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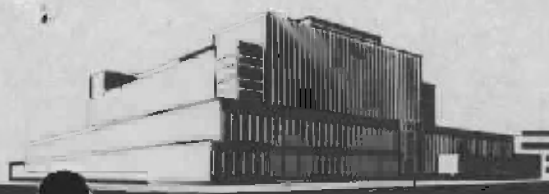

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FOREST SERVICE
In Cooperation with the University of Wisconsin

THE TWO-COAT SYSTEM OF HOUSE PAINTING[1]

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Summary

With the house paints generally available in 1958, three coats of paint are usually necessary on new exterior woodwork to ensure fully satisfactory painting of best durability. Yet many, probably most, new houses are receiving only two coats of paint, and their owners are finding it necessary to repaint sooner than would be the case had better work been done to begin with.

The history of two-coat painting is reviewed briefly. Experimental data are presented that show how, with a given paint, durability depends on the thickness of coating whether the thickness is provided by two thick coats or by three or more thinner ones. Two-coat work requires that each coat be applied as heavily as practicable and requires further that the paint contain a very high proportion of nonvolatile material, pigments and drying oils. From the early 1930's to 1943, primers and finish-coat paints made especially for two-coat work were widely available and gave satisfactory results when used correctly. Since 1943 nearly all finish-coat paints have been made too rich in volatile thinners to make coatings of sufficient thickness in two-coat work, and perhaps painters have taken less care to apply as much paint as they should. As a result, most two-coat painting in 1958 has become scanty painting.

In addition, the experimental data reported demonstrate a superiority of well-designed special priming paints over self-priming[3], especially for painting such woods as Douglas-fir and southern yellow pine, but they show also that the primer and finish-coat paint should be designed carefully for use together,

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[2] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

[3] Definitions of some of the technical terms used in this report appear in Appendix II.

because a primer may give good results with some finish-coat paints and prove incompatible with others. When three coats of paint can be applied, best results on Douglas-fir and southern yellow pine can be obtained with aluminum priming paint, provided that the aluminum paint is made with a vehicle properly designed for that purpose.

History of Two-Coat Initial Painting

During the fourth quarter of the nineteenth century it was commonly considered necessary to apply at least four coats in the initial painting of exterior woodwork. Paints were mixed with much liquid and what we now consider little pigment. Priming coats consisted chiefly of linseed oil with very little pigment. Undercoats were rich in turpentine. Finish coats were mostly oil with moderate proportions of pigment. For cheap work initial painting was sometimes done with three coats only but such practice was frowned upon as false economy (28).

Gradually painters learned to mix their paints with more pigment and less volatile thinner and to spread them in thicker coats until three coats became sufficient for best durability. By the outbreak of the first World War three-coat initial painting had become the generally accepted practice. House paints were designed and recommendations for using them were based on the standard of three-coat initial painting. For cheap work initial painting was sometimes done with two coats only but such practice was frowned upon as false economy (30, 38).

Serious rebellion against these standards began about 1920 when a boom in house construction following a long stagnant period found labor costs far higher than they had ever been before. Speculative builders resorted to two-coat work to reduce cost of application, often with the frank recognition that temporary paint jobs that would require repainting within a year or two were all that was expected. Good initial appearance with uniform gloss and reasonble opacity were essential but painters soon found that they could not provide uniform gloss and reasonable opacity by merely eliminating the undercoat of three-coat work. The thin priming paints characteristic of the old three-coat system do not seal wood effectively against absorption of oil from the next coat of paint (30, p.21). In addition, the level of opacity of the paints of 1920 was such that any material diminution in thickness of coating resulted in failure to hide the wood acceptably.

To meet the demand for two-coat initial painting, therefore, painters had to invent a new technique of application in which the full amount of paint previously applied in three coats was put on in two by greatly reducing the spreading rate of both coats. The new technique was one of painting in thick coats. The economy was effected entirely in labor, not in material. The greatly diminished spreading rates, however, involved the further requirement that the paint for both coats be unusually high in content of total pigment so that the

consistency would be favorable for application in thick coats without running and sagging and without wrinkling during drying. The painters could make the necessary paint mixtures with paste paints such as lead-in-oil but the prepared paints of 1920 were generally too low in pigment content to be suitable for two-coat initial painting.

