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U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

WASHINGTON

September 13, 1948

Letter
Circular

LC915
(Superseding
LC747)

PAINTING EXTERIOR WALLS OF POROUS MASONRY

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Contents

I. INTRODUCTION

The extensive use of porous masonry products (cast concrete, stucco, brick, asbestos cement siding, unglazed tile and concrete and light-weight aggregate block) for exterior walls above grade has increased the need for information concerning paints (see VII, 1 (a)) suitable for decorating and in some cases waterproofing these structures (see VII, 1 (b)). This letter circular is intended as a guide to the consumer in selecting the type of paint best suited to his needs and to give general directions regarding its use. Where these directions vary from those supplied by the manufacturer of the material, the manufacturer's recommendations should be given preference.

Paints for masonry wall surfaces may be divided into four classes: cement-water paint, resin-emulsion paint, oil paint, and paint containing rubber in the vehicle. These paints are also suitable for use on such masonry surfaces as foundations, interior walls, gate posts and (fence) enclosure walls, but they should not be used on floors which are subject to abrasion. Instead, for such surfaces a very hard-drying paint with good water resistance and good gloss retention is recommended. Whitewash, another commonly used coating for masonry, will be mentioned only briefly, because the National Lime Association in their publication "Whitewash and Cold Water Paints" (see VII, 3) treats the subject thoroughly, giving formulas, directions for application, and suggested uses.

In selecting the type of paint to be used, some consideration should be given to the physical characteristics of the surface, such as relative moisture content and age, texture and porosity and, in the case of repainting, the type of coating previously applied. Cement-water paints are particularly suitable for application on walls which are damp at the time of painting or may become damp after painting as a result of structural defects, new structures (less than 6 months old) which normally contain water-soluble alkaline salts, and open-textured surfaces (for example cinder, concrete and lightweight aggregate block). They are not recommended for stopping leakage through porous walls exposed to appreciable water pressure, particularly if the paint is applied to the inside of wall. For such conditions a more positive treatment (for example, a coating of hot bituminous material applied to the outside of the wall) is suggested. Close-textured surfaces (cast concrete, asbestos-cement siding, tile, etc.) which are relatively dry may be painted with resin emulsion paint or paints containing rubber in the vehicle. Walls which are dry at the time of painting and are so constructed as to remain dry after painting may be decorated satisfactorily with oil paints.

The durability and ultimate satisfactoriness of the paint selected will depend to a large extent on the preparation of the wall surface and the application of the paint. Because of the difference in physical and chemical properties of the four types of paint, each type will be considered separately.

II. CEMENT-WATER PAINT

Cement-water paints are water-dilutable paints, packaged in powder form and are composed chiefly of portland cement or portland cement and lime. The composition and physical requirements of a desirable paint of this kind are covered in Federal Specification TT-P-21 (see VII, 2). Many of the proprietary cement-water paints on the market conform to this specification. It should be noted, however, that the composition of the paint powder is secondary in importance to the condition of the painting surface, the method of application and the curing of the paint film as factors in determining the durability of the coating.

A typical cement-water paint film is hard, strong, and relatively brittle. These properties, together with shrinkage on drying, may result in the development of fine checking, sometimes called "map-cracking". Such paints should weather by erosion, that is by the gradual wearing away of the coating. This behavior is considered normal and unless erosion is rapid and the map-cracking is progressive such a breakdown is not serious. Rapid chalking is a characteristic quality of soft, weak films and leads to proportionately rapid deterioration in color, opacity, and durability. Usually it is due either to a deficiency of portland cement in the paint or to the failure to provide adequate curing, which is necessary to the proper hydration and hardening of the cement. Soft films also may be caused by ingredients such as casein or other organic compounds, which prevent normal reaction between the cement and water.

Cement-water paint possesses good decorating qualities as to hiding power and color. However, when wetted, as by rain, it becomes somewhat translucent and darker in color. On drying, the film returns to its original opaqueness and color.

1. Cleaning of Surface.- The minimum amount of surface preparation should consist of thoroughly removing all dirt, dust and efflorescence from the surface. Dirt and dust should be washed off with clean water. To remove efflorescence, first wet the masonry, then apply a 20-percent solution of muriatic (hydrochloric) acid and after about 5 minutes scrub off the salts with stiff bristle brushes. It is best to wash small areas. The surface must be thoroughly rinsed with clean water after an acid treatment. (Caution: Rubber gloves should be worn when using the acid wash.)

