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UNITED STATES GOVERNMENT SPECIFICATION FOR
WHITE PAINT AND TINTED PAINTS MADE ON A
WHITE BASE, SEMIPASTE AND READY MIXED.¹

FEDERAL SPECIFICATIONS BOARD.

STANDARD SPECIFICATION NO. 10.

This Specification was officially adopted by the Federal Specifications Board on February 3, 1922, for the use of the Departments and Independent Establishments of the Government in the purchase of materials covered by it.

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1. GENERAL.

White paint and tinted paints made on a white base may be ordered either in the form of semipaste pigment ground in linseed oil or of ready-mixed paint.

The semipaste shall be purchased by net weight, the ready-mixed paint either by weight or volume (231 cubic inches to the gallon).

(a) PIGMENT.—The pigment shall be composed of:

	Maximum.	Minimum.
	Per cent.	Per cent.
White lead (basic carbonate, basic sulphate, or a mixture thereof)	70	45
Zinc oxide (ZnO)	55	30
White mineral pigments, containing no lead or zinc compounds, pure tinting colors, or any mixture thereof	15	0

¹It is believed that this specification admits practically all high-grade prepared paints generally available in the United States, and which are therefore obtainable without requiring manufacturers to make up special lots. On large contracts for which paint will be specially made, the purchaser may require the bidder to submit the formula of the paint he proposes to furnish as conforming to the specifications.

In no case shall the sum of the basic lead carbonate, basic lead sulphate, and zinc oxide be less than 85 per cent. The lead and zinc pigments may be introduced in the form of any mixture preferred of basic carbonate white lead, basic sulphate white lead, zinc oxide, or leaded zinc, provided the above requirements as to composition are met. The total lead dissolved by dilute acetic acid and hot acid ammonium acetate, weighed as lead sulphate, and this weight multiplied by the factor 0.883 shall be considered white lead. (It is not possible to determine the amount of lead carbonate and lead sulphate when carbonates or sulphates of other metals such as calcium are present. Also neither basic lead carbonate nor basic lead sulphate are definite compounds. The factor to convert PbSO_4 to $(\text{PbCO}_3)_2 \text{Pb}(\text{OH})_2$ is 0.854, to convert PbSO_4 to PbSO_4PbO is 0.868, and to convert PbSO_4 to $(\text{PbSO}_4)_2 \text{PbO}$ is 0.913. The arbitrary factor used under this specification is the mean of the largest and smallest of these three factors.

(b) LIQUID.—The liquid in semipaste paint shall be entirely pure raw or refined linseed oil; in ready-mixed paint it shall contain not less than 90 per cent pure raw linseed oil, the balance to be combined drier and thinner. The thinner shall be turpentine, volatile mineral spirits, or a mixture thereof.

(c) SEMIPASTE.—Semipaste shall be made by thoroughly grinding the pigment with pure raw or refined linseed oil.

The semipaste as received and three months thereafter shall be not caked in the container and shall break up readily in linseed oil to form a smooth paint of brushing consistency. It shall mix readily with linseed oil, turpentine, or volatile mineral spirits, or any combination of these substances, in all proportions without curdling. The color and hiding power when specified shall be equal to that of a sample mutually agreed upon by buyer and seller. The weight per gallon shall be not less than 19.0 pounds. The paste shall consist of:

	Maximum.	Minimum.
	Per cent.	Per cent.
Pigment	77	73
Linseed oil	27	23
Moisture and other volatile matter	0.7
Coarse particles and "skins" (total residue retained on No. 325 screen based on pigment)	2.0

(d) READY-MIXED PAINT.—Ready-mixed paints shall be well ground, shall not settle badly or cake in the container, shall be readily broken up with a paddle to a smooth uniform paint of good

brushing consistency, and shall dry within 18 hours to a full oil gloss, without streaking, running, or sagging. The color and hiding power when specified shall be equal to those of a sample mutually agreed upon by buyer and seller. The weight per gallon shall be not less than 15¾ pounds. The paint shall consist of:

	Maximum.	Minimum.
	Per cent.	Per cent.
Pigment.....	66	62
Liquid (containing at least 90 per cent linseed oil).....	38	34
Water.....	0.5
Coarse particles and "skins" (total residue retained on No. 325 screen based on pigment).....	2.0

NOTE.—Deliveries will, in general, be sampled and tested by the following methods, but the purchaser reserves the right to use any additional available information to ascertain whether the material meets the specification.

