

TT-E-515A
April 5, 1971

SUPERSEDING
Fed. Spec. TT-E-515
August 30, 1963

FEDERAL SPECIFICATION

ENAMEL, ALKYD, LUSTRELESS, QUICK-DRYING

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

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers one type and one grade of a lustreless quick drying alkyd enamel for use as a finishing coat on equipment. It provides two compositions one of which is suitable for use under AIR POLLUTION REGULATIONS (see 6.6).

1.2 Classification. Enamel covered by this specification shall be of the following composition as specified:

Composition G - General use.

Composition L - Limited use (see 6.6).

2. APPLICABLE DOCUMENTS

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

FSC 8010

TT-E-515A

Federal Specifications:

- TT-P-143 - Paint, Varnish, Lacquer and Related Materials; Packaging, Packing, and Marking of.
- TT-P-442 - Pigment, Titanium Dioxide (for Protective Coatings).
- TT-P-664 - Primer Coating, Synthetic, Rust-Inhibiting, Lacquer-Resisting.
- TT-S-735 - Standard Test Fluids; Hydrocarbon.
- TT-T-266 - Thinner; Dope and Lacquer (Cellulose Nitrate).
- TT-T-306 - Thinner; Synthetic Enamel.
- PPP-T-60 - Tape; Pressure Sensitive Adhesive, Waterproof (for Packaging and Sealing).

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 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, D.C. 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, Washington, D. C., Atlanta, Chicago, Kansas City, Mo., Fort Worth, Denver, San Francisco, Los Angeles and Seattle, Washington.)

(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.)

3. REQUIREMENTS

3.1 Qualification. The enamel furnished under this specification shall be products which are qualified for listing on the applicable Qualified Products List at the time set for opening of bids (see 6.3). Any change in the formulation of a qualified product will necessitate its requalification. The material supplied under contract shall be identical, within manufacturing tolerances, to the product receiving qualification.

3.2 Composition.

3.2.1 Vehicle.

3.2.1.1 Composition G. The vehicle shall be a resin modified drying oil phthalic alkyd resin conforming to the requirements of Table I together with the necessary amounts of driers and volatile aromatic type solvents to meet the requirements of this specification. Small amounts of wetting agents, anti-oxidants, and stabilizers may be used. The volatile material shall contain no benzol, chlorinated or other solvent of highly toxic nature.

TABLE I. Characteristics of alkyd resin

	Minimum	Maximum
Total solids	49	51
Viscosity, Gardner tubes	U	Y
Color, Gardner Color Standards of 1953	--	13
Phthalic anhydride, percent by weight of resin solids	38	--
Unsaponifiable matter, percent by weight of resin solids	--	5
Vegetable oil acids, percent by weight of resin solids	32	--
Acid number	--	32

3.2.1.2 Composition L. The vehicle shall be the same as 3.2.1.1 except the volatile solvents used shall conform to the following requirements by volume when tested as in 4.3.3.

- (a) Aromatic compounds with eight or more carbon atoms except ethyl benzene: 8 percent maximum.
- (b) Ethyl benzene and toluene: 20 percent maximum.
- (c) Solvents with an olefinic or cyclo-olefinic type of unsaturation: negative test (see 6.7).
- (d) Ketones - negative.
- (e) Total of a + b: 20 percent maximum.

3.2.2 Pigment. Any combination of the pigments listed in Table II for any specific color shall make up the basic hiding pigmentation for that color. Hiding pigments shall be chemically pure and free from extenders. The titanium dioxide shall be rutile chalk resisting type conforming to type III of TT-P-442. Small amounts of other shading pigments may be used when necessary to match the color chips, provided these additional pigments have good color permanence. Extender pigments shall be siliceous matter or siliceous matter and barytes and shall not exceed the amount specified in Table III. The amount of barytes shall not exceed 20 percent of the extender content by weight. Calcium sulfate or carbonate shall not be employed alone or as a component part of any pigment.

TT-E-515A

TABLE II. Pigmentation

Color	Fed. Std. No. 595 Color No.	Pigmentation
Dull red	30109	Red or yellow iron oxide
Maroon	30111	Titanium dioxide, red iron oxide, carbon or lampblack
Field drab	30118	Red or yellow iron oxide, titanium dioxide, carbon or lampblack
Earth yellow	30257	Titanium dioxide, red or yellow iron oxide, carbon or lampblack
Sand	30277	Titanium dioxide, red or yellow iron oxide, carbon or lampblack
Red	31136	Toluidine red
Orange	32246	Chrome yellow, molybdate orange
Yellow	33538	Chrome yellow, yellow iron oxide
Light yellow	33711	Titanium dioxide, yellow iron oxide
Olive drab	34087	Red or yellow iron oxide, chrome yellow, titanium dioxide, carbon or lampblack
Medium green	34102	Chrome green, iron blue, red or yellow iron oxide, chrome yellow for green, carbon or lampblack
Green	34108	Chrome green, chrome yellow for green, iron blue
Blue drab	34158	Phthalocyanine blue, titanium dioxide, yellow iron oxide, chrome yellow, carbon or lampblack
Insignia blue	35044	Iron blue, titanium dioxide, carbon or lampblack
Medium blue	35109	Iron blue, titanium dioxide, yellow iron oxide, carbon or lampblack
Light blue	35193	Iron or phthalocyanine blue, titanium dioxide, chrome yellow
Slate	26132 ^{1/}	Titanium dioxide, yellow iron oxide, carbon or lampblack
Ocean gray	36176	Titanium dioxide, phthalocyanine blue, carbon or lampblack
Blue gray	36231	Titanium dioxide, phthalocyanine blue, carbon or lampblack
Black	37038	Black iron oxide, carbon or lampblack
Purple	37144	Titanium dioxide, thioindigold maroon, dichloro-iso-dibenzanthrone violet
White	37875	Titanium dioxide