Old coatings of whitewash and flaking or scaling cement-water paint should also be removed, using the acid treatment outlined for efflorescence.

Firmly adhering coatings of portland cement-water paint or cement-water paints which are "chalking" or "dusting" need not be removed. Brushing with a stiff brush is usually sufficient.

Old coatings of organic paint (resin-emulsion, oil, etc.) must be completely removed. Usually this can be done most effectively by sandblasting.

2. Wetting the Surface.- Before applying the paint the masonry should be thoroughly wetted to control the surface suction and to provide a reserve of moisture to aid in the proper hardening of the paint. A garden hose adjusted to give a fine spray is well suited for this purpose. A superficial dampening with a brush dipped into a bucket of water is inadequate for exterior walls but may be satisfactory for walls in cool basements. Usually it is sufficient to wet the walls in one operation not more than an hour before painting. The spray should be applied in such a manner that each part is sprayed 3 or 4 times for about 10 seconds each, time being

allowed between applications for the water to soak into the surface. If the surface tends to dry rapidly, as it may in hot weather, it should be redampened slightly just in advance of painting - it should be moist but should not be dripping wet or have a noticeable water film when the paint is applied.

3. Mixing and Preparing the Paint.- Proprietary cement-water paints require only the addition of and mixing with water to prepare them for use. Generally it is better to purchase the mill-ground commercial product, but for those who wish to make the paint the following formulas for job-mixed paints have given satisfactory results both as to durability and appearance:

Formula No. 1

	Parts by Volume
White portland cement	2
*Aggregate (white or light-colored silica sand (passing No. 20 sieve and not more than 15 percent passing No. 100 sieve))	1

*Washed mortar sand sieved through 16-mesh fly screen may be used.

Formula No. 2

	Parts by Weight
White portland cement	70
Hydrated lime[1]	30

Formula No. 3

	Parts by Weight
White portland cement	77
Hydrated lime[1]	15
Calcium stearate	1
Calcium chloride	4
Titanium dioxide or zinc sulfide	3

[1] The total free (unhydrated) calcium oxide (CaO) and magnesium oxide (MgO) in the hydrated lime should not exceed 8 percent by weight of the hydrated lime.

Formula 1, sometimes called "grout coat" is highly recommended for use on coarse-textured-masonry block, untooled mortar joints and similar surfaces which need to be filled or painted. It can be used as a priming or finishing material, and it is very durable. For the first coat on exceptionally coarse block a better filling action is obtained and a more even texture produced if the formula is modified to contain equal parts by volume of cement and sand.

Formula 1 or its modification is recommended as a base coat on open-textured masonry which is to be finished with one of the organic paints. By this means, a more uniform painting surface is secured, thereby increasing the spreading rate of the finishing paint. Another and perhaps more important contribution of the grout base is that by adequately filling the voids in the surface the danger of water penetration by wind-driven rain is greatly reduced.

Formula 2 is a good paint for general use. It is simple in composition, easy to mix and apply, and produces a hard weather resistant coating.

The third formula approximates the composition of many of the proprietary brands of cement-water paint. Because of its complexity, however, it is difficult to mix properly by hand. If this paint is mixed on the job, the calcium stearate (a water repellent) and titanium dioxide or zinc sulfide (opaque pigments to increase the wet opacity of the paint) should be intimately mixed with the lime and portland cement, and the calcium chloride (hygroscopic salt) should be added to the gaging water.

Calcium chloride in amounts up to 4 or 5 percent may be added to formulas 1 and 2. This salt aids curing of the portland cement by drawing moisture from the air and also accelerates the rate of hardening.

Tinted paints may be made by adding suitable amounts of coloring pigments, but due to the difficulty of producing uniform colors by hand mixing it is suggested that tinted paints should be commercial brands which are mill ground in the factory.

In preparing the job-mixed paint the various dry constituents should be thoroughly mixed together in the dry state, except the calcium chloride which should be added to the gaging water. Small batches, 50 lbs. or less, may be mixed by stirring the material together in a tub and then sifting this mixture 2 or 3 times through fly screen. The powder paint should be stored in moisture-proof containers until used.

