving further references	Paragraph of this specification giving requirements
Total solids	4041	–	Table II
Pigment volume	4312	–	Table II
Calcium oxide	7141	–	Table I
Coarse particles and skins	4092	–	Table I
Water	4082	–	Table I
Extender pigment	5271	–	Table II
Vehicle solids	4052	–	Table II
Phthalic anhydride	7021	–	Table I
Color	4250	4.4.3	3.1
Rosin and rosin derivatives in isolated vehicle	5031	–	3.2.2
Volatile content	7355, 7356	4.4.4	3.2.3
Specular gloss, 60°	6101	4.4.5	Table I
Hiding power (contrast ratio)	4122	4.4.6	Table II
Condition in container	3011	4.4.7	3.4.1
Storage stability partially full container	3021	4.4.8	3.4.1.1
Viscosity:			
Packaged	4281	–	Table I
Reduced	4282	4.4.9	Table I
Fineness of grind	4411	–	Table I
Drying time	4061	4.4.10	Table I
Dilution stability	4203	4.4.11	3.4.2
Brushing properties	4321	4.4.12	3.4.3
Dipping properties	4341	4.4.13	3.4.4
Spraying properties	4331	4.4.14	3.4.5
Panel preparation	–	4.4.15	–
Flexibility	6221	4.4.16	3.4.6
Knife test	6304	4.4.17	3.4.7
Dry-cleaning solvent resistance	6011	4.4.18	3.4.8
Water resistance	6011	4.4.19	3.4.9
Accelerated weathering	6152	4.4.20	3.4.10
Salt spray resistance	6061	4.4.21	3.4.11
Toxicity	–	4.4.22	3.4.12

4.4.3 **Color.** In accordance with method 4250 of FED-STD-141 compare the color with the film of enamel on the white carrara glass panel prepared for the hiding power test and observe for compliance with 3.1.

4.4.4 **Volatile content.** Determine solvents as in methods 7355 and 7356 of FED-STD-141 for compliance with 3.2.3.

4.4.5 **Specular gloss.** Draw down the enamel using a 0.0020-inch (0.0040-inch gap clearance) film applicator. Test as specified in method 6101 of FED-STD-141 for compliance with table I.

4.4.6 **Hiding power (contrast ratio).** Determine the contrast ratio in accordance with method 4122 of FED-STD-141, except measure the dry film thickness in accordance with method 6183 of FED-STD-141. Use a film applicator that will deposit a 3-inch wide film with a dry film thickness of 0.0010 inch maximum. Air dry type I for 72 hours. Type II panels shall be baked at 250° ± 5° F for 18 minutes and then air dried for 24 hours. Determine the reflectance and verify the film thickness in the area in which the reflectance was measured. Calculate the contrast ratio and check for compliance with table II.

4.4.7 **Condition in container.** Determine package condition in accordance with method 3011 of FED-STD-141 and observe for compliance with 3.4.1.

4.4.8 **Storage stability, partially full container.** Determine skinning after 24 hours in accordance with method 3021 of FED-STD-141 for compliance with 3.4.1.1.

4.4.9 **Viscosity (reduced).** Reduce the enamel with thinner conforming to table IV in a ratio recommended by the manufacturer. Test according to method 4282 of FED-STD-141 for compliance with table I.

4.4.10 **Drying time.** Determine drying time in accordance with method 4061 of FED-STD-141 under referee conditions using a 0.0020-inch (0.0040-inch gap clearance) film applicator. Check for compliance with table I.

Table IV

THINNER

Ingredient	Percent by weight
VM&P naptha (8% max. aromatic)	65
n-Butyl alcohol (TT-B-846)	20
Toluene (TT-T-548)	15

4.4.11 **Dilution stability.** Reduce one volume of packaged enamel with one volume of thinner conforming to table IV. Test according to method 4203 of FED-STD-141 for compliance with 3.4.2.

4.4.12 **Brushing properties.** Apply the enamel to a 4- by 12-inch steel panel, conforming to QQ-S-698, using a 1-1/2-inch brush, in accordance with method 4321 of FED-STD-141 for compliance with 3.4.3.