2. SAMPLING.

It is mutually agreed by buyer and seller that a single package out of each lot of not more than 1,000 packages shall be taken as representative of the whole. Whenever possible an original unopened container shall be sent to the laboratory, and when this is for any reason not done, the inspector shall determine by thorough testing with a paddle or spatula whether the material meets the requirement regarding caking in the container. He shall then thoroughly mix the contents of the container and draw a sample of not less than 5 pounds of the thoroughly mixed paint, place it in a clean, dry metal or glass container, which must be filled with the sample, closed with a tight cover, sealed, marked, and sent to the laboratory for test with the inspector's report on caking in container.

When requested, a duplicate sample may be taken from the same package and delivered to the seller, and the inspector may take a third sample to hold for test in case of dispute.

3. LABORATORY EXAMINATION—SEMIPASTE.

(a) **CAKING IN CONTAINER.**—When an original package is received in the laboratory it shall be weighed, opened, and stirred with a stiff spatula or paddle. The paste must be no more difficult to break up than a normal good grade of semipaste paint. The semipaste shall finally be thoroughly mixed, removed from the container, and the container wiped clean and weighed. This weight subtracted from the weight of the original package gives the net weight of the contents. A portion of thoroughly mixed

semipaste shall be placed in a clean container and the portions for the remaining tests promptly weighed out.

(b) COLOR.—Place some of the paint on a clean, clear glass plate. Place some of the standard agreed upon beside the sample on the plate, turn the glass over, and compare the colors.

(c) WEIGHT PER GALLON.—From the weight of a known volume of the paste calculate the specific gravity, which multiplied by 8.33 gives the weight in pounds per gallon. Any suitable container of known volume may be used for the purpose, but a short cylinder of heavy glass with rounded bottom about 75 mm high and having a capacity of from 125 to 175 cc (a glass cap to keep dust from reagent bottle stopper) is a convenient apparatus for the purpose. The capacity of this vessel is determined to within 1 cc. The paste is packed into it until completely full, the top leveled off smooth with a spatula, and weighed to ± 0.5 g. Subtract the weight of the empty container and divide the remainder by the number of cubic centimeters representing the capacity of the container. The quotient is the specific gravity, which can be thus determined within ± 2 in the second decimal place.

(d) MIXING WITH LINSEED OIL.—One hundred grams of the paste shall be placed in a cup, 18 cc linseed oil added slowly with careful stirring and mixing with a spatula or paddle. The resulting mixture must be smooth and of good brushing consistency.

(e) MOISTURE AND OTHER VOLATILE MATTER.—Weigh accurately from 3 to 5 g of the paste into a tared flat-bottomed dish about 5 cm in diameter, spreading the paste over the bottom. Heat at 105 to 110° C. for one hour, cool, and weigh. Calculate loss in weight as percentage of moisture and volatile matter.

(f) PERCENTAGE OF PIGMENT.—Weigh accurately about 15 g of the paste into a weighed centrifuge tube. Add 20 to 30 cc of "extraction mixture" (see reagents), mix thoroughly with a glass rod, wash the rod with more of the extraction mixture, and add sufficient of the reagent to make a total of 60 cc in the tube. Place the tube in the container of a centrifuge, surround with water, and counterbalance the container of the opposite arm with a similar tube or a tube with water. Whirl at a moderate speed until well settled. Decant the clear supernatant liquid. Repeat the extraction twice with 40 cc of extraction mixture and once with 40 cc of ether. After drawing off the ether, set the tube in a beaker of water at about 80° C. or on top of a warm oven for 10 minutes, then in an oven at 110 to 115° C. for two hours.

Cool, weigh, and calculate the percentage of pigment. Grind the pigment to a fine powder, pass through a No. 80 screen to remove any skins, and preserve in a stoppered bottle.