^{1/}The gloss of color standard 26132 should be disregarded.

3.3 Quantitative requirements.

3.3.1 Specific quantitative requirements. Each color shall conform to its specific requirements in Table III when tested as specified in 4.3.

TABLE III. Specific quantitative requirements

Color Corresponding to Table II	Solids, percent by weight of enamel			Pigment, percent by weight of total pigment		Pigment volume percent of total solids	Contrast ratio
	Total solids	Pigment solids	Vehicle solids	Prime Pigment ^{1/}	Extender pigment		
	Min.	Min.	Max.	Min.	Max.	Max.	Min.
Dull red	58	36	40	19	38 (Fe ₂ O ₃)	60	0.98
Maroon	60	39	43	17	25 (Fe ₂ O ₃)	60	0.98
Field drab	58	36	40	19	30 (Fe ₂ O ₃)	65	0.98
Earth yellow	60	39	43	17	20 (Fe ₂ O ₃) 10 (TiO ₂)	65	0.98
Sand	60	39	43	17	22 (TiO ₂)	65	0.98
Red	53	30	34	19	---	70	0.92
Orange	60	39	43	17	20 (PbCrO ₄)	70	0.92
Yellow	60	39	43	17	37 (PbCrO ₄)	55	0.92
Light yellow	60	39	43	17	30 (TiO ₂)	65	0.92
Olive drab	60	39	43	17	30 (Fe ₂ O ₃) ^{2/}	65	0.98
Medium green	58	39	43	17	20 (Fe ₂ O ₃)	65	0.98
Green	60	36	40	21	25 (PbCrO ₄)	65	0.95
Blue drab	58	36	40	19	17 (TiO ₂)	75	0.98
Insignia blue	55	32	36	19	---	70	0.98
Medium blue	58	36	40	19	25 (TiO ₂)	65	0.98
Light blue	58	36	40	19	25 (TiO ₂)	70	0.98
Slate	58	36	40	19	30 (TiO ₂)	65	0.98
Ocean gray	58	36	40	19	25 (TiO ₂)	70	0.98
Blue gray	60	36	40	21	30 (TiO ₂)	65	0.98
Black	55	36	40	17	15 (Fe ₃ O ₄)	83	0.98
Purple	58	36	40	19	20 (TiO ₂)	70	0.98
White	60	39	43	17	47 (TiO ₂)	50	0.92

^{1/}On analysis compute prime pigment as indicated in parenthesis.

^{2/}Lead chromate (PbCrO₄) may be substituted on an equal weight basis.

TT-E-515A

3.3.2 General quantitative requirements. The enamel tested as in 4.2 shall comply with the requirements of Table IV.

TABLE IV. General quantitative requirements

Characteristics	Minimum	Maximum
Phthalic anhydride, percent by weight of vehicle solids	37	--
Oil acids, percent by weight of vehicle solids	30	--
Unsaponifiable, percent by weight of vehicle solids	--	5
Water, percent by weight of enamel	--	1.0
Coarse particles and skins, percent by weight of pigment	--	0.5
Specular gloss, 60°	--	6
Sheen, 85°	--	15
Directional reflectance, white only, percent	83	--
Flash point, Pensky-Martens Tester, degrees Fahrenheit	75	--
Fineness of grind	4	--
Viscosity:		
Package, Krebs-Stormer shearing rate - 200 RPM:		
Grams	125	175
Equivalent Krebs' Units (K.U.)	67	77
Reduced, No. 4 Ford cup, seconds	15	25
Drying time:		
Set to touch, minutes	--	6
Dry hard, minutes	--	10
After tack free, minutes	--	15
Full hardness, hours	--	--

3.4 Qualitative requirements.

3.4.1 Color. The enamel shall be furnished in the Fed. Std. No. 595 color number specified in the contract or purchase order (see 6.2). When tested as in 4.3.11 it shall acceptably match the standard color chip in Fed. Std. No. 595.

3.4.2 Condition in container. The enamel, tested as in 4.3.12, shall be free from grit, seeds, skins, or livering in a freshly opened full container and shall show no more pigment settling or caking than can be easily and completely reincorporated to a smooth homogeneous state.

