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September 25, 1975
SUPERSEDING
Fed. Spec. TT-E-490D
September 27, 1972

FEDERAL SPECIFICATION

ENAMEL, SILICONE ALKYD COPOLYMER, SEMIGLOSS
(FOR EXTERIOR AND INTERIOR USE)

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

1. SCOPE

1.1 Scope. This specification covers a copolymerized silicone alkyd enamel for use on primed, smooth metal surfaces. The material complies with Air Pollution Regulations, "Rule 66".

2. APPLICABLE DOCUMENTS

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

Federal Specifications:

P-P-546	-	Polish, Automobile, Liquid and Paste.
TT-P-636	-	Primer Coating, Alkyd, Wood and Ferrous Metals.
TT-T-291	-	Thinner; Paint, Volatile Spirits (Petroleum Spirits).
PPP-P-1892	-	Paint, Varnish, Lacquer and Related materials; Packaging, Packing, and Marking of.
PPP-T-60	-	Tape, Packaging, Waterproof.

Federal Standards:

Fed. Test Method Std. No. 141 - Paint, Varnish, Lacquer and Related Materials; Methods of Inspection, Sampling, and Testing.
Fed. Std. No. 595 - Colors.

(Activities outside the Federal Government my 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 see are available without charge from Business Service Centers at the General Services Administration Regional Offices in Boston, New York, Washington, DC, Atlanta, Chicago, Kansas City, NO, Fort Worth, Denver, San Francisco, Los Angeles, and Seattle, MA.)

(Federal Government activities my 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 suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

FSC 8010

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

American Society for Testing and Materials (ASTM) Standards:

D 93 - Flash Point by Pensky-Martens Closed Tester.
D 476 - Titanium Dioxide Pigment.
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 Pigments in Vehicle System.
D 1296 - Odor of Volatile Solvents and Diluents.
D 1542 - Qualitative Tests for Rosin in Varnishes.
D 2088 - Test for Low Concentration of Lead in Paints.
D 2244 - Instrumental Evaluation of Color Difference of Opaque Materials.
D 2800, D 2245, D 1983 - Analysis of Soya Oil.
D 3335 - Determination of Low Concentration of Lead in Paints by Atomic Absorption Spectroscopy.
E 97 - Daylight Directional Reflectance.

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

3. REQUIREMENTS

3.1 Qualification. Enamels furnished under this specification shall he products which are qualified for listing on the applicable Qualified Products List at the time set for opening of bids (see 6.2). Any change in formulation of the qualified product will necessitate its requalification. The materials supplied under the contract shall be identical, within manufacturing tolerances, to the product receiving qualification.

3.2 Composition.

3.2.1 Pigment. The pigments listed in table I, or any combination thereof, shall make up the basic pigmentation for the color specified. The titanium dioxide pigment shall conform to ASTM D 476 type IV. Small amounts of shading pigments and titanium dioxide may be used when necessary to match the color specified (see 6.2), provided the enamel complies with requirements of this specification. The maximum lead content allowable shall be not more than 0.3 percent of the nonvolatile portion except for those colors indicated in table I.

TABLE I. Pigmentation guide

Color No. Fed. Std. No. 595	Color Designation	Pigmentation [1]
20045	Dk. brown	Titanium dioxide, rod iron oxide, yellow iron oxide, carbon black or lampblack.
20061	Maroon	Titanium dioxide, red iron oxide, yellow iron oxide, carbon black or lampblack.
20313	Lt. brown	Titanium dioxide, red iron oxide, yellow iron oxide, carbon black or lampblack.
21105	Red*	Quinacridone red, light stable

		molybdate orange.
21136	Red*	Quinacridone violet, light stable molybdate orange, titanium dioxide.
22190	Orange*	Light stable molybdate orange.
22246	Orange*	Light stable molybdate orange, chrome yellow.
23538	Yellow*	Titanium dioxide, light stable chrome yellow.
23578	Yellow	Titanium dioxide, yellow and red iron oxide carbon black or lampblack.
23655	Yellow*	Titanium dioxide, nickel titanium dioxide, light stable molybdate orange.
24052	Green*	Chrome green, iron blue, chrome yellow.
24087	Olive drab*	Yellow iron oxide, red iron oxide, carbon black or lampblack, chrome yellow, titanium dioxide.
24108	Dk. green*	Chrome oxide green, phthalocyanine green, yellow iron oxide.
24260	Green*	Chrome green, iron blue, chrome yellow.
24325	Lt. green	Titanium dioxide, phthalocyanine green.
25045	Strata blue*	Iron blue, copper phthalocyanine blue, chrome yellow, titanium dioxide, carbon black or lampblack, quinacridone red.

TABLE I. Pigmentation guide (Cont.)

Color No. Fed. Std. No. 595	Color Designation	Pigmentation [1]
25177	Lt. blue	Titanium dioxide, phthalocyanine blue, red iron oxide, carbon black or lampblack.
25299	Turquoise	Titanium dioxide, phthalocyanine blue, yellow iron oxide, carbon black.
26187	Medium gray*	Titanium dioxide, yellow iron oxide, chrome yellow, phthalocyanine blue, carbon black or lampblack.
26521	Gray	Titanium dioxide, yellow iron oxide, carbon black or lampblack.
26270	Gray (Navy-Haze-Gray)	Titanium dioxide, carbon black or lampblack.
27038	Black	Carbon black, iron blue.
27875	White	Titanium dioxide.
27886	White	Titanium dioxide.

