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REPORT D.S.C. #67-2

CC: J. W. NESTOR, WILM. CC: C. W. STAHL, TOLEDO
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DIVISIONAL PLANTS CHEMICAL GROUPS

330-LINE DISPERSION STABILIZATION CONCEPT
FINAL DURABILITY REPORT
PERFORMANCE IN ALKYD, NITROGEN-ALKYD AND
THERMOSETTING ACRYLIC ENAMEL SYSTEMS

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PREPARED BY: C. L. DAWKINS
DATE ISSUED: JULY 17, 1967
PROJECT NO.: P-63, DISPERSION STABILIZATION
CONCEPT
PREVIOUS REPORTS: MARCH, 1964; AUGUST 1965;
MAY, 1966.

ABSTRACT:

Product systems containing 330-Line Dispersions are equivalent in durability performance to systems containing conventional base analogs.

Data demonstrate that 330-Line Dispersions are satisfactory replacements for conventional base analogs in alkyd, nitrogen-alkyd and thermosetting acrylic enamel product systems.

Conclusions are based on the analysis of data compiled from the evaluation of over 120 exposure series (approximately 6,000 panels). These exposure series include data on the twenty-four 330-Line Dispersions scheduled for commercialization in September, 1967.

OBJECTIVE:

Determine if 330-Line Dispersions are satisfactory replacements for conventional base analogs in alkyd, nitrogen-alkyd and thermosetting acrylic enamel product systems with respect to durability performance.

CONCLUSIONS:

- 1) 330-Line Dispersions are satisfactory replacements for their conventional base analogs in alkyd, nitrogen-alkyd, and thermosetting acrylic enamel product systems with respect to durability performance.
- 2) Use of Dispersion Stabilization Concept (DSC) technology as a formulating tool produces dispersions which are equivalent in durability performance to dispersions formulated by use of conventional technology. From this conclusion, it is predicted that dispersions formulated with DSC technology will give satisfactory durability performance in many product qualities. This prediction is supported by durability data covering a wide spectrum of product qualities.
- 3) Batch-to-batch variation in pigment has a greater effect on durability than does the technology, either DSC or conventional, applied in development of the dispersion.

REASONS FOR REPORT:

This report is issued to:

- (1) Indicate the successful completion of the durability phase of the P-63 Project.
- (2) Present the conclusions derived from the evaluation of over 6,000 exposure panels.
- (3) Act as a durability reference for the full scale 330-Line commercialization proposal.
- (4) Serve as an across-the-board final report for all exposure series in the P-63 project in lieu of individual reports for each series.
- (5) Delineate future action.
- (6) Up-date previous durability reports by introducing data covering longer term exposure.

FUTURE ACTION:

- (1) Twenty-four 330-Line Dispersions are scheduled for commercialization in place of their 42, 732 and 743-Line counterparts in September, 1967.
- (2) Based on the information now available, no extensive durability evaluations are planned for new dispersions which may be added to the current 330-Line Dispersion gamut. Routine, high-spot evaluations will be made where deemed necessary.
- (3) Evaluation of active exposure series will continue according to standard procedure until normal lengths of exposure are achieved.

PREPARED BY:

C. L. Dawkins
C. L. DAWKINS

APPROVED BY:

J. L. Abbamondi
J. L. ABBAMONDI

APPROVED BY:

C. N. Swinehart
C. N. SWINEHART, JR.,
SUPERVISOR

CLD:jp
7/18/67

DISCUSSION:

Background:

Commercial application of 330-Line Dispersions involves the elimination of several dispersion lines by replacement with a single dispersion line. Before implementing commercial application it is necessary to show that the durability performance of a particular vehicle system is not adversely affected by use of 330-Line Dispersions. Satisfactory durability performance was established based on exposure data presented in M. H. Schaffer's report of May 3, 1966.

At that time, the duration of exposure of 330-Line Dispersions was sufficient to support durability conclusions. With longer term exposure data now available, earlier results are reinforced and previous conclusions are confirmed.

