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Letter Circular

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THE PAINTING OF EXTERIOR WOOD SURFACES

This letter circular is designed to answer average letters of inquiry on the subject of painting exterior wood surfaces; it is, necessarily, incomplete. For more detailed information the references given in Letter Circular LC795, "Publications on Paint, Varnish and Bituminous Materials", should be consulted. Letter Circular LC795 also gives information as to how Federal Specifications for paint and other materials may be obtained. This publication will be sent free from the National Bureau of Standards. The reader is also referred to Building Materials and Structures Report BMS 105, Paint Manual, price $1.00, for sale by the Superintendent of Documents, Government Printing Office, Washington 25, D. C. This manual is non-technical in nature and provides practical information for the application of protective coatings. A section on paint failures on exterior wood surfaces with the causes traced and remedies suggested is included.

The subject of painting exterior wood surfaces has been studied at the National Bureau of Standards for over a quarter of a century. Most of the work has included the exposure to outdoor weather of paints of known composition, that is, paints made in the laboratory. The emphasis in these investigations, in fact, has been on the performance of various formulations rather than on proprietary products since the latter are, naturally, subject to change. This letter circular does not give information on brands of paint.

GENERAL

Prepared house paints have changed in the last several years, particularly with respect to pigments. A blend of titanium-magnesium, titanium dioxide, leaded zinc oxide, white lead, and transparent extenders (magnesium silicate) for white, and combinations of lead titanate or the chalk-resisting titanium dioxides, together with leaded zinc oxide, white lead, and magnesium silicate for tints have increased in use. One result of this is that the hiding power or opacity of the paint has increased. Prior to World War II, raw linseed oil was the most satisfactory drying oil available for use in exterior house paints and consequently was the most widely used. Some manufacturers blended a small amount (5 to 8 percent of the vehicle) of heat-bodied

linseed oil or processed tung oil along with the raw linseed oil. Because of the scarcity of linseed oil during the war, the amount of this oil in house paints was reduced from about 5 pounds of oil per gallon of paint to about 3 3/4 pounds; about one-half of the oil was heat-bodied (thickened like honey). It is not certain as yet how much oil will be used in the typical postwar house paint. However, it is expected that the trend will be toward the use of more of the heat-bodied linseed oil than the 5 to 8 percent used prior to the war, but probably not as much as during the war period. Possibly the total oil content of the typical exterior house paint will be about 4 1/2 pounds per gallon of paint, the oil consisting of about 75 percent raw and 25 percent heat-bodied linseed oils; tung and soya bean oils may also be present. Some of the postwar paints may revert to prewar levels where the oil was practically wholly raw or refined linseed oil (unbodied). These paints have the property of easy brushing - an important feature.

TWO-COAT PAINT SYSTEM

Formerly accepted practice required a minimum of three coats of paint for initial painting on exterior wood, and this practice is still largely followed. However, special primers for wood and two-coat paint systems have been developed in recent years. The oil in some of these primers is a blend of linseed and tung oils (with or without a small amount of resins); the entire oil may be bodied or it may be a blend or raw and bodied oils. Manufacturers of white lead have on the market a two-coat system of paint pigmented with white lead alone. For best results in a two-coat paint system, the topcoat should be designed to go over a special primer. Properly designed and properly applied two-coat paint systems should give good durability. As much paint should be applied in two coats as is normally applied in the older method of three-coat painting. The usual spreading rate for three-coat painting on smoothly planed wood should be about 550 to 600 square feet per gallon for the first or priming-coat paint and about 600 to 650 square feet per gallon for each of the next two coats. In the two-coat paint system, the primer should be spread at about 450 square feet per gallon and the finish coat at about 550 square feet per gallon. In either case, the total thickness of the dry paint coats should be of the order of 0.0045 to 0.0055 inch. Rough surfaces and weather-beaten wood require much more paint than has been indicated for smoothly planed wood.

DARK COLORED PAINTS

In general, dark-colored paints are not only cheaper but are more durable than white or light-colored paints. For example, a red or brown iron oxide-linseed oil paint meeting Federal Specification TT-P-31a, which is the kind of paint commonly used on barns, lasts much longer than any white linseed oil paint. Likewise tinted paints generally are more durable than white paints.