[1] Extenders and shading pigments may be used provided these pigments have good color permanence and the finish product complies with the requirements specified herein.

* Theses enamels may contain lead in excess of 0.5 percent when analyzed in accordance with ASTM Method D 2088 or D 3355. Such enamels shall not be used in dwellings, household equipment, toys, etc. The supplier shall furnish proper labeling, marking, and intended use for such enamels on every container.

3.2.2 Vehicle. The vehicle shall consist of silicon-modified long oil soya alkyd of the air-drying type, together with suitable thinners, driers, antiskinning agents, wetting agents, dispersing agents, and stabilizers combined, producing an enamel conforming to all requirements specified herein. The characteristics of the vehicle shall be as specified in table II.

3.2.2.1 The volatile thinner shall conform to TT-T-291, type II, Grade A, or any other solvent system complying with Rule 66.[1] A certificate of compliance from the supplier to this requirement is necessary.

3.2.2.2 Identification. The copolymer, when tested an specified in 4.3.27, shall give two similar spectra, both of which shall show the significant bands of both the alkyd and silicone resins as shown in figure 1. Neither spectra shall show an absorption band in the 13.9 - 14.0 [mu]m region and both shall show a sharp narrow band at 7.0 pm.

3.3 Qualitative requirements.

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

3.3.2 Storage stability.

3.3.2.1 Partially full container. The enamel shall show no skinning when tested as specified 4.3.4.1 After aging as specified in 4.3.4.1, the enamel shall show no livering, curdling, hard caking or gummy sediment. It shall mix readily to a smooth homogeneous state: any skin formation shall be

continuous and easily removed.

3.3.2.2 Full container. The enamel shall show no skinning, livering, curdling, hard caking, nor tough gummy sediment, when tested as specified in 4.3.4.2. It shall remix readily to a smooth homogeneous state, shall have a consistency within 62 - 82 Kreb's Units and shall meet all other requirements of this specification. The consistency change shall not be greater than 5 units from the original K.U.

3.3.3 Dilution stability. When thinned as specified in 4.3.5, the enamel shall remain stable and uniform, showing no precipitation or curdling. Slight pigment settling shall be permitted.

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[1] Information on Rule 66 may be obtained from the Los Angeles Air Pollution Control District, Los Angeles, CA 90013.

3.3.4 Brushing properties. The enamel, tested as specified in 4.3.6, shall brush satisfactorily and shall dry to a uniform film, free from seeds, runs, sags or streaks.

3.3.5 Rolling properties. When tested as in 4.3.7, the enamel shall dry to a uniform film, free from seeds, runs, sags or streaks. The dried film shall show an even and smooth finish.

3.3.6 Spraying properties. The enamel, tested an specified in 4.3.8, shall spray satisfactorily, and shall show no running, sagging, streaking, or orange peel. The air dried film shall show no seeding, dusting, floating, fogging, mottling, hazing, or other film defects.

3.3.7 Color. The color of the enamel specified in the contract or order (see 6.2 and 6.4) shall match the color chip in Fed. Std. No. 595, or a color mutually agreed own by buyer and supplier, when tested as specified in 4.3.9.

3.3.8 Odor. When tested as specified in 4.3.10, the odor of the wet enamel and of the film at any interval of drying shall not be obnoxious or objectionable.

3.3.9 Anchorage. A film of the enamel, tested as specified in 4.3.11, shall show no removal or loosening of the enamel beyond 1.6 mm (1/16 inch) on either side of the score line.

3.3.10 Flexibility. A film of the enamel, tested as specified in 4.3.12, shall bond without cracking or flaking.

3.3.11 Knife test. A film of enamel tested as specified in 4.3.13 shall adhere tightly to the metal, and shall not flake or crack. The film shall ribbon or curl from the metal on cutting, and the cut shall show beveled edges.

3.3.12 Recoating. When tested as specified in 4.3.14, recasting of a dried film shall produce irregularities.

3.3.13 Water resistance. A film of the enamel, tested as specified in 4.3.15, small show no blistering or wrinkling when examined immediately after removal from distilled water. When examined 2 hours after removal, there shall be no softening, whitening, at dulling. After 24 hours air drying, the portion of the panel which was immersed shall be indistinguishable with regard to hardness, adhesion, and general appearance from a panel prepared at the same time but not immersed, and shall retain at least 80 percent of 600 deg. specular gloss of the comparison panel.

3.3.14 Accelerated weathering. Film of enamel, tested as specified in 4.3.16, shall show no chalking, a loss of not more than 50 percent of the gloss measured prior to exposure, and color change equivalent to a lightness index difference of not more than four units, except that the change for yellows shall not exceed six units.

3.3.15 Weather resistance. A film of enamel, tested as specified in 4.3.17, shall show no appreciable film deterioration or color change and shall show no more than light chalking (No. 6 of method 6411 of Fed. Test Method Std. No. 141). The film, after exposure, shall have a 60 deg. gloss of not less than 25: shall readily polish to a semigloss, and reflect a clear sharp image. There shall be no checking, cracking, or other impairment of film integrity, and the polished area shall be restored to substantially the original color except for orange 22190 and yellows 23536 and 23655, which may show slight darkening.

3.3.16 Toxicity. The enamel shall contain no benzene (benzol) or chlorinated compounds when tested as specified in 4.3.18.

