EVALUATION OF INTERIOR AND EXTERIOR LATEX PAINTS

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SUMMARY

In general, some of the wood panels that have only one coat of paint over bare wood and one coat of paint over primed wood are showing signs of deterioration. The wood panels that have two coats of paint over bare wood and two coats of paint over primed wood are still performing satisfactorily.

The results on the thin film exposure from the second interim report, dated April, 1975, will have to be used to determine if the rate of film loss and X-ray monitoring is a satisfactory method of predicting latex paint life. The additional outdoor exposure on the thin film coatings has proven too severe and 90% of the panels that were being exposed have failed radically, leaving no pigments to monitor with X-ray.

INTRODUCTION

This is the third interim report written on this project. 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.

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. In addition, 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.

In this interim report, it is planned to emphasize the general appearance of each coat and reflectance and color change on wood and concrete substrates. Since all of the thin films that were applied over the wood substrates have completely deteriorated, X-ray monitoring would be of no value.

Outdoor exposure of the paints on wood and concrete have been continued.

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.

PROCEDURE

PAINTS

There are at present twenty-four coatings undergoing outdoor exposure. The length of exposure thus far on a wood substrate has been 2-1/2 years, and the length of exposure over a concrete substrate has been 1500 hours of accelerated weathering in an Atlar Weather-ometer, plus 2-1/2 years of outdoor exposure. All outdoor exposures are at a 45° angle with the horizon facing due south.

One of the methods employed in evaluating the coatings used over different substrates was a rating called General Appearance. General Appearance encompassed the following properties:

1. Chalking
2. Cracking
3. Delamination
4. Mildew

The exposed panels, both green and white, were subjected to analyses by Light Reflectance, using a Hunter Color Difference Meter. The green panels were additionally subjected to another test using the Hunter Color Meter to determine the fading properties.

THIN FILMS

Of the original thin film coatings that were prepared and used for tracing pigment degradation, only 7 panels remain that contain an ample amount of coating to give fairly accurate X-ray analysis. The other panels have completely lost the coating due to exposure. Any theoretical analysis of X-ray tracing will have to be predicted in the final report on data that had been accumulated up to the second interim report, which included outdoor exposures of 1-1/2 years. This analysis will be completed in the final report since this third interim report only contains a minimum of data (7 panels).

X-RAY TECHNIQUES

Some X-ray pigment counting was performed on the 7 panels that remained from the thin fiml theory tests.

The pigments monitored were:

Titanum dioxide (Rutile)
Titanum dioxide (Anatase)
Calcite
Zinc oxide

DISCUSSION OF RESULTS

Table I 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 exposure has been for 2-1/2 years. The general trend of Table I indicates that the light reflectance has decreased after 2-1/2 years' exposure.

The first reading, taken after 1-1/2 years' exposure, indicated a decrease in reflectance over the original values. Theoretically, a rise, due to chalking and subsequent pigment exposure, would have been expected. After 2-1/2 years' exposure, the reflectance values continued to decrease. One possible explanation for this behavior is that the expected rise in reflectivity 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 affect on the decrease in reflectivity.

Table 2 of the appendix 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. As can be discerned from the tables, the two-coat application indicates 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 3 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 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 2-1/2 years' exposure, the trend has continued but at a lesser rate. This is indicated by a smaller than normal change in the "a" and "b" values, and also by Table 1, which also had smaller than normal changes. Normal changes referred to are the changes up to 1-1/2 years of outdoor exposure.

Table 4 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 following the pattern established during the second interim report, that is, a reduction in both the "a" and "b" values. There are paints that indicate a slight or no increase in the "b" values (C, E, I, J). It could be that these coatings are not self-cleaning, and thereby retain some pigments, or possibly that the binders are beginning to yellow more substantially than the remaining coatings.

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.

Table 5 lists the general appearance of the various coatings, both green and white, over a concrete substrate. As can be seen from the table, six companies are represented in the top 7 for both the green and white. This is a visual examination compiled from three independent researchers who used chalking, fading, cracking, and delamination as parameters.

Table 6 lists the general appearance of the various coatings, white only, over a primed wood substrate. As can be determined from the table, four companies are represented in the top 7 for single and two-coat applications. Some of the coatings did indicate poor self-cleansing properties.

Table 7 lists the general appearance of the various coatings, white only, over bare wood substrates. As can be seen from the table, four companies are represented in the top 7 for single and two-coat applications. Again some of the coatings indicated poor self-cleansing properties.

Table 8 lists the general appearance of the various coatings, green only, over primed wood substrates. As can be seen from the table, six companies are represented in the top 7 for single and two-coat applications.

