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The term "Controlled Penetration" used so extensively in describing the performance of paint undercoaters is a "catch the eye" phrase meaning little or nothing.

Instead of how much oil shall be permitted to soak into the wood. it is rather a dual situation of how much oil in quantity shall remain in the paint film, and how much shall go into the wood surface.

In two paint undercoats, the same percentage of oil may penetrate into the wood, yet one paint will give excellent durability and the other fail badly, because in the second case there was not sufficient oil present to provide for the proper quantity in the film and also in the wood.

In practical formulations of undercoaters, the pigments used control in a large measure the amount of the oil retained in the paint film. The outstanding success of White Lead as a highly durable paint pigment is due in an essential measure to its ability to retain the proper amount of oil in the film for maximum durability.

Most pigments vary materially in their ability to control the performance of the oil, some retaining an excessive amount in the paint film, some giving too much oil to the wood surface over which applied and the problem of a wise selection is important.

Ozlo Leaded Zinc is the only other pigment we know of which has an oil holding quality closely similar to that of White Lead. These two pigments are the predominant constituents of S-W's #450 Undercoater and control the balance of oil in the film and in the wood.

Illustration:

In two undercoat paints containing the same volumes of oil and pigment, which in one case was White Lead and in the other Ozlo Leaded Zinc, spread equally on a normal wood surface -

22.5 gal. oil went into the wood and 24.8 gal. retained in the film of the WL Pt.
 21.0 " " " " " " " 26.3 " " " " " " Ozlo
 Leaded Zinc Pt.

If the combination of pigments used do not have the proper oil holding qualities the formula becomes unbalanced and frequently an insufficient amount of oil will be retained in the film, tending to lower durability, peeling, flaking, etc.

Aside from a pigment combination of proper oil holding qualities, there must be sufficient oil present to thoroughly saturate the wood fibres at and near the surface to prevent undue alternate swelling and shrinking of the wood surface during rainy and dry weather, thus producing a solid foundation for the paint undercoat; otherwise, poor durability can result with attendant peeling and flaking of the paint film.

The performance of two well known paint primers, designated as Primers "A" and "B" compared with S-W's #450 Undercoater is shown by the following figures, on the basis of 100 gallons of paint.

	Total Oil	Oil Absorbed	Oil in Film	Per Cent Oils and	
	Gals.	Gals.	Gals.	Oil	Pigment
Paint Primer "A"	39.7	22.2	17.5	40%	60%
Paint Primer "B"	46.5	28.6	17.9	43	57
S-W #450 Undercoater	47.3	25.1	22.2	47	53

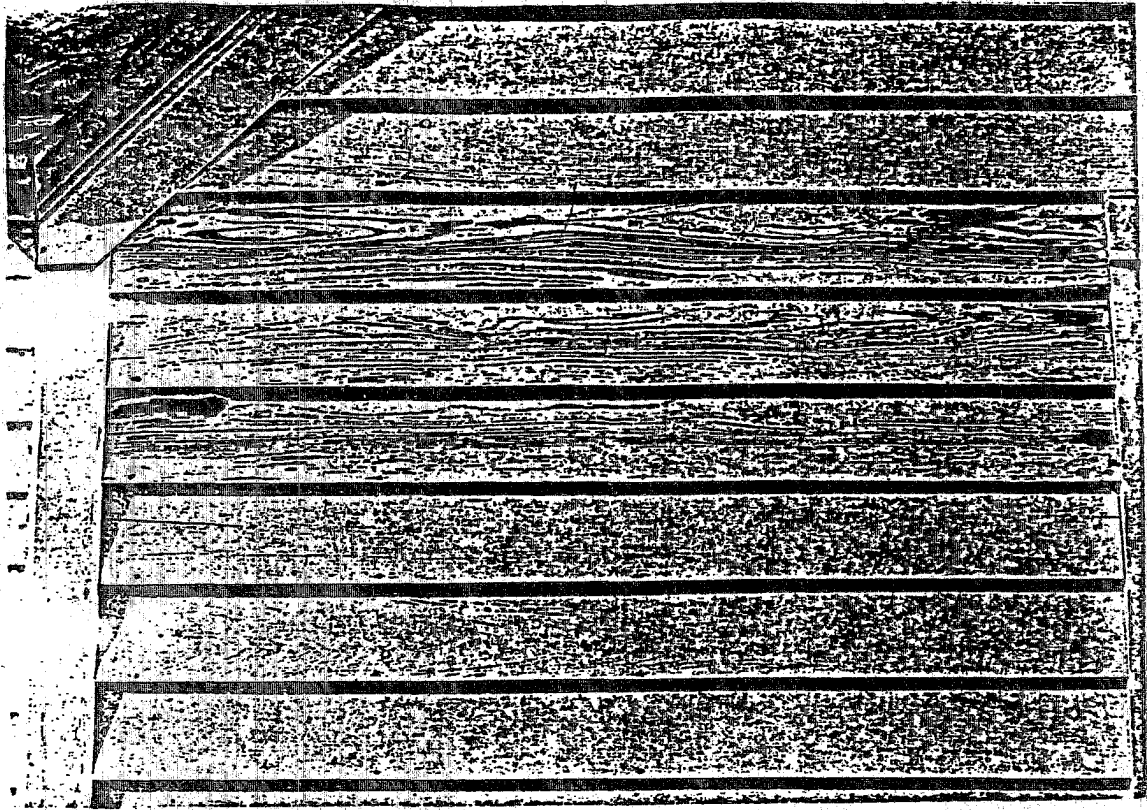
Comparing Primer "A" with S-W's #450 Undercoater, it appears to be deficient both in its capacity to supply sufficient oil to the wood surface and also to retain sufficient oil in the paint film, to ensure high durability.