Experimental Procedure:

The entire gamut of 330-Line Dispersions was considered in the durability evaluation phase of the P-63 Project. The following general procedures apply to the bulk of these dispersions concerning levels of exposure, locations of exposure and evaluations of exposure, etc.:

- (1) Colorants were exposed in masstones, tints and mixed color active product formulas.
- (2) Masstones, tints and mixed color active product formulas underwent exposure by Accelerated Weatherometer (X-1 Cycle) at Philadelphia and exterior exposure at the Florida and/or Delaware Exposure Stations.
- (3) Metallics as well as non-metallics were exposed.
- (4) Experimental exposure panels were examined and evaluated at regular intervals for all film failure characteristics, i.e., gloss, water-spotting, exudation, mildew, dirt collection, chalking, checking, cracking, blistering, flaking, bronzing, rusting, color-change, et.al., as compared with controls.
- (5) Recommendations regarding levels of exposure (P/B) were derived from the formulating tables and correlated with the levels of commercial usage. Tables used are as follows:
 - (a) The 15 and 93-Line Formulating Tables were used in formulating straight alkyds.

- (b) The 780-Line Formulating Tables were used in formulating nitrogen-alkyds.
- (c) The 938-Line Formulating Tables were used in formulating thermosetting acrylic enamels, (TAE).

Performance Criteria:

- 1) Durability was based on results obtained at the Florida Exposure Station.
- 2) Conclusions are based on the active scaled-up 330-Line Dispersions in alkyd, nitrogen-alkyd and thermosetting acrylic enamel product systems.
- 3) Durability was based on interpretation of gloss unit differences, since differences in other film failure properties were insignificant.

Description of Tables:

Table I, "330-Line Dispersions", lists the 330-Line dispersions scheduled for commercialization and shows the 42, 732 and/or 743-Line conventional dispersions which are being replaced.

Table II, "330-Line Dispersion Durability Table", shows the durability ratings of 330-Line Dispersions after Florida exposure.

Table II shows only 30 of the exposure series covered in this durability study and should therefore be considered only representative of the durability performance of 330-Line Dispersions. All ratings in this table refer to the durability performance of 330-Line Dispersions (experimentals) as compared with conventional dispersions (controls). Ratings are based on interpretation of gloss unit differences and are as follows:

- (1) + means better than control or superior by 10 or more gloss units at one exposure level(s) and at least equal in the other (s).
- (2) E+ means marginally better than control or superior by 6 to 10 gloss units at one level(s) and at least equal in the other(s).
- (3) E means $\pm$ 5 gloss units at all level(s).
- (4) E- means marginally poorer than control or inferior by 6 to 10 gloss units at one level(s) and equal ($\pm$ 5) gloss units in the other(s).
- (5) - means poorer than control or inferior by 10 or more gloss units at one level(s), and deficient at least 6 gloss units in the other(s).

Table III shows, "Statistical Curve For Durability Performance Of 330-Line Dispersions", as compared with conventional dispersions.

Results of earlier (shorter term) and current (longer term) exterior exposure of the basic formulating gamut indicate, statistically, a Gaussian type distribution with respect to durability performance. The percentage distributions are as follows:

	<u>Equal to Control</u>	<u>Better than Control</u>	<u>Poorer than Control</u>
Earlier Results	56%	30%	14%
Current Results	74%	14%	12%

Both "Earlier" and "Current" results correlate with accelerated weathering results.

Table IV lists numerically, "Exposure Series In Alkyd Product Systems".

Table V lists numerically, "Exposure Series In Nitrogen Alkyd Systems".

Table VI lists numerically, "Exposure Series In Thermosetting Acrylic Enamel Systems."

Each series in Tables IV, V and VI was exposed in at least 4 different sets. Information pertaining to "Completed Exterior Exposure" and "Disposition" is omitted for certain series. In such cases the durability performance is based on the most up-to-date information regarding the particular series. Several series are omitted because they are not within the specific range of this report. For instance, there is limited, but satisfactory durability information on 330-Line replacements in vinyl enamels, acrylic lacquers and Trimethylolethane (TME)-Benzoic Acid formulations.

TABLE ID.S.C. #67-2330-LINE DISPERSIONS330-LINE COLORANT42, 732 AND/OR 743-LINE
CONVENTIONAL DISPERSION
ANALOG

330-3243	-----	W-224
	-----	W-225
	-----	W-243
	-----	W-253
330-3300	-----	W-300
330-2312	-----	W-312
330-1327*	-----	W-300
330-1355	-----	W-355
330-1362	-----	W-362
330-1384	-----	W-384
330-1393	-----	W-393
330-1505	-----	W-505
330-1550 (40-B-8640)	-----	W-558
330-2582	-----	W-582
330-1588 (40-B-8641)	-----	W-519
330-1608*	-----	W-608
330-1612	-----	W-612
330-1622	-----	W-622
330-2630	-----	W-630
330-1655	-----	W-655
330-1658	-----	W-658
330-1679	-----	W-679
330-1686	-----	W-686
330-1687	-----	W-687
330-1785	-----	W-750
	-----	W-785
330-1818	-----	W-818
330-1819	-----	W-819
330-1830	-----	W-830