3.4.3 Storage stability.

3.4.3.1 Partially full container. When tested as in 4.3.13.1, the enamel shall show no skinning after 48 hours. After aging for 7 days at 60°C. as in 4.3.13.1 the enamel shall show no livering, curdling, tough gummy sediment, nor hard caking. The enamel shall mix readily to a smooth homogeneous state and any skin formed shall be continuous and easily removed.

3.4.3.2 Full container. The enamel shall show no skinning, livering, curdling, hard caking, nor tough gummy sediment when tested as in 4.3.13.2. It shall remix readily to a smooth homogeneous state, shall have a maximum viscosity of 89 Krebs' Units and shall meet all other requirements of this specification.

3.4.4 Dilution stability. When tested as in 4.3.14 the enamel shall show no evidence of livering or curdling. The film shall show no seeding or other evidence of incompatibility.

3.4.5 Suspension properties. The enamel shall show no more than slight settling, no caking, and shall completely redisperse to a smooth homogeneous state when tested as in 4.3.15.

3.4.6 Brushing properties. The enamel, tested as in 4.3.16, shall brush satisfactorily in all respects and shall dry to a smooth, uniform film free from seeds, runs, sags or streaks.

3.4.7 Dipping properties. When tested as in 4.3.17, the enamel shall show satisfactory dipping properties and shall present a smooth appearance, free from sagging, running or excessive silking.

3.4.8 Spraying properties. The enamel, tested as in 4.3.18, 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 lustreless finish free from seediness.

3.4.9 Flexibility. A film of enamel tested as in 4.3.19 shall withstand bending without cracking or flaking.

3.4.10 Knife test. A film of enamel tested as in 4.3.20 shall adhere tightly and not flake, crack, or powder from the metal. The cut shall show beveled edges.

3.4.11 Adhesion. A film of enamel tested as in 4.3.21 shall show no removal of the coating by the adhesive tape beyond one-sixteenth inch on either side of the score line.

3.4.12 Water resistance. A film of enamel tested as in 4.3.22 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, adhesion and gloss from a panel prepared at the same time but not immersed. There shall be no change in color other than a slight fading.

TT-E-515A

3.4.13 Hydrocarbon resistance. A film of enamel tested as in 4.3.23 shall show no wrinkling or blistering immediately after removal of the panel from the fluid. 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, adhesion and gloss from a panel prepared at the same time but not immersed. A tendency for the red #31136 to become milky in appearance shall be disregarded. There shall be no change in color other than a slight fading.

3.4.14 Lacquer resistance. A film of enamel tested as in 4.3.24 shall withstand recoating with white lacquer after drying or aging for the stated time intervals. There shall be no blistering, wrinkling, film irregularities or other evidence of lifting. With the exception of red #31136, the film shall contain no bleeding pigments which will discolor the white lacquer.

3.4.15 Recoating. A film of enamel tested as in 4.3.25 shall not blister, wrinkle, or show other evidence of lifting when recoated with white enamel. With the exception of red (color number 31136) the film shall contain no bleeding pigments which will discolor the white enamel.

3.4.16 Accelerated weathering. A film of enamel tested as in 4.3.26 shall show no more than slight chalking (No. 8 Method 6411 of Fed. Test Method Std. No. 141) and a color change equivalent to a lightness index difference not exceeding 4 units.

3.4.17 Weather resistance. A film of enamel exposed as in 4.3.27 shall show no checking, cracking or appreciable film deterioration. There shall be no more than moderate chalking (No. 4 Method 6411 of Fed. Test Method Std. 141) of colors sand, light yellow, light blue, medium blue, slate, blue gray, ocean gray, white, purple and no more than light chalking (No. 6 Method 6411 of Fed. Test Method Std. No. 141) of all other colors. The film shall show no excessive change in value or 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.

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 the prescribed requirements.

4.1.1 Sampling and inspection. Sampling and inspection shall be performed in accordance with section 1000 of Fed. Test Method Std. No. 141.

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

- (a) Qualification.
- (b) Acceptance of individual lots.
- (c) Acceptance for use as component on end item.

4.2.1 Qualification tests. The qualification tests shall consist of tests for all requirements specified in section 3 (see 6.3).

4.2.2 Acceptance tests. Acceptance tests for acceptance of individual lots shall consist of tests for requirements specified in section 3 with the exception of storage stability (see 3.4.3 and 4.3.13) and weather resistance (see 3.4.17 and 4.3.27).

4.2.3 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:

- Phthalic anhydride
- Drying oil acids
- Gloss
- Fineness of grind
- Flexibility
- Knife test
- Water resistance
- Hydrocarbon resistance
- Lacquer resistance

4.3 Test methods.

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

4.3.2 The following tests shall be conducted in accordance with applicable methods of Fed. Test Method Std. No. 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.