The common varieties of wood used in house construction vary materially as to their porosity and in the amount of oil required to "satisfy" the wood surface. It is obvious that S-W #450 Undercoater has a considerably greater margin of safety in doing this job adequately and giving excellent durability over a wide variety of wood surfaces.

Comparing Primer "B" with S-W's #450 Undercoater, we note that while the total oil content is excellent, it appears unbalanced in its capacity to retain oil in the paint film. A deficiency in this respect can be serious as to durability as above indicated.

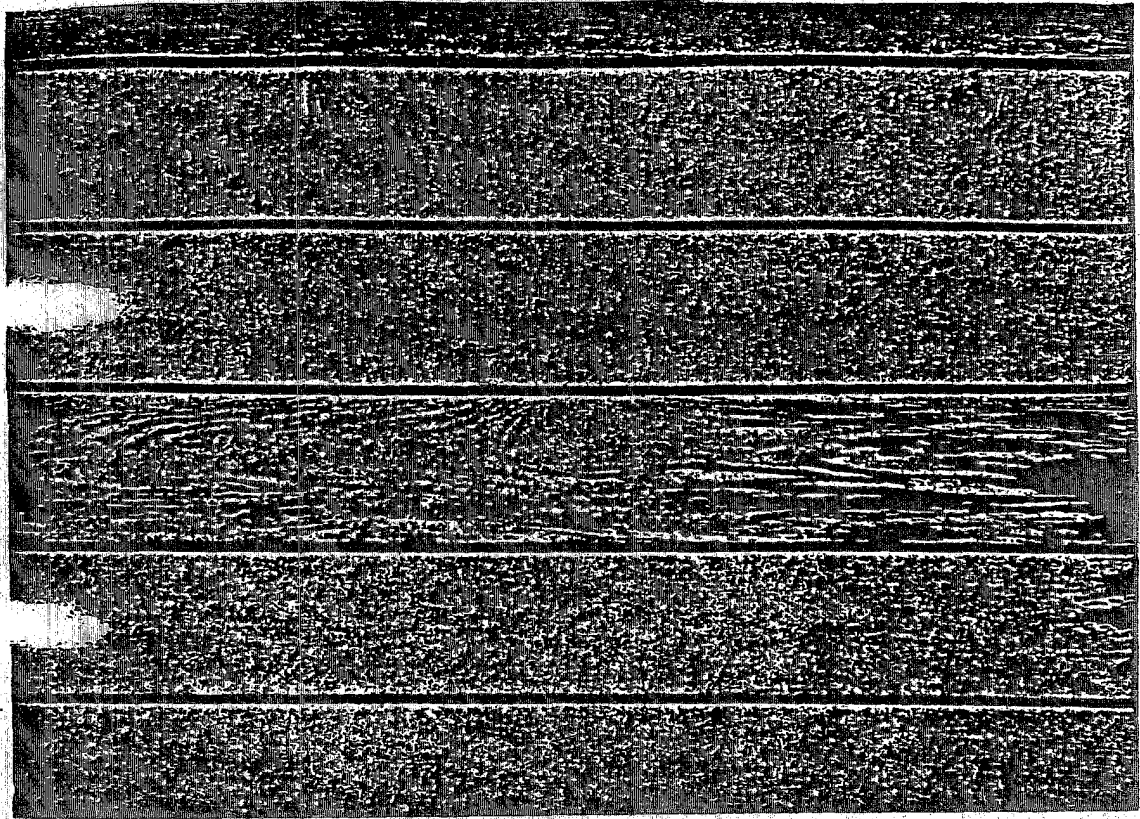
Neither Paint Primer "A" or "B" contains Ozlo Leaded Zinc, regarded as a most necessary type of pigment to give balanced performance of the oil in both the film and on the wood surface. S-W #450 Undercoater does contain the proper percentage which together with the high White Lead content serves to maintain a balanced performance.

It is to be noted that a lack of balance may not show a lowered durability until one or two years after application of the paint, when peeling or flaking from the wood may occur, or peeling between coats due to a lack of "balance" between the Primer and the Finish Coat.