When preparing a paint for use, the recommended procedure is first to reduce the dry material to a stiff paste by adding water in small portions, with constant stirring, after which additional water should be gradually stirred into the paste until the desired consistency is obtained. The proper amount of water will vary, depending upon the fineness of the dry materials, and should be determined by trial. The mixed paint should have the consistency of rich cream except that a slightly thinner consistency is recommended for the first coat applied to open-textured concrete surfaces, such as concrete masonry units.

The paint should be vigorously stirred for several minutes until it is of uniform consistency and all particles are thoroughly wetted. Workability will be improved by allowing the mixture to stand 20 to 30 minutes with occasional stirring. Most paints remain in a usable condition for 3 or 4 hours after being prepared although in hot weather some paints, especially those containing calcium chloride should be used within 3 hours.

While being used the paint usually tends to stiffen, due to chemical and physical reactions and evaporation of the water, and it is common practice to thin the paint with additional water when necessary to maintain the desired consistency. There seems to be no serious objection to retempering white paints, provided it is properly done. The paint should first be stirred vigorously as sometimes this operation will restore its fluidity. Any additional water required should be added in small increments and thoroughly incorporated.

4. Application of Paint.- The surface should be uniformly damp but with no free water.

For obvious reasons, no painting should be done on frozen masonry or when the paint may be exposed to temperatures below 45° F within 48 hours after application.

When weather conditions are such as to cause the paint to dry rapidly, it is advisable to work "in the shade" in so far as practicable. This makes it easier to keep the surface uniformly damp and helps to prevent too rapid drying of the paint.

The paint should be applied in two coats. Preferably not less than 24 hours should be allowed between coats. The first coat should be slightly moistened with water before applying the second coat. "Doubling back" or the application of a doubly thick coat is not conducive to good results.

Most portland cement paints can not be satisfactorily applied with the ordinary hair-bristle paint brush. Proper application requires a brush with relatively short, stiff fiber bristles such as fender brushes (commercially sold for cleaning the under side of automobile fenders), ordinary scrub brushes, or roofers brushes. Experiments indicate that when painting for the dual purposes of decorating and waterproofing both coats should be vigorously scrubbed on in such a manner as to work the paint back into the voids and provide a continuous paint film free from pinholes or other openings through which water might penetrate.

Tests made by the American Concrete Institute of rain resistance of painted masonry walls indicate that paints applied with spray equipment provide less protection than coatings scrubbed on. Spray application therefore is recommended only for dense concrete or interior surfaces, or when the paint is not required for waterproofing purposes.

While excessively thick films are to be guarded against, there is a tendency in practice to use too much water in the paint and to brush it out too thin. Such coatings may look well at first but generally lose their opacity and protective value much sooner than thicker films. The proper spreading rate is difficult to estimate for portland cement paint because of the difference in the texture of the masonry to be covered. However, on smooth masonry the spreading rate would be about 100 sq. ft. per gallon of mixed paint for two coats (dry film thickness approximately 0.015 inch), and on rough masonry the rate would be about 50 sq. ft. per gallon (film thickness 0.030 inch).

5. Curing the Paint.- Proper hardening of paint films of this type depends upon the availability of moisture for chemical reaction with the portland cement. The moisture in the masonry walls, in the paint itself, and in the air is utilized for this purpose but usually this is not enough. In most cases it is desirable to sprinkle the painted surface two or three times a day with a fog spray such as used for dampening the walls prior to painting, and it is recommended that this be done between coats and for 2 days after the final coat, starting as soon as the paint has set sufficiently not to be damaged by the spray, usually 6 to 12 hours after application. Damp curing in this way will improve the hardness and durability of the paint in every case and in some instances will mean the difference between a satisfactory and a poor paint job.

III. RESIN-EMULSION PAINT

Resin-emulsion paints tend to bridge the gap between water- and oil-base paints in that they are water-thinned materials whose dry film properties closely resemble those of a flat oil paint. The product is an oil-in-water emulsion in which the vehicle is an emulsion of film-forming oils, resins, etc., in an aqueous phase. The water phase contains a number of ingredients, including water, an emulsifying agent, a bodying agent, and preservative. The oil phase may consist of oils, resins, and driers.