TT-E-515A

TABLE V. Index

Item	Test Method		
	Applicable method in Fed. Test Method Std. No. 141	Paragraph of this specification giving further references	Paragraph of this specification giving requirements
Isolation of vehicle (super centrifuge)	4032	--	--
Benzol	5091	--	3.2.1.1
Chlorinated solvents	5132	--	3.2.1.1
Aromatic hydrocarbons	--	4.3.3.2	3.2.1.2
Olefinic and cyclo-olefinic compounds	--	4.3.3.3	3.2.1.2
Ketones	--	4.3.3.4	3.2.1.2
Total solids	4041	--	Tables I & II
Viscosity, Gardner tubes	4271	--	Table I
Color of transparent liquids	4248	--	Table I
Phthalic anhydride	7014	--	Tables I & IV
Unsaponifiable	7014	--	Tables I & IV
Oil acids	7014	--	Tables I & IV
Acid number	5072	--	Table I
Pigment solids	4022	--	Table III
Vehicle solids	4041	--	Table III
Pigment analysis	4021	4.3.4	Table I
Fe ₂ O ₃ - iron oxide	7141	4.3.4.1	Table III
Fe ₃ O ₄ - iron oxide	7141	4.3.4.2	Table III
TiO ₂ - titanium dioxide	7083	4.3.4.3	Table III
PbCrO ₄ - Lead chromate	7131	4.3.4.4	Table III
Other pigments	--	4.3.4.5	Table II
Extender pigment, total	5271	4.3.5.1	Table III
Extender pigment, analysis	7281	4.3.5.2	3.2.2
Pigment volume	4312	--	Table III
Hiding power (contrast ratio)	4122	4.3.6	Table III
Water	4082	--	Table IV
Coarse particles and skins	4092	--	Table IV
Specular gloss, 60°	6101	4.3.7	Table IV
Sheen, 85°	6103	4.3.8	Table IV
Directional reflectance	6121	--	Table IV
Flash point	4293	--	Table IV
Fineness of grind	4411	--	Table IV
Viscosity:	--	4.3.9	
Package	4281	4.3.9.1	Table IV
Reduced	4282	4.3.9.2	Table IV
Drying time:			
Set to touch	4061	--	Table IV
Dry hard	4061	--	Table IV
After tack free	4061 par 3.7.2	--	Table IV
Full hardness	4061	4.3.10	Table IV

TABLE V. Index (continued)

Item	Test Method		
	Applicable method in Fed. Test Method Std. No. 141	Paragraph of this specification giving further references	Paragraph of this specification giving requirements
Color	4250	4.3.11	3.4.1
Condition in container	3011	4.3.12	3.4.2
Storage stability	--	4.3.13	3.4.3
Partially full container	3021	4.3.13.1	3.4.3.1
Full container	3022	4.3.13.2	3.4.3.2
Dilution stability	4203	4.3.14	3.4.4
Suspension properties	--	4.3.15	3.4.5
Brushing properties	4321, 2141	4.3.16	3.4.6
Dipping properties	4341, 2121	4.3.17	3.4.7
Spraying properties	4331, 2131	4.3.18	3.4.8
Flexibility	6221	4.3.19	3.4.9
Knife test	6304	4.3.20	3.4.10
Adhesion	--	4.3.21	3.4.11
Water resistance	6011	4.3.22	3.4.12
Hydrocarbon resistance	6011	4.3.23	3.4.13
Lacquer resistance	6251	4.3.24	3.4.14
Recoating	6252	4.3.25	3.4.15
Accelerated weathering	6152, 6122	4.3.26	3.4.16
Weather resistance	6160	4.3.27	3.4.17

4.3.3 Solvent analysis for composition L.

4.3.3.1 Separation of volatile portion. Pour about 15 grams of the enamel into a 50 ml. distilling flask. Add 10 ml. of tricresyl phosphate and several anti-bumping stones or Berl saddles. Fit a release valve into the mouth of the flask and attach a delivery tube to the side arm, extending into a receiver. The receiver consists of a test tube (20 x 150 mm) with side arm for attaching to a vacuum pump. The glass delivery tube should reach 1-1/2 inches from the bottom of the tube. Immerse the receiver in a dry ice-acetone bath. Preheat a silicone oil bath to 180°C. Raise the oil bath until the oil reaches the sample level. Reduce the pressure slowly to 10 mm. of mercury. After all solvent has distilled, carefully release the vacuum using the valve that is connected to the distilling flask. Reserve the collected distillate for the aromatic solvent determination and the test for ketone, olefinic and cyclo-olefinic compounds.

TT-E-515A

4.3.3.2 Determination of aromatic hydrocarbons.

Apparatus: A gas chromatograph equipped with a thermal conductivity detector.

Column Preparation: Two lengths of 1/4-inch copper tubing, 6-ft. and 18-ft. long, are packed with 35% N,N-Bis(2-cyanoethyl) formamide on 60- to 80- mesh Chromosorb P.