Unbalanced Primer Resulting
in Peeling from the Wood

0007-SWP-000006700



Additional Example Showing
Peeling from the Wood

0007-SWP-000006701



Unbalanced Relation Between Primer and
Finish Coat Resulting in Peeling Between
Coats

0007-SWP-000006702

A very important factor governing the durability of any paint system is the total film thickness of that paint system as actually applied on a given surface. Obviously, the actual film thickness of a given undercoat as applied depends principally on

- (a) Volume of pigment plus inert
- (b) Total volume of vehicle solids
- (c) Per Cent of oil absorbed and per cent retained in film

It is generally agreed that for an exterior paint system to have adequate protective value and to give satisfactory service that the total actual film thickness should not be less than 0.004". Referring to Table 1 attached, it is interesting to note that the larger amount of oil retained in the film by Rex 450 and the New Jersey Zinc type primer definitely contributes to greater film thickness and therefore better durability of the system.

The spreading rate obtained with any particular primer or undercoater under practical painting conditions will vary according to its specific characteristics. Assuming two spreading rates within a reasonable range, i.e., 400 and 500 square feet per gallon respectively, and allowing for absorption of vehicle solids, we find that the actual film thickness contributed by the various first coats are as follows:

	<u>400 sq.ft./gal.</u>	<u>500 sq.ft./gal.</u>
Krebs		
Broeker's 1st Coat	0.00144"	0.00115"
SWP Outside White		
1st Coat Reduction	0.00145"	0.00116"
W.L. in Oil 1st Coat	0.00122"	0.00098"
New Jersey Zinc Primer	0.00199"	0.00159"
450 Undercoater	0.00192"	0.00154"
Paint Primer "A"	0.00167"	0.00134"
Paint Primer "B"	0.00173"	0.00139"

The greater film thickness of #450 Undercoat as compared with white lead in oil, and primers such as "A" and "B," naturally makes a greater contribution toward the final film thickness of the entire paint system applied. Other things being equal, superior durability would result.

Table 1
Paint Primers
Distribution of Oil Between Wood and Paint Film

Formula	Total Oil Per 100 Gals.	Gals. Abs.	Gals. in Film	Gals. Pig- ment	P.V.C. Paint	P.V.C. Film	% Oil Abs.	Vol. of Film Gals.
Krebs' 1st Coat	68.3	50.5	17.8	18.1	21.0%	50.5%	74.0%	35.9
SWP Outside White 1st Coat Reduction	66.6	49.5	17.1	19.1	22.3	53.0	74.4	36.2
White Lead in Oil 1st Coat	58.5	45.7	12.8	17.9	23.0	58.0	78.0	30.4
New Jersey Zinc Primer	58.9	35.0	23.9	25.6	30.2	51.7	59.5	49.5
450 Undercoater	47.3	25.1	22.2	25.7	35.2	53.7	53.0	47.9
Paint Primer "B"	46.5	28.6	17.9	23.9	33.9	57.2	61.5	41.8
Paint Primer "A"	39.7	22.2	17.5	25.8	39.6	59.5	55.8	43.3

Table 2
Effect of Individual Pigments in 450 Undercoater Type of Formulation

Pigment	Total Oil Per 100 Gals.	Gals. Abs.	Gals. in Film	Gals. Pig- ment	P.V.C. Paint	P.V.C. Film	% Oil Abs.
Titanox B	47.3	26.7	20.6	25.7	35.2%	55.6%	56.5%
White Lead	47.3	22.5	24.8	25.7	35.2	50.8	47.5
Leaded Zinc 35/65	47.3	21.0	26.3	25.7	35.2	49.5	44.4
Asbestine	47.3	13.72	33.58	25.7	35.2	43.0	29.0
Asbestine 75% Amorphous Silica 25%	47.3	14.75	32.55	25.7	35.2	43.3	31.2
Amorphous Silica (calc.)	47.3	17.9	29.4	25.7	35.2	46.6	37.8
Titanium Oxide	47.3	5.91	41.39	25.7	35.2	38.8	12.5

Table 3
Effect of Oils in 450 Undercoat on Type of Pigmentation

Vehicle	Total Oil Per 100 Gals.	Gals. Abs.	Gals. In Film	Gals. Pig- ment	P.V.C. Paint	P.V.C. Film	% Oil Abs.
Combined Vehicle Rex 450	47.3	25.1	22.2	25.7	35.2%	53.7%	53%
(2)	47.3	27.4	19.9	25.7	35.2	56.3	58%
(785)*	47.3	26.5	20.8	25.7	35.2	55.2	56%
(2) 45% (2281) 55%	47.3	23.2	24.1	25.7	35.2	51.6	49%
(2281) (Calc.)**	47.3	19.9	27.4	25.7	35.2	48.3	42%
(2)	50.3	29.8	20.5	25.7	33.8	55.5	59.2%
(785)	50.3	29.7	20.6	25.7	33.8	55.5	59.0%

* Slightly heat bodied Linseed Oil

** Strongly bodied Tung and Perilla Oil

Table 4
Absorption of Oil From Finish Coat by Priming Coats

	Top Coat	Total Gals. Oil/100 Gals.	Gals. Abs.	Gals. Left	% Abs.	Orig. P.V.C.	P.V.C. Film
SWP - Outside White	Rex 471	66.5	4.25	61.25	6.4%	28.4%	29.7%
450 Undercoat	Rex 471	66.5	3.86	62.64	5.8	28.4	29.6
Paint Primer "A"	Rex 471	66.5	4.25	61.25	6.4	28.4	29.7

CIH & FMV:MLK