WHITE LEAD AND OIL PAINTS MIXED-ON-THE-JOB VERSUS PREPARED PAINTS

It is impossible to make positive statements as to the relative merits of white lead-linseed oil paint mixed by the painter on the job, and commercial ready-mixed white or tinted paint. If one were called upon to decide between white lead paint and all brands of ready-mixed white paint, the answer would be that the white lead paint would be the safest to use. On the whole, probably white lead paint mixed on the job averages better than other white oil paints, but straight white lead paint is not always the best white paint for every job. Painters necessarily know more about handling white lead paint than they know about mixed paints. In other words, a white lead paint may be regarded as more foolproof, but it is not entirely so. It is not uncommon for painters to use too much oil in mixing white lead.

Mixed-pigment prepared paint, for example titanium-lead-zinc paint meeting the requirements given in Federal Specification TT-P-40, Type I, will probably be as good as, and in some respects may be more desirable than, the straight white lead paint. Class A paint under this designation provides a white paint designed to weather slowly by mild chalking and thus remain white; Class C is a tint-base material so formulated as to yield maximum retention of the tint.

Federal Specification TT-P-40, Type II, also covers ready-mixed, straight white lead-linseed oil paint for the finish coat, and gives formulas for mixing the priming and intermediate coats of paint. The National Lead Company, 111 Broadway, New York 6, N. Y., and the Eagle-Picher Company, American Building, Cincinnati 1, Ohio, issue booklets which give formulas for mixing straight white lead paints. Several of these formulas are given at the end of this letter circular.

White lead paint dries to a soft film which has a tendency to collect dirt in the first few months of exposure, but later this dirt generally chalks off. The film decays largely by chalking followed by surface checking and crumbling and leaves an excellent surface for repainting. Sometimes zinc oxide (in paste form) is added to white lead paint to make the film harder and thus reduce the tendency to take up dirt. The addition of too much zinc oxide, however, makes the film so hard that it cracks and leaves a poor surface for repainting. A good mixture is 80 percent white lead paste and 20 percent zinc oxide paste.

It is sometimes advisable, particularly at the seashore, to add a small amount of good exterior varnish to the topcoat of paint. The amount of varnish added should be quite small - about a pint to a gallon of paint. However, care should be taken to select a varnish that mixes properly with the paint, because some good spar varnishes thicken some paints. The varnish should be tried in the paint on a small scale to see that it mixes properly. It is not advisable to add varnish to the undercoats.

In addition to the paints just described, new types of quick-drying house paints have appeared on the market. They dry more quickly than the regular linseed oil type and hold their luster and color better than the usual house paint. These new paints frequently contain synthetic resins and are referred to as enamelized paints. These paints usually contain high-strength opaque white pigments such as titanium pigments. For solid colors, pure, high-strength pigments are preferred. The use of enamelized paints, particularly for trim colors, is growing. Care is needed in their formulation.

Briefly summing up the question of outside paints in white and light tints, there are numerous formulas but no one "best" paint. It is believed that with proper care in application good results can be had with either straight white lead or with mixed-pigment paints similar to those described in Federal Specification TT-P-40.

EXTERIOR PAINTING

Of equal if not greater importance than the paint is the condition of the surface on which it is applied. The surface should be dry, and any structural defects that permit water to get in the wood back of the paint coating should be corrected before painting. Water back of a paint film will ruin the best paint. This is the most common cause of paint blistering; the cure is to eliminate the source of the moisture.

Outside house painting may be done nearly any time during the year provided conditions are satisfactory, as explained below. Probably the best time is during fall and spring, with fall probably first choice.

NEW WORK

Painting should be done only in clear, dry weather. The surface should be free from dew or frost and should not be painted until it feels dry to the hand. Painting should not be done when the temperature is below 50° F or in urgent cases below 40° F, and in no case when the temperature is expected to drop 20 degrees or well below 50° F. Precaution should be taken not to paint after a sudden drop in temperature. Work should be stopped early enough in the afternoon to allow the paint to set before a sudden drop in temperature occurs. As a rule, dry woodwork can be painted immediately after erection. If the lumber is green when placed or has been made very wet for some other reason, it is suggested that at least 1 week of dry, sunny weather precede the painting. Probably the ideal condition for outdoor painting is a bright, sunny day, not too windy, with a temperature of about 75° F and a relative humidity of about 40 percent.

