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FEDERAL SPECIFICATION PAINT PIGMENTS AND MIXING FORMULAS

This is primarily a digest of the sections of Bureau of Standards Technologic Paper No. 274, "Use of United States Government Specification Paints and Paint Materials", (December 15, 1924),¹ by P. H. Walker and E. F. Hickson, and Letter Circular No. 333 (July 11, 1932), "Outside House Painting";² dealing with Federal Specification paint pigments, and typical paint mixing formulas using Federal Specifications Executive Committee paste pigments and dry red lead.

The following papers contain additional information relative to paint pigments, oil paints, and water paints:

- TIBM - 30 "Paint Pigments--White"
- TIBM - 31 "Paint Pigments--Black, Red, and Lakes"
- TIBM - 32 "Paint Pigments--Yellow, Brown, Blue, Green, and Bronze"
- TIBM - 34 "Federal Specification Ready-Mixed Paints, Semi-paste Paints and Mixing Formulas"
- TIBM - 35 "Preparation of Paints from Paste and Dry Pigments"
- TIBM - 36 "Preparation of Paints from Semipaste Paints, Thinning Ready-Mixed Paints, and Preparation of Water Paints"
- TIBM - 43 "Aluminum Paints"

¹Available from Superintendent of Documents, Government Printing Office, Washington, D. C. (Price 10 cents).

²Available from the National Bureau of Standards, Washington, D. C. (Free).

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Federal Specifications are those approved by the Director of Procurement, and are binding upon and govern all executive departments and independent establishments of the Federal Government in the purchase of supplies with due regard to available types, grades, and sizes.¹

Pigments are "the fine solid particles used in the preparation of paint, and substantially insoluble in the vehicle."² In general it may be assumed that pigments composed of very fine particles and having higher refractive indices provide the greatest covering power and capacity. With the exception of red lead, it is generally advisable to purchase paint pigments in paste form.

White Lead³

In purchasing white lead in quantity a standard sample for color and color strength should be agreed upon if such properties are to be considered in accepting or rejecting deliveries under the following Federal Specifications:

TT-W-251a: "White Lead; Basic-Carbonate, Dry, Paste-In-Oil, and Sempaste Containing Volatile Thinner". In this specification "paste-in-oil" is the usual "stiff" or "heavy" paste white lead. "Sempaste containing volatile thinner" is also known as "soft-paste white lead"; it can be poured from a bucket and is therefore easier to break up than the stiff paste.

TT-W-261: "White Lead; Basic Sulphate, Dry and Paste-In-Oil".
Use: White lead is the most important of the white pigments. It is used in light-colored paints, and is the only white pigment that may be successfully used alone in white linseed oil paints intended for outdoor exposures. While either basic carbonate or basic sulphate white lead may be used, basic carbonate is generally preferred. Basic sulphate finds its greatest use in ready-mixed paints.

White Lead Paint Mixing Formulas: Formulas No. 1, 4, 5, and 6 (page 6 of this digest) for making white lead paints represent good average practice for most painting operations.

White Lead Linseed Oil Paints: These paints are easy to spread and have good covering qualities. Drying to a comparatively soft film they do not generally decay by cracking, but chalk, which condition is satisfactory for repainting. Because of their softness such paints show a greater tendency to take up dirt than those having harder films.

¹Copies of all Federal Specifications mentioned in this digest may be obtained from the Superintendent of Documents, Washington, D. C. (Price 5 cents each).

²Quoted from "Standard Definitions of Terms Relating to Paint Specifications", American Society for Testing Materials (1933), pp. 735-739.

³See TIBM - 30.

Zinc Oxide¹

In purchasing zinc oxide in quantity a standard sample for color and color strength should be agreed upon if such properties are to be considered in accepting or rejecting deliveries under the following Federal Specifications:

TT-Z-301: "Zinc Oxide; Dry and Paste-In-Oil"

TT-Z-321: "Zinc Oxide; Leaded, Dry and Paste-In-Oil"

Use: Zinc oxide should not be used alone as an oil paint for outdoor exposure. It may be used alone, however, in a varnish vehicle in the manufacture of high grade enamels. The hardening effect of zinc oxide is distinctly beneficial when used with mildly chalking pigments, such as white lead. With badly chalking pigments, such as titanium oxide pigment, the addition of zinc oxide is necessary to produce satisfactory paints. Either American process zinc oxide or leaded zinc oxides should be used in mixed pigment oil paints for general use, although special kinds are recommended for use in exterior paint formulation. For special oil paints to resist sulphide fumes, and for white enamels, French process zinc oxide is preferred.