3.4 Quantitative requirements.

3.4.1 Vehicle. The composition of the vehicle shall be as specified in table II.

TABLE II. Vehicle ingredients

Characteristics	Requirements Minimum	Maximum
Copolymer resin solids, percent by weight of nonvolatile	50	--
Silicone contents percent by weight of nonvolatile vehicle	30	--
Phthalic anhydride, percent by weight of nonvolatile vehicle	14	17
Drying oil acids, percent by weight of nonvolatile vehicle	41	55
Soya oil	Positive	
Phenolic resin	Negative	
Rosin	Negative	

3.4.2 Quantitative requirements of the enamel. The quantitative requirements of enamel shall be an specified in table III and table IV.

TABLE III. Quantitative requirements of the enamel

Characteristics	Requirements Minimum	Maximum
Flash point, Pensky-Martens, closed cup, deg. C (deg. F)	29 (85)	--
Water, percent by weight of enamel	--	0.5
Coarse particles and skins (retained on No. 325 mesh) percent by weight of pigment		0.5
Gloss, 60 deg. specular (for all colors except Navy-Haze-Gray)	40	60
Gloss, 60 deg. specular (for Navy-Haze-Gray, Color # 26270)	40	50
Consistency, Krebs-Stormer, shearing rate, 200 r.p.m.: grams	125	175
Equivalent K.U.	67	77
Fineness of grind	6	---
Daylight 45 deg., 0 deg. directional reflectance (white enamel)	87	---
Drying times		
Set to touch, hours	---	2
Dry hard, hours	---	8

3.4.2.1 Hiding power (contrast ratio). A dry film thickness of 25.4 [mu]m (one mil) maximum of white enamel (minimum reflectance 84 percent) shall give a dry film contrast ratio of 0.95. The minimum contrast ratio for tints applied to the thickness in terms of apparent reflectivity when tested an in 4.3 shall be as specified in table IV.

TABLE IV. Minimum dry film contrast ratio for tints

Apparent reflectivity of tint Percent	Contrast ratio	Apparent refractivity of tint Percent	Contrast ratio
82	0.94	70	0.97
80	0.94	69	0.97
78	0.95	66	0.98
76	0.95	64	0.98
74	0.96	62	0.98
72	0.96	60 or below	0.98

3.4.3 Specific quantitative requirements. The specific quantitative requirements for each color shall be as specified in table V. On analysis of

the pigments, compute hiding pigment as indicated on column 4 and extender pigment in column 5. Lead chromate ($PbCrO_4$) may be substituted on equal weight basis.

TABLE V. Specific quantitative requirements (percent by weight of enamel)

Color No. Fed. Std. 595	Color Designation	Total solids	Hiding pigment		Extender pigment		Vehicle solids
		Minimum	Minimum	Maximum	Minimum	Maximum	Minimum
20045	Dk. brown	62	7 (Fe_2O_3)	11	---	28	29
20061	Maroon	64	7 (Fe_2O_3)	11	---	28	29
20313	Lt. brown	65	19 (Fe_2O_3)	23	---	24	25
21105	Red	64	12 -	16	---	26	30
21136	Red	61	22 -	25	---	23	26
22190	Orange	62	24 -	27	---	24	25
22244	Orange	62	25 -	29	---	22	25
23530	Yellow	66	33 ($PbCrO_4$)	37	---	20	23
23578	Yellow	61	23 ($PbCrO_4$)	27	---	25	23
23455	Yellow	66	33 ($PbCrO_4$)	37	---	20	23
24052	Green	62	10 ($PbCro_4$)	14	---	28	28
24087	Olive drab	62	12 ($PbCrO_4$)	16	---	24	26
24109	Dk. green	62	15 ($PbCro_4$)	19	---	27	28
24260	Green	62	21 ($PbCrO_4$)	25	---	23	32
24325	Lt. green	64	21 ($PbCrO_4$)	25	---	24	26
25045	Strata blue	51	3 -	7	---	35	30
25177	Lt. blue	64	21 -	25	---	25	28
25299	Turquoise	64	17 ($PbCrO_4$)	21	---	26	29
26197	Medium gray	59	21 (TiO_2)	25	---	26	27
26251	Gray	61	23 (TiO_2)	27	---	24	25
26270	Gray (Navy-Haze)	63	14 (TiO_2)	18	---	24	26
27032	Black	58	2 (Carbon black)	5	---	37	32
27875	White	63	27 (TiO_2)	31	---	26	30
27886	White (off)	64	31 (Tio_2)	35	---	28	29
	Other tints	65	27 ($Ti0_2$)	31	---	28	28

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 that supplies and services conform to prescribed requirements.

4.1.1 Sampling and inspection. Sampling and inspection shall be in accordance with method 1031 of Fed. Test Method Std. No. 141.

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

(a) Qualification.
(b) Acceptance of individual lots.

4.2.1 Qualification testing shall consist of all the tests of this specification.

4.2.2 Acceptance testing of individual lots shall consist of all tests in

section 3 with the exception of storage stability (see 3.3.2.2 and 4.3.4.2) and weather resistance (see 3.3.15 and 4.3.17).

4.3 Test methods.

4.3.1 Test conditions. The routine and referee tasting conditions shall be in accordance with section 7, Fed. Test Method Std. No. 141 except as otherwise specified herein.

4.3.2 The tests Indicated in table VI shall be conducted in accordance with Fed. Test Method Std. No. 141 except an indicated in paragraph reference. The right is reserved to make any additional tests deemed necessary to determine that the enamel meets the requirements of this specification. Failure to pass any test, or noncompliance to the requirements of Section 3 shall be cause for rejection of the lot.