Table 9 lists the general appearance of the various coatings, green only, over bare wood substrates. As can be determined, five companies are represented in the top 7 for single and two-coat applications. The panels have been returned to the outdoor exposure rack for an additional one-year weathering, after which data will be accumulated and a final report written as to the validity of the X-ray theory of thin film weathering. Also at that time, the top 6 coatings for DOTD use in Louisiana will be selected.

Table 10 lists the X-ray counts for various panels containing from 1 to 8 coats of latex paint. In two cases, only 1 coat of latex paint was applied, with 1 and 2 coats of binder applied. It can be seen from the table that there was a decrease in the anatase, Calcite, and ZnO counts from 1-1/2 to 2-1/2 years' exposure. This would appear to indicate an erosion of the paint film. The X-ray counts in the Rutile pigment indicated no trend, with the values fluctuating excessively. These panels have been returned to outdoor exposure, and final recommendations on X-ray monitoring will be made at the conclusion of the project.

APPENDIX

TABLE I

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
Sample	Color			
A	White	81.33	74.31	70.87
	Green	64.55	59.89	61.40
B	White	88.84	77.60	77.93
	Green	45.50	49.52	49.05
C	White	76.61	71.54	70.81
	Green	81.77	73.77	72.18
D	White	91.80	79.99	75.06
	Green	72.15	63.18	58.57
E	White	90.62	79.78	77.59
	Green	66.09	62.94	60.14
F	White	84.72	69.03	73.08
	Green	68.24	61.51	60.70
G	White	81.99	69.54	69.07
	Green	61.44	59.34	58.66
H	White	86.44	77.23	75.32
	Green	64.95	55.79	55.61
I	White	84.11	76.53	74.73
	Green	54.35	52.46	48.94
J	White	82.82	75.61	73.61
	Green	56.83	60.38	59.59
K	White			76.83
	Green			51.73

TABLE I
(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
Sample Color			
L White			72.93
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 2

Wood Panels
(Exposed Outdoors at 45° South)

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

Exposure:

Company	Color	0	1-1/2 yrs.	1 Coat over Bare Wood	2 Coats over Bare Wood	1 Coat over Primed Wood	2 Coats over Primed Wood
A	White	86.56	82.82	71.46	77.58	71.91	75.57
	Green	68.05	58.38	62.10	64.17	63.46	63.40
B	White	93.82	83.82	84.03	74.01	75.77	77.38
	Green	46.99	50.87	47.06	50.47	48.32	49.51
C	White	81.12	77.32	72.38	76.79	72.05	76.25
	Green	84.12	74.47	68.20	72.02	70.53	74.70
D	White	92.21	84.86	72.06	81.65	76.97	80.95
	Green	71.17	60.50	55.84	60.54	58.38	61.33
E	White	93.17	88.87	72.87	77.95	76.62	78.34
	Green	68.60	63.45	59.98	61.62	61.27	61.62
F	White	86.12	77.85	60.69	78.30	76.15	78.05
	Green	70.87	62.82	61.24	65.03	61.99	62.18
G	White	83.97	77.32	72.70	74.56	72.10	74.53
	Green	62.63	61.74	58.98	61.00	59.46	59.92
H	White	90.80	88.50	78.07	84.72	76.64	84.28
	Green	75.08	66.28	60.43	66.75	64.68	63.86
I	White	86.43	82.71	77.16	77.40	77.17	80.53
	Green	58.10	52.93	49.36	52.02	52.81	52.05
J	White	86.68	83.68	73.95	81.34	78.38	81.82
	Green	58.48	61.35	59.49	61.07	60.63	61.64
K	White			84.40	88.61	81.13	87.13
	Green			52.73	52.53	53.02	51.14
L	White			77.16	84.84	77.37	84.33

TABLE 3

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
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
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
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
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
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

TABLE 3
(continued)

Company	Exposure	a	b
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
K	1500 hrs. plus 2-1/2 yrs.	- 14.06	11.50