*Not scheduled for commercialization

TABLE II

330-LINE DISPERSION DURABILITY TABLE

COLORANT	ALKYD SYSTEMS			NITROGEN-ALKYD SYSTEMS			TAE SYSTEMS		
	RATING*	SERIES	COMPLETED EXPOSURE	RATING	SERIES	COMPLETED EXPOSURE	RATING	SERIES	COMPLETED EXPOSURE
330-3243	E-	20764	15 mos.	+	20777	16 mos.	E-	19969	30 mos.
330-3300	E	19829	24 mos.	E+	19997	18 mos.	E	20568	21 mos.
330-1312	E	19823	24 mos.	E+	20645	22 mos.	E	19969	30 mos.
330-1327	E+	19829	24 mos.	E	19997	18 mos.			
330-1355	E	20530	21 mos.	E	20647	12 mos.			
330-1362	E	19904	24 mos.	E	19932	24 mos.			
330-1384	E	19829	24 mos.	E	19921	24 mos.			
330-1393	E+	19812	24 mos.	E+	20831	14 mos.			
330-1505	E	19823	24 mos.	E-	19881	24 mos.	E-	19969	30 mos.
330-1550		---	---		---	---			
330-1559	E	20844	12 mos.	E	20844	12 mos.			
330-2582	E	20530	21 mos.	E	20516	24 mos.	E	19969	30 mos.
330-1588		---	---		---	---			
330-1608	E	19904	24 mos.	-	20786	15 mos.			
330-1612	E	19845	26 mos.	E	19921	24 mos.	E	20568	21 mos.
330-1622	E	20522	18 mos.	E-	19957	24 mos.	E	20568	21 mos.
330-2630	E	20704	18 mos.	E	20647	12 mos.	E-	19969	30 mos.
330-1655	E	19692	27 mos.	E	19692	30 mos.	E	20568	21 mos.
330-1658	E	19845	26 mos.	+	19932	24 mos.			
330-1679	E	19869	20 mos.	E	19921	24 mos.			
330-1686	E	19823	24 mos.	E	19881	24 mos.	E	20568	21 mos.
330-1687	E	19845	26 mos.	E	19921	24 mos.	E	19969	30 mos.
330-1785	E	19803	24 mos.	E-	19833	24 mos.	E+	19969	30 mos.
330-1818	E+	20508	18 mos.	E+	19974	24 mos.	E	19969	30 mos.
330-1819	E	19812	24 mos.	E-	19974	24 mos.			
330-1830	E+	20883	12 mos.		---	---			