We may call this technique of initial painting the two-coat system with self-priming. When done honestly by painters who had mastered the technique it proved far more than a temporary expedient and compared favorable in durability with good three-coat work. When done incompetently the shortcomings were usually apparent before the painter could escape responsibility for them. As a result the practice spread beyond the field of speculative building and gained wide acceptance. Paint manufacturers slowly began to recognize it by printing directions for two-coat initial painting on their labels, first on paste paints but later on prepared paints as well. Usually these directions indicated that two-coat work was considered less satisfactory than three-coat work and the directions called merely for elmination of the undercoat of three-coat work without changing the thinning for either primer or finish paint and without pointing out the need for lower spreading rates in two-coat work.

Special Primers

Until about 1936 house painting was generally considered in terms of one-paint systems; that is, self-priming was the accepted practice. The industry was long opposed to special primers for house painting in spite of their general use im metal painting, in woodwork enameling, and in much industrial finishing. Objections to special primers for house painting arose from the fact that the industry had waged a long fight against the use of inferior materials, such as yellow ochre paint, cheap paint, and odds and ends accumulated about the paint shop, as priming coats for house painting (30, p.18).

Favorable consideration of special primers for house painting began about 1927 with the purpose of improving the durability of paint on the heavier softwoods in which the wide bands of summerwood lead to relatively early crumbling or flaking of coatings (5,10,22,33,35,36,37) or of improving the resistance of coatings to moisture blistering (35). Interest in adapting them to two-coat initial painting arose about 1936. For holding coatings intact over summerwood, aluminum priming paint made with a suitable vehicle has proved outstandingly satisfactory (5,9,10,15,19,22) but has been regarded with disfavor by most paint manufacturers and is unsuitable for two-coat systems because of its color.

The studies made of special primers overthrew the traditional theory that priming paint for wood should be low in content of pigment and high in content of volatile thinner in order to promote deep penetration into the wood. Deep penetration, in fact, proved to be wasteful and even harmful because it consists of vehicle alone, separated from the paint film and isolated in the cavities of wood cells beneath the painted surface (3,26,35,37). Useful penetration is limited to the filling with paint i.e., with pigment and vehicle together -- of those wood cavities that open directly into the surface on which the paint is

applied. Beyond that point, pigments cannot penetrate because the openings between cavities are too small to permit their passage. Ordinary house paints, when used according to the self-priming technique, penetrate wastefully and can be improved by restraining undue penetration. The principle of designing primers to restrain wasteful penetration of vehicle has become known as "controlled penetration," a term that appeared first in advertising (31) rather than in technical publications.

One means of controlling penetration is the incorporation of bodied oil in the vehicle (18,31,35), a fact that was disclosed some years before its application in special primers was realized (16). Another means that seems to be less widely appreciated is formulation with a high level of pigmentation favoring application at low spreading rate, that is, in thick coatings (7,33). A thick layer of pigment, especially if made up of pigments that adhere strongly to the vehicle, exercises a capillary competition with the wood and holds more of the vehicle in the paint. Most of the modern special primers make use of both of these methods, though some of them rely more on bodied vehicle than on high pigmentation.

Complete elimination of zinc oxide from special primers is recommended by one school of thought on the subject (33,34) and is opposed by another (36,37). Most of the primers now on the market either contain no zinc oxide or contain much less than is used in the finish paint sold with them.

Conclusions about the use of zinc oxide in special primers must be subordinated to the more fundamental problem of compatibility between primer and finish paint. The finish paints on the market differ so widely in properties (12,27,32,34) that no one primer can be expected to prove compatible with all of them. When the finish paint contains no zinc oxide, the primer should be zincless (13); but, on the other hand, some zincless primers produce alligatoring and intercoat flaking of finish paints containing zinc oxide, which is corrected when zinc oxide is incorporated in the primer also (33,37). Leaders of both schools of thought concerning the place of zinc oxide in primers agree that compatibility is a dominant consideration and that the offering of any one primer for general use under all finish paints cannot be expected to give the best results in all cases (33,36). For that reason a special primer and a finish paint as a rule should be manufactured for use together as a painting system.

Since the special primers with controlled penetration lend themselves readily to a high level of pigmentation favoring application in thick coats, may be made with a high content of opaque pigment, and offer great protection against spotted chalking and fading, they were proposed about 1936 as a particularly effective means of meeting the demand for two-coat initial painting (33,34). The proposal contemplated special formulation of the finish paint for application in thick coats and the offering of primer and finish paint together as fully equal or superior to the older three-coat painting. The term "two-coat system" as first advertised to the public (18) meant a primer and finish paint of this kind. The directions given on the label described two-coat initial painting only, limited thinning of either product to very moderate additions of oil or volatile, if any, and implied that the paints were to be applied in thicker coats than were customary in three-coat painting.