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 4

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 yrs.	- 5.44	12.39	
	2-1/2 yrs.	- 3.85	12.09	2 coats over Bare Wood
		- 3.93	12.10	2 coats over Primed Wood
B	0	- 8.75	12.83	
	1-1/2 yrs.	- 6.21	10.81	
	2-1/2 yrs.	- 4.89	11.09	2 coats over Bare Wood
		- 4.93	10.73	2 coats over Primed Wood
C	0	- 6.71	11.43	
	1-1/2 yrs.	- 3.28	5.51	
	2-1/2 yrs.	- 2.55	6.87	2 coats over Bare Wood
		- 2.63	7.17	2 coats over Primed Wood
D	0	- 7.75	14.22	
	1-1/2 yrs.	- 6.44	12.48	
	2-1/2 yrs.	- 5.93	9.93	2 coats over Bare Wood
		- 5.86	9.81	2 coats over Primed Wood
E	0	- 9.57	12.45	
	1-1/2 yrs.	- 7.09	7.68	
	2-1/2 yrs.	- 5.90	8.00	2 coats over Bare Wood
		- 5.48	9.74	2 coats over Primed Wood
F	0	- 7.32	15.71	
	1-1/2 yrs.	- 5.79	13.35	
	2-1/2 yrs.	- 4.74	10.22	2 coats over Bare Wood
		- 4.60	10.06	2 coats over Primed Wood
G	0	- 8.18	10.50	
	1-1/2 yrs.	- 6.96	7.15	
	2-1/2 yrs.	- 6.60	7.31	2 coats over Bare Wood
		- 5.76	6.41	2 coats over Primed Wood

TABLE 4
(continued)

Company	Exposure	a	b	
H	0	- 8.61	8.50	
	1-1/2 yrs.	- 6.90	8.16	
	2-1/2 yrs.	- 5.03	8.33	2 coats over Bare Wood
		- 5.08	7.43	2 coats over Primed Wood
I	0	- 10.43	18.27	
	1-1/2 yrs.	- 6.42	9.31	
	2-1/2 yrs.	- 5.12	8.99	2 coats over Bare Wood
		- 5.07	9.20	2 coats over Primed Wood
J	0	- 5.56	9.76	
	1-1/2 yrs.	- 3.57	9.05	
	2-1/2 yrs.	- 2.44	9.85	2 coats over Bare Wood
		- 2.53	9.84	2 coats over Primed Wood
K	0	-24.74	18.16	
	1 yr.	-20.56	14.81	
	2-1/2 yrs.	- 18.20	13.50	2 coats over Bare Wood
		- 18.20	13.44	2 coats over Primed Wood

TABLE 5

General Appearance Rating
Of Coatings Over
Concrete Panels

(White) Company *	(Green) Company
J	F
E	A
1	B
B	K
D	I
A	E
K	J
H	G
F	D
C	C
G	H
L	
D (Tint Base)	

* From top to bottom indicates performance standings

TABLE 6

General Appearance Rating
Of Coatings Over
Wood Primed Panels (White)

1 Coat Company	2 Coats Company
I	K
J	J
D	L
D (Tint Base)	D (Tint Base)
F	C
K	B (NSC)
L	G
C	A
B	H
G	I
A	D (NSC)
H	F
E	E (NSC)

* NSC - Not self-cleaning

TABLE 7

General Appearance Rating
Of Coatings Over
Bare Wood Panels (White)

Company (1 Coat)	Company (2 Coats)
D	K
J	J
G	L
L	D (Tint Base)
A	C
K	B (NSC)
I	G
D (Tint Base)	A
B	H
C	I
H	D (NSC)
E	F
F	E

* NSC - Not self-cleaning

TABLE 8

General Appearance Rating
Of Coatings Over
Wood Primed Panels (Green)

Company (1 Coat)	Company (2 Coats)
K	K
J	J
I	I
F	F
E	E
G	D
D	B
B	A
A	G
H	H
C	C

TABLE 9

General Appearance Rating
Of Coatings Over
Bare Wood Panels (Green)

Company (1 Coat)	Company (2 Coats)
K	K
J	J
G	I
A	F
I	E
B	G
F	D
H	B
D	A
E	H
C	C

TABLE 10

Wood Panels 5 to 10

Counts in X-Ray Diffraction
(Company A White)
(From chart peak height)
(counts per second)

Peak:			Anatase	Rutile	Calcite	ZnO
Panel	Coats	Exposure				
5	1	0	59	394	389	135
		1-1/2 years	71.0	452	180	94.0
		2-1/2 years	31	506	69	34
7	4	0	63	436	445	139
		1-1/2 years	83.0	518	213	114
		2-1/2 years	64	460	154	68
8	8	0	55	334	338	132
		1-1/2 years	68.0	421	203	88.0
		2-1/2 years	60	430	160	77
9	1 plus 1*	0	44	289	265	93
		1-1/2 years	40.5	315	271	62.5
		2-1/2 years	6	122	107	26
10	1 plus 2*	0	34	211	173	78
		1-1/2 years	25.0	216	185	44.5
		2-1/2 years	13.0	346	379	61

* Indicates the number of coats of clear latex over the paint coat.