Zinc Oxide Paint Mixing Formulas: Formulas calling for zinc oxide in this digest are only approximations as different lots of zinc oxide, conforming to Federal specifications practically identical in composition, vary to a great extent in their oil absorbing properties. In preparing such zinc oxide paints the operator should mix the paint to brushing consistency, rather than attempt to hold fast to the quantitative proportions given.

Formulas No. 1, 4, and 5 (page 6) may generally be used for mixtures of zinc oxide with at least three times as much white lead. With mixtures containing more zinc oxide it is advisable to increase the proportions of the turpentine and drier.

Proportions of zinc oxide paste specified in formulas No. 8 and 9 are generally considered to be the maximum amounts advisable to use. Such paints are especially desirable for seashore exposures. For average weather conditions, two parts of zinc oxide paste mixed with six or seven parts of white lead paste provide durable paints.

Zinc Oxide Linseed Oil Paints: While such paints have been used successfully in some parts of Europe, experience in America indicates that they are not satisfactory. Some so-called zinc oxide oil paints intended for outdoor exposure are sold in America, but those found to be satisfactory contained large proportions of other pigments, generally white lead, or a mixture of white lead and titanium pigments.

¹See TIBM - 30.

Red Lead¹

Federal Specification, TT-R-191 "Red Lead; Dry and Paste-In-Oil."

Dry Red Lead Versus Paste Red Lead: Paste red lead is somewhat easier and safer to handle than dry red lead. It has a tendency, however, to harden in the container within a comparatively short time. Therefore, purchasers are cautioned against buying red lead in paste form unless it is to be used by the contractor within three months after shipment. As heat accelerates the tendency of red lead paste to cake or harden, it should not be stored in places subject to high temperatures. It is generally safer to stock the dry form of red lead, although some excellent red lead pastes are being made today, containing 97 percent and over of true red lead.

Red Lead Paint Mixing Formulas: Formulas given in Federal specification TT-R-191; using the dry form (20 pounds dry red lead, 5 pints raw linseed oil, 2 gills turpentine, and 2 gills liquid drier), and the paste form (20 pounds red lead paste, 3 pints raw linseed oil, 2 gills turpentine, and 2 gills liquid drier) produce excellent paints for metal. Such paints weigh about 25 pounds per gallon.

In this digest, formulas No. 10 and 11 (page 6) are for first coat work on iron and steel, to be followed by a second coat of the same paint tinted with about 3/4 pound lampblack in oil, or any dark-colored oil paint which will modify the color of the red lead. The change in color of succeeding coats is suggested to make it easier for an inspector to see that the required number of coats are applied. For the third coat, any good grade of outside paint as given in formulas No. 5, 9, 19, 24, 29, 33, or 37 may be used.² As white paints produced from formulas No. 5, 9, and 19 do not possess sufficient hiding power in one coat, they should be tinted a warm gray by adding 8 to 12 ounces of yellow ochre in oil and 4 to 8 ounces of lampblack in oil to every 100 pounds.

Formulas No. 12 and 13 are said to be good priming coats for wood. Two succeeding coats of white made from formulas No. 4 and 5, or No. 18 and 19² will practically hide the priming coat.

Red Lead Paints: Red lead is probably the best and most generally used pigment for first coats on all kinds of structural iron and steel surfaces. It is not commonly used for priming wood, however, as more coats of paint would be required to hide its color when white or light finish tints are desired. Red lead linseed oil paint is the best known protection from outdoor exposure for iron and steel.

¹ See TIBM - 31.

² Formulas Nos. 18, 19, 24, 29, 33, and 37 will be found in TIBM - 34.

The heavier red lead paints are made, the greater protection they afford. While paints weighing from twenty-two to over thirty pounds per gallon (containing five to two and one-half gallons linseed oil per one hundred pounds dry red lead) are sometimes used on metal, the lighter mixtures are not recommended. Mixtures heavier than those resulting from the specified formulas should be used only in exceptional cases.