TABLE VI. Index

Characteristics	Requirements Reference	Applicable tests: Fed. Test Method Std. No. 141	Applicable tests: ASTM Method	Paragraph Reference
Condition 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
Rolling properties	3.3.5	4335		4.3.7
Spraying properties	3.3.5	4331		4.3.8
Color	3.3.7	4250		4.3.9
Odor	3.3.8		D 1296	4.3.10
Anchorage	3.3.9	----		4.3.11
Flexibility	3.3.10	6221		4.3.12
Knife test	3.3.11	6304		4.3.13
Recoating properties	3.3.12	4061		4.3.14
Water resistance	3.3.13			4.3.15
Accelerated weathering	3.3.14	6152	Sec. 50	4.3.16
Weather resistance	3.3.15	----		4.3.17
Toxicity	3.3.16	----		4.3.19
Copolymer resin solids	Table II	----		4.3.19
Silicone content	Table II	----		4.3.20
Phthalic anhydride	Table II	----		4.3.21
Drying oil acids	Table II	D 1398		4.3.22
Soya oil	Table II		D 2800, D 2245, D 1983	------
Phenolic resin	Table II	5141		------
Rosin	Table II		D 1542 Sec. 4A	------
Flash point	Table III		D 93	------
Water	Table III	4081		------
Coarse particles	Table III	4092		------
Consistency	Table III		D 562	------
Fineness of grind	Table III		D 1210	------
Drying time	Table III	4061		------
Daylight 45 deg., 0 deg. directional reflectance	Table III		E 97	------
Gloss 60 deg. specular	Table III	6101		------
Dry opacity (contrast ratio)	Table IV	4122		4.3.23
Total solids	Table V	----		4.3.24
Hiding pigment	Table V	----		4.3.25.1
Other pigments	Table V	----		4.3.25.2
Extender	Table V	----		------
Vehicle solids	Table V	----		4.3.26

4.3.3 Condition in container. Determine package condition on acceptance testing in accordance with method 3011 of Fed. Test Method Std. No. 141, and observe for compliance with 3.3.1. On qualification testing evaluate pigment settling or caking by proceeding as in method 3011, but do not stir. Reseal and then agitate the can for 3 minutes on a paint shaker. On reexamination of the contents, the disclosure of any gel bodies or undispersed pigment indicates unsatisfactory settling properties.

4.3.4 Storage stability.

4.3.4.1 Partially full container. Determine skinning after 49 hours in accordance with method 3021 of Fed. Test Method Std. No. 141, except use a 3/4-filled 1/2-pint multiple friction top can. Reseal and age for 7 days at 60 deg. C (140 deg. F) and observe for Compliance with 3.3.2.1.

4.3.4.2 Full container. In accordance with method 3022 of Fed. Test Method Std. No. 141, allow a full standard quart can of enamel to stand undisturbed for 12 months and than examine the contents. Evaluate pigment settling or caking as specified in 4.4.11, but agitate the can for 5 minutes on the paint shaker prior to re-examination. Determine viscosity and make other applicable tests for compliance with 3.3.2.2.

4.3.5 Dilution stability. Reduce one part by volume of enamel as packaged with one part by volume of thinner conforming to TT-T-291, type II, grade A. Then test as specified in method 4203 of Fed. Test Method Std. No. 141 for compliance with 3.3.3.

4.3.6 Brushing properties. Determine brushing properties of the packaged enamel, as specified in method 4321 of Fed Test Method Std. No. 141, for compliance with 3.3.4. As a referee test use method 4494 of Fed. Test Method Std. No. 141, except make the drawdown a minimum of 25 cm (10 inches) long on a clear glass plate. Contact of the 102 [mu]m (4 mil) strip with the next thicker strip at any point within the 14 (5.5 inch) central portion of the blade path indicates sagging.

4.3.7 Rolling properties. Determine rolling properties of the enamel, in accordance with method 4335 of Fed. Test Method Std. No. 141, for compliance with 3.3.5.

4.3.8 Spraying properties. Reduce 8 parts by volume of enamel with one part by volume of thinner conforming to TT-T-291, type II, grade A. Spray on a steel panel to dry film thickness between 23 to 28 [mu]m (0.009 to 0.0011) inch, and observe for spraying properties an specified in method 4331 of Fed. Test Method Std. No. 141 for compliance with 3.3.6.

4.3.9 Color. Draw down a coat of the enamel an a white opaque glass panel using a doctor blade with a 152 [mu]m (0.006 inch) gap clearance designed to deposit a wet film thickness of approximately 76 [mu]m (0.003 inch). After 48 hours air drying, compare the dried film with a standard chip (Fed. Std. No. 595, or a color agreed upon by buyer and supplier) in accordance with method 4250 of Fed. Test Method Std. No. 141 for compliance with 3.3.7. If doubt exists as to the satisfactoriness of the match, the color shall show not more than one unit of color difference in the direction of minus L, a, and b values from the standard chip, when tested in accordance with ASTM D 2244.

4.3.10 Odor. Test for odor as specified in ASTM method D 1296, and observe for compliance with 3.3.8.

4.3.11 Anchorage. Prepare a panel as specified in 4.3.8 and air dry for 18 hours, then bake for 2 hours at 105 deg. +/- 2 deg. C (221 deg. +/- 4 deg. F).