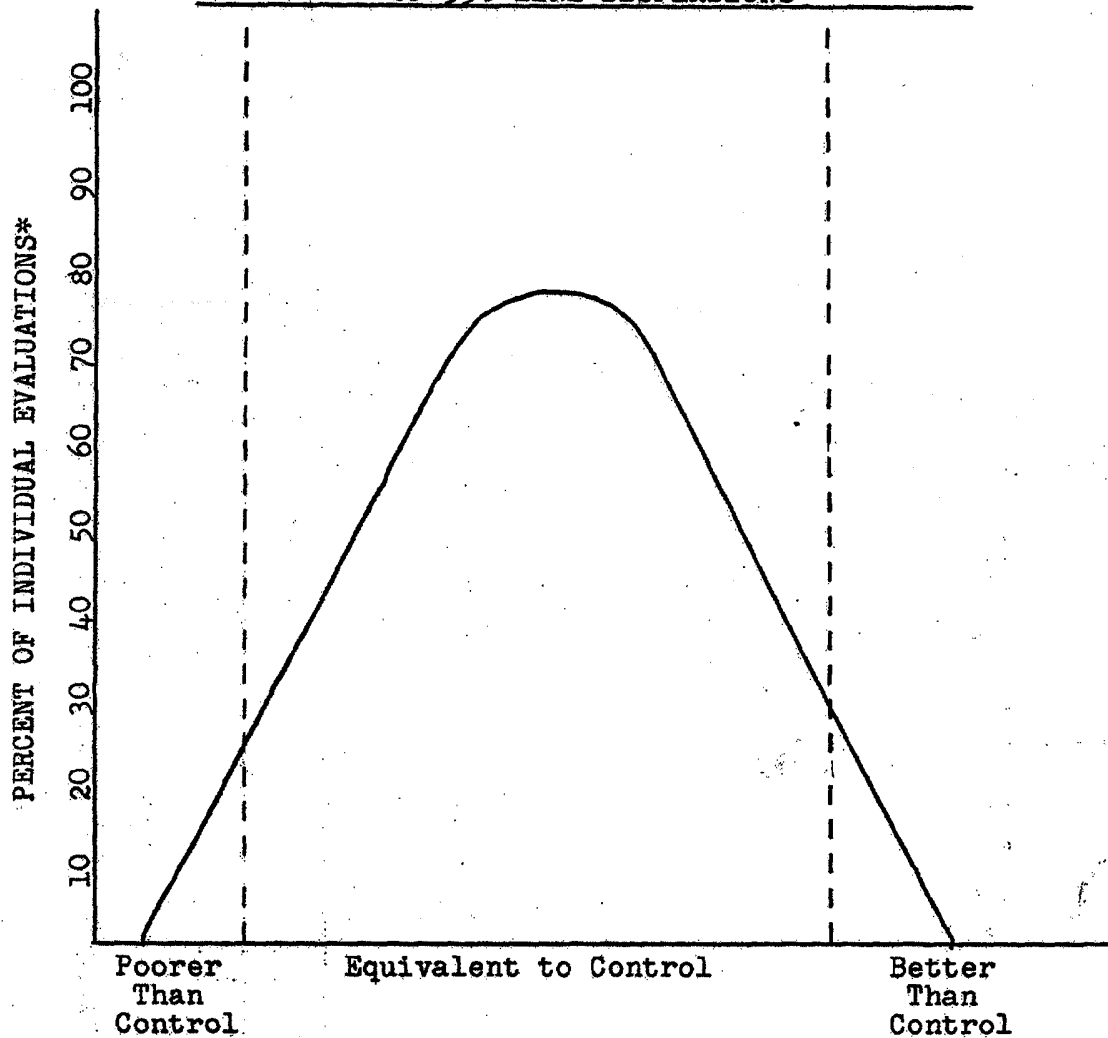
*Ratings:

+ means better than control
 E+ means marginally better than control
 E means equivalent to control
 E- means marginally poorer than control
 - means poorer than control

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TABLE III

STATISTICAL CURVE FOR DURABILITY PERFORMANCE
OF 330-LINE DISPERSIONS



*Based on 200,000 individual gloss readings.

TABLE IV

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SERIES EXPOSED IN ALKYD VEHICLE SYSTEMS

<u>EXPOSURE SERIES</u>	<u>PIGMENT REPLACED BY 330-LINE</u>	<u>LEVEL</u>	<u>COMPLETED EXTERIOR EXPOSURE</u>	<u>DISPOSITION</u>
19655	W-785	(M) Masstones; (T) Tints; (X) Mixed.	30 mos.	Retired
19667	W-505 W-630 W-785 W-224	M. T. X.	30 mos.	Re-ex.* 6 mos.
19684	W-679	M.	30 mos.	Re-ex. 6 mos.
19692	W-655	M. T.	27 mos.	Re-ex. 3 mos.
19760	W-785	M. T.	30 mos.	Retired
19785	W-785	T.		
19803	W-785	M. T.		
19812	W-393	M. T.	27 mos.	Re-ex. 3 mos.
19823	W-505 W-312 W-686	M. T.	24 mos.	Re-ex. 3 mos.
19829	W-300 W-384	M. T.	24 mos.	Re-ex. 6 mos.
19845	W-612 W-658 W-630 W-687	M. T.	26 mos.	Retired
19864	W-686 W-622 W-785 W-612 W-225 W-655 W-300 W-224 W-262 W-630	M. T. X.	24 mos.	Re-ex. 3 mos.
19869	W-362 W-679	M. T.	12 mos.	Re-ex. 3 mos.
19898	W-386 W-819 W-658 W-362 W-224 W-505 W-225	X.	24 mos.	Re-ex. 3 mos.

*Re-ex. = Re-exposed.

Table IV (cont.)

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Series Exposed in Alkyd Vehicle Systems (cont.)

