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**NEWARK PLANT
PIGMENT COLOR RESEARCH REPORT**

Final Report

**Blistering & Rusting of Paint Films
on Continuous Immersion**

Period Covered: **June 1943 - October 1944**

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NEWARK PLANT

PIGMENT COLOR RESEARCH REPORT

Final Report

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on Continuous Immersion

Period Covered: June 1943 - October 1944

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E. Hoskin

DATE SUBMITTED: 10/31/44

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R. R. Denlow
11/14/44

DATE ISSUED: 11-15-44

INTRODUCTION:

The original purpose of this study was to develop additional information on blistering which might be useful in designing future tests. Unfortunately, it was impossible to follow the tests closely except in the early stages and most of the paints remained in water for 456 days before they were finally examined. At this time, blistering was severe in all cases and there was not much difference between them. Their final condition is reported simply to complete the record.

Previous work (see for example KM-43-164) that topcoated and untopcoated panels behaved differently in respect to blistering on immersion. Therefore in this series duplicate panels of each type were exposed. As a possible means of simplifying future tests, it was decided to expose panels topcoated on one side only.

Two vehicles were used viz. KV-15 and KV-26. The pigment systems are listed in Table I.

SUMMARY AND CONCLUSIONS:

Specifically, the work was carried out with the following objectives.

1. To determine the relative behavior of zinc yellow, "Impedex", iron oxide, and asbestine when used as a single pigment or in combination in a primer film when exposed to the distilled water immersion test.
2. To compare the behavior of topcoated and untopcoated primer films when exposed to the distilled water immersion test.
3. To determine the possibility of using a single panel, one side of which is topcoated, the other side of which is untopcoated, instead of using two panels both sides of which are alike, either topcoated or untopcoated.

Comparison of the behavior of the various pigments in primer films is based (1) on the time required for the films to show blistering or rusting, and (2) on the rusting of the metal under the film after long immersion. The conclusions which follow are based primarily on the behavior of untopcoated primers because the use of a topcoat obliterated most of the differences in performance obtained between the primers (see chart). Some of the results obtained do not check those from earlier experiments (cf. 6749) and any conclusions drawn in these cases are correspondingly uncertain.

1. Phenolic/alkyd (KV-26) primers of 0/100, 50/50, and 100/0 per cent "Impedex"/zinc yellow showed that "Impedex" lengthened the time elapsed before the untopcoated film failed by blistering. The improvement was roughly in proportion to the amount of "Impedex" used. This tendency was also indicated by the corresponding

KV-15 primer. The loss of yellow color which occurred along with blistering increased in proportion to the amount of "Impedex" used.

2. Final observation of the above panels after 456 days immersion revealed the tendency of "Impedex" to improve the adhesion of the primer film to the metal surface, but at the same time to decrease the tendency of zinc yellow to prevent sub-film corrosion.
3. Final observation of the above panels also led to the conclusion that topcoat adhesion to the primer was improved when the zinc yellow/"Impedex" ratio was large.
4. Phenolic/alkyd (KV-26) primers of 0/100, 50/50, and 100/0 --- "Impedex"/Asbestine showed that "Impedex" lengthened the time elapsed before the untopcoated film failed by blistering roughly in proportion to the amount of "Impedex" used. The final condition of the panels was also better when "Impedex" was present.
5. Red Lead in R.L.O. gave a very good performance.
6. The extent of blistering after 456 days immersion was bad for all panels. The size of the blisters varied on the individual panel from large to small, the number of smaller ones increasing in the case of zinc yellow and asbestine primers with increasing amounts of "Impedex". The 100% "Impedex" primers had the finest size blisters. Correlation between size of blisters and primer adhesion for these paints was also observed, the finer the blisters the better the primer adhesion.
7. The "Impedex"/zinc yellow -- 50/50 primer was superior to the "Impedex"/iron oxide -- 50/50 primer in life of the film and protection of the panel against rust.
8. In general, results (resistance of the film to early blistering and rusting and protection of the panel against rust on long immersion) obtained with separate panels agreed with the results obtained using single panels, one side topcoated, the other side untopcoated. However, it is doubtful whether single panels are practical for general use in immersion testing, as very often the length of time necessary to obtain the desired results differs for topcoated panels from the length of time required for untopcoated panels.
9. All topcoated panels showed early and about equal signs of failure by blistering. The one and two coat panels of the Navy Dark Gray topcoat were about alike in film life and final condition. The final condition of the panels after 456 days immersion varied in protection of the metal against rust, topcoat adhesion, and kind of blistering according to the primer used.

10. An unpigmented KV-26 film was found to give excellent protection. The KV-15 film (unpigmented) was very poor.

EXPERIMENTAL DETAILS:

References:

N.B. 984-32 Navy Dark Gray topcoat
N.B. 1016-12 Immersion test results
N.B. 1021-19 Preparation of Primers and Panels
N.B. 1059-3 Immersion Test Procedure
N.B. 1021-p.50,51 Preparation of Panels
S-6749 October 16, 1944, W. F. Spengeman

Pigment Volume - 40%
Vehicle - KV-15 --- 50/50 = Rezyl 849-1 (solids)/R.L.O.
KV-26 --- 65/35 = phenolic spar varnish/GE-2466
(The spar varnish = 25 gal. oil length BR-254
50/50 tung./L.O. vehicle)
R.L.O. --- Red Lead primer only
Means of Grinding - Ball mill

Table I lists the systems which were investigated and shows both their behavior in the early stages of the test and the condition after 456 days immersion in distilled water. Sub film rusting was evaluated by stripping the paint from the panel.

