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Marshall Laboratory
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MEMORANDUM REPORT NO. M-474

GLOSS UNIFORMITY OF 301-892 #40 OUTSIDE WHITE

INTRODUCTION:

The objective was to determine the gloss uniformity, or gloss variability, of 301-892 high gloss #40 Outside White versus the performance of two major competitive paints. The work was undertaken primarily because of the Sales Department's difficulty in preparing uniform appearing demonstration panels. Information about the performance of 347-817 House Primer is also available from this work.

The competitive paints used were Devoe's #547 Outside White Gloss (SR-44773) and Sherwin-Williams #471 Gloss White House Paint (SR-44771). Included as an added control was 301-885 last previous #40 O.W.

SUMMARY AND CONCLUSIONS:

1. Average Gloss

The overall gloss of 301-892 is lower than Sherwin-Williams, but higher than 301-885 and Devoe's House Paint.

	Over Clapboard	Primed Pearlboard
SWP	59.6	78
301-892	52.8	78
301-885	36.7	56
Devoe	33.4	57

2. House Primer 347-817 is deficient in gloss hold-out; this confirms previous information.

Average gloss of all paints over 347-817	40.6
" " " " self-primed	50.6

3. Variability in Gloss

a. Variability of gloss on one test area (Variability among the 8 gloss readings on the panel):

Over 347-817. 301-885 is less variable than Sherwin-Williams. Sherwin-Williams is less variable than 301-892 and Devoe. 301-892 and Devoe are equal - the most variable paints.

Self-primed and competitive paints over their respective primers.

301-885 and S-W over S-W Primer are equal and less variable than Devoe self-primed. These are the only significant differences. 301-892 is between S-W and Devoe, but not significantly different from either.

b. Variability due to Topcoat Spreading Rate: Gloss of the topcoat is affected by changes in the spreading rate of the topcoat.

Over 347-817. An increase in topcoat spreading rate from 500 to 750 sq.ft./gal. reduces gloss of the Devoe paint more than it reduces the gloss of 301-885 and SWP. 301-892 is reduced to an intermediate degree not significantly different from any.

Self-primed and competitive paints over their respective primers,

The corresponding increase in topcoat spreading rate reduces the gloss of both 301-892 and Devoe more than it reduces the gloss of 301-885 and Sherwin-Williams. Therefore, 301-892 and Devoe are deficient in gloss uniformity as it is affected by topcoat spreading rate.

c. Variability due to Prime Coat Spreading Rate:

An increase from 450 to 750 sq.ft./gal. in prime coat spreading rate has a small overall effect of reducing topcoat gloss, but does not affect one paint more or less than another.

The evidence shows that 301-892 is somewhat less foolproof in gloss uniformity than the Sherwin-Williams product and may explain

why the Sales personnel had difficulty in preparing uniform demonstration panels. However, in view of the fact that 301-892 was rated satisfactory for this property in the 1951 field tests conducted by the Sales Department, we feel that the difference probably has little practical significance. Large scale tests, covering a direct comparison between 301-892 and the Sherwin-Williams product, would be needed to settle this point.

PROPOSED ACTION:

1. 347-817 needs to be improved for hold-out; this is now an active objective on Project P-1047.

2. Before undertaking work to improve the gloss uniformity of 301-892, we should make large scale application tests (on houses) to determine whether the difference observed here between 301-892 and Sherwin-Williams has any practical significance. This should cover new wood and repaint, and self-priming and application over the improved primer (Paragraph 1). We will bring this up for a decision at the P-1047 objective review on July 14.

3. Gloss uniformity will also be considered in the present Class C work to improve application properties.

DETAILS:

Experimental Design: The experimental work involved the following variables:

4	Topcoats over a common (347-817) primer.
4	Topcoats self-primed
2	Competitive topcoats over their respective primers
2	Topcoat spreading rates (500 and 750 sq.ft./gal.)
2	Prime coat spreading rates (450 and 750 sq.ft./gal.)
2	Replicates

Total Determinations - 80

The above variables were designed to show differences in gloss between topcoats, effect on gloss of 347-817 House Primer versus self-priming and the effect on gloss of spreading rate of topcoat and primer coat which were used as a measure of gloss variability. In addition, each determination was a mean of 8 individual gloss readings on one test area. The average variability among these 8 readings was also used as a measure of gloss variability. The non-uniformity of gloss at laps as experienced in earlier products is not evaluated in these tests. Sixty degree gloss measurements were made using the Photo Volt glossmeter.

For purposes of statistical analysis, all systems primed with 347-817 House Primer were treated in one problem while the self-primed systems and the competitive paints over their own primer were treated as individual problems.

Edge-grained red cedar clapboards were used as substrate for these tests. Each panel was divided in the middle to give two 6" x 18" test areas. On each panel, the variable between the two test areas was prime coat spreading rate, i. e. 450 sq.ft./gal. on one end and 750 sq.ft./gal. on the other. Each panel had one topcoat spreading over the entire length of the panel.