4.3.11.1 Procedure. Condition the panel for 1 hour under referee testing condition (see section 7 of Fed. Test Method Std. No. 141) then score a line through to the metal across the width of the film using a sharp pointed knife. The film shall then be taped perpendicular to and across the score line with waterproof, pressure sensitive tape 19 mm (3/4 inch) wide conforming to PPP-T-60, type IV. Press the tape in firm contact with pressure. Allow approximately 10 seconds for the test area to return to room temperature. Grasp the force and of the tape and at a rapid speed strip it from the film by pulling back from the panel at approximately 180 deg. angle. Observe for compliance with 3.3.9.

4.3.12 Flexibility. Determine flexibility in accordance with 6221 of Fed. Test Method Std. No. 141. Apply a 2-inch wide film of enamel using a film

applicator that will give a dry film thickness of 23 to 28 [mu]m (0.0009 to 0.0011 inch) on a smooth finish steel panel prepared in accordance with method 2011 of Fed. Test Method Std. No. 141 using the aliphatic naphthaethylene glycol monoethyl other mixture. The panel shall be prepared from now cold rolled rust-free carbon steel 25.4 +/- 2.5 [mu]m (0.010 +/- 0.001 inch) thick with a Rockwell 15-T maximum hardness of 82 and finished with a surface roughness of 8 to 12 microinches. Air-dry in a horizontal position for 18 hours and then bake for 168 hours at 105 deg. +/- 2 deg. C (221 deg. +/- 4 deg. F). Condition the panel for 1/2 hour under referee conditions. Bend over a 174 inch (6.35 mm) mandrel. Examine the coating for cracks over the area of the bond in a strong light at a 7-diameter magnification for compliance with 3.3.10.

4.3.13 Knife test. Perform the knife test as specified in method 6304 of Fed. Test Method No. 141, using the flat portion of the panel trap from the flexibility test (4.3.12), and observe for compliance with 3.3.11.

4.3.14 Recoating. Prepare the enamel as specified in method 4061 of Fed. Test Method Std. No. 141. Air dry for 24 hours under referee testing conditions. Apply a second coat crosswise to the first coat, and then air dry as before. Examine for compliance with 3.3.12.

4.3.15 Water resistance. Draw down a film of enamel with a 51 [mu]m (0.002 inch) 102 [mu]m (0.004-inch) gap clearance) film applicator on a steel panel which was solvent cleaned and phosphate coated an specified in method 2011, procedure B of Fed. Test Method Std. No. 141, and air dry for 7 days. All exposed uncoated metal surfaces shall be coated with wax or other suitable coating and the panel immersed in distilled water at 23 deg. +/- 1 deg. C (73 deg. +/- 2 deg. F) for 18 hours as specified in method 6011 of Fed. Test Method Std. No. 141. At the end of the test period remove and examine for compliance with 3.3.13.

4.3.16 Accelerated weathering. Draw down file of enamel on duplicate flat tin panels (method 2012) with a 63 [mu]m (0.0025 inch) gap clearance film applicator. Allow the panels to air dry for 168 hours. Measure the gloss and directional reflectance and subject the coated panels for 300 hours to accelerated weathering using the twin arc apparatus in accordance with method 6152 of Fed. Test Method Std. No. 141. Examine for chalking and then wash under running water with a thoroughly degreased lamb's wool pad to remove any scum or dirt. Wipe dry with clean cheesecloth and let stand for 2 hours. Measure the glass and directional reflectance, and compute the average percentage loss of gloss. Determine the amount of color change, expressed as lightness index difference (L), using method 6122 of Fed. Test Method Std. No. 141. Check results for compliance with 3.3.14.

4.3.17 Weather resistance. Spray a coat of primer (20 to 25 [mu]m (0.0008 to 0.0010 inch) dry film thickness) conforming to TT-P-636 on two 102 x 306 [mu]m (4 by 12 inch) steel panels phosphoric acid etched as specified in method 2011, procedure B of Fed. Test Method Std. No. 141. Air-dry for 18 hours. Spray a coat of the enamel 23 to 28 [mu]m (0.0009 to 0.0011 inch) dry film thickness and air-dry for 96 hours. Place on outdoor exposure in accordance with method 6160 of Fed. Test Method Std. No. 141 in the southern part of Florida for 6 months. At the end of the exposure period, wash the panels with a warm soap solution using a soft sponge and examine for film deterioration and color chance. Measure the 60 deg. gloss in accordance with method 6101 of Fed. Test Method Std. No. 141. Applying no more than moderate pressure, hand polish a portion of the exposed film using liquid automobile polish conforming to P-P-546 and a soft cloth. Examine the polished area for restoration of color and gloss and inspect with a magnification of approximately 5 power for film integrity for compliance with 3.3.15.

4.3.18 Toxicity. The manufacturer shall certify that the enamel contains no benzene (benzol), chlorinated solvents, or other ingredients which are toxicologically hazardous under normal conditions of usage.

4.3.19 Copolymer resin solids (isopropanol extraction). Weigh 5 grams (to the nearest one-tenth mg.) of extracted vehicle into a tared centrifuge bottle or tube fitted with a cap. Add 50 ml of isopropanol (technical grade), cap the bottle or tube, and shake vigorously for 2 minutes. Centrifuge for 15 minutes at a minimum of 2,000 r.p.m. Decant the isopropanol extract, and repeat the extraction with two 50-ml portions of isopropanol. Decant the last extraction, and condition the bottle or tube at room temperature for 15 minutes, then place the bottle or tube in a 135 deg.

