EVALUATION OF INTERIOR AND EXTERIOR LATEX PAINTS

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SUMMARY

The wood panels that have only one coat of paint over bare wood and one coat of paint over primed wood are continuing to show signs of deterioration. The wood panels that have two coats of paint over bare wood and two coats of paint over primed wood are deteriorating at a different rate for certain paints than presented in the third report.

These results indicate that there is at present no satisfactory way to predict long term durability of paints other than the time consuming process of outdoor exposure.

IMPLEMENTATION

The research findings of this report enabled the DOTD Materials personnel to write specifications that will produce a good long lasting latex coating which will give good protection to wood. This type of coating, when specified properly as to pigment composition and type of emulsified binder, will yield aesthetic qualities to a previously unsightly surface.

INTRODUCTION

This is the fourth report written on the evaluation of interior and exterior latex paints. In the first interim report, it was proposed to measure by X-ray techniques the thickness of thin paint films before and after weatherometer or outdoor exposure and, from the results, predict the useful life of the paint.[1]

The second interim report was concerned primarily with establishing the value of using thin films of paint on various substrates. The rate of erosion of each paint was determined from the calculated value of wet films of paint together with X-ray monitoring. Secondly, color change and light reflectance on wood and concrete substrates aided in determining the performance of each coating after an exposure period of 1 1/2 years at 45° south. Finally, a scanning electron microscope was used to obtain a few electron micrographs of weathered coated and uncoated wood panels and of coated aluminum panels.[2]

In the third interim report the general appearance of each coat and reflectance and color change on wood and concrete substrates were emphasized. Also, it was decided that X-ray monitoring was of no value since all of the thin films that were applied over the wood substrates had completely deteriorated.[3]

This report deals with a continuation of outdoor exposure of the paints on wood and concrete panels. A final rating on the basis of general appearance has been made by several independent researchers.

SCOPE

The scope of this project is twofold:

1. The primary aim of this project is to find a number of highly qualified interior and exterior latex paints.

2. The secondary aim is to develop, where necessary, suitable methods for the rapid evaluation of such paints.

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[1] R. W. Kewish, Evaluation of Interior and Exterior Latex Paints, Interim Report No. 1 (Baton Rouge: Louisiana Department of Highways, 1974).

[2] R. W. Kewish and Sidney A. Rathe, Evaluation of Interior and Exterior Latex Paints, Interim Report No. 2 (Baton Rouge: Louisiana Department of Highways, 1975).

[3] David G. Azar, Evaluation of Interior and Exterior Latex Paints, Interim Report No. 3, (Baton Rouge: Louisiana Department of Transportation and Development, 1977).

PROCEDURE

Twenty-four (twenty-three recovered) coatings underwent outdoor exposure. The length of exposure for a wood substrate was about 4 years, and the length of exposure over a concrete substrate was 1500 hours of accelerated weathering in an Atlas Weatherometer, plus 4 years of outdoor exposure. All outdoor exposures were at a 45° angle with the horizon facing due south.

As discussed in the third report, the method employed in evaluating the coatings used over different substrates was a subjective and relative rating encompassing chalking, cracking, delamination, and mildew called general appearance.

DISCUSSION OF RESULTS

In Table 1, the general appearance rating of coatings over concrete panels for 2 1/2 and 4 years are compared. There is general agreement, but for certain specific paints there are marked differences in ratings after 2 1/2 years and 4 years. For example, company F's white paint faired much better in the 2 1/2 to 4 year interval than the other white paints; however, their green paint degraded much faster than the other green paints. Also, companies J and G had better ratings after 4 years than after 2 1/2 years for their green paints.

In Table 2, the general appearance ratings of one and two coatings of white paint over primed wood panels are illustrated. Again there are some general agreements in the 2 1/2 years of exposure findings, but in many cases the degradation rate between 2 1/2 years and 4 years has changed. Here, companies B and E with a one-coat application showed marked improvement in ratings after 4 years as opposed to their 2 1/2 years ratings. Company K with a one-coat application degraded faster in the 2 1/2 years to 4 years interval than the other companies.