Operating Conditions:	<u>6-ft.</u>	<u>18-ft.</u>
Detector cell temperature, °C.	300	300
Detector cell current, ma.	150	150
Injection port temperature, °C.	300	300
Helium flow at exit, cc/minute	175	110
Column temperature, °C.	125	70

4.3.3.2.1 Aromatic and oxygenated solvents - procedure A. Install the 6-ft. column and follow the operating conditions described above. Inject about 3 microliters of the isolated distillate and scan the chromatogram. The aliphatic solvents will emerge within 1 minute and the complete chromatogram should develop in about 5 minutes. From the position of the peaks observed on the chromatogram, select an internal standard that will be free of interference, such as cyclopentanol or cyclohexanol. Add 0.6 ml. of internal standard to 3 ml. of the distillate, analyze according to the above procedure. Peaks emerging after 1 minute are aromatic solvents along with any oxygenated solvents that may be present. Calculate the percent of aromatic and oxygenated solvents as follows:

$$\% \text{ aromatic and oxygenated solvents, v/v} = \frac{20* \times A}{1.02** \times B}$$

where, A = area of aromatic and oxygenated solvents

B = area of internal standard

* is percent of internal standard added

** is correction factor if cyclopentanol is used. If another internal standard is used calibrate to determine the correction factor.

NOTE: If the above determination exceeds 8 percent, continue with the following procedure:

4.3.3.2.2 Total aromatic content - procedure B. Place 5 ml. of the distillate in a 10-ml. glass stoppered graduate. Add 5 ml. of 85 percent sulfuric acid slowly while the graduate is being cooled with tap water. After the acid has been added, shake vigorously for 2 minutes then allow the layers to separate. Remove as much of the top layer as possible and wash with distilled water. Carefully pipet 3 ml. of the washed solvent into a small flask followed by 0.6 ml. of the internal standard. Mix and analyze according to procedure A. Calculate the percent of aromatics after acid treatment in the same manner as in procedure A and the percent of total aromatic solvents as follows:

$$\% \text{ total aromatic solvents, v/v} = \frac{B \times (100 - A)}{100 - B}$$

where, A = percent of aromatic and oxygenated solvents from procedure A.
B = percent of aromatic solvents after acid treatment.

NOTE: If the total aromatic content of the solvent is between 8 percent and 20 percent, continue with the following procedure:

4.3.3.2.3 Toluene and ethylbenzene - procedure C. Install the 18-ft. column and follow the operating conditions described for that column. Add 0.3 ml. of high purity benzene to the 3 ml. sample used in procedure A. If the results of procedures A and B indicated the presence of oxygenated solvents, treat this sample with 85 percent sulfuric acid (use 3 ml. acid) as described in procedure B. Inject about 3 microliters of sample and allow the chromatograph to develop until all of the xylene isomers appear. Purge the column by raising the column temperature to 120°C. After the high boiling materials emerge reset the column temperature to 70°C. Calculate the percent of toluene and ethylbenzene as follows:

$$\% \text{ toluene, v/v} = \frac{(\text{area of toluene peak})(1.017)* (10)**}{(\text{area of benzene peak})}$$

$$\% \text{ ethylbenzene, v/v} = \frac{(\text{area of ethylbenzene peak})(1.054)* (10)**}{(\text{area of benzene peak})}$$

where, * is the correction factor for the detector response.
** is the percentage of internal standard added.

NOTE: Sensitivity of the instrument should be adjusted to keep peaks from running off the scale. Appropriate corrections must be made for changes in sensitivity when computing the peak areas.

TT-E-515A

4.3.3.3 Test for olefinic or cyclo-olefinic compounds. Take 2 test tubes and place 2 drops of the distillate in each. Dissolve the first sample in 1 ml. of carbon tetrachloride and add 1 drop of 1 percent bromine in carbon tetrachloride. Shake and allow to set for 5 minutes. A positive test is indicated by the complete absence of yellow color when observed against a white background. Dissolve the second sample in 1 ml. of acetone and add 1 drop of 1 percent permanganate solution (1 gram of potassium permanganate crystals in 95 mls. of acetone and 5 mls. of water). Shake and allow to set for 2 minutes. A positive test is indicated by the decolorization of the purple solution. The solvent is considered to fail the test for olefinic and cyclo-olefinic compounds if either of the above tests is positive (see 3.2.1.2 and 6.7).

4.3.3.4 Test for ketones.

4.3.3.4.1 Reagent. Two grams of 2,4-dinitrophenylhydrazine + 4 mls. of concentrated sulfuric acid + 30 mls. methanol (add slowly) + 10 mls. water.

4.3.3.4.2 Procedure. Pipette 1 ml. of reagent into a 20 x 170 mm. test tube. Add 10 drops of distillate (see 4.3.3.1) and shake for 30 seconds. A yellow precipitate or cloud in the reagent layer indicates the presence of ketones. Run a blank using one milliliter of reagent and 10 drops of mineral spirits.

4.3.4 Analysis of pigment. Extract the pigment as in method 4021 of Fed. Test Method Std. No. 141.

4.3.4.1 Iron oxide (Fe_2O_3) content. Determine the iron oxide (as Fe_2O_3) content on the extracted pigment in accordance with method 7141 of Fed. Test Method Std. No. 141.

