

TT-E-491C  
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SUPERSEDING  
Fed. Spec. TT-E-491B  
March 2, 1965

## FEDERAL SPECIFICATION

### ENAMEL; GLOSS, SYNTHETIC (FOR METAL AND WOOD FURNITURE)

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for use of all Federal Agencies.

#### 1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers a synthetic, gloss enamel for metal and wood furniture to be applied by brushing, spraying, or dipping.

#### 1.2 Classification.

##### 1.2.1 The enamel shall be of two classes.

Class 1 - Air-drying.

Class 2 - Baking.

#### 2. APPLICABLE DOCUMENTS

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

##### Federal Specifications:

- O-S-642 - Sodium Phosphate, Tribasic, Technical; Anhydrous, Dodecahydrate, and Monohydrate.
- P-S-591 - Soap, Laundry, Bar.
- TT-R-266 - Resin, Alkyd; Solutions.
- TT-T-291 - Thinner; Paint, Volatile Spirits (Petroleum-Spirits).
- PPP-P-1892 - Paint, Varnish, Lacquer and Related materials; Packaging, Packing and Marking of.

##### Federal Standards:

Fed. Test Method Std.No.141 - Paint, Varnish, Lacquer and Related materials; Method of Inspection, Sampling, and Testing.

Fed. Std. No. 595 - Colors.

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

(Single copies of this specification and other Federal Specifications required by activities outside the Federal Government for bidding purposes are available without charge from Business Service Centers at the General Services Administration Regional Offices in Boston, New York, Philadelphia; Washington, DC, Atlanta, Chicago, Kansas City, MO, Fort Worth, Houston, Denver, San Francisco, Los Angeles, and Seattle, WA.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

#### Military Standard:

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.

(Copies of Military Specifications and Standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

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

#### American Society for Testing and Materials (ASTM) Standards:

- D 562 - Consistency of Paints Using the Stormer Viscosimeter.
- D 563 - Phthalic Anhydride Content of Alkyd Resins and Resin Solutions.
- D 1210 - Fineness of Dispersion of Pigment-Vehicle Systems.
- D 1296 - Odor of Volatile Solvents and Diluents.
- E 97 - 45 deg., 0 deg. Directional Reflectance of Opaque Specimens by Filter Photometry.

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

### 3. REQUIREMENTS

3.1 Color. The color of the enamel specified in the contract or order (see 6.2) shall match that of the standard color chip in Fed. Std. No. 595, when tested as specified in 4.3.2.

3.2 Vehicle. The vehicle shall conform to TT-R-266, Types III, IV or VI. The thinner shall be mineral spirits conforming to TT-T-291, Type II, Grade A. Driers, wetting agents, phenolic resin, suspension agents, and other additives may be added, provided the finished product meets all the requirements specified herein.

3.3 Qualitative requirements (Classes 1 and 2).

3.3.1 Condition in container. The enamel, when tested as specified in 4.3.3, shall be free of grit, seeds, skins, lumps, or livering, and shall show no more pigment settling or caking than can readily be reincorporated to a smooth homogenous state.

### 3.3.2 Storage stability.

3.3.2.1 Partially full container. The enamel shall show no skinning when tested as specified in 4.3.4.1. After storage as specified in 4.3.4.1, the enamel shall show no livering, curdling, hard caking, or gummy sediment, and shall mix readily to a smooth homogeneous state.

3.3.2.2 Full container. The enamel shall show no skinning, livering, curdling, hard and dry caking, or tough, gummy sediment when tested as in 4.3.4.2. After storage for 12 months, as specified in 4.3.4.2, the enamel shall remix readily to a smooth homogenous state. There shall be no change in the drying time, and the viscosity shall be within 67 and 82 KU (see table I).

3.3.3 Dilution stability. When thinned as specified in 4.3.5, the enamel shall remain stable and uniform, showing no precipitation, curdling, or separation. Any pigment settling shall be easily redispersed to a homogeneous state.

3.3.4 Brushing properties. The enamel, when tested as specified in 4.3.6, shall brush satisfactorily in all respects and shall dry to a smooth, glossy, uniform film free from seeds, runs, and streaks. The dried film shall be free from brush marks, bubbler, craters, pigment floatation, and streaking.

3.3.5 Spraying properties. The enamel, when tested as specified in 4.3.7, shall spray satisfactorily, and shall show no running, sagging, streaking, or pronounced orange peel. The air-dried film shall show no seeding, dusting, floating, flagging, mottling, hazing, or other film defects.