The pigments used are the same as in exterior oil paints, consisting of titanium-base pigments and extenders such as silica and mica. The chemical composition and performance characteristics of resin-emulsion paints for exterior use are described in Federal Specification TT-P-18, Paint; Alkyd Resin-Emulsion, Exterior, Paste, Tints and White (see VII, 2).

Resin-emulsion paint may be used on most porous masonry surfaces, including asbestos-cement siding, which has not been previously coated with a waterproofing compound. It should not be used on magnesite stucco.

1. Preparation of the Surface.- In preparing the surface, remove all dirt, dust, efflorescence and loose particles from the surface and remove any flaking or scaling paint by scraping or wire-brushing. Dull any glossy areas by sanding. Badly mildewed surfaces should be scrubbed with either a solution of one part of bichloride of mercury (Poison) in 100 parts of water or a solution containing one pound of trisodium phosphate to one gallon of water. Remove oil, grease, and wax by scrubbing with mineral spirits, following by washing with water containing trisodium phosphate (about two ounces to the gallon), then rinse thoroughly with clean water. Resin-emulsion paint should not be applied over a glue-bound water paint, calcimine, or whitewash. A solution of trisodium phosphate (1 pound/gallon) will soften glue and aid in the removal of the glue-bound paint; calcimine and whitewash must be removed by scraping and wire-brushing. Acid washes, which are effective in cleaning walls coated with the above materials, should not be used, since a trace of acid left on the wall will harm the emulsion paint. (Caution: Rubber gloves should be worn when using the bichloride or mercury or trisodium phosphate solutions.)

2. Mixing the Paint.- Resin-emulsion paints are packaged in paste form and need to be thinned with water before they are applied. They should be mixed in clean metal containers (not wood). For ordinary conditions, add slowly while stirring 1/2 gallon of water to the gallon of paste. However, manufacturer's directions should be followed. The desired consistency is generally thinner than that of oil paint, in fact peeling may result if the paint is applied too thick. For best results the paint should then be strained. If more paint is mixed than can be used in one day, keep the paint covered with a damp cloth. Mixed paint should be used within a week.

3. Application of the Paint.- Resin-emulsion paint may be applied by brush or spray. Two coats are recommended and the temperature should be above 40° F when painting. No size or priming coat is generally required, but on open-textured masonry (such as unvibrated block) a grout base coat (Formula 1, page 4) is advantageous to fill the voids in the wall surface. On very warm days it may be advisable to moisten the surface to be painted with water prior to applying the paint. The paint dries rapidly (1 to 4 hours) and may be recoated in 6 to 8 hours. The film becomes hard overnight. One gallon of the paste paint will cover approximately 200 to 450 square feet per gallon, depending on the surface and application.

Brushes and spray guns should be washed with warm soapy water immediately after using.

IV. OIL PAINTS

Oil paints designed for use on masonry are usually ready-mixed paints containing weather-resistant opaque pigments suspended in drying oils, resins, and thinners. They should be formulated so that the first coat seals the surface sufficiently to prevent spots or flashes of the second coat. Two coats are necessary for good hiding and durability. The chemical composition and physical characteristics of a satisfactory oil paint for masonry surfaces are specified in Federal Specification TT-P-24 (see Section VII, 2).

It should again be mentioned that moisture back of the paint film will seriously impair the life of the coating -- therefore the application of oil paint to new masonry should be deferred until the walls have had time to dry. This may require 3 months to 1 year, depending on the thickness and porosity of the wall and the weather conditions. It is equally important to prevent water from entering the walls subsequent to painting, hence the importance of repairing any structural defects such as leaks around flashing, doors and windows, and in the case of open textured surfaces the application of a cement-sand-base coat (Formula 1, page 4) prior to painting.

1. Preparation of the Surface.- Adequate preparation of the surface contributes to the durability and appearance of the paint coating. The minimum amount of surface preparation should consist of thoroughly removing all dirt, dust, form oil and efflorescence. Dirt and dust should be brushed off, using stiff fiber or wire brushes. To remove efflorescence first wet the surface, then apply a 20-percent solution of muriatic acid and after five minutes scour off the salt deposits with a stiff bristle brush. If necessary, a stronger acid concentration may be used. It is best to work on small areas, not more than four square feet. The surface must be thoroughly washed with an abundance of clean water after each acid treatment. Since large amounts of water are needed to thoroughly rinse the walls after the acid treatment, the walls should be allowed to dry two or three days before applying the paint. It is practicable to remove traces of form oil with steel brushes, abrasive stones, or a lye solution. However, if the surface is generally contaminated with oil, it will be more effective to lightly sandblast the area to be painted or postpone painting until the oil has been removed by the action of the weather.