(g) PREPARATION OF FATTY ACIDS.—To about 25 g of the paste in a porcelain casserole, add 15 cc of aqueous sodium hydroxide (see reagents) and 75 cc of ethyl alcohol mix and heat uncovered on a steam bath until saponification is complete (about one hour). Add 100 cc of water, boil, add an excess of sulphuric acid of specific gravity 1.2 (8 to 10 cc will usually suffice), boil, stir, and transfer to a separatory funnel to which some water has been previously added. Draw off as much as possible of the acid aqueous layer and lead sulphate precipitate, wash once with water, then add 50 cc of water and 50 cc of ether. Shake very gently with a whirling motion to dissolve the fatty acids in the ether, but not so violently as to form an emulsion. Draw off the aqueous layer and wash the ether layer with one 15 cc portion of water and then with 5 cc portions of water until free from sulphuric acid. Then draw off the water layer completely. Transfer the ether solution to a dry flask and add 25 to 50 g anhydrous sodium sulphate. Stopper the flask and let stand with occasional shaking at a temperature below 25° C. until the water is completely removed from the ether solution, which will be shown by the solution becoming perfectly clear above the solid sodium sulphate. Decant this clear solution, if necessary through a dry filter paper, into a dry 100 cc Erlenmeyer flask. Pass a rapid current of dry air (pass through a CaCl₂ tower) into the mouth of the Erlenmeyer flask and heat to a temperature below 75° C. on a dry hot plate until the ether is entirely driven off.

NOTE.—It is important to follow all of the details, since ether generally contains alcohol and after washing with water always contains water. It is very difficult to remove water and alcohol by evaporation from fatty acids, but the washing of the ether solution and subsequent drying with anhydrous sodium sulphate removes both water and alcohol. Ether, in the absence of water and alcohol, is easily removed from fatty acids by gentle heat.

The fatty acids prepared as above should be kept in a stoppered flask and examined at once.

(h) TEST FOR MINERAL OIL AND OTHER UNSAPONIFIABLE MATTER.—Place 10 drops of the fatty acid (g) in a 50 cc test tube, add 5 cc of alcoholic soda (see reagents), boil vigorously for five minutes, add 40 cc of water, and mix; a clear solution indicates that not more than traces of unsaponifiable matter are present. If the solution is not clear, the oil is not pure linseed oil.

(i) IODINE NUMBER OF FATTY ACIDS.—Place a small quantity of the fatty acids (*g*) in a small weighing burette or beaker. Weigh accurately. Transfer by dropping about 0.15 g (0.10 to 0.20 g) into a 500 cc bottle having a well-ground glass stopper, or an Erlenmeyer flask having a specially flanged neck for the iodine test. Reweigh the burette or beaker and determine amount of sample used. Add 10 cc of chloroform. Whirl the bottle to dissolve the sample. Add 10 cc of chloroform to two empty bottles like that used for the sample. Add to each bottle 25 cc of the Hanus solution (see reagents) and let stand with occasional shaking for one-half hour. Add 10 cc of the 15 per cent potassium iodide solution and 100 cc of water, and titrate with standard sodium thiosulphate using starch as indicator. The titrations on the two blank tests should agree within 0.1 cc. From the difference between the average of the blank titrations and the titration on the sample and the iodine value of the thiosulphate solution, calculate the iodine number of the sample tested. (Iodine number is centigrams of iodine to 1 g of sample.) If the iodine number is less than 170, the oil does not meet the specification.

(j) COARSE PARTICLES AND SKINS.—Dry in an oven at 105 to 110° C. a No. 325 screen, cool, and weigh accurately. Weigh an amount of semipaste containing 10 g of pigment (see 3 (*f*)), add 100 cc of kerosene, mix thoroughly, and wash with kerosene through the screen, breaking up all lumps, but not grinding. After washing with kerosene until all but the particles too coarse to pass the screen have been washed through, wash all kerosene from the screen with ether or petroleum ether, heat the screen for one hour at 105 to 110° C., cool, and weigh.