3.3.6 Dipping properties. When tested as specified in 4.3.8, the dried film shall show no drips, runs, or thick edges.

3.3.7 Odor. The odor of the wet enamel and of the film at any interval of drying shall not be obnoxious or objectionable, when tested as specified in 4.3.9. There shall be no residual odor after 24 hours of drying.

3.3.8 Adhesion (tape test). The enamel, when tested as specified in 4.3.10, shall show no removal of the film or loosening beyond 1.6 mm on either side of the score line.

3.3.9 Flexibility. A film of the enamel, prepared and tested as specified in 4.3.11, shall withstand bending without cracking or flaking.

3.3.10 Knife test. When tested as specified in 4.3.12, the enamel shall adhere tightly to and shall not flake from the metal.

3.3.11 Resistance to cleaning compounds (trisodium phosphate, soap, carbolic solutions, and alcohol). When tested as specified in 4.3.13, the enamel shall show no loss of gloss or adhesion, no deterioration of the film such as blistering, checking, or softening, and no change of odor.

3.3.12 Resistance to (cold and hot) water. The enamel, when tested as specified in 4.3.14, shall show no blistering or wrinkling immediately upon removal of the panels from either hot or cold water.

3.3.13 Resistance to petroleum solvent. When tested as specified in 4.3.15, the enamel shall show no blistering or wrinkling immediately upon removal from the mineral spirits. Any softening, dulling, or whitening effect shall have disappeared completed after 24 hours air-drying.

3.3.14 Resistance to loss of gloss, chalking, and color change. When tested as specified in 4.3.16, the enamel shall show no chalking, and a gloss of not less than 40. Any color change shall be equivalent to a lightness difference of not more than 2 units.

#### 3.4 Quantitative requirements.

3.4.1 Quantitative requirements. The quantitative requirements shall be as specified in table I and 3.4.2 (table II).

TABLE I. Quantitative requirements

Characteristics	Requirements	
	Minimum	Maximum
Total solids, percent by weight of enamel:		
White	60	---
Tints and olive drab	50	---
Nonvolatile vehicle, percent by weight of vehicle:		
White	40	---
Tints and olive drab	35	---
Phthalic anhydride, percent by weight of nonvolatile vehicle	15	---
Drying oil acids, percent by weight of nonvolatile vehicle	31	---
Water content, percent by weight of enamel	---	1.0
Consistency, Krebs-Stormer, Shearing rate, 200 RPM:		
Grams	125	175
Equivalent K.U.	67	77
Drying time of class 1 enamel:		
Set touch, minutes	10	120
Dry hard, hours	---	18
Baking time of class 2 enamel, at 121 +/- 2 deg. C, minutes	---	45
Coarse particles and skins, percent by weight of pigment	---	2.0
Fineness of grind	7	---
Directional reflections, 45 deg., 0 deg. (White only), percent	80	---
Gloss, 60 deg.	80	---
Lead, percent by weight of total non-volatile	---	0.06

3.4.2 Hiding power (contrast ratio). Not more than 7.0 ml per square foot (540 square feet per gallon) of the white enamel (minimum reflectance 80 percent) shall be required to give a film contrast ratio of 0.94. The minimum dry film contrast ratio for tints applied to the same wet film thickness in terms of apparent reflectivity shall be as shown in table II.

TABLE II. Minimum dry film contrast ratio for tints.

Apparent reflectivity of tints, percent	Contrast ratio
81 and above	.94
75-80	.95
71-74	.97
67-70	.98
61-66	.99
60 and lower	1.00

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order the contractor is responsible for the performance of all inspection requirements a specified herein. Except as otherwise specified in the contract or order the contractor 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 that supplies and services conform to prescribed requirements.

##### 4.2 Sampling and inspection.

4.2.1 Inspection of preparation for delivery. The packaging, packing, and marking shall be inspected in accordance with the requirements of PPP-P-1892.

4.2.2 Lot. The enamel shall be assembled into lots as specified in MIL-STD-105. In MIL-STD-105, the words "essentially the same conditions" shall be interpreted to mean a manufacturer's batch, which is defined as the end product of all raw materials mixed, blended, or processed in a single operation.

4.2.3 Sampling of the end item. For the purposes of sampling, the lot shall be expressed in units of gallons. Samples from lots shall be taken in accordance with MIL-STD-105 using inspection level S-2 and an acceptable quality level (AQL) of 2.5.

4.2.4 The contractor shall submit to the contracting officer a certificate of compliance indicating that the enamel complies with the storage stability requirement as specified in 3.3.2.2. When certificates of compliance are submitted, the Government reserves the right to test such items to determine the validity of the certificate.