C (275 deg. F) oven for three hours. Remove the bottle or tube, cool for 30 minutes at room temperature. and weigh. Calculate the copolymer solids for compliance with table II.

Calculations:

$$\text{Percent copolymer Solids} = \frac{R \times 100}{S \times D}$$

Where: R = Weight of residue (in bottle or tube).
S = Weight of sample (extracted vehicle).
D = Percent of nonvolatile matter (extracted vehicle).

4.3.20 Silicone ($H_3Si_3O_2$) content of extracted vehicle.

4.3.20.1 Silicon (silica-SiO_2).

4.3.20.1.1 Reagents:

Sulfuric acid (fuming), 30 percent (A.C.S. reagent grade).
Nitric acid (fuming, 15 percent (A.C.S. reagent grade).
Chlorobenzend, C.P.

4.3.20.1.2 Apparatus:

Micro-Kjeldahl rack
Muffle furnace at 1000 deg. C (1832 deg. F)
Platinum crucible

4.3.20.1.3 Procedure. Weigh a sample (extracted vehicle) which will yield about 70 to 100 mg of silicon dioxide, usually 0.1 to 0.3 g. of resin, directly into a tared platinum crucible. Evaporate the solvent an a hot plate at low temperature or in an oven under partial vacuum at 105 deg. C (221 deg. F). (The solvent may be evaporated by infrared lamp.) After evaporation is complete, add 4 or 5 drops of chlorobenzene to reduce frothing and stir thoroughly and gently. Add 1-1/2 ml of 30 percent fuming sulfuric acid to the solution at room temperature, followed by 0.5 ml of 15 percent fuming nitric acid. Digest solution over a low flame or heat on a micro-kjeldahl rack for several hours. Add nitric acid if necessary to complete the oxidation, but cool the solution before adding the nitric acid to avoid excessive frothing. When the mass has solidified and danger of frothing is past, heat the crucible carefully over a burner in such a manner that the sample does not spatter. If carbonaceous matter is still present, add nitric acid and continue heating. Carbonaceous matter should be removed to avoid the formation of silicon carbide. If carbonaceous residue still persists, oxidize with a slow stream of oxygen into the crucible during heating by suitable mans. Place the crucible in a muffle furnace at 1000 deg. (1832 deg. F) for about one hour or until the ashing is complete. Remove, place in a desiccator to cool to constant weight, then weigh.

4.3.20.1.4 Calculation:

$$\text{Percent silicon} = \frac{\text{wt. of } SiO_2 \times 20 \times 100}{\text{wt. of sample in gm} \times 60 \times \text{percent vehicle solids}}$$

Convert percent silicon (found in the analysis) to percent Silicone for compliance with table II by using conversion factor (see 4.3.20.1.5).

4.3.20.1.5 Conversion factor. The conversion factor is dependent an the copolymer resin used. The supplier shall furnish the quality control representative and contracting officer the commercial designation of the copolymer resin used and the conversion factor of the resin. The conversion factor shall not be less than 4.35 and not more than 4.85 (see 6.7).

4.3.21 Phthalic anhydride. Determine phthalic anhydride in accordance with method 7022 of Fed. Test Method Std. No. 141. This method can be replaced by a slightly altered method 7014, by substituting petroleum other for chloroform.

4.3.22 Drying oil acids. Determine the drying oil acids content in accordance with method 7031 of Fed. Test Method Std. No. 141. This method can be replaced by a slightly altered method 7014 by substituting petroleum

other for chloroform.

4.3.23 Hiding power (contrast ratio). The hiding power of the enamel shall be No. 141, except determined in accordance with method 4122 of Fed. Test Method Std. No. 141, except that a suitable chart may be substituted for the carrara glass. For reds 21105 and 21136, use a file applicator that will deposit a 76 mm (3-inch) wide film with a dry film thickness at approximately 38 [mu]m (0-0015 inch) maximum and for all other colors a dry film thickness of approximately 25 [mu]m (0.0010 inch) maximum. Air dry for 72 hours, then determine the reflectance and verity the film thickness in the area in which the reflectance was measured. Calculate the contrast ratio and check for compliance with 3.4.2.1 and table IV.

4.3.24 Total solids. Weigh to the nearest 0.1 milligram a small disposable aluminum dish approximately 51 mm (2 inches) in diameter, that has been provided with a tared aluminum cover. Weigh into the dish a very small sample of enamel that does not exceed 0.3 gram. Dissolve the sample in 2 ml at reagent-grade toluene, and dry for 30 minutes in a gravity convection oven at 105 deg. C (221 deg. F). Upon cooling, reweigh to the nearest 0.1 milligram, calculate, and observe for compliance with table V.

4.3.25 Pigment analysis.

4.3.25.1 Prime (hiding) pigments. Determine iron oxide (Fe_2O_3); titanium dioxide (TiO_2); and lead chromate ($PbCrO_4$ in accordance with methods 7141, 7083, and 7131 respectively of Fed. Test Method Std. No. 141. Lead chromate ($PbCrO_4$ may be substituted on an equal-weight basis.

4.3.25.2 Other pigments. Industry is given latitude in the selection of organic pigments or combination, provided the products meet all the requirements.