Most manufacturers in 1936 were unwilling to abandon the three-coat system and to commit themselves fully to two-coat initial painting. Some tried offering a two-coat system with special primer and finish paint in addition to their older line of prepared paint, but this overburdened dealers' paint stocks and confused sales programs. The compromise generally adopted was to add only one new product, a special primer with controlled penetration, to the regular line of prepared paint. The primer and the prepared paint together were then offered as a two-coat system. In such two-coat systems, however, the primer alone takes the entire burden of making up for the elimination of an undercoat. That it cannot reasonably be expected to do so was indicated by the fact that so many of the manufacturers' directions of that time expressed a preference for three-coat work.

The special primer supplementing a conventional prepared paint led to exceedingly complicated directions for application. Some paint labels attempted to describe as many as four methods of initial painting, (1) three-coat work with self-priming, (2) three-coat work with special primer or with the special primer used for both primer and undercoat, (3) two-coat painting with special primer, and (4) two-coat painting with self-primer. As a rule, no difference in thinning was directed for two-coat and for three-coat work and nothing was said about changing the spreading rates.

In 1938 to 1940 the Federal Housing Administration's concern about the acceptability of two-coat initial painting led to more careful consideration of the necessary requirements by manufacturers. It became generally customary to insist upon a special primer of the same brand as the finish paint and to state clearly in label directions that the paints were to be thinned little if at all and were to be applied in thick coats, usually 450 square feet per gallon for the primer and 550 square feet per gallon for the finish coat. Meantime there had also been continuous improvement in quality of finish paints since 1920, particularly in increased content of pigment and consequent suitability for application in thick coats.

By 1940 the two-coat system became thoroughly established and generally accepted. Few continued to regard it as a cheap, inferior method of painting. Much first-class painting was being done with it. Not all two-coat painting was superior, however, for painters could, if they wished, "skin the job" by stretching the paint too far even more readily in 1940 than they could in 1920 (25). The 1940 paints had more opacity and would hide the wood in thinner coats than were necessary with the 1920 paints, and the feature of controlled penetration in the 1940 primers reduced the danger of uneven gloss or "suction spots" if the primer was too stingily applied. Short-lived paint jobs of reasonably good initial appearance became possible.

Developments Since 1943

Up to 1943, most manufacturers' best brands of house paint contained at least 87 percent by volume of nonvolatile ingredients, which required at least 4-3/4 pounds of drying oil per gallon, and, when applied on a well primed surface at

550 square feet per gallon, left a dried coating at least 0.0025 inch thick. In 1943, amid wartime shortages of raw materials, the paint industry was required to limit the drying oil in house paints to 3-3/4 pounds a gallon (39). This was accomplished by bodying about half the oil used and greatly increasing the proportion of paint thinner. The nonvolatile content was thereby reduced to about 73 percent. When applied at 550 square feet per gallon, the dried coating left was only 0.0021 inch thick. Application at less than 550 square feet per gallon to regain the lost coating thickness was impracticable, especially since the bodied-oil paints had more tendency to run or sag when applied in thick coats than the older paints did. The bodied-oil paints, then, made it necessary either to accept coatings of less thickness when dry than was considered necessary with the paints richer in oil, or else to abandon the two-coat system for three coats.

For the most part the two-coat system was retained and gained even wider use even though it meant the acceptance of thinner coatings. Controversy exists about the relative durability of the thinner coatings of bodied-oil paints and the thicker coatings of paints richer in oil. Some hold that the bodied oil adds enough to the durability to offset the loss in film thickness. Others hold a contrary view. It may be significant, however, that the two-coat system is now generally regarded as less durable than three-coat painting. Even those who in 1940 claimed that their two-coat systems were fully equal in durability to conventional three-coat work no longer make that claim.

After the mandatory restriction on oil consumption was withdrawn at the close of the war, some manufacturers increased the proportion of oil to 4 or 4-1/4 pounds a gallon but so many remained at the wartime level that competion in the end made the "oil-restricted" paints the general practice. Less publicity seems to have been given to the need for applying thick coats of paint in two-coat work. There has consequently been a decided tendency to apply far too little paint in the initial painting of new houses.