Some concrete surfaces are so dense (glazed) as to make paint adhesion difficult to obtain. Concrete that is cast against plywood, Presdwood, or steel forms frequently presents such a problem. It is suggested that preparatory to painting, such surfaces be either acid washed, lightly sandblasted, or rubbed with coarse-grit abrasive stones until the glaze is removed.

Old coatings of organic paint or cement-base water paint in sound condition need not be removed. Whitewash or peeling, scaling, or flaking paints should be completely removed.

On open-textured masonry a cement-sand-base coat (Formula 1) modified Section II, 3) should be applied and cured as outlined in Section II, 1, 2, 3, 4 and 5. This mixture may also be used to fill faulty mortar joints or to obliterate map cracks in stucco or concrete. Large cracks in masonry walls should be cut to provide a channel with edges perpendicular to the surface or slightly undercut, and the opening filled with a mortar made by mixing 2 or 3 parts of mortar sand with one part of portland cement and enough water to give a putty-like consistency. To minimize shrinkage of the mortar after placement, the mortar should be mixed at least 1/2 hour before use. The surfaces to receive the mortar should be thoroughly wetted and then scrubbed with cement grout, and the mortar trowelled into place while the grout is still soft. After the mortar has set it should be damp-cured for at least 3 days.

A minimum of 90 days of good drying weather should elapse before applying oil paint over the cement-sand-base coat or mortar-filled joints and cracks. When it is not practicable to wait 90 days before painting, a caulking compound rather than the cement-mortar should be used as a crack filler.

2. Application of the Paint.- Oil paints should not be applied during damp or humid weather or when the temperature is below 50° F. At least one week of clear dry weather should precede the application of the first coat. As masonry surfaces tend to chill and collect condensed moisture, painting early in the morning and late afternion should be avoided except in dry climates.

Manufacturers usually give directions for thinning, but in the absence of such directions the following may be used:

First Coat or Primer.-

High grade masonry oil paint.	1 gallon
Spar varnish (non-reactive)	1/2 gallon
Paint thinner (mineral spirits or turpentine) . .	1/4 gallon

Second Coat.-

Use paint as received or if too thick for satisfactory brushing add a small amount of mineral spirits or turpentine.

V. PAINTS CONTAINING SYNTHETIC RUBBER

There are two types of synthetic-rubber paints; the rubber-solution type in which the synthetic rubber is incorporated in a vehicle of treated drying oils, aromatic hydrocarbons, and coal tar thinners and pigmented with opaque,

weather resistant pigments and the rubber emulsion or latex type.

The rubber solution and rubber emulsion paints are available in most paint stores. The term "rubber-resin", "rubber-base" or "rubberized" usually appears on the label of the solution paint. The designation rubber emulsion has been superseded by "latex" as a means of identifying the water-thinned coatings. Such descriptive terms as "latex polymer", "vinyl emulsion", "polyvinyl acetate" and "acrylic" are used by the manufacturers to indicate the vehicle composition of these products.

Both types of paint give films which are resistant to moisture, alkali and blistering. They should weather by gradual chalking.

1. Preparation of the Surface.- The procedure outlined in Section IV, 1, for removing dirt, dust, loose mortar, form oil, efflorescence, and glaze (on dense surfaces) should be followed in preparing the surface for rubber paints. It is particularly important to remove the glaze so that the first coat can "strike in" the surface, otherwise poor adhesion usually results.

A hard, dust free cement-sand-base coat (Formula 1, Section II, 3) offers an ideal surface for these paints, and it is recommended that on open-textured material the cement-sand coat be applied followed by two coats of the rubber or latex paint.

Oil paint coatings must be removed before applying rubber solution paints, because the thinners used in these paints act as solvents for the oil paints. The latex paints may be applied over chalk-free flat oil paints.

2. Application of the Paint.- Rubber base or latex paints may be applied to dry or damp walls. It is usually necessary to thin the rubber base paint for the first coat, using the thinner recommended by the manufacturer, as some paint thinners are incompatible with these materials. Both types of paint dry to touch within 3 hours but at least 18 hours drying should be allowed between coats.