KNOTS

Oil paint applied over knots and sappy wood is likely to alligator and peel, and with pine woods to discolor. There is apt to be more alligatoring of paint over knots on southern exposure, because of more sunshine, and more yellow discoloration of the paint over knots on the north side, where there is less sunshine. The knots may be spot-painted with orange shellac varnish or with a good grade of aluminum paint, applied a dry or two before the regular paint. When shellac varnish is applied too liberally over the knots, the paint on weathering tends to peel off. When the shellac varnish is applied thin, the paint may not peel but yellow discoloration may show through from the pitch.

MOISTURE

As has been stated, excessive moisture back of the paint film is responsible for many failures (blistering and peeling) of paint on exterior wood surfaces. The interior plaster in a new frame dwelling house contains a great deal of moisture that dries slowly. A properly formulated priming coat permits this moisture to pass through the film. Paint applied to exterior wood siding before the new plaster is dry may blister and peel. Moisture may get in through defects of construction. Condensation from moisture-laden air may develop from various sources, such as increased thermal insulation, from cooking, bathing, laundry work, etc. Where blistering of paint is prevalent, the building should be checked for adequate ventilation, and the installation of a vapor barrier on the inside of exterior walls given consideration.

NAIL HOLES

Nail holes and cracks should be properly filled with pure linseed oil putty as soon as the priming coat is dry. After about a week of clear, warm weather, the putty should be hard enough to receive the second coat.

VARNISHED SURFACES

Window sills and outside doors are sometimes varnished. Three coats of spar varnish should be applied. While the finish on exterior woodwork properly painted with two or three coats of high-grade oil paint approximately the color of the wood should last at least 4 years before repainting, similarly exposed woodwork finished with good quality spar varnish will probably need to be revarnished annually.

EFFECT OF CLIMATE, LOCATION, AND POSITION

Paint on exterior wood weathers or fails differently in different climates. Weathering of paint is a gradual process dependent primarily on sunlight and in a secondary way on rain. Thus, the same paint will fail sooner in Southern Florida than in Maine. In dry, arid regions with plenty of sunshine (some of the southwest regions), paint tends to become very brittle. Thus, if a paint tends to fail by cracking and flaking, this condition will be accentuated. In regions where relative humidity is never very low (Southern Seaboard), paint generally fails mostly by chalking with little or no cracking and flaking. However, the growth of mildew on painted surfaces is often troublesome in such climates. In the Northeast there is generally an in-between condition, and a paint may fail by both chalking and cracking. With respect to location, paint normally fails first on the south and east sides of a house because of more sunshine. Accordingly on any area that is shaded by overhanging eaves, gable ends, trees, and nearby houses, the paint will tend to last longer. With respect to position, paint normally fails sooner on horizontal surfaces, such as steps, porch floors, and roofs, and on surfaces sloping at an angle such as hand rails on steps, than on vertical surfaces.

REFINISHING

The fundamental principles just described for the painting of new wood are applicable to repaint work. The success of a repainting job depends on how well any scaling paint as well as insecurely attached paint is removed from the wood. It is imperative that all insecurely attached paint be thoroughly removed from the surface.

(a) Removal of Loose Paint.- All old paint that is peeling or flaking should be removed, preferably by burning it off with a torch or by the use of paint and varnish remover. When this is not feasible, all loose paint should be removed by wire brushing or scraping. Following wire brushing and scraping, the surface should be sanded with No. 1 1/2 or No. 2 garnet paper.

(b) Knots.- All pitch should be scraped or burned from knots. In general, no further preparation, such as spot painting of knots with shellac varnish or aluminum paint, is necessary, although customary practices may be followed.

(c) Additional Measures for Smoothing Surfaces.- Decayed or split boards that cannot be suitably prepared for repainting should be removed and replaced. All loose boards should be securely fastened, using large-headed nails, preferably galvanized. Protruding nails should be removed or driven into the wood. Open nail holes and holes from countersunk nails should be filled with a good whiting-white lead putty. Gaps between ends of siding and corner boards or window and door casings should be filled with calking compound. Surfaces soiled with roofing pitch and tar, should be scraped free from this foreign matter and the surface thoroughly washed with mineral spirits.