4.3.4.2 Iron oxide (Fe_3O_4) content. Determine the iron oxide (as Fe_3O_4) content on the extracted pigment in accordance with method 7141 of Fed. Test Method Std. No. 141 and calculate the total iron to Fe_3O_4 .

4.3.4.3 Titanium dioxide (TiO_2) content. Determine the titanium dioxide (TiO_2) content on the extracted pigment in accordance with method 7083 of Fed. Test Method Std. No. 141.

4.3.4.4 Lead chromate (PbCrO_4) content. Determine the lead chromate (PbCrO_4) content on the extracted pigment in accordance with method 7131 of Fed. Test Method Std. No. 141.

4.3.4.5 Other permissible pigments. Make appropriate qualitative and quantitative tests on the extracted pigment to determine if permissible pigments were used in formulating the different colors of enamel.

4.3.5 Extender pigment.

4.3.5.1 Total extender pigment content. Determine matter insoluble in acid in the extracted pigment by method 5271 of Fed. Test Method Std. No. 141.

4.3.5.2 Extender pigment analysis. Determine barium sulfate, siliceous material, and calcium (sulfate or carbonate) by the applicable portions of method 7281 of Fed. Method Std. No. 141.

4.3.6 Hiding power (contrast ratio). Determine the contrast ratio in accordance with method 4122 of Fed. Test Method Std. No. 141. For red (31136), orange (32246), yellow (33538), light yellow (33711), and white (37875) use a film applicator that will deposit a 3 inch wide film with a dry film thickness of 0.0015 inch maximum and for all other colors a dry film thickness of 0.0010 inch maximum. Air dry for 72 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 III.

4.3.7 Specular gloss, 60°. Draw down the package material using a 0.002 inch (0.004-inch gap clearance) film applicator. Measure the gloss as in method 6101 of Fed. Test Method Std. No. 141 and check for compliance with Table IV.

4.3.8 Sheen, 85°. Determine 85° sheen as in method 6103 of Fed. Test Method Std. No. 141 on the draw down prepared as in 4.3.7 and check for compliance with Table IV.

4.3.9 Viscosity.

4.3.9.1 Package. Proceed as in method 4281 of Fed. Test Method Std. No. 141 except that the method of mixing shall be to agitate the can for 3 minutes on a paint shaker^{1/}. Check for compliance with Table IV.

4.3.9.2 Reduced. Reduce four parts by volume of the packaged enamel with one part by volume of thinner conforming to TT-T-306. Except that thinner used with composition L shall conform with Table VI. Check for compliance with Table IV.

TABLE VI. Thinner for Composition L

Ingredient	Percent by weight
VMP naphtha (8% max. aromatic)	65
n-Butyl alcohol	20
Toluene	15

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

TT-E-515A

4.3.10 Full hardness. Determine full hardness in accordance with method 4061 except the enamel shall be drawn down with a 0.002 inch (0.004-inch gap clearance) film applicator on a 4 by 12 inch steel panel that has been phosphoric acid etched as in method 2011, procedure B of Fed. Test Method Std. No. 141. Check for compliance with Table IV.

4.3.11 Color. In accordance with method 4250 of Fed. Test Method Std. No. 141, match the specified color chip of Fed. Std. No. 595 with the pigmented coating on the white carrara glass panel prepared for the hiding power test (4.3.6). Observe for compliance with 3.4.1.

4.3.12 Condition in container. Determine package condition for acceptance testing in accordance with method 3011 of Fed. Test Method Std. No. 141. For qualification testing determine pigment settling or caking as follows: Proceed as in method 3011 of Fed. Test Method Std. No. 141, but do not stir. Reseal and then agitate the can for 3 minutes on a paint shaker. On re-examination of the contents, the disclosure of any gel bodies or undispersed pigment indicates unsatisfactory settling properties. Observe for compliance with 3.4.2.

4.3.13 Storage stability.

4.3.13.1 Partially full container. Determine 48 hour skinning in accordance with method 3021 of Fed. Test Method Std. No. 141 and observe for compliance with 3.4.3.1. Reseal and age for 7 days at 60°C. and observe for compliance with 3.4.3.1.

4.3.13.2 Full container. In accordance with method 3022 of Fed. Test Method Std. No. 141, allow a full standard quart can of the packaged enamel to stand undisturbed for six months and then examine the contents. Evaluate pigment settling or caking as in 4.3.12, but agitate the can for 5 minutes on the paint shaker prior to re-examination. Determine viscosity and examine for compliance with 3.4.3.2.

4.3.14 Dilution stability. Reduce one volume of packaged enamel with one volume of thinner conforming to TT-T-306 by slowly adding the thinner to the enamel with constant stirring. For composition L thinner shall conform to Table VI. After standing 24 hours examine for compliance with 3.4.4. Remix and using a 0.0005 inch (0.0010-inch gap clearance) film applicator, draw down a film of the mixture on clear plate glass. Examine by transmitted light while the film is wet and after drying for compliance with 3.4.4.