4. ANALYSIS OF PIGMENT.

(a) QUALITATIVE ANALYSIS.—A complete qualitative analysis following the well-established methods is always advisable, but the work may be usually very much shortened by adding acetic acid slowly to the pigment until all carbonate is decomposed (noting whether any hydrogen sulphide is evolved), then adding a large excess of acid ammonium acetate, boiling, filtering, and testing the filtrate for metals other than lead and zinc (especially calcium and barium). The absence of calcium in this filtrate indicates that the extending pigments contain no calcium carbonate or calcium sulphate; the absence of barium indicates that the extending pigments contain no barium carbonate. Test another portion

of pigment with hydrochloric acid (1:1). No odor of hydrogen sulphide should develop.

(b) **WHITE LEAD.**—Weigh accurately about 1 g of the pigment, transfer to a 250 cc beaker, moisten with a few drops of alcohol, add slowly dilute (about 20 per cent) acetic acid until all carbonate is decomposed (no further effervescence), then add 50 cc of acid ammonium acetate solution (see reagents), and boil for two minutes. Decant through a weighed Gooch crucible, leaving any undecomposed matter in the beaker. Wash the Gooch crucible with a small amount (about 20 cc) of hot water. To the residue in the beaker add 50 cc of the acid ammonium acetate solution and boil two minutes. Filter through the same Gooch crucible, transferring the insoluble matter to the crucible, and wash thoroughly with hot water. Dry the crucible at 105 to 120° C., cool, and weigh. In cases where siliceous material was used as the white extending pigments, the material retained on the Gooch crucible will approximate the amount of white extending and tinting pigments.

Unite the filtrates and pass in a stream of hydrogen sulphide to complete precipitation; let the mixed sulphides of lead and zinc settle, filter on paper, wash with water containing hydrogen sulphide, dissolve the sulphides in hot nitric acid (1:3), and determine lead as sulphate in the usual manner, weighing as PbSO_4 . Multiply lead sulphate weight by the factor 0.883 and report as white lead.

(c) **ZINC OXIDE.**—Weigh accurately about 1 g of the pigment, transfer to a 400 cc beaker, add 30 cc of hydrochloric acid (1:2), boil for two or three minutes, add 200 cc of water and a small piece of litmus paper; add strong ammonia until slightly alkaline, render just acid with hydrochloric acid, then add 3 cc of strong hydrochloric acid, heat nearly to boiling, and titrate with standard ferrocyanide as in standardizing that solution (see reagents). Calculate total zinc as zinc oxide.

(d) *Calculations.*—Add the percentage of white lead (see 4(b)), zinc oxide (see 4(c)), and subtract from 100; the remainder is reported as extending and tinting pigments.

5. LABORATORY EXAMINATION—MIXED PAINT.

(a) **CAKING IN CONTAINER.**—Follow the procedure outlined in 3(a), noting that the paint should be no more difficult to break up than a good grade of mixed paint.

(b) COLOR.—Follow the procedure outlined in 3(b).

(c) WEIGHT PER GALLON.—Weigh a clean, dry, 100 cc graduated flask. Fill to the mark with the thoroughly mixed paint and weigh again. The increase in weight expressed in grams, divided by 100, gives the specific gravity, which multiplied by 8.33 gives the weight in pounds per gallon.

(d) BRUSHING PROPERTIES AND TIME OF DRYING.—Brush the well-mixed paint on a suitable panel, which may be ground glass, steel, or well-filled wood. Note whether the paint works satisfactorily under the brush. Place the panel in a vertical position in a well-ventilated room and let stand for 18 hours. The paint should be dry and free from streaks.

(e) WATER.—Mix 100 g of the paint in a 300 cc flask with 75 cc of toluol. Connect with a condenser and distill until about 50 cc of distillate has been collected in a graduate. The temperature in the flask should be then about 105 to 110° C. The number of cubic centimeters of water collecting under the toluol in the receiver is the percentage of water in the paint.

(f) VOLATILE THINNER.—Follow the procedure outlined in 3(e). Correct the result for any water found (see 5(e)) and report the remainder as volatile thinner.

(g) PERCENTAGE OF PIGMENT.—Follow the procedure outlined in 3(f).

(h) TESTING NONVOLATILE VEHICLE.—Follow the procedure outlined in 3(g), 3(h), and 3(i), except that in the preparation of the fatty acids the mixture of paint and alkali is heated on the steam bath until all volatile thinner is driven off.