For the two-coat application, Companies I and F received considerable improvement in ratings after 4 years as compared to their 2 1/2 years rating. Companies D, C, and B with a two-coat application degraded faster in the 2 1/2 years to 4 years interval than the other competing companies did.

In Table 3, the general appearance ratings of one and two coatings of white paint over bare wood panels after 4 years indicate variance with previous results obtained after 2 1/2 years of exposure. This is the same anomalous trend for certain paints that the other two tables provided. Companies I, D, and C for the one-coat application degraded less rapidly in the 2 1/2 years to 4 years interval than the other companies did. But company J's paint degraded faster in the same period than its competition. For the two-coat application, again, Company I, along with Company F, showed marked improvement in ratings after 4 years as opposed to their 2 1/2 years ratings. Companies D, C, and B degraded faster in the 2 1/2 to 4 years interval than the other white paints.

In Table 4, the general appearance ratings of one and two coatings of green paints over primed wood panels are presented. The anomalous trend is reduced but still present on a limited basis. For the one application, Company H for the first time showed a significant improvement in rating after 4 years, compared to its rating after 2 1/2 years. Company F had a significant loss in rating after 4 years compared to its rating after 2 1/2 years. For the two-coat application, the only really outstanding change was for Company D. In this case, the loss in rating after 4 years compared to 2 1/2 years is graphically illustrated.

In Table 5, the general appearance ratings of one and two coatings of green paint over bare wood panels are listed. Here the results are similar to the third report except for Company D (one coat) and Company B (two coats) showing improved durability.

Table 6 of the appendix lists the light reflectance values obtained using a Hunter Color Meter for both the white and green coatings over concrete panels. These samples were prepared and received 1500 hours weatherometer exposure prior to outdoor exposure at a 45° angle facing south. The outdoor exposures recorded are for zero years, 1 1/2 years, 2 1/2 years, and 4 years. The general trend of Table 6 indicates that the light reflectance has decreased with time through the four-year period.

The readings taken after 1 1/2 years, 2 1/2 years, and 4 years of exposure indicate a general decrease in reflectance over the original values. Theoretically, a rise due to chalking and subsequent pigment exposure would have been expected. One possible explanation for the decrease in reflectance is that the expected rise in reflectivities took place on the concrete panels before the first reading, at which time the reflectivities had already begun to decline. Since the concrete surface was rough compared to the wood, it follows that the coatings would wear faster on concrete. The uneven concrete surface dictates an uneven film of paint, with the concrete peaks wearing through the paint film at a faster rate due to the fact that they are covered by a thinner film. The rougher surface may also contribute to dust retention in the concrete panels, another contributing factor in the decrease in reflectivity.

Table 7 lists the light reflectance values obtained using a Hunter Color Meter for both white and green coatings over bare wood and wood previously primed with a black coating. The general trend, with few exceptions, indicates the two-coat application gives superior performance as far as light reflectance is concerned. In several instances, there were

definite increases in reflectance values for both the white and green coatings. The two-coat application of the same coating over itself indicated better reflectance values than one-coat over primed wood, whereas the two-coat application over bare wood was similar in performance to the two-coat application over primed wood.

Table 8 lists the color changes in the green coatings when applied over a concrete substrate. The trend for each coating was established in the second interim report. Basically, all the coatings were reported to be shifting from a green color toward a neutral. This fading was indicated by a decrease in the "a" value and an increase in the "b" value. After 4 years' exposure, the trend in the "a" value changes has continued; however, the "b" value changes do not show any consistent trend.

Table 9 lists the color changes that were measured in the green coatings over a wood substrate using a Hunter Color Meter. As can be noticed, the changes in the "a" and "b" values for the major part are not following the pattern established during the second and third interim report, that is, a reduction in both the "a" and "b" values. The values obtained for two coats over bare wood and two coats over primed wood are very close, indicating that the wood is playing a negligible part in forcing failure of the coating due to oils from the wood entering the coating and causing yellowing.