(d) Mildew.- Under very severe conditions, some painted surfaces show the presence of mildew (this should not be mistaken for dirt). All badly mildewed surfaces should be washed prior to repainting. An effective solution is one (1) pound of trisodium phosphate or sodium carbonate dissolved in one (1) gallon of water. After thorough scrubbing, the areas should be rinsed with clean water and allowed to dry before painting. Badly mildewed areas may be specially treated with a solution of one (1) part of bichloride of mercury (poison!) in 300 parts of water. After drying, the surface may be painted. One Government agency requires the paint manufacturer to grind or disperse one (1) part by weight of bichloride of mercury in each six-hundred (600) parts by weight of paint. In addition to bichloride of mercury, commercial fungicides are available for combating mildew on exterior painted surfaces.

WHEN TO PAINT

It is a mistake to paint the exterior of a house either too frequently or too infrequently. Some paints, particularly a pure white lead paint, will tolerate neglect before repainting better than other paints. If a paint is chalking or showing dirt, it does not mean necessarily that it is time to repaint. When a white painted house is repainted every other year in order to maintain a fine appearance, eventually the paint coat will fail by cracking because of the inability of thick films of paint to withstand expansion and contraction. Better practice is to wash the surface every other year and to repaint about every fourth year. The average thickness of a paint coating on a newly completed outside paint job is about five thousandths of an inch (0.005 inch). Repainting should be spaced so that a total thickness at any time is between two thousandths (0.002) and six thousandths (0.006) inch. Too thin an application will of course result in early failure. When the paint starts to develop cracks (assuming a good grade of paint is used) which reach to the wood, repainting should be done, before a period of neglect begins. This statement applies particularly to the modern multiple-pigment prepared paints. Paint normally wears out most rapidly on the south side of the building where it is most directly exposed to the sunlight. The time for repainting is determined by the part of the building on which the paint fails first.

EFFECT OF OLD PAINT

There is evidence that the behavior of the finish coat (especially on repainting) depends also upon what kind of paint is underneath. Combination of dissimilar paints may lead to abnormal or early deterioration. Probably the safest plan is to use the same type of paint that was used previously, provided it has given satisfaction.

PAINTING CHARACTERISTICS OF DIFFERENT WOODS

There are variations in the paint-holding properties of the woods in general use. Extensive investigations on this subject have been made at the Forest Products Laboratory, Madison, Wisconsin. The woods which hold paint longest and suffer least when repainting is neglected are cedar, redwood, and cypress; next in order are northern white pine, western white pine, and sugar pine; in the third group are Ponderosa pine, spruce, and hemlock; and in the last group are Douglas fir, western larch, and southern yellow pine.

SUGGESTED FORMULAS FOR EXTERIOR PAINT MIXED-ON-THE-JOB USING WHITE LEAD PASTE

The following formulas are suggested for those who wish to mix their own paint. However, ready-mixed paints (whether pure white lead or multiple-pigment paints) are available and are recommended:

	Priming Coat	Second Coat	Finish Coat
White lead soft paste	100 lbs.	100 lbs.	100 lbs.
Raw linseed oil	4 gals.	1 1/2 gals.	3 1/4 gals.*
Turpentine	2 gals.	1 1/2 gals.	---
Liquid drier	1 pint	1 pint	1 pint
Total	9 3/8 gal.	6 3/8 gal.	6 5/8 gal.
Approximate spreading rate per gal., 1 coat	500 sq. ft.	600 sq. ft.	700 sq. ft.

Previously Painted Wood

	First Coat	Finish Coat
White lead soft paste	100 lbs.	100 lbs.
Raw linseed oil	2 gals.	3 1/4 gals.*
Turpentine	2 gals.	--
Liquid drier	1 pint	1 pint
Total	7 3/8 gals.	6 5/8 gals.

*Excess dirt collection on the paint coat will be lessened if the oil is reduced to 3 gallons and a pint of turpentine substituted.

In addition to the information given in this letter circular om painting exterior wood surfaces, information on painting exterior masonry surfaces, including concrete block, cinder block, concrete, brick, and cement-asbestos siding, may be found in the Bureau's Letter Circular LC747, "Painting Exterior Walls of Porous Masonry". Information on painting exterior metal (steel galvanized metal, tin plate and copper) is contained in the Bureau's Letter Circular LC422, "The Painting of Structural Metal". Letter circulars are available free by writing the Bureau.