Repainting

The logical development of two-coat initial painting is one-coat repainting. In practice, of course, much one-coat repainting has been done for many years, even though most of the advice given to the public calls for two coats. When repainting is done at reasonable intervals, before the old paint starts to crumble or flake seriously, one generous coat of highly pigmented paint, such as the finish paint of a two-coat system, is sufficient. Indeed there is an advantage in a program of one-coat repainting in that it is less likely in the course of time to build up excessive thickness of coating, which is a common cause of unsatisfactory paint service for older houses. The danger in one-coat repainting is that, if the paint is spread too far, enough oil will be sucked in by the old paint to make the new paint dry with uneven gloss. Badly cracked old paint, for example, may show suction spots over the cracks. The bodied-oil paints are less likely to be affected in this way than the paints richer in oil, because the bodied oil imparts the property of controlled penetration. About 1948 a few brands of "one-coat house paints" were put on the market for such use in repainting when the old paint is still in reasonably

good condition. It is by no means certain, however, that special paints are needed for this purpose.

When repainting is delayed until there is much bare wood exposed, two-coat repainting is necessary. For such conditions the special primers with controlled penetration have obvious advantages when used as the undercoats.

Experimental Part

The Forest Products Laboratory has been concerned with the problems of two-coat initial painting since its painting studies began in 1924. The first series of exposure tests dealt with the painting characteristics of the native softwoods, but the second series, started in the fall of 1924, was the first of many series dealing with two-coat initial painting. In all of them, careful attention was paid to the thickness of coating.

Relation Between Spreading Rate and Film Thickness

The series of tests on the native softwoods (1) revealed an extremely wide variation in the spreading rate at which different painters apply paint even when the paints and their thinning proportions are identical and the surfaces and conditions of application are as similar as it is possible to make them. The data on spreading rate, which have been published in detail (2), show that the personal habit of the painter governed the spreading rate to a much greater degree than the nature of the wood or the kind of paint. Among 11 painters, each painting 56 panels, the range in average spreading rate was 561 to 869 square feet per gallon for priming coat, 732 to 1,286 for undercoat, and 705 to 1,335 for finish coat. Observations of practical work in painting houses show that these data are by no means extreme; on the contrary, they underestimate the variations encountered in commercial painting practice where painters are accustomed to thinning paint as they see fit in addition to brushing it out according to individual habit. Unfortunately, spreading rate has been considered almost entirely from the point of view of economy in consumption of paint, and its bearing on the thickness of coating necessary for good durability has been largely overlooked (11,23).

If paint is spread uniformly on a smooth, nonabsorptive surface the thickness of the wet film in inches, T_W, is related to the spreading rate in square feet per gallon, S, by the equation

$$T_W = 231 \div 144\ S.$$

The wet film thickness can be measured directly immediately after application by means of a Pfund film gage (23,24 p. 103) or an Interchemical film gage (20). The wet film shrinks in thickness as the volatile ingredients evaporate. A small increase in volume of the drying oil during drying (29 p. 21) may be

neglected. The thickness of the dry film, therefore, is

$$T_d = 231\ nv + 144\ S,$$

in which nv is the fraction of the nonvolatile ingredients (pigment plus nonvolatile vehicle) in the paint by volume. Bare wood, however, is an absorptive surface; part of the priming paint sinks into the lumina of wood cells that open into the surface and part of the oil from the paint penetrates still deeper into the wood (3,24 p. 134, fig. 215, 26). There is no convenient technique for measuring these losses and they undoubtedly vary with the nature of the wood, the composition of the paint, and the spreading rate, but many observations at the Forest Products Laboratory indicate that reasonable agreement between estimated and directly measured thickness of dry film is obtained by assuming that half of the nonvolatile vehicle and all of the volatile thinner are lost during drying, so that

$$T_d = 231\left[1 - 1/2\ (nv - p) - (1 - nv)\right] + 144\ S,$$

in which p is the fraction of total pigment in the paint by volume. The equation reduces to

$$T_d = 231\ (nv + p) + 2 \times 144\ S.$$

Dry film thickness can be measured directly by carefully cutting sections through the painted surface for observation under a microscope with micrometer eyepiece (24, p.143).

To illustrate the calculation of dry film thickness, assume that a priming coat containing p = 0.25 and nv = 0.70 is applied to bare wood at 450 square feet per gallon. For the priming coat,

$$T_d = 231\ (0.70 + 0.25) + 2 \times 144 \times 450 = 0.00169 \text{ inch}$$

and for the finish coat,

$$T_d = 231 \times 0.90 + 144 \times 550 = 0.00262 \text{ inch.}$$

The estimated thickness of the resulting coating is then

$$0.00169 + 0.00262 = 0.0043 \text{ inch.}$$

During exposure to the weather the film thickness shrinks, at first as a result of contracting of the drying oil (17) and later from chalking and erosion. Coatings of house paint lose from 0.0004 to 0.0007 inch of thickness yearly, according to the kind of paint, when exposed to the weather facing south at Madison, Wisconsin.