<u>Exposure Series</u>	<u>Pigment Replacement by 330-Line</u>	<u>Level</u>	<u>Completed Exterior Exposure</u>	<u>Disposition</u>
19904	W-785 W-312 W-259 W-622 W-608 W-224 W-362	M.T.	24 mo.	Reex. 6 mo.
19951	W-785 W-819 W-630	T	24 mo.	Reex. 6 mo.
19970 19974 20507	W-505 W-679 W-582 W-224	T X	24 mo.	Reex. 6 mo.
20508	W-612 W-818 W-819	M.T.	21 mo.	Reex. 6 mo.
20516 20522	W-622 W-630	M.T.	18 mo.	Reex. 6 mo.
20530	W-582	M.T.	21 mo.	Reex. 6 mo.
20547	W-355 W-630 W-224 W-785	X	21 mo.	Reex. 3 mo.
20565	W-386 W-819 W-505 W-785 W-259 W-658 W-362	X	21 mo.	Reex. 6 mo.
20545	W-622 W-686	X	18 mo.	Reex. 6 mo.
20613 20631	W-622	M.T.	18 mo.	Reex. 6 mo.
20704	W-630	M.T.	18 mo.	Reex. 6 mo.
20722 20742	W-679 W-686	M M	18 mo.	

Table IV (cont.)

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Series Exposed in Alkyd Vehicle Systems (cont.)

<u>Exposure Series</u>	<u>Pigment Replacement by 330-Line</u>	<u>Level</u>	<u>Completed Exterior Exposure</u>	<u>Disposition</u>
20756	W-686	M	18 mo.	Reex. 6 mo.
20764	W-224	M	15 mo.	Reex. 3 mo.
20775	W-362	M.T.		
20816	W-686	M.T.	12 mo.	Reex. 6 mo.
20839	W-658	T	12 mo.	Reex. 3 mo.
20844	W-559	M.T.X.	12 mo.	Reex. 3 mo.
	W-505			
20845			22 mo.	Reex. 3 mo.
20863	W-686	M	12 mo.	Reex. 6 mo.
20883	W-830	M.T.X.	12 mo.	Reex. 3 mo.
	W-312			
	W-355			
20900	W-686	M	9 mo.	Reex. 6 mo.
20913	W-679	M.T.	12 mo.	Reex. 3 mo.
20949	W-785	M.T.	9 mo.	Reex. 6 mo.
20962	W-785	X	9 mo.	Reex. 3 mo.
20992	W-393	M	9 mo.	Reex. 3 mo.
20993	W-505	M		
21003	W-582	M	9 mo.	Reex. 3 mo.
21010	W-819	M	9 mo.	Reex. 3 mo.
21027	W-559	M	9 mo.	Reex. 3 mo.
21046	W-819	M		
21049	W-505	X	9 mo.	Reex. 3 mo.
	W-582			
	W-785			
21059	W-785	M.T.		
21201	W-679	M	6 mo.	Reex. 6 mo.
21202	W-582	M	3 mo.	Reex. 3 mo.
21242	W-550	M	3 mo.	Reex. 6 mo.
21246	W-686	M.T.		
21252	W-505	M.T.	3 mo.	Reex. 6 mo.
21258	W-550	M.T.	3 mo.	Reex. 6 mo.
21268	W-679	M.T.		
21290	W-630	M.T.		
21311	W-622	M.T.		
21321	W-655	M.T.		
21324	W-355	M.T.		
21337	W-519	M.		

TABLE V

D.S.C. #67-2

SERIES EXPOSED IN NITROGEN-ALKYD VEHICLE SYSTEMS

<u>Exposure Series</u>	<u>Pigment Replacement by 330-Line</u>	<u>Level</u>	<u>Completed Exterior Exposure</u>	<u>Disposition</u>
19543	W-612	M	36 mo.	Retired
	W-384			
19568	W-612	M.T.X.	30 mo.	Retired
	W-630			
	W-785			
	W-224			
19655	W-785	M.T.X.	30 mo.	Retired
	W-505			
19666	W-384	M	31 mo.	Retired
19667	W-630	M.T.X.	30 mo.	Reex. 3 mo.
	W-785			
	W-224			
19684	W-679	M	30 mo.	Reex. 6 mo.
19692	W-655	M.T.	30 mo.	Reex. 6 mo.
17905	W-612	M.T.	24 mo.	Reex. 6 mo.
19715				
19791	W-655	X	33 mo.	Retired
	W-312			
	W-224			
	W-384			
	W-300			
	W-505			
	W-785			
	W-658			
	W-819			
	W-687			
	W-630			
19804	W-679	M		
19843	W-300	M	27 mo.	Reex. 6 mo.
20647	W-630	M.T.	18 mo.	Reex. 6 mo.
	W-355			
20722	W-679	M		
20741	W-224	M.T.		
20749	W-687	M	16 mo.	Reex. 3 mo.
20756	W-686	M	18 mo.	Reex. 6 mo.
20767	W-655	M	14 mo.	Reex. 4 mo.