4.3.15 Suspension properties. Reduce four parts by volume of enamel with one part by volume of thinner conforming to TT-T-306. For composition L thinner shall conform to Table VI. Place 6 ounces of the reduced enamel in an 8-ounce glass jar. Allow the stoppered jar to remain undisturbed for 24 hours and then place the unopened jar on a paint shaker as in 4.3.12 and agitate the contents for 20 seconds. Re-examine the material for any evidence of nonhomogeneity or undispersed pigment. Observe for compliance with 3.4.5.

4.3.16 Brushing properties. Apply the enamel to a 4 by 12 inch steel panel using a 1-1/2 inch brush and observe for brushing properties in accordance with method 4321 of Fed. Test Method Std. No. 141 for compliance with 3.4.6.

4.3.17 Dipping properties. Reduce four parts by volume of enamel with one part by volume of thinner conforming to TT-T-306. For composition L thinner shall conform to Table VI. Test the dipping properties of the thinned enamel in accordance with method 4341 of Fed. Test Method Std. No. 141 and observe for compliance with 3.4.7.

4.3.18 Spraying properties. Reduce four parts by volume of enamel with one part by volume of thinner conforming to TT-T-306. For composition L thinner shall conform to Table VI. Spray on steel panel to give a dry film thickness between 0.0010 and 0.0012 inch and observe for spraying properties in accordance with method 4331 of Fed. Test Method Std. No. 141 and observe for compliance with 3.4.8. For referee test use automatic application per method 2131 of Fed. Test Method Std. No. 141.

4.3.19 Flexibility. Determine flexibility in accordance with method 6221 of Fed. Test Method Std. No. 141. Apply a 2-inch wide film of enamel with a film applicator that will give a dry film thickness of 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 naphtha ethylene glycol monoethyl ether mixture. The panel shall be prepared from new cold rolled carbon steel rust-free 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 the enamel in a horizontal position for 1/2 hour and then bake for 24 hours at $105^\circ \pm 2^\circ\text{C}$. ($221^\circ \pm 4^\circ\text{F}$.). Condition the panel for 1/2 hour under referee conditions. Bend over a 1/4 inch mandrel. Examine the coating for cracks over the area of the bend in a strong light at a 7-diameter magnification for compliance with 3.4.9.

4.3.20 Knife test. Perform the knife test in accordance with method 6304 of Fed. Test Method Std. No. 141 using a flat portion of the baked panel from the flexibility test. Observe for compliance with 3.4.10.

4.3.21 Adhesion, tape test.

4.3.21.1 Panel preparation. Using a 0.0020 inch (0.0040 inch gap clearance) film applicator, draw down a 2-inch wide film of the enamel on a steel panel, solvent cleaned and phosphoric acid etched in accordance with procedure B, method 2011 of Fed. Test Method Std. No. 141.

TT-E-515A

4.3.21.2 Procedure. Air dry the specimen for 1 hour under referee conditions and 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 adhesive tape (3/4 inch wide) conforming to PPP-T-60, Type IV. The tape shall be pressed in firm contact with the film and shall extend for approximately one inch on each side of the score line. All air bubbles may be rolled out by firm pressure of the thumb. Allow approximately 10 seconds for the test area to return to room temperature. Grasp a free end of the tape, and at a rapid speed, strip it from the specimen by pulling the tape back upon itself at an angle of 180°. Observe the specimen for compliance with 3.4.11.

4.3.22 Water resistance. Prepare two panels in accordance with 4.3.21.1 and air dry for 72 hours. Coat all exposed, uncoated metal surfaces with wax or other suitable coating and immerse one of the panels for 18 hours in distilled water at $23^{\circ} + 1^{\circ}\text{C}$. ($73.4^{\circ} + 2^{\circ}\text{F}$.) in accordance with method 6011 of Fed. Test Method Std. No. 141. At the end of the test period remove the panel from the water and inspect for compliance with the requirements of 3.4.12.

4.3.23 Hydrocarbon resistance. Prepare two panels in accordance with 4.3.21.1 and allow to air dry for 72 hours. Immerse one panel in a hydrocarbon fluid conforming to TT-S-735, Type III at $23^{\circ} + 1^{\circ}\text{C}$. ($73.4^{\circ} + 2^{\circ}\text{F}$.) for 4 hours in accordance with method 6011 of Fed. Test Method Std. No. 141. At the end of the test period remove the panel from the hydrocarbon fluid and examine for compliance with the requirements of 3.4.13. Any gum line above the level of the test fluid should be disregarded.

4.3.24 Lacquer resistance. Prepare three panels in accordance with 4.3.21.1 and air dry under referee conditions for 1, 24, and 96 hours respectively. At the end of its drying period immerse each panel for five seconds to a depth of 2-1/2 inches in a white test lacquer (Table VII) which has been reduced for spray by the addition of one part by volume of lacquer thinner conforming to TT-T-266 to 2 parts by volume of the test lacquer. Allow to drain and dry in a vertical position. Examine after 10 minutes and 24 hours for compliance with 3.4.14.