The brushing technique used for applying enamels should be used for the rubber base paints. "Back-brushing" or "working" the paint will cause it to roll and pull under the brush. As the paint tends to "set" rather quickly due to the evaporation rate of the thinners, it is advisable to work in in the shade in so far as practicable.

The latex coatings are characterized by the ease with which they can be applied by brush or roller and their freedom from "laps". The manufacturer's directions for application and thinning should be followed. Only water should be used to clean the painting equipment.

VI. WHITEWASH

Whitewash is one of the oldest paints and is used to decorate both exterior and interior surfaces.

The principal ingredient in whitewash is lime paste. A satisfactory paste can be made with hydrated lime, but better results are obtained by using quicklime paste that has been slaked with enough water to make a moderately stiff paste and kept in a loosely covered container for several days, or longer. Eight gallons of stiff lime paste are made by slaking 25 lb. of quicklime in 10 gallons of water, or by soaking 50 lb. of hydrated lime in 6 gallons of water. The paste should then be strained through a fine screen to remove lumps or foreign matter.

Whitewash (Sec. VII, 3) can be made from various combinations of lime paste and other ingredients. Two good formulas for whitewash are:

Formula No. 1

Casein	5 lb.
Trisodium phosphate	3 lb.
Lime paste	8 gal.

The casein should be soaked in 2 gallons of hot water until thoroughly softened (approximately 2 hours). The trisodium phosphate dissolved in 1 gallon of water is added to the casein mixture and the mixture stirred until the casein dissolves. This solution should be mixed with the lime paste and 3 gallons of water.

Formula No. 2

Common salt	12 lb.
Powdered alum	6 lb.
Molasses	1 qt.
Lime paste	8 gal.

The salt and alum are dissolved in 4 gallons of hot water, after which the molasses is added to the mixture. The resulting clear solution is then added to the lime paste, stirred vigorously, and thinned with water to the desired consistency. This whitewash has a yellow tinge when first applied, but the color disappears in a few days leaving a white film.

A satisfactory whitewash or cold water paint can be made by diluting a moderately heavy cold lime paste (about 33 lb. of hydrated lime and 8 gallons of water) with 5 gallons of skim milk.

VII. PUBLICATIONS

The publications listed below give more detailed information on the subject of masonry paints and painting than can be covered in this letter circular.

1. Building Materials and Structures Reports

a. BMS 110. Paints for Exterior Masonry Walls - 20 cents

This publication gives data on the relative durability and performance of four classes of masonry paints, as determined by their behavior on wall panels of brick, concrete, cinder, and light-weight aggregate block, cast concrete, and asbestos-cement shingles.

b. BMS 7. Water Permeability of Masonry Walls - OP*

c. BMS 76. Effect of Outdoor Exposure on the Water Permeability of Masonry Walls - OP

d. BMS 82. Water Permeability of Walls Built of Masonry Units - 25 cents

e. BMS 94. Water Permeability and Weathering Resistance of Stucco-Faced, Gunite-Faced and "Knap Concrete Unit" Walls - OP

f. BMS 95. Tests of Cement-Water Paints and Other Waterproofings for Unit Masonry Walls - 30 cents

2. Letter Circulars

a. LC813. Dampness in Basements and Ground Floors - Free

b. LC1018. Dampness in Masonry Walls Above Grade - Free

The publications are of particular interest to those seeking information on waterproofing masonry above grade. The Building Materials and Structures Reports may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at the price indicated. The Letter Circulars are free upon request to the National Bureau of Standards.

*OP = Out of Print

3. Federal Specifications

a. TT-P-18. Paint; Alkyd Resin Emulsion Exterior Paste, Tints and White

b. TT-P-21. Paint; Cement-Water, Powder, White and Tints (For Interior and Exterior Use)

c. TT-P-24. Paint; Concrete and Masonry, Exterior, Eggshell Finish, Ready-Mixed, White and Tints

Copies of these specifications may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., price 5 cents each.

4. Whitewash Bulletin

a. Bulletin 304-F. Whitewash and Cold Water Paints.

This publication is published by the National Lime Association, Washington, D. C., and copies may be obtained free upon request to the National Lime Association.