Two-Coat Painting With Self-Priming

In a series of tests of two-coat initial painting with self-priming started in 1924 at Madison, Wis., the two-coat work was done by merely omitting the undercoat of the three-coat work, just as the label directions of many paint manufacturers often recommended. Left-hand halves or test panels (fig. 1) received two-coat jobs and right-hand halves three-coat jobs. Panels were

painted at four levels of spreading rate which were roughly for priming and finish coats, respectively (1) 1,600 and 3,000 (2) 1,200 and 1,300 (3) 950 and 900, and (4) 650 and 600 square feet per gallon. The first level represented the scantiest and the fourth level the fullest application practicable on vertical surfaces with these typical paints of that period. On the left half of panel 91 in figure 1 the coating was 0.0023 and on the right half 0.0035 inches thick initially; on panel 92, left, it was 0.0035 and on 92 right, 0.0055 inch thick; on panel 95, left, 0.0026, the right, 0.0044 inch thick; and on panel 96 left, 0.0043, and right, 0.0063 inches thick. Similar tests were made also on panels of white pine.

Details of the technique of testing of the Forest Products Laboratory (8) and of the methods of evaluating results (4) have been published. Paints are described in the concise terminology and symbols of the Laboratory's system (14) as outlined in Appendix I to this report.

Two paints were used in the 1924 tests. One was pure white lead paint, paint L, mixed for finish coat with p = 0.246 and nv = 0.962, for undercoat with p = 0.272 and nv = 0.724, and for priming coat with p = 0.181 and nv = 0.761. The second was paint $(LZ_{30})_{80}$, mixed for finish coat with p = 0.226 and nv = 0.922, for undercoat with p = 0.201 and nv = 0.820, and for priming coat with p = 0.174 and nv = 0.807.

Table 1 reports the amount of paint and of paint nonvolatile applied to each test area in gallons per 1,000 square feet, the estimated thickness of the coating in inches, the initial appearance of the coating, and its durability. The judgments of initial appearance are based on adequacy of hiding of the grain of the wood and on uniformity of gloss. To hide the wood completely, a coating not less than 0.05 inch thick proved necessary. Most house owners, however, were satisfied at that time by a degree of hiding corresponding to the rating "fair," which was obtained with coatings approximately 0.035 inch thick. All coatings that attained ratings of "fair" or "good" in initial appearance dried with uniform gloss and weathered without spotted chalking, indicating that the priming and undercoat in three-coat work succeeded in sealing the wood against absorption of oil from the finish coat. With the paints used hiding power was a fairly reliable guide to the amount of paint required both to escape uneven gloss and spotted chalking and to attain reasonably good durability.

Both of the paints used develop characteristic checking patterns comparatively early, usually during their second year of exposure. With paint L, the checking pattern is reticulate practically from its beginning but with paint $(LZ_{30})_{80}$ it begins with parallel pattern and becomes reticulate later on. With both paints, checking began a little earlier and became somewhat more conspicuous in the thicker coatings than it was in the thinner ones.

The results indicate that durability is a function of the thickness of the coating, not of the number of coats. At any given film thickness the durability was about the same whether the thickness was built up with two coats or with three. The paints used, however, were designed primarily for use in

three-coat work and were too low in content of pigment to be convenient for application in the thick coats necessary for good two-coat work. Under many conditions of weather there would undoubtedly have been trouble with wrinkling during drying of the finish coats applied at the lowest level of spreading rate in these experiments. The results therefore indicate that two-coat initial painting by mere omission of the undercoat of three-coat work is impracticable even when priming and finish paints are applied in the thickest coats possible. To make two-coat work practicable, the paints must be properly designed for application in thick coats.

Accordingly, further exposure tests were made in 1926 in which paint $(LZ_{30})_{80}$ was redesigned with higher content of pigment and was then thinned differently for two-coat and for three-coat work. As made up, the paint contained p = 0.242 and nv - 0.923. This was considered a high level of pigmentation in 1926 but is not so considered at the present time. The paint was used unthinned for finish coat in two-coat work but for finish coat in three-coat painting it was thinned with 1/2 pint of linseed oil per gallon. The thinning for all coats together with the spreading rates, amount of paint applied, estimated thickness of coating, and durability are recorded in table 2. The paint was tested in white, ivory, and gray colors on panels of southern yellow pine.