Titanium Pigment¹

Use: Although titanium pigment is exceedingly opaque, it cannot be used alone in an exterior wall paint because such paints will chalk excessively. In oil paints titanium pigment is generally mixed with from thirty to thirty-five percent zinc oxide by weight. Excellent enamel paints are made from titanium pigments in varnish vehicles. The only durable white paint for use on outdoor exposures that will retain its color in localities subjected to excessive amounts of hydrogen sulphide, should be one in which the pigment consists essentially of titanium pigment and zinc oxide and, including any driers, free from lead.

Titanium Zinc Oxide Paint Mixing Formulas: Formulas 15 and 16 (page 6) have been found to be suitable for producing such paints.

Yellow Ocher²

Federal Specification: TT-O-111 "Ocher; Dry, Paste-In-Japan, and Paste-In-Oil." It is advisable to purchase yellow ocher in oil, and to agree upon a standard sample of color, tone, and color strength, when purchasing it in quantity.

¹See TIBM - 30.

²See TIBM - 32.

**PAINT MIXING FORMULAS USING FEDERAL SPECIFICATIONS EXECUTIVE COMMITTEE PASTE
PIGMENTS AND DRY RED LEAD^A**

PURPOSE	FOR- MULA NO.	PIGMENT	RAW LINSEED OIL JJJ-O-336 ^B		TURPENTINE LLL-T-791 ^B		DRIER TT-D-651 ^B		APPROXIMATE YIELD		
			TYPE ^C	LBS.	GALLONS	GALLONS	PINTS	GALLONS			
PRIMING COATS WOOD NEW WORK	1	A	100	3 TO 4	2	TO 4	1	TO 2	7	2/3 TO 11	
	12	A & C	60 & 40	2	TO 4	1	3/4 TO 2	1	TO 2	6	TO 8 1/3
	13	A & D	60 & 40	1 3/4	TO 4	1	3/4 TO 2	1	TO 2	6	TO 7
BODY COATS WOOD, OUTSIDE, NEW AND FIRST COAT REPAINTING	4	A	100	1	TO 2	1	1/2 TO 2 ^D	1		6	TO 7
	8	A & B	50 & 50	1 1/2	TO 2	2	TO 3 ^D	4		7	1/4 TO 8 3/4
	15	B & E	40 & 60	2	TO 2 1/2	2	TO 3 ^D	4		8	3/4 TO 10 1/4
FINISH COATS OUTSIDE	5	A	100	3	TO 4 1/2	1 1/8	TO 1 1/4 ^D	1		6	1/2 TO 7 1/2
	9	A & B	50 & 50	3	TO 4	1 1/2	TO 3 1/4 ^D	2	TO 3	7	TO 8 1/2
	16	B & E	40 & 60	4	TO 4 1/2	1 1/2	TO 3 1/4 ^D	4	TO 5	9	1/4 TO 10
PRIMING COATS ON METAL	10	C	100	3 1/8		5/16 ^D		2 1/2		5	1/4
	11	D	100	3		5/16 ^D		2 1/2		5	3/4
FINISH COATS INSIDE FLAT TO EGGSHELL GLOSS				VARNISH ^E PINTS							
	6	A	100	1	TO 6	1 1/2	TO 3	1/4	TO 1/2	4	1/4 TO 6 1/2

^A ALTHOUGH MANY OTHER MIXTURES MAY BE SUCCESSFULLY USED, THESE ARE TYPICAL PAINT MIXING FORMULAS. THE AMOUNTS GIVEN ARE CORRECT FOR AVERAGE CONDITIONS. AN EXPERIENCED PAINTER WILL VARY THE AMOUNTS OF THE DIFFERENT INGREDIENTS TO SUIT THE NATURE OF THE SURFACE TO BE PAINTED, WEATHER CONDITIONS, ETC.

^B FEDERAL SPECIFICATION NUMBER.