4.4.13 **Dipping properties.** Reduce the enamel for dipping with thinner conforming to table IV in a ratio recommended by the manufacturer. Test according to method 4341 of FED-STD-141 for compliance with 3.4.4.

4.4.14 **Spraying properties.** Reduce the enamel as in 4.4.9. Spray on a steel panel to a dry film thickness between 0.0009 to 0.0011 inch and observe for spraying properties in accordance with method 4331 of FED-STD-141 for compliance with 3.4.5. For referee test, use automatic application per method 2131 of FED-STD-141.

4.4.15 **Panel preparation.** Spray the enamel as in 4.4.14 on ten (10) 3- by 6-inch steel panels solvent cleaned in accordance with method 2011 of FED-STD-141 and on two (2) 3- by 6-inch flat tin plate panels prepared in accordance with method 2012 of FED-STD-141 using the petroleum naphtha ethylene glycol monoethylether mixture. Air dry type I panels for 72 hours. Type II panels shall be baked at 250° ± 5° F for 18 minutes and then air dried for 24 hours. Use where applicable in the subsequent tests.

4.4.16 **Flexibility.** Determine flexibility according to method 6221 of FED-STD-141 on a tin panel prepared as in 4.4.15. Bend over a 1/4-inch mandrel and examine for compliance with 3.4.6.

4.4.17 **Knife test.** Perform the knife test in accordance with method 6304 of FED-STD-141 on a steel panel prepared as in 4.4.15. Observe for compliance with 3.4.7.

4.4.18 **Dry-cleaning solvent resistance.** Immerse two steel panels prepared as in 4.4.15 in dry cleaning solvent conforming to P-D-680 for 24 hours according to method 6011 of FED-STD-141 for compliance with 3.4.8.

4.4.19 **Water resistance.** Immerse two steel panels prepared as in 4.4.15 in distilled water for 18 hours in accordance with method 6011 of FED-STD-141 for compliance with 3.4.9.

4.4.20 **Accelerated weathering.** Expose two steel panels prepared as in 4.4.15 for 280 hours to accelerated weathering as in method 6152 of FED-STD-141 using a twin arc apparatus. Check for compliance with 3.4.10.

4.4.21 **Salt spray resistance.** Expose two steel panels prepared as in 4.4.15 for 200 hours to salt spray as in method 6061 of FED-STD-141. Check for compliance with 3.4.11.

4.4.22 **Toxicity.** The manufacturer shall certify that the enamel contains no benzene (benzol), chlorinated compounds, or hydrolyzable chlorine derivatives.

5. PREPARATION FOR DELIVERY

5.1 The enamel shall be furnished in pressurized dispensers, 1-quart or 1-gallon multiple friction top containers, in 5-gallon lug cover steel pails or in 55-gallon steel drums as specified (see 6.2). The enamel shall be packaged level A or C; packed level A or C as specified (see 6.2) in accordance with TT-P-143.

5.2 **Marking.** In addition to any special marking interior packages and exterior containers shall be marked in accordance with MIL-STD-129.

6. NOTES

6.1 The semi-gloss enamels covered by this specification have good weather resistance and are intended for use as exterior surface protective coatings for projectiles, rockets, powder and cartridge tanks and other ammunition, as well as for the identification by color marking of such ammunition.

6.2 **Ordering data.** Procurement documents should specify the following:

a. Title, number and date of this specification
b. Size of container
c. Level of packaging and level of packing
d. Type and class
e. Color.

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

6.4 Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Custodian:

Navy - OS

Preparing activity:

Navy - OS
(Project No. 8010-N116)

SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 22-R255

INSTRUCTIONS: This sheet is to be filled out by personnel, either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments and suggestions submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or serve to amend contractual requirements.

SPECIFICATION MIL-E-16663A (OS), ENAMEL, SEMI-GLOSS, (FOR METAL SURFACES OF AMMUNITION AND AMMUNITION CONTAINERS)

ORGANIZATION

CITY AND STATE

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO *(If "yes", in what way?)*

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity - Optional)*

DATE

DD FORM 1 JAN 66 1426

REPLACES EDITION OF 1 OCT 64 WHICH MAY BE USED.

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