Coatings of practically equal thickness were obtained in both two-coat and three-coat work, and the resulting durabilities were likewise practically equal (fig. 2). All of the coatings dried with uniform gloss and color and during exposure, gloss was lost and chalking and fading developed uniformly on all panels. The durabilities observed agreed closely with those found for coatings of similar thickness of paint $(LZ_{30})_{80}$ on southern yellow pine in the 1924 tests. As in the 1924 tests, checking began a little earlier and became more conspicuous in three-coat work than in two-coat work. The results, therefore, disagree with the ancient dictum that "three thin coats are better than two heavy ones" (28 p.42).

Between 1926 and 1931 there were six other series of exposure tests started by the Forest Products Laboratory in which two-coat and three-coat initial painting with self-priming were compared. Besides Madison, exposures were made at Tucson, Ariz., Fresno, Calif., and St. Paul, Minn. In addition to paints L and $(LZ_{30})_{80}$, the following paints were tested: LZ_{55}, LZ_{23}, $(LZ_{37})_{72}$, $(LZ_{20})_{80}$, $(TZ_{23})_{83}$, and $(SZ_{30})_{69}$. Tests were made on western redcedar, redwood, ponderosa pine, eastern white pine, red pine, and southern yellow pine. In one of the series, four-coat initial painting was compared with three-coat and two-coat painting. All of these series indicated that the durability depends upon the thickness of the coating regardless of the number of coats. The following conclusions were published in 1934 (6) as a result of the tests made at St. Paul in cooperation with the Northwestern Paint and Varnish Production Club and the Minnesota chapter of the Painting and Decorating Contractors of America:

"With the white lead paint and the titanium and zinc paint the best two-coat job proved equal or superior in durability on the whole to the best three-coat job on the same boards. With the lead and zinc paint the best two-coat job was

slightly inferior to the best three-coat job except on redcedar, where it was better. By reason of the higher pigment concentrations and lower spreading rates followed in the two-coat painting, roughly similar total quantities of paint were applied in the two-coat and three-coat jobs. It is evident that two-coat painting when done in the manner followed in these experiments is thoroughly practicable and gives coatings that closely approach good three-coat work in durability and prove distinctly better than poor three-coat work."

As indicated by table 1 and confirmed by the later tests, the desirable thickness of coating for good durability with most house paints seems to be of the order of 0.0045 to 0.0055 inch. Thicker coatings may be still more durable, but the checking or cracking patterns developed as the paint ages tend to become too conspicuous. To attain a film thickness of 0.0045 inch in two-coat work the primer should be applied at a spreading rate of approximately 450 square feet per gallon and the finish coat at 500 square feet per gallon. To do so under practical working conditions, paints are required of higher consistency and higher content of pigment than the industry was accustomed to offering until about 1936. In the Wood Handbook of the Forest Products Laboratory, when first published in 1935 (21), it was reported that: "Much painting of new wood is now done with only two coats, but this practice frequently leads to unsatisfactory results. When properly done, two-coat painting is practicable, but it requires more skillful workmanship than three-coat painting."

Two-Coat Painting With Special Primer

In 1936 the Forest Products Laboratory started a series of exposure tests on two-coat and three-coat initial painting with special primers. The purpose was to study the case in which a special primer is offered to supplement a conventional line of prepared paint, or simply for use "under any good house paint." It was not intended to represent the case in which the finish paint as well as the primer is designed for application in thick coats and the two are offered together as a two-coat system meeting the requirements for the best standards of painting. The special primers used in the tests were either commercial products submitted by their manufacturers with the request that they be tested or were made according to formulas proposed by manufacturers of raw materials and known to be in commercial use. Eight finish paints were used over each primer; seven of these were made at the Laboratory to represent the range in types of prepared paints on the market at that time, and one was white lead paint mixed from commercial soft past white lead.

The tests were made on panels of Douglas-fir and southern yellow pine exposed vertically facing south at Madison, Wis. These woods were chosen because one object of the test was to learn whether the special primers give better service than self-priming on such woods and if so, how they compare for that purpose with aluminum primer. The series occupied five units, numbers 19 to 23, inclusive, of test fence No. 3. Each unit was 6 feet long by 7.5 feet high and was covered with 16 boards of 6- inch drop siding, alternately Douglas-fir and southern yellow pine. Each unit was marked off into four vertical strips, each 1.5 feet wide, for priming with three special primers and self-priming, respectively. For subsequent coats of finish paint the units were subdivided