Table V (cont.)

D.S.C. #67-2

Series Exposed in Nitrogen-Alkyd Vehicle Systems (Cont.)

<u>Exposure Series</u>	<u>Pigment Replacement by 330-Line</u>	<u>Level</u>	<u>Completed Exterior Exposure</u>	<u>Disposition</u>
20777	W-224	M.T.	16 mo.	Reex. 3 mo.
20781	W-785	M.X		
	W-224			
	W-630			
	W-384			
	W-679			
	W-612			
20786	W-608	M.T.		
20806	W-687	M.T.	14 mo.	Reex. 4 mo.
20815	W-686	M	12 mo.	Reex. 3 mo.
20816	W-686	M.T.	12 mo.	Reex. 6 mo.
20822	W-362	M.T.		
20831	W-393	M		
20836	W-630	X	12 mo.	Reex. 6 mo.
	W-362			
	W-582			
	W-312			
	W-505			
	W-785			
	W-559			
20844	W-559	M.T.X.	12 mo.	Reex. 3 mo.
	W-505			
20876	W-686	M	12 mo.	Reex. 6 mo.
20882	W-679	M	12 mo.	Reex. 3 mo.
20914	W-582	M	12 mo.	Reex. 3 mo.
20920	W-224	M		
20931	W-686	M.X.	9 mo.	Reex. 3 mo.
20949	W-785	M.T.	9 mo.	Reex. 6 mo.
20979	W-785	M		
	W-224			
	W-505			
	W-312			
	W-630			
20993	W-505	M		
21003	W-582	M	9 mo.	Reex. 3 mo.
21010	W-819	M	9 mo.	Reex. 3 mo.

Table V (cont.)D.S.C. #67-2Series Exposed in Nitrogen-Alkyd Vehicle Systems (Cont.)

<u>Exposure Series</u>	<u>Pigment Replacement by 330-Line</u>	<u>Level</u>	<u>Completed Exterior Exposure</u>	<u>Disposition</u>
21020	W-393	M	9 mo.	Reex. 6 mo.
21027	W-559	M	9 mo.	Reex. 3 mo.
21049	W-505	X	9 mo.	Reex. 3 mo.
	W-582			
	W-785			
21094	W-224	M	6 mo.	Reex. 3 mo.
21095	W-224	M.T.	6 mo.	Reex. 3 mo.
21192	W-582	M	6 mo.	Reex. 6 mo.
21251	W-686	M.T.		
21252	W-505	M.T.	3 mo.	Reex. 6 mo.
21268	W-679	M.T.		
21275	W-505	X	3 mo.	Reex. 6 mo.
	W-550			
21311	W-622	M.T.		
21321	W-655	M.T.		

TABLE VI

D.S.C.#67-2

SERIES EXPOSED IN TAE SYSTEM

<u>Exposure Series</u>	<u>Pigment Replaced by 330-Line</u>	<u>Level</u>	<u>Completed Exterior Exposure</u>	<u>Disposition</u>
19688 (acrylic lacquer)	W-630	M	30 mo.	Retired
19887 (vinyl enamel)	W-750			
	W-253	X	34 mo.	Retired
	W-630			
	W-243			
	W-362			
19926 (vinyl enamel)	W-750	X	24 mo.	Reex. 6 mo.
	W-608			
	W-253			
	W-551			
	W-243			
	W-630			
	W-362			
19949	W-819	T		
	W-818			
19969	W-505	X	30 mo.	Retired
	W-224			
	W-785			
	W-630			
	W-818			
	W-582			
	W-312			
	W-687			
20538 (vinyl enamel)	W-750	X		
	W-687			
	W-608			
20561	W-505	T	18 mo.	Reex. 6 mo.
20568	W-686	X	21 mo.	Reex. 3 mo.
	W-622			
	W-243			
	W-300			
	W-655			
	W-612			
20607	W-312	M.T.		
	W-785			
20643	W-505	X		
	W-224			
20644 (vinyl enamel)	W-754	X		
	W-551			
	W-253			