For the effect of primer and topcoat spreading rates, the variability was estimated by an analysis of variance using the data shown in Table I. The "between boards" variance and the error variance were calculated directly from the data. The "between boards" variance was found not to be significant by the "F" ratio test, therefore, the two variances were combined to give the overall standard deviation of the test - 3.82 gloss units. All confidence limits shown on the attached tables are for a probability level of 95%.

For the variability of individual gloss measurements on each test area, the mean standard deviation for each system was estimated by the "Method of Ranges" described in H. E. Wagner's letter dated 6/8/51 titled "A Graphical Method for Analysis of Variance".

The results of these tests are listed in the attached tables. The individual gloss determinations for each test area are shown in Table I. In Table II is shown the average gloss for the particular batch of each paint, both self-primed and over primer. It will be noted here that only one batch of each product was used. The effect of batch variation on gloss uniformity has not been determined. The most obvious conclusion to be drawn from Table II is the inferiority in gloss hold-out of the 347-817 House Primer, while the competitive primers are equally as good as their topcoat self-primed.

The effect of topcoat spreading rate is illustrated in Table III. The change from 500 sq.ft. per gallon to 750 sq. ft. per gallon has a highly significant general effect on gloss level. With the exception of the system 301-885 self-primed this change in spreading rate has a significant effect on each individual paint system. The interaction between topcoats and topcoat spreading rate has been used as one measure of gloss uniformity. Thus, it will be noted that, over 347-817, the Devoe paint is affected to a signifi-- cantly greater extent than either 301-885 or Sherwin-Williams, and that 301-892 is intermediate, but not significantly different from any. The pattern is the same with the self-primed systems, except that both 301-892 and Devow show a significantly larger change than 301-885 and SWP.

The effect of prime coat spreading rate (Table IV) is very small and only significant where 347-817 is used in the system. Only

one individual paint, 301-892, shows significantly lower gloss with an increase in primer spreading rate There is no significant difference between topcoats in this test.

In Table V is listed the average standard deviation for each paint of the 8 individual gloss measurements which make up one determination as shown in Table I. The standard deviation is used as a measure of the dispersion or variability of gloss on the panel and comparisons between products are made by the "F" ratio test. In the systems over 347-817, it will be noted that 301-885, at least this particular batch, is most uniform, S-W is intermediate and 301-892 and Devoe are least uniform. Of the independent systems only 301-885 self-primed and Sherwin-Williams over S-W Primer are significantly more uniform than the Devoe paint self-primed. There are no other significant differences in this group.

A visual examination of the panels, without an attempt to rating them, confirms in general, the above conclusions as drawn from the analysis of gloss measurements. The Devoe paint was easily recognized as having the least uniform gloss of all the paints and 301-892 was clearly lower and less uniform in gloss than Sherwin-Williams.

It will be noted that in the competitive products, the gloss of Sherwin-Williams paint has increased since the last previous evaluation and that the Devoe product has decreased in gloss. An examination of label analyses shows that the following changes have been made which may account partially for the change in gloss level: In Sherwin-Williams #471 Gloss White, the solids has been increased and pigment volume reduced by increasing the amount of "Raw Linseed Oil" with a reduction in drier and thinner content. In Devoe's #547 Outside White Gloss, TiO_2 has been reduced slightly with a corresponding increase in calcium carbonate extender and the vehicle now contains 11% (of total liquid vehicle) of "Processed Castor Oil."

References:

Experimental data are located in Notebook #3850 page 161 and Notebook #5457 pages 14 through 16. Statistical calculations are located in Nobebook #5457 pages 56 through 72.

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TABLE I

INDIVIDUAL GLOSS DETERMINATIONS

		301-892		301-885		Devoe		SWP	
		500	750	500	750	500	750	500	750
Over 347-817	450	56.0 58.9	45.6 41.0	36.6 36.5	32.1 27.4	42.0 39.6	22.1 21.1	61.8 61.3	47.9 49.6
	750	46.6 54.8	46.9 30.8	35.4 35.4	22.8 25.3	45.0 32.1	19.9 16.8	54.9 57.8	46.0 50.6
Self-Primed	450	62.8 65.5	57.4 45.5	46.3 47.1	38.4 41.1	44.9 48.3	29.6 28.5	68.5 72.0	57.1 64.9
	750	70.9 64.0	48.8 50.6	44.3 39.6	39.6 38.8	44.8 46.0	25.1 28.7	66.3 68.8	61.8 64.6
Over Devoe Primer	450					44.6 48.0	25.6 28.9		
	750					45.9 38.5	23.6 31.8		
Over SWP Primer	450							71.1 67.3	60.6 65.9
	750							70.1 66.5	63.9 59.5

Each determination a mean of 8 gloss measurements.