4.3.25.3 Extender pigments. Determine barium sulfate and siliceous matter by the applicable portions of method 7281 of Fed. Test Method Std. No. 141, and check against permissible limits for extender specified in table V. If appreciably below amount permitted, determine calcium (sulfate or carbonate) by the same method as indicated.

4.3.26 Vehicle solids. Determine vehicle solids in accordance with method 4052 of Fed. Test Method Std. No. 141, for compliance with table V.

4.3.27 Identification of copolymer. Test qualitatively for the copolymer by agitating 0.5 gram sample of the extracted vehicle with the three successive 20 ml portions of isopropanol, decanting off the alcohol and saving each portion. Scan the infrared spectrum from 2 to 15 [mu]m of a solvent-free film of both the isopropanol insoluble portion and the soluble portion after evaporation of the alcohol. Check for compliance with paragraph 3.2.2.2.

4.3.28 Inspection of preparation for delivery. The packaging, packing, and marking of the enamel shall be inspected to determine compliance with the requirements of section 5 in accordance with PPP-P-1892. Any container in the sample having one or more defects, or under required fill shall be rejected, and if the number of defective containers in an sample exceeds the acceptance number of the appropriate sampling plan of MIL-STD-105, the lot represented by the sample shall be rejected.

5. PREPARATION FOR DELIVERY

5.1 Packaging, packing, and marking. The enamel shall be packaged, packed, and marked in accordance with PPP-P-1892. The levels of packaging and packing shall be A, B, or C, as specified (see 6.2). The enamel shall be furnished in 1-quart can, 1-gallon can, 5-gallon pail, 55-gallon drum (see 6.2).

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

CAUTION: This enamel contains volatile solvents, with probable 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, air-drying, semigloss enamel made from a copolymer of long-oil alkyd and silicone resins, and intended for use an primed metal, particularly on smooth, exterior metal. It is highly weather-resistant and is characterized by excellent color and gloss retention, good drying, freedom from aftertack, and good flexibility. The enamel nay be applied with brush, roller, or spray.

6.1.1 Some additional intended used of enamels meeting this specification are an follows:

Semigloss finish for: Machinery
Refinishing trucks and buses.
Passenger and freight cars.
Metal drum
Metal signs
Metal railing and fences
Marine use above water
Metal trim (exterior)
Metal sidings
Metal doors and bucks
Metal structures (exterior)
Properly primed wood (exterior)

6.1.2 For gloss finish refer to material under Federal Specification TT-C-1593, Enamel, Silicone Alkyd Copolymer, Gloss (For Exterior and Interior Use).

6.1.3 This enamel is not intended for painting interior plastered walls.

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

(a) Title, number, and data of this specification.
(b) Color required (see 3.2).
(c) Size of container required (see 5.1).
(d) Levels of packaging and packing required (see 5.1).

6.3 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 boon so listed by that date. The attention of the supplier 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 my be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the General Services Administration, Federal Supply Service, Chemicals and Paints Division, Crystal Mall Bldg 4, Washington, DC 20406, and information pertaining to qualification of products may be obtained from that activity.

6.4 Tinted and solid color enamel may be purchased under this specification by indicating the desired color in the bid invitations and contracts. To obtain a match for a particular color not covered by Fed. Std. No. 595, the seller and the testing laboratory should be supplied with wet samples or color chips of the color desired.

6.3 The enamel covered by this specification should be satisfactory for brushing and rolling at package consistency.

6.6 The enamel covered by this specification should be purchased by volume, the unit being one U.S. gallon of 231 cubic inches at 20 deg. C (69 deg. F). The weight per gallon will vary depending on the formulation, for example: An olive drab enamel will weigh about 8-1/2 pounds per gallon, a white enamel about 9-1/2 pounds, and red enamel about 8 pounds.

6.7 Convert the silicon (silica) content of the enamel to silicone alkyd as specified in table II by using conversion factors of commercially available copolymer resins:

Dow Corning -- 4.35
G.E. SR-176 -- 4.85

CIVIL AGENCY COORDINATING ACTIVITIES:

GSA-FSS
HUD-HEE

Preparing activity:

GSA-FSS

Military custodians:

Army - MR
Navy - YD
Air Force - 94

Review activities:
Army - ME

Military coordinating activity:

Army - MR

TT-E-490E
AMENDMENT-2
November 9, 197
SUPERSEDING
Amendment-2
June 23, 1977

FEDERAL SPECIFICATION

ENAMEL, SILICONE ALKYD COPOLYMER, SEMIGLOSS
(FOR EXTERIOR AND INTERIOR NON-RESIDENTIAL USE)

This amendment which forms a part of Federal Specification TT-E-490E, dated September 25, 1975, was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

PAGE 1

Paragraph 1.1, delete second sentence and add, "Certain colors are formulated with lead-containing pigments (sea table I) and shall not be used in residential structures."

Paragraph 2.1, under Federal Specifications, delete "PPP-P-1892 - Paint, Varnish, Lacquer and Related Materials; Packaging, Packing, and Marking of" and add PPP-B-636 - Boxes, Shipping, Fiberboard.

Under Paragraph 2.1, Federal Specifications, add: "PPP-C-96 - Cans, Metal, 28-Gage and Lighter."

PAGE 2

Under paragraph 2.2. add:

National Motor Freight Traffic Association, Inc., Agent:

National Motor Freight Classification.

(Application for copies should be addressed to the American Trucking Associations, Inc., Traffic Department, 1616 P Street, N.W., Washington, DC 20036.)

Uniform Classification Committees, Agent.

Uniform Freight Classification.