^C TYPE OF PIGMENT

A—PASTE WHITE LEAD. BASIC CARBONATE (TT-W-251A) GENERALLY PREFERRED. BASIC SULPHATE (TT-W-201) MAY BE USED. IF SOFT-PASTE WHITE LEAD (SEMI-PASTE CONTAINING VOLATILE THINNER) IS USED, THE RECOMMENDED PRACTICE IS TO REDUCE BY 1 QUART THE AMOUNT OF TURPENTINE CALLED FOR IN THE FORMULAS. ONE HUNDRED POUNDS PASTE WILL OCCUPY ABOUT 2 2/3 GALLONS.

B—PASTE ZINC OXIDE (TT-Z-301) OR PASTE ZINC OXIDE, LEADED (TT-Z-321). FIFTY POUNDS WHITE LEAD PASTE AND 50 POUNDS ZINC OXIDE PASTE WILL OCCUPY ABOUT 3 1/4 GALLONS.

C—DRY RED LEAD (TT-R-191). ONE HUNDRED POUNDS DRY RED LEAD WILL OCCUPY ABOUT 1 1/3 GALLONS.

D—PASTE RED LEAD (TT-R-191). ONE HUNDRED POUNDS PASTE RED LEAD WILL OCCUPY ABOUT 2 1/6 GALLONS.

E—PASTE TITANIUM PIGMENT. ONE HUNDRED POUNDS PASTE TITANIUM PIGMENT WILL OCCUPY ABOUT 4 1/2 GALLONS. A 100 POUND MIXTURE (60% TITANIUM, 40% ZINC OXIDE) WILL OCCUPY ABOUT 4 1/4 GALLONS.

^D VOLATILE MINERAL SPIRITS (TT-T-291) MAY BE USED IN PLACE OF TURPENTINE IN THIS FORMULA.

^E EITHER WATER-RESISTING SPAR VARNISH (TT-V-121A) OR INTERIOR VARNISH (TT-V-71) MAY BE USED.

NOTE—IN NEARLY ALL OF THESE FORMULAS, EXCEPT THOSE FOR PRIMING COATS ON NEW WOOD, A MIXTURE OF 1/3 TO 1/2 BOILED LINSEED OIL AND THE REMAINDER RAW LINSEED OIL MAY BE SUBSTITUTED FOR THE RAW OIL, OMITTING THE DRIER.

Conclusions

Cost and Durability

Dark-colored paints are less expensive and more durable than white or light-colored paints.

Iron Oxide Linseed Oil paint meeting Federal Specification TT-P-31 will last much longer than any white linseed oil paint.

Tinted paints are more durable than the basic white paint untinted. Cream, ivory, and tan tints are more durable than sky blue. White or light-tinted paints must contain expensive white pigments to be satisfactory.

White Lead versus Ready-Mixed White Paint: When painting is done by a skilled painter or under skilled supervision, the straight white lead linseed oil paint, generally mixed on the job is more "fool proof" and safer to use, as painters generally know more about handling white lead paint than they do about mixed paints. In mixing white lead linseed oil paints, the amounts of oil given, in the formulas on page 6 of this digest, should never be exceeded. Better results will be obtained by using the lower limits in the amount of oil.

Lead-Zinc paint meeting Federal Specification TT-P-36 will probably be as good as, and in some respects may be more desirable than, straight white lead paint, particularly for tinted paints.

Titanium-Zinc Paint: A properly made mixed white paint with a pigment approximating 7 percent titanium oxide, 58 percent white lead, 25 percent zinc oxide, and 10 percent extender should give excellent service (see Federal Specification TT-P-101a, Type A).

Seashore or Marine Exposures: It is frequently advisable, particularly at the seashore, to add from 1 pint to 1 quart of water-resisting spar varnish to each gallon of paint just before it is applied. It is not advisable to add varnish to paints for undercoat work.

Quick-Drying House Paints: The purpose of such paints is to obtain a quicker drying product than the regular linseed oil type, and one that holds its luster and color better than the usual house paint. They frequently contain synthetic resins and high-strength opaque white pigments, such as titanium pigments. For solid colors, pure, high-strength pigments are preferred. Others contain high-hiding white pigments (with substantial amounts of white lead), in a vehicle, the drying oils of which are a blend of about 80-90 percent linseed and 10-20 percent tung (China wood) oils. A part of the oil is added in a thickened form.