TABLE II

MEAN GLOSS FOR EACH TOPCOAT

	OVER 347-817	SELF-PRIMED	OVERALL
301-892	47.6 ±2.7	58.1 ± 2.7	52.8 ± 1.9
301-885	31.4 ±2.7	41.9 ± 2.7	36.7 ± 1.9
DEVOE	29.8 ±2.7	37.0 ± 2.7	33.4 ± 1.9
S W P	53.7 ±2.7	65.5 ± 2.7	59.6 ± 1.9
DEVOE OVER DEVOE PRIMER		35.9 ± 2.7	
S W P OVER SWP PRIMER		65.6 ± 2.7	

TABLE III

EFFECT OF TOPCOAT SPREADING RATE ON GLOSS

A. OVER 347-817

	500 Sq.Ft./Gal.	750 Sq.Ft./Gal.	Mean Difference
301-892	54.1 ± 3.8	41.1 ± 3.8	13.0 ± 5.4
301-885	36.0 ± 3.8	26.9 ± 3.8	9.1 ± 5.4
Devoe	39.7 ± 3.8	20.0 ± 3.8	19.7 ± 5.4
S W P	60.0 ± 3.8	48.5 ± 3.8	11.5 ± 5.4
Overall	47.2 ± 1.9	34.1 ± 1.9	13.1 ± 2.7

B. SELF-PRIMED AND INDEPENDENT PROPRIETARY SYSTEMS

301-892	65.5 ± 3.8	50.6 ± 3.8	14.9 ± 5.4
301-885	44.3 ± 3.8	39.5 ± 3.8	4.8 ± 5.4
Devoe	46.0 ± 3.8	28.2 ± 3.8	17.8 ± 5.4
S W P	68.9 ± 3.8	62.1 ± 3.8	6.8 ± 5.4
Devoe over Devoe Primer	44.2 ± 3.8	27.5 ± 3.8	16.7 ± 5.4
S W P over SWP Primer	68.8 ± 3.8	62.5 ± 3.8	6.3 ± 5.4

Confidence limit of any difference between two "Mean Differences":

± 7.6

TABLE IV

EFFECT OF PRIME COAT SPREADING RATE ON GLOSS

A. OVER 347-817

	450 Sq.Ft./Gal.	750 Sq.Ft./Gal.	Mean Difference
301-892	50.4 ± 3.8	44.8 ± 3.8	5.6 ± 5.4
301-885	33.1 ± 3.8	29.7 ± 3.8	3.4 ± 5.4
Devoe	31.2 ± 3.8	28.4 ± 3.8	2.8 ± 5.4
S W P	55.1 ± 3.8	52.3 ± 3.8	2.8 ± 5.4
Overall	42.4 ± 1.9	38.8 ± 1.9	3.6 ± 2.7

B. SELF-PRIMED AND INDEPENDENT PROPRIETARY SYSTEMS

301-892	57.6 ± 3.8	58.6 ± 3.8	-1.0 ± 5.4
301-885	43.2 ± 3.8	40.6 ± 3.8	2.6 ± 5.4
Devoe	37.8 ± 3.8	33.4 ± 3.8	4.4 ± 5.4
S W P	65.6 ± 3.8	65.4 ± 3.8	0.2 ± 5.4
Devoe over Devoe Primer	36.8 ± 3.8	34.9 ± 3.8	1.9 ± 5.4
SWP over SWP Primer	66.2 ± 3.8	65.0 ± 3.8	1.2 ± 5.4

Confidence limits of any difference between two "Mean Differences":

± 7.6

TABLE V

MEAN STANDARD DEVIATION OF INDIVIDUAL GLOSS MEASUREMENTS

A. OVER 347-817

	Mean Gloss	Mean Standard Deviation	Mean Variance
301-892	47.6	5.26	27.67
301-885	31.4	2.85	8.12
Devoe	29.8	5.26	27.67
S W P	53.7	3.86	14.90

For n = 56

$F = \frac{27.67}{8.12} = 3.41$, p = 99% $F = \frac{14.90}{8.12} = 1.83$, p = 95%

$F = \frac{27.67}{14.90} = 1.85$, p = 95%

B. SELF-PRIMED AND INDEPENDENT PROPRIETARY SYSTEMS

301-892	58.1	4.04	16.32
301-885	41.9	3.51	12.32
Devoe	37.0	4.61	21.25
S W P	65.5	3.95	15.60
Devoe over Devoe Primer	35.9	3.86	14.90
S W P over SWP Primer	65.6	3.47	12.04

for n = 56

$F = \frac{21.25}{12.04} = 1.76$, p = 95% $F = \frac{21.25}{12.32} = 1.72$, p = 95%

$F = \frac{21.25}{14.90} = 1.40$, p < 95%