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

Paragraph 3.1. delete in its entirety.

PACE 3

Footnote below table I, line 3, delete "0.5" and substitute "0.06".
Paragraph 3.2.1, line 6, delete "0.5" and substitute "0.06".

Paragraph 3.3.2.2. delete in its entirety.

PACE 4

Paragraph 3.3.15, delete in its entirety.

Table II, line 2, delete and substitute: "Silica (SiO_2) content, percent by weight of nonvolatile vehicle" with a minimum requirement of "14.0".

Table III, line 10, under minimum requirements, delete "87" and substitute "84".

FSC 8010

Table V, Line 25, change requirements for color no. 27888, off-white to the following total solids, minimum, "65"; hiding pigment, minimum "24" and maximum "28"; extender pigment, maximum, "20"; and vehicle solids, minimum "25".

Add paragraph 3.5 as follows;

3.5 Precautionary marking. All containers of paint shall be marked with a warning label.

3.5.1 All containers of paint which contain lead compounds in excess of 0.06 percent by weight (calculated as load metal) in the total nonvolatile contest shall be sacked with the following-warning notices:

"WARNING"
"CONTAINS LEAD. DRIED FILM OF THIS PAINT
MAY BE HARMFUL IF EATEN OR CHEWED."

"Do not apply on toys and other children's articles, furniture, or interior surfaces of any dwelling at facility which my be occupied or used by children."

"Do not apply an these exterior surfaces of dwelling units, such as window sills, porches, stairs, or railings to which children may be commonly exposed."

"Keep out of reach of children."

3.5.2 Containers of paint in which lead has not been specifically introduced but is not restricted to 0.06 percent shall carry the following label:

"WARNING"

"This paint is restricted to non-residential application. It has not been tested to ensure less than 0.06 percent lead content."

"Do not apply on toys and other children's articles, furniture, or interior surfaces of any dwellings or facility which may be occupied or used by children."

"Do not apply on such exterior surfaced of duelling units as window sills, porches, stairs, or railings to which children may be commonly exposed."

"Keep out of reach of children."

Add paragraph 3.6:

"3.6 Quantities. The enamel shall be furnished in 1-quart, 1-gallon, 5-gallon, and 55-gallon quantities, as specified in the contract or order (see 6.2)"

Paragraph 4.2, delete in its entirety and substitute:

"4.2 Testing. Testing under this specification shall be for all requirements in section 3."

Paragraph 4.2.1, delete in its entirety.

Paragraph 4.2.2, delete in its entirety.

Table VI, line 15, delete in its entirety.

Table VI, line 18, delete "silicone content" under characteristics and substitute "silica (SiO_2) content."

Paragraph 4.3.4.2, delete in its entirety.

PAGE 9

Paragraph 4.3.17, delete in its entirety.

Paragraph 4.3.15, delete in its entirety and substitute:

4.3.18 Toxicity. Method 5132 of Federal Test Method Standard No. 141 shall be used to determine the presence of chlorinated solvents and method 7356, procedure B shall be used to determine the presence of benzene for compliance with the requirement in 3.3.16."

PAGE 10

Paragraph 4.3.20, change "Silicone ($H_3Si_3O_2$) content of extracted vehicle" to Silica "(SiO_2) content of extracted vehicle."

Paragraph 4.3.20.1.4, delete in its entirety and add:

$$\text{Percent silica} = \frac{\text{Weight of asn} \times 100}{\text{Weight of sample} \times \text{non-volatile vehicle fraction}}$$

Paragraph 4.3.20.1.5, delete in its entirety.

Paragraph 4.3.21, delete the last sentence.

Paragraph 4.3.22, delete the last sentence.

PAGE 11

Paragraph 4.3.28, delete in its entirety and substitute the following:

"4.3.28 Inspection of preparation for delivery. An inspection shall be made to determine whether the packaging, packing, and marking comply with the requirements of section 5. The sample unit shall be one shipping container. Sampling shall be in accordance with MIL-STD-105. The inspection level shall be S-2 with an AQL of 4.0 percent defective."

Delete section 5 and substitute:

5. PREPARATION FOR DELIVERY

5.1 Packaging. Packaging shall be level A or commercial, as specified (see 6.2).

5.1.1 Level A. The 1-quart and 1-gallon quantities of enamel shall be packaged in metal can conforming to PPP-C-96, type V, class 2. Exterior plan B coating and side seam striping shall be required. The can shall be provided with wire handles which shall be galvanized or otherwise protectively coated to resist corrosion.

See paragraph 5.2.1 for the preparation for delivery of 5-gallon and 55-gallon quantities.

5.1.2 Commercial. The 1-quart and 1-gallon quantities of enamel shall be packaged in accordance with normal commercial practice. The complete package shall be designed to protect the enamel against damage during shipment, handling, and storage.

See paragraph 5.2.2 for the preparation for delivery of 5-gallon and 55-gallon quantities.

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

5.2.1 Level A. Twelve 1-quart cans of four 1-gallon cans of enamel, packaged as specified in 3.1, shall be packaged in close-fitting boxes conforming to PPP-B-636, grade V3c, V3s, or V2s. The boxes shall be closed, waterproofed, and reinforced in accordance with the appendix to PPP-B-636. Alternatively, cleated plywood, wire bound or nailed wood boxes shall be acceptable shipping containers when lined with a waterproof barrier material. The edges of the barrier material shall be sealed with waterproof tape or adhesive.