TABLE VII. Test Lacquer

Ingredient	Percent by weight
White dispersion ^{1/}	17
Cellulose nitrate RS 1/2 second (65% in ethyl alcohol)	10
Alkyd resin (65% in xylene) ^{2/}	13
Dioctyl phthalate	3
Butyl acetate	26
Butyl cellosolve	9
Butyl alcohol	8
Xylene	14

^{1/}Shall consist of the following:

Rutile titanium dioxide	60.0
RS 1/2 second nitrocellulose	8.0
Ethyl alcohol	3.5
Ethyl acetate	16.0
Toluene	12.5

^{2/}Shall be a nondrying type alkyd containing castor oil and phthalic anhydride as follows:

Phthalic anhydride	35
Castor oil acids	45

4.3.25 Recoating. Prepare two panels in accordance with 4.3.21.1 and air dry for 24 and 96 hours respectively. At the end of its drying period immerse each panel to a depth of 2-1/2 inches in a white enamel conforming to this specification which has been reduced with one part by volume of thinner conforming to TT-T-306 to four parts by volume of package material. At the end of 5 seconds remove the panel, dry in a vertical position and examine for compliance with 3.4.15.

4.3.26 Accelerated weathering. Prepare a test panel of enamel as specified in 4.3.19 and air dry for 72 hours. Measure the directional reflectance and expose the panel for 168 hours to accelerated weathering in accordance with method 6152 of Fed. Test Method Std. No. 141 using a twin arc apparatus. Examine the exposed panel for chalking by rubbing with a piece of velvet or cheesecloth wrapped around the finger. Using moderate pressure, draw the cloth across the width of the panel in two different directions. Measure the directional reflectance (method 6121) on an unrubbed area of the exposed panel and determine the amount of color change expressed as lightness index difference (ΔL), using method 6122 of Fed. Test Method Std. No. 141. Check accelerated weathering test results for compliance with 3.4.16.

TT-E-515A

4.3.27 Weather resistance. Two 4- by 12-inch steel panels solvent cleaned and phosphoric acid etched in accordance with procedure B method 2011 of Fer Test Method Std. No. 141 shall be sprayed with a coat of primer conforming to TT-P-664 to a uniform dry film thickness between 0.0008 and 0.0010 inch. Air dry 4 hours and then spray with a coat of enamel having a uniform dry film thickness between 0.0010 and 0.0012 inch. Air dry for 96 hours and place on outdoor exposure for 18 months at an angle of 45° South in the climate of Washington, D. C. At the conclusion of the exposure period inspect the panels for compliance with 3.4.17. Determine chalking as in 4.3.26. Wash the panels with a warm soap solution using a soft sponge or cloth; rinse, dry, and examine for color change.

4.3.28 Packaging, packing, and marking. The enamel shall be inspected for compliance with the packaging, packing, and marking requirements of section 5.

5. PREPARATION FOR DELIVERY

5.1 Packaging, packing and marking. The enamel shall be packaged, packed, and marked in accordance with TT-P-143. The level of packaging shall be A or C, and the level of packing shall be A, B, or C, as specified (see 6.2). The enamel shall be furnished in 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).

6. NOTES

6.1 Intended use. The enamel covered by this specification is intended for use as a fast drying finish coat for equipment.

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

- (a) Title, number, and date of this specification.
- (b) Composition required (1.2).
- (c) Color and color number (3.4.1).
- (d) Size of container required (Section 5).
- (e) Level of packaging and level of packing (Section 5).

TT-E-515A

6.3 Qualification. With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. The attention of suppliers 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. The activity responsible for the Qualified Products List is the U. S. Army Aberdeen Research & Development Center, Coating and Chemical Laboratory, Aberdeen Proving Ground, Maryland 21005, and information pertaining to qualification of products may be obtained from that activity.

6.4 The olive drab enamel is contemplated to be comparable in performance to the following approximate composition by weight:

Olive Drab Enamel

148 lbs.	Synthetic yellow iron oxide
5 lbs	Carbon black
264 lbs.	Acicular talc
200 lbs.	Resin modified 39% phthalic anhydride alkyd resin (U to Y at 50% solids in xylene)
178 lbs.	Xylene

Grind 18 to 20 hours in a pebble mill and reduce as follows:

200 lbs.	Resin modified 39% phthalic anhydride alkyd resin (U to Y at 50% solids in xylene)
3 lbs	Lead naphthenate drier
1-1/2 lbs.	Cobalt naphthenate drier
1 lbs.	Anti-skinning agent

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

6.6 Composition L enamels should be specified for use in areas with regulations controlling the emission of solvents into the atmosphere.

6.7 The test for olefinic and cyclo-olefinic compounds will not be positive for solvents containing less than 1 percent of these compounds.

MILITARY CUSTODIANS:

Army - MR
Air Force - 84

Review activities:

Army - GL

User activities:

Army - MI, CE
Navy - OS

Preparing activity:

Army - MR

CIVIL AGENCY INTEREST:

GSA

Orders for this publication are to be placed with General Services Administration, acting as an agent for the Superintendent of Documents. See section 2 of this specification to obtain extra copies and other documents referenced herein. Price 20 cents each.