The chart shows in graphic form the time required for blistering to develop. Blistering after 456 days was graded by the system now in use by the Paint Laboratory rather than by the ASTM method. The "X"'s represent the area covered by blisters; X = very small area, XXXXXX = entire area. The letters represent the size of the blisters, A = pinhead size, F = very large (25¢ piece). Two letters are generally given in Table I, for example, A-D, to represent the size range.

TABLE I

PANEL	VEHICLE	PIGMENT	DAYS ELAPSED BEFORE BLISTERING (2) (3)	EXTENT OF BLISTERING AFTER 114 DAYS (1)	TOPCOAT ADHESION AFTER 114 DAYS	RESISTANCE TO SUB-FILM RUST AFTER 456 DAYS
1218-19 UN	KV-15	Zinc Yellow 100%	1	++	--	--
1222-23 TOP	"	"	1	Under Primer	V. poor	--
1220-21 UN	"	"	1	--	--	--
1220-21 TOP	"	"	1	Mostly under primer	V. poor	--
1224-25 UN	KV-15	"Imindex" 50 by Zinc Yellow 50 volume	2	--	--	--
1228-29 TOP	"	"	1	Some between coats	poor	--
1226-27 UN	"	"	2	--	--	--
1226-27 TOP	"	"	1	Under topcoat only	V. poor	--
1230-31 UN	KV-15	Red Lead 100%	2	--	--	--
1234-35 TOP	"	"	2	large, between coats	poor	--
1232-33 UN	"	"	2	--	--	--
1232-33 TOP	"	"	1	large between coats	V. poor	--
1236-37 UN	R.L.O.	Red Lead 100%	507.41 L	AFTER 456 DAYS XXXX A-	AFTER 456 DAYS --	Excellent
1240-41 TOP	"	"	1	XXXX+ A-f	Fair +	Excellent
1238-39 UN	"	"	1	XXXX A-d-	--	Excellent
1238-39 TOP	"	"	2	XXXXX C	Poor +	Excellent
1242-43 UN	KV-26	Zinc Yellow 100%	2 all L	XXXXX A-f ²	--	Good+
1246-47 TOP	"	"	2	XXXXX A-B ²	Good-	Good+
1244-45 UN	"	"	2	XXXXX A-E ²	--	Good+
1244-45 TOP	"	"	2	XXXXX A-D ²	Good ²	Good
1248-49 UN	KV-26	"Imindex" 50 by Zinc Yellow 50 volume	6 L	XXXXX A-C	--	Excellent
1252-53 TOP	"	"	2	XXXXX A-C	Good+	Excellent
1250-51 UN	"	"	7 L	XXXXX A-B ²	--	Excellent
1250-51 TOP	"	"	5	XXXXX A-B	Good ²	Excellent

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Table I (cont'd)

1254-55 UN	KV-26	"Immedex" Iron oxide	50 by vol. 50	2	XXXX A-C	--	Fair+
1258-59 TOP	"	"	"	2	XXXX A-C	Fair+	" Good
1256-57 UN	"	"	"	2	XXXX A-D	--	Fair-
1256-57 TOP	"	"	"	2	XXXX A-C	Fair	Fair
1260-61 UN	KV-26	"Immedex" Asbestine	50 by vol. 50	4	XXXX A-B, D-E	--	Fair-
1264-65 TOP	"	"	"	2	XXXX A-D	Excell	Good+
1262-63 UN	"	"	"	114	XXXX A-F	--	Poor+
1262-63 TOP	"	"	"	2	XXXX A-D	Excell	Fair-
1266-67 UN	KV-26	Asbestine	100%	1	XXXX A-F	--	Excell-
1270-71 TOP	"	"	"	2	XXXX A-B	Fair	Excell-
1268-69 UN	"	"	"	1	XXXX B-E	--	Good
1268-69 TOP	"	"	"	2	XXXX A-F	Fair	Good
1272-73 UN	KV-26	"Immedex"	100%	17 L	XXXX B-D	--	Poor+
1276-77 TOP	"	"	"	2	XXXX A-B	Fair	Poor+
1274-75 UN	"	"	"	114 L	XXXX B	--	Poor+
1274-75 TOP	"	"	"	2	XXXX A	FAIR	Poor+
1278-79 UN	KV-26	NONE		94 R	XXXX B	--	Excell-
1280-81 TOP	"	"		1	XXXX A-E	Poor+	Excell
1282-83 UN	KV-15	NONE		1	AFTER 114 DAYS	--	--
1284-85 TOP	"	"		1	Water under primer	Poor	--
1286-87 UN	NAVY DARK GRAY TOPCOAT			2 R	AFTER 456 DAYS		
1288-89 TOP	"	"	"	2	XXXX A-C	--	Good+
					XXXX A-E	Fair	Fair

(1) Duplicate panels agree except in cases marked "

(2) Panels marked "R" showed film failure by rusting before blistering. Numbers in these cases designate days elapsed before film rusted.

(3) Panels marked "L" showed evidence of leaching along with failure by blistering.

UN = untopcoated panels - both sides same

TOP = topcoated panels - both sides same

(= single panel, one side untopcoated, other side topcoated.

EXPOSURE AND DEVELOPMENT TEST

400 27.

Series 1016-12

Frames 1218-1237

- 101 = unexposed panel (both sides)
- 102 = exposed panel (both sides)
- 103 = single panel - one side exposed, other side unexposed
- 104 = film failure by blistering (at the time indicated)
- 105 = blistering. All not marked with "X" called by blistering.
- 106 = film handling along with failure by blistering or burning.

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Days Elapsed Before Film Showed Evidence of Rusting or Blistering
(Average of 4 Ratings)