From all nine tables the results seem to indicate that long term wearability can only be determined by actual long term exposure. Although certain companies' paints continued to degrade in a somewhat predictable manner, there is no way to tell before experimentation which companies' paints will show improved durability upon further exposure.

CONCLUSIONS

The results of this report did not yield any suitable method for the rapid evaluation of paints. The X-Ray diffraction method of tracing pigment disappearance was not considered successful.

Practically all the latex paints studied were considered good. There were, however, several paints that were in a superior class. The pigments and emulsified binders for these paints were evaluated and will be used in writing specifications for latex based paints.

APPENDIX

TABLE 1

GENERAL APPEARANCE RATING
OF COATINGS OVER CONCRETE PANELS
(2 1/2 and 4 year exposure)

	White Paint		Green Paint	
Ranking*	4 Year	2 1/2 Year**	4 Year	2 1/2 Year**
1	Company J	Company J	Company K	Company F
2	Company E	Company E	Company B	Company A
3	Company A	Company I	Company E	Company B
4	Company F	Company B	Company J	Company K
5	Company B	Company D	Company G	Company I
6	Company I	Company A	Company A	Company E
7	Company D	Company K	Company D	Company J
8	Company C	Company H	Company C	Company G
9	Company K	Company F	Company F	Company D
10	Company L	Company C	Company H	Company C
11	Company H	Company G	Company D	Company H
12	Company G	Company L		

* 1 being the best

** See Report #3

TABLE 2

GENERAL APPEARANCE RATING
OF WHITE PAINT COATINGS OVER WOOD PRIMED PANELS
(2 1/2 and 4 year exposure)

	1 Coat		2 Coats	
Rating*	4 Year	2 1/2 Year**	4 Year	2 1/2 Year**
1	Company I	Company I	Company K	Company K
2	Company F	Company J	Company L	Company J
3	Company E	Company D	Company J	Company L
4	Company D	Company D'	Company I	Company D'
5	Company B	Company F	Company F	Company C
6	Company J	Company K	Company G	Company B
7	Company D'	Company L	Company C	Company G
8	Company G	Company C	Company D'	Company A
9	Company C	Company B	Company B	Company H
10	Company K	Company G	Company E	Company I
11	Company L	Company A	Company D	Company D
12		Company H		Company F
13		Company E		Company E

* 1 being the best

** See Report #3

TABLE 3

GENERAL APPEARANCE RATING
OF WHITE PAINT COATINGS OVER BARE WOOD PANELS
(2 1/2 and 4 year exposure)

	1 Coat		2 Coats	
Rating*	4 Year	2 1/2 Year**	4 Year	2 1/2 Year**
1	Company G	Company D	Company K	Company K
2	Company I	Company J	Company L	Company J
3	Company D'	Company G	Company J	Company L
4	Company D	Company L	Company I	Company D'
5	Company C	Company A	Company F	Company C
6	Company L	Company K	Company G	Company B
7	Company K	Company I	Company C	Company G
8	Company B	Company D'	Company D'	Company A
9	Company J	Company B	Company B	Company H
10	Company F	Company C	Company E	Company I
11	Company E	Company H	Company D	Company D
12		Company E		Company F
13		Company F		Company E

* 1 being the best

** See Report #3

TABLE 4

GENERAL APPEARANCE RATING
OF GREEN PAINT COATINGS OVER WOOD PRIMED PANELS
(2 1/2 and 4 year exposure)