(i) COARSE PARTICLES AND SKINS.—Follow the procedure outlined in 3(j).

(j) TESTING PIGMENT.—Follow the procedure outlined in 4(a) to 4(d), inclusive.

6. REAGENTS.

(a) ACID AMMONIUM ACETATE SOLUTION.—Mix 150 cc of 80 per cent acetic acid, 100 cc of water, and 95 cc of strong ammonia (specific gravity, 0.90).

(b) URANYL INDICATOR FOR ZINC TITRATION.—A 5 per cent solution of uranyl nitrate in water or a 5 per cent solution of uranyl acetate in water made slightly acid with acetic acid.

(c) STANDARD POTASSIUM FERROCYANIDE.—Dissolve 22 g of the pure salt in water and dilute to 1,000 cc. To standardize,

transfer about 0.2 g (accurately weighed) of pure metallic zinc or freshly ignited pure zinc oxide to a 400 cc beaker. Dissolve in 10 cc of hydrochloric acid and 20 cc of water. Drop in a small piece of litmus paper, add ammonium hydroxide until slightly alkaline, then add hydrochloric acid until just acid, and then 3 cc of strong hydrochloric acid. Dilute to about 250 cc with hot water and heat nearly to boiling. Run in the ferrocyanide solution slowly from a burette with constant stirring until a drop tested on a white porcelain plate with a drop of the uranyl indicator shows a brown tinge after standing one minute. A blank should be run with the same amounts of reagents and water as in the standardization. The amount of ferrocyanide solution required for the blank should be subtracted from the amounts used in standardization and in titration of the sample. The standardization must be made under the same conditions of temperature, volume, and acidity as obtained when the sample is titrated.

(d) STANDARD SODIUM THIOSULPHATE SOLUTION.—Dissolve pure sodium thiosulphate in distilled water (that has been well boiled to free it from carbon dioxide) in the proportion of 24.83 g crystallized sodium thiosulphate to 1,000 cc of the solution. It is best to let this solution stand for about two weeks before standardizing. Standardize with pure resublimed iodine. (See Treadwell-Hall, *Analytical Chemistry*, vol. 2, 3d ed., p. 646.) This solution will be approximately decinormal, and it is best to leave it as it is after determining its exact iodine value, rather than to attempt to adjust it to exactly decinormal. Preserve in a stock bottle provided with a guard tube filled with soda lime.

(e) STARCH SOLUTION.—Stir up 2 to 3 g of potato starch or 5 g of soluble starch with 100 cc of 1 per cent salicylic acid solution, add 300 to 400 cc boiling water, and boil the mixture until the starch is practically dissolved, then dilute to 1 liter.

(f) EXTRACTION MIXTURE.—

- 10 volumes ether (ethyl ether).
- 6 volumes benzol.
- 4 volumes methyl alcohol.
- 1 volume acetone.

(g) AQUEOUS SODIUM HYDROXIDE.—Dissolve 100 g of sodium hydroxide in distilled water and dilute to 300 cc.

(h) POTASSIUM IODIDE SOLUTION.—Dissolve 150 g of potassium iodide free from iodate in distilled water and dilute to 1,000 cc

(i) HANUS SOLUTION.—Dissolve 13.2 g of iodine in 1,000 cc of 99.5 per cent glacial acetic acid, which will not reduce chromic acid. Add enough bromine to double the halogen content, determined by titration (3 cc of bromine is about the proper amount). The iodine may be dissolved by the aid of heat, but the solution should be cold when the bromine is added.

(j) ALCOHOLIC SODIUM HYDROXIDE SOLUTION.—Dissolve pure sodium hydroxide in 95 per cent ethyl alcohol in the proportion of about 22 g per 1,000 cc. Let stand in a stoppered bottle. Decant the clear liquid into another bottle and keep well stoppered. This solution should be colorless or only slightly yellow when used, and it will keep colorless longer if the alcohol is previously treated with sodium hydroxide (about 80 g to 1,000 cc), kept at about 50° C. for 15 days, and then distilled.

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