##### 4.3 Test procedures.

4.3.1 The enamel shall be tested according to the test methods indicated in table III. Unless otherwise specified, standard testing conditions are a temperature of 23 +/- 1 deg C (73 +/- 2 deg F) and a relative humidity of 50 +/- 5 percent. All test reports shall contain the individual values utilized in expressing the final result. All tests shall be evaluated for conformance to the requirements specified in section 3. Failure to pass any test, or noncompliance with any requirement, shall be cause for rejection of the sample.

TABLE III. Test methods

Characteristics	Requirement reference	Fed. Test Method Std. No. 141	ASTM	Reference paragraph
Color	3.1.1	4250	----	4.3.2
Condition in container	3.3.1	3011	----	4.3.3
Storage stability	3.3.2	3021, 3022	----	4.3.4
Dilution stability	3.3.3	4203	----	4.3.5
Brushing properties	3.3.4	4321	----	4.3.6
Spraying properties	3.3.5	4331	----	4.3.7
Dipping properties	3.3.6	4341	----	4.3.8
Odor	3.3.7	----	D 1296	4.3.9
Adhesion	3.3.8	----	----	4.3.10
Flexibility	3.3.9	6221	----	4.3.11
Knife test	3.3.10	6304	----	4.3.12
Resistance to cleaning compounds	3.3.11	----	----	4.3.13
Resistance to water	3.3.12	----	----	4.3.14
Resistance to petroleum solvent	3.3.13	----	----	4.3.15
Resistance to loss of gloss, chalking, and color change	3.3.14	----	----	4.3.16
Total solids	Table I	4041	----	----
Nonvolatile vehicle	Table I	4051	----	----
Phthalic anhydride	Table I	----	D 563	----
Drying oil acids	Table I	7031	----	----
Water content	Table I	4081	----	----
Consistency	Table I	----	D 562	----
Drying time	Table I	4061	----	----
Baking time	Table I	4542	----	----
Coarse particles	Table I	4092	----	----
Fineness of grind	Table I	----	D 1210	----
Directional reflectance	Table I	----	E 97	----
60 deg. gloss	Table I	6101	----	----
Lead content	Table I	----	----	4.3.17
Hiding power	3.4.2	4122	----	----

4.3.2 Color. Determine the color of the enamel in accordance with method 4250 of Fed. Test Method Std. No.141, using a 38 um (.0015 inch) dry film thickness applied by draw down on a white opaque gloss or a test panel. Evaluate for compliance with 3.1.

4.3.3 Condition in container. Determine the package condition of the enamel in accordance with method 3011 of Fed. Test Method Std. No.141, and evaluate for compliance with 3.3.1.

4.3.4 Storage stability.

4.3.4.1 Partially full container. Determine the skinning properties after 48 hours storage in a partially full container in accordance with method 3021 of Fed. Test Method Std. No. 141, and evaluate for compliance with 3.3.2.1.

4.3.4.2 Full container. Determine the storage stability of the enamel in accordance with method 3022 of Fed. Test Method Std. No. 141 by allowing a full standard quart can to stand undisturbed for 12 months. Examine pigment settling or caking, but agitate the can for 5 minutes on a paint shaker prior to examination. Evaluate the test results for compliance with 3.3.2.2.

4.3.5 Brushing properties. Determine the brushing properties of the packaged enamel in accordance with method 4321 of Fed. Test Method Std. No. 141, and evaluate for compliance with 3.3.4.

4.3.6 Dilution properties. Mix thoroughly 1 part by volume of thinner conforming to TT-T-291, type II, grade A, with 3 parts by volume of the enamel. Slowly add the thinner to the enamel with constant stirring, then allow to stand for 24 hours. After the test period, evaluate for compliance with 3.3.3.

4.3.7 Spraying properties. Reduce 8 parts by volume of enamel to 1 part by volume of thinner conforming to TT-T-291, type II, grade A. Spray on a 76 by 127 mm steel panel prepared as specified in 4.3.10 to a dry film thickness between 23 to 28 mm (0.0009 to 0.0011 inch), and observe spraying properties in accordance with method 4331 of Fed. Test Method No. 141. Evaluate for compliance with 3.3.5.

4.3.8 Dipping properties. Reduce the enamel in accordance with manufacturer's direction; then run the test as provided in method 4341 of Fed. Test Method Std.No. 141. Evaluate for compliance with 3.3.6.