	1 Coat		2 Coats	
Rating*	4 Year	2 1/2 Year**	4 Year	2 1/2 Year**
1	Company K	Company K	Company K	Company K
2	Company J	Company J	Company E	Company J
3	Company G	Company I	Company J	Company I
4	Company I	Company F	Company I	Company F
5	Company H	Company E	Company F	Company E
6	Company E	Company G	Company B	Company D'
7	Company A	Company D'	Company G	Company B
8	Company C	Company B	Company H	Company A
9	Company F	Company A	Company A	Company G
10	Company D'	Company H	Company C	Company H
11	Company B	Company C	Company D'	Company C

* 1 being the best

** See Report #3

TABLE 5

GENERAL APPEARANCE RATING
OF GREEN PAINT COATINGS OVER BARE WOOD PANELS
(2 1/2 and 4 year exposure)

	1 Coat		2 Coats	
Rating*	4 Year	2 1/2 Year**	4 Year	2 1/2 Year**
1	Company K	Company K	Company K	Company K
2	Company J	Company J	Company E	Company J
3	Company A	Company G	Company J	Company I
4	Company I	Company A	Company I	Company F
5	Company D'	Company I	Company F	Company E
6	Company G	Company B	Company B	Company G
7	Company B	Company F	Company G	Company D'
8	Company F	Company H	Company H	Company B
9	Company E	Company D'	Company A	Company A
10	Company H	Company E	Company C	Company H
11	Company C	Company C	Company D'	Company C

* 1 being the best

** See Report #3

TABLE 6

Concrete Panels

Light Reflectance
(Y, Hunter Color and Color Difference Meter)

Exposure:		0	1500 hrs. weatherometer, plus 1-1/2 yrs. outdoors, 45° south	1500 hrs. weatherometer, plus 2-1/2 yrs. outdoors, 45° south	1500 hrs. weatherometer plus 4.0 yrs. outdoors, 45° south
Sample	Color				
A	White	81.33	74.31	70.87	66.05
	Green	64.55	59.89	61.40	56.13
B	White	88.84	77.60	77.93	71.74
	Green	45.50	49.52	49.05	44.60
C	White	76.61	71.54	70.81	61.15
	Green	81.77	73.77	72.18	
D	White	91.80	79.99	75.06	55.06
	Green	72.15	63.18	58.57	
E	White	90.62	79.78	77.59	75.35
	Green	66.09	62.94	60.14	54.06
F	White	84.72	69.03	73.08	70.58
	Green	68.24	61.51	60.70	
G	White	81.99	69.54	69.07	65.62
	Green	61.44	59.34	58.66	58.08
H	White	86.44	77.23	75.32	66.56
	Green	64.95	55.79	55.61	49.47
I	White	84.11	76.53	74.73	71.23
	Green	54.35	52.46	48.94	
J	White	82.82	75.61	73.61	72.55
	Green	56.83	60.38	59.59	57.40
K	White			76.83	68.74
	Green			51.73	51.22

TABLE 6
(continued)

Exposure:	0	1500 hrs. weatherometer, plus 1-1/2 yrs. outdoors, 45° south	1500 hrs. weatherometer, plus 2-1/2 yrs. outdoors, 45° south	1500 hrs. weatherometer, plus 4.0 yrs. outdoors, 45° south
Sample Color				
L White			72.93	65.89
D' White (Tint Base)			75.70	

A decrease in the light reflectance means dirt and/or mildew collection and/or flaking off or erosion of the paint. With a green paint an increase in the light reflectance indicates fading.

TABLE 7

WOOD PANELS

(Exposed Outdoors at 45° south)
Light Reflectance
(Y, Hunter Color and Color Difference Meter)

