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File: 1810

Flint 2, Michigan
October 22, 1953

MEMORANDUM REPORT NO. F-101

COMPARISON OF ALUMINUM PIGMENTS IN "DUCO" AND "DULUX"

INTRODUCTION:

The purpose of this report is to summarize results of laboratory work designed to define the preferred fine, medium and coarse grades of aluminum pigments for both "Duco" and "Dulux". Since there are at present seventeen active grades of aluminum pigment pastes, some simplification of this structure was considered highly desirable. This work was designed to study the majority of the active aluminums in automotive metallics and to select the preferred candidates, based on the optimum brightness, two-tone effect, gloss, and resistance to leafing, settling, and seeding.

SUMMARY AND CONCLUSIONS:

1. Of the fine grades of aluminums examined, W-82 (Alcoa #1590) gave the best balance of properties in both "Duco" and "Dulux" metallics. (Tables I and II), and is classified as the preferred fine grade aluminum.
2. In the medium-coarse grades W-100 (Alcoa #1595) returned the optimum balance of properties in "Duco" and "Dulux" metallic enamels, (Tables I and II), and is classified as the preferred aluminum for this grade.
3. Among the coarser grades W-80 (Alcoa #222) and W-81 (Alcoa #240) were about equivalent in properties in "Duco" with the exception of a high rate of settling for W-80. In the case of "Dulux" W-80 was slightly better than W-81 in strength. Both these pigments have been classified in the "C" group, i.e. restricted to existing products.

ACTION TAKEN OR PROPOSED:

The Pigments Dispersion Committee has reviewed the currently active aluminum pastes and have classified W-82 as the preferred fine grade aluminum, and W-100 as the preferred medium-coarse grade for "Duco" and "Dulux". Six of the aluminums have been proposed for obsolescence (Table III). Currently the Flint and Parlin Laboratories are in process of a plant alignment program to replace W-173 with W-82 in 282 Line fine aluminum tinting for "Duco" metallics. Release Letters F-523 and F-529 proposing release of W-100 aluminum for metallic "Duco" lacquers and metallic "Dulux" enamels have been written and approved.

EXPERIMENTAL DETAIL

Preparation of "Dulux" and "Duco" Metallics

Three lots each of sixteen currently active aluminum pigment pastes from the Aluminum Company of America, and Reynolds Metals Company were formulated into 32 Line mill bases and 282 Line tintings at equivalent aluminum metal content. Using W-82 pigment paste (Alcoa #1590) as a control for degree of lightness the aluminum tintings were let down into complementary gray "Dulux" and "Duco" metallic enamels shaded both lighter and darker than the W-82 control. Pearlboard spray-outs were prepared from these enamels and lightness values ("G") determined with the Colormaster (DuPont Differential Colorimeter). Semi-logarithmic plots of "G" values versus pounds of aluminum tinting were prepared