4.3.9 Odor. Observe the odor of the enamel in accordance with ASTM D 1296, and evaluate for compliance with 3.3.7.

4.3.10 Adhesion (classes 1 and 2). Prepare four steel panels in accordance with method 2011 of Fed. Test Method Std.No. 141, then spray the sample on these panels as described. Two panels shall be air-dried for 48 hours in a horizontal position, and the other two panels shall be air-dried for 15 minutes and baked for 7 hours at 121 +/- 2 deg. C. Condition the panels for at least 15 minutes at standard condition. On two panels (one air-dried, one baked), score a line through to the substrate and across the width of the film using a sharp pointed knife. Apply waterproof, pressure-sensitive tape (85 mm wide) conforming to PPP-T-60, type IV, perpendicular to and across the score line. The tape shall extend about one inch on each side of the score line. Press the tape in firm contact with the film by using firm thumb pressure. after 10 seconds, grasp the free end of the tape and at a rapid speed, strip it from the film by pulling back at an angle of approximately 180 deg. Evaluate for compliance with 3.3.8.

4.3.11 Flexibility. In accordance with method 6221 of Fed. Test Method Std. No. 141, determine the flexibility of the enamel using two panels (one air-dried, one baked) prepared in 4.3.10. For class I (air-dried), bend over a 3.2 mm mandrel, and for class 2 (baked), bend over a 19.2 mm mandrel. Examine the bend, and evaluate for compliance with 3.3.9.

4.3.12 Knife test. Perform the knife test in accordance with method 6304 of Fed. Test Method Std. No. 141 on the flat portion of the panels used in the flexibility tests. Examine the cut and the edges, and evaluate for compliance with 3.3.10.

4.3.13 Resistance to cleaning compounds (class 1 and 3). Prepare 16 panels as described in 4.3.7. Eight of these panels shall be air-died (class 1), and the other eight shall be baked (class 2) as described in 4.3.10.

4.3.13.1 Trisodiumphosphate. Use two panels (one air-dried, one baked) prepared in 4.3.13 for this test. Place the test panels in a level, horizontal position. Lay 2-inch watch glasses on the center of the panels, then draw a ring around the edge of the glasses with a grease pencil. Remove the glasses from the panels, leveling the ring outlined on the surfaces. Flood the circle areas with 3 ml of a 2-percent aqueous solution of trisodium phosphate conforming to O-S-642. Carefully cover the solution with watchglasses to prevent evaporation. Keep the panels at room temperature for 1/2 hour. Remove glasses from the panels and clean the areas by washing under running water with a soft sponge. Gently wipe dry with a soft cloth. Allow the panel to condition at room temperature for 5 hours. Examine the areas and evaluate for compliance with 3.3.11.

4.3.13.2 Soap. Place two panels (one air-dried, one baked) prepared in 4.3.13 in two separate 400-ml beakers containing 200 ml of an aqueous 0.25 percent sodium hydroxide solution containing 2 percent yellow laundry soap conforming to P-S-591. Leave the panels immersed for 15 minutes. Remove the panels, wash thoroughly with running water and allow to dry at room temperature. Heat one beaker to 50 deg. C and into the solution immerse a fresh air-dried panel; heat the other beaker to 82 deg. C and into the solution immerse a fresh baked panel. Maintain the temperature for each beaker as described above for 5 minutes. Remove the panels, wash thoroughly with running water, and allow to dry at room temperature for two hours. Examine the four panels and evaluate for compliance with 3.3.11.

4.3.13.3 Carbolizer. Into separate 400-ml beakers containing 200 ml of an aqueous solution of 0.5 percent saponated solution of cresol, U.S.P., immerse one air-dried and one baked panel. Allow the panels to remain in the solution for 15 minutes at room temperature. Remove the panels, wash thoroughly with running water, wipe off excess water, and allow to dry at room temperature for 2 hours. Examine the panels and evaluate for compliance with 3.3.11.

4.3.13.4 Alcohol. Place one air-dried and one baked panel in a 400 ml beaker containing 200 ml of 50 percent aqueous ethyl alcohol. Allow to remain immersed at standard conditions for 15 minutes. Remove the panels, wash thoroughly with running water, wipe off excess water, and allow to dry at room temperature for 2 hours. Examine the panels, and evaluate for compliance with 3.3.11.

#### 4.3.14 Resistance to water.

4.3.14.1 Cold water. Place one air-dried and one bake panel prepared s specified in 4.3.13 in 400-ml beaker containing 200 ml of distilled water at room temperature and allow to remain for 16 hours. Remove and allow to dry for 2 hours. Examine and evaluate for compliance with 3.3.12.