Company	Color	1 coat over Bare Wood	2 coats over Bare Wood	1 coat over Primed Wood	2 coats over Primed Wood
A					
	Green	57.33	64.40	55.66	61.31
B	White	79.70	70.58	82.85	69.51
	Green	40.25	47.22	42.57	46.63
C	White	66.61	70.02	69.51	71.95
	Green	53.01	70.25	68.32	71.41
D	White	65.17	74.76	71.11	69.27
	Green	44.87	54.91	53.50	56.66
E	White	35.89	77.82	77.33	79.05
	Green	48.48	64.26	58.93	63.36
F	White	50.02	77.37	76.04	78.37
	Green	56.85	64.00	61.82	62.39
G	White	70.18	68.12	70.49	69.56
	Green	55.60	59.15	57.88	57.32
H					
	Green	48.19	58.69	58.06	52.36
I	White	72.63	75.76	75.23	77.76
	Green	49.45	51.63	53.06	51.05
J	White	62.09	79.51	74.77	78.87
	Green	57.08	58.65	57.89	57.31
K	White	71.16	83.65	76.66	81.35
	Green	50.00	52.14	52.86	51.68
L	White	71.66	80.27	66.31	81.19

TABLE 8

Concrete Panels

Color Changes, Green Paints
(Hunter Color and Color Difference Meter)

Company	Exposure	a*	b*
A	0	- 6.33	11.54
	1500 hrs. plus 1-1/2 yrs.	- 4.25	11.54
	1500 hrs. plus 2-1/2 yrs.	- 3.11	12.09
	1500 hrs. plus 4 yrs.	- 2.98	11.68
B	0	- 8.50	12.41
	1500 hrs. plus 1-1/2 yrs.	- 4.97	12.00
	1500 hrs. plus 2-1/2 yrs.	- 4.34	12.54
	1500 hrs. plus 4 yrs.	- 4.60	11.59
C	0	- 6.01	10.17
	1500 hrs. plus 1-1/2 yrs.	- 2.31	7.70
	1500 hrs. plus 2-1/2 yrs.	- 2.17	7.67
D	0	- 6.97	6.75
	1500 hrs. plus 1-1/2 yrs.	- 6.40	9.55
	1500 hrs. plus 2-1/2 yrs.	- 5.88	9.13
E	0	- 9.52	12.38
	1500 hrs. plus 1-1/2 yrs.	- 5.71	7.41
	1500 hrs. plus 2-1/2 yrs.	- 5.38	8.26
	1500 hrs. plus 4 yrs.	- 5.42	8.09
F	0	- 7.08	15.23
	1500 hrs. plus 1-1/2 yrs.	- 4.92	12.70
	1500 hrs. plus 2-1/2 yrs.	- 4.09	10.90
G	0	- 8.17	10.16
	1500 hrs. plus 1-1/2 yrs.	- 4.72	8.39
	1500 hrs. plus 2-1/2 yrs.	- 3.97	8.06
	1500 hrs. plus 4 yrs.	- 3.70	7.93
H	0	- 8.50	7.41
	1500 hrs. plus 1-1/2 yrs.	- 4.72	9.22
	1500 hrs. plus 2-1/2 yrs.	- 3.52	10.16
	1500 hrs. plus 4 yrs.	- 3.71	9.46

TABLE 8
(continued)

Company	Exposure	a*	b*
I	0	-10.06	17.62
	1500 hrs. plus 1-1/2 yrs.	- 5.45	8.98
	1500 hrs. plus 2-1/2 yrs.	- 4.46	8.75
J	0	- 5.72	9.50
	1500 hrs. plus 1-1/2 yrs.	- 2.47	9.46
	1500 hrs. plus 2-1/2 yrs.	- 2.21	9.79
	1500 hrs. plus 4 yrs.	- 3.01	9.69
K	1500 hrs. plus 2-1/2 yrs.	-14.06	11.50
	1500 hrs. plus 4 yrs.	-11.40	10.66

*An increase (smaller negative number) in the "a" value indicates a shift from green toward neutral, that is, fading. An increase in the "b" value indicates a shift toward yellow. A decrease in the "b" value indicates a shift toward neutral.

TABLE 9

WOOD PANELS

Color Changes, Green Paints
(2 coats over bare wood)
(outdoor exposure at 45° south)
(Hunter Color and Color Difference Meter)

Company	Exposure	a	b	
A	0	- 6.58	12.15	
	1 1/2	- 5.44	12.39	
	2 1/2	- 3.85	12.09	2 coats over Bare Wood
		- 3.93	12.10	2 coats over Primed Wood
	4	- 4.02	11.74	2 coats over Bare Wood
		- 4.29	12.13	2 coats over Primed Wood
B	0	- 8.75	12.83	
	1 1/2	- 6.21	10.81	
	2 1/2	- 4.89	11.09	2 coats over Bare Wood
		- 4.93	10.73	2 coats over Primed Wood
	4	- 5.80	10.26	2 coats over Bare Wood
		- 5.84	10.41	2 coats over Primed Wood
C	0	- 6.71	11.43	
	1 1/2	- 3.28	5.51	
	2 1/2	- 2.55	6.87	2 coats over Bare Wood
		- 2.63	7.17	2 coats over Primed Wood
	4	- 2.76	5.59	2 coats over Bare Wood
		- 2.77	5.23	2 coats over Primed Wood
D	0	- 7.75	14.22	
	1 1/2	- 6.44	12.48	
	2 1/2	- 5.93	9.93	2 coats over Bare Wood
		- 5.86	9.81	2 coats over Primed Wood
	4 1/2	- 5.82	10.00	2 coats over Bare Wood
		- 5.86	9.72	2 coats over Primed Wood
E	0	- 9.57	12.45	
	1 1/2	- 7.09	7.68	
	2 1/2	- 5.90	8.00	2 coats over Bare Wood
		- 5.48	9.74	2 coats over Primed Wood
	4 1/2	- 6.87	7.59	2 coats over Bare Wood
		- 6.75	6.75	2 coats over Primed Wood

TABLE 9
(continued)

WOOD PANELS

Color Changes, Green Paints
(2 coats over bare wood)
(outdoor exposure at 45° south)
(Hunter Color and Color Difference Meter)

Company	Exposure	a	b	
F	0	- 7.32	15.71	
	1 1/2	- 5.79	13.35	
	2 1/2	- 4.74	10.22	2 coats over Bare Wood
		- 4.60	10.06	2 coats over Primed Wood
	4	- 5.20	10.03	2 coats over Bare Wood
		- 5.20	10.82	2 coats over Primed Wood
G	0	- 8.18	10.50	
	1 1/2	- 6.96	7.15	
	2 1/2	- 6.60	7.31	2 coats over Bare Wood
		- 5.76	6.41	2 coats over Primed Wood
	4	- 6.61	7.17	2 coats over Bare Wood
		- 5.99	6.42	2 coats over Primed Wood
H	0	- 8.61	8.50	
	1 1/2	- 6.90	8.16	
	2 1/2	- 5.03	8.33	2 coats over Bare Wood
		- 5.08	7.43	2 coats over Primed Wood
	4	- 5.56	7.75	2 coats over Bare Wood
		- 4.92	8.89	2 coats over Primed Wood
I	0	-10.43	18.27	
	1 1/2	- 6.42	9.31	
	2 1/2	- 5.12	8.99	2 coats over Bare Wood
		- 5.07	9.20	2 coats over Primed Wood
	4	- 5.38	8.95	2 coats over Bare Wood
		- 5.52	9.13	2 coats over Primed Wood
J	0	- 5.56	9.76	
	1 1/2	- 3.57	9.05	
	2 1/2	- 2.44	9.85	2 coats over Bare Wood
		- 2.53	9.84	2 coats over Primed Wood
	4	- 2.85	8.66	2 coats over Bare Wood
		- 3.35	9.14	2 coats over Primed Wood
K	0	-24.74	18.16	
	1 1/2	-20.56	14.81	
	2 1/2	-18.20	13.50	2 coats over Bare Wood
		-18.20	13.50	2 coats over Primed Wood
		-17.87	12.58	2 coats over Bare Wood
		-17.04	12.50	2 coats over Primed Wood