4.3.14.2 Hot water. In a 400 ml beaker contains 200 ml of boiling distilled water, place air-dried and a baked panel. Allow the panels to remain in the boiling water for 15 minutes. Remove the panels, allow to dry for 2 hours, and evaluate for compliance with 3.3.12.

4.3.15 Resistance to petroleum solvent. Place two panels (one air-dried, one baked) in separate 400-ml beakers containing 200 ml of mineral spirits conforming to T-T-291, type II, grade A. Allow to remain in the solution for 18 hours at room temperature. Remove and allow to dry for 24 hours. Examine and evaluate for compliance with 3.3.13.



4.3.16 Resistance to loss of gloss, chalking and color change. Apply by brush a coat of enamel to a dry film thickness of approximately 38 um on two steel panels prepared as specified in 4.3.10. Apply a coat of aluminum paint to the back of the coated panels and allow to dry for 24 hours; then subject the coated panels to accelerated weathering for 168 hours in accordance with method 6152 of Fed. Test Method Std. No.141. Examine the exposed coating for chalking, loss of gloss, and color change. Measure the directional reflectance by ASTM E97. Determine the lightness difference in accordance with method 6122 of Fed. Test Method Std. No. 141. Evaluate for compliance with 3.3.14.

#### 4.4.17 Lead content.

4.4.17.1 Sample preparation. Using 0.006-inch film applicator and a mechanical applicator plate, duplicate drawdowns for each sample of well-mixed paint shall be made on a standard paint penetration chart and dried for 24 hours. The drawdown shall be at least 10 inches long on the sealed portion of the penetration chart. The drawdown shall be cut into discs of appropriate size to fit the sample holder of a fluorescence X-ray spectrometer.

4.4.17.2 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. The settings for a wavelength dispersive fluorescence spectrometer shall be as follows. (1)

Element	Analytical Line	Angle	Crystal	Detection	Colli-mator	X-ray tube (Mo)	
Pb	L	33.93	LiF(200)	Flow S.C.	Fine	60kV	45Ma
Pb (backgrd I)		33.00	LiF(200)	Flow S.C.	Fine	60kV	45Ma
Pb (backgrd II)		35.50	LiF(200)	Flow S.C.	Fine	60kV	45Ma
Mo	K	2033	LiF(200)	Flow S.C.	Fine	60kV	45Ma

Pulse height selection shall be used in all measurements and counting time shall be 100 seconds. Place the sample disc in the spectrometer. Measure the count rates of lead, lead background, and Molybdenum Compton scattered background from the X-ray tube.

(1) Energy dispersive fluorescence spectrometers shall be set up according to the manufacturer's manual.

#### 4.4.17.3 Calculation.

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

where I equals gross intensity. These results shall be compared with those obtained using a 0.06 percent lead standard made up from the same type of paint sample and evaluated for compliance with the requirement in table I.

## 5. PREPARATION FOR DELIVERY

5.1 Packaging, packing and marking. When specified, the enamel shall be packaged, packed and marked in accordance with PPP-P-1892. Unless otherwise specified, commercial packaging and packing shall be used (see 6.2). The enamel shall be furnished in one-quart metal cans, one-gallon metal cans, or five-gallon metal pails as specified (see 6.2).

5.1.1 Precautionary markings. In addition to the marking required by PPP-P-1892, all individual containers shall have the following markings:

CAUTION: This enamel contains volatile solvents, with hazardous vapors. Use with adequate ventilation. Avoid prolonged breathing of vapors or spray mists. The solvents are highly flammable. Avoid open flame and smoking.

## 6. NOTES

6.1 Intended use. This specification covers a high-grade, synthetic-type gloss enamel in white, light tints, and oiled drab. It is intended for use over a prime coat. This enamel will provide a finish of maximum washability and durability.

6.1.1 Enamel covered by this specification should be satisfactory for brushing at package consistency, and for spray and dip application when thinned in accordance with manufacturer's directions. The directions for thinning shall be marked on individual containers.

6.1.2 In general, the baking-type enamel specified herein is used in furniture-finishing factories or in government establishments properly equipped for spraying, dipping, and baking. The air-drying enamel will be used for touching up and redecorating.

6.2 Ordering data. Purchasers should select the preferred options permitted herein, and include the following information in procurement documents.

- (a) Title, number, and date of this specification.
- (b) Color required (see 3.1.1).
- (c) Class required (see 1.2.1).
- (d) Size of container required (see 5.1).
- (e) Levels of packaging and packing required (see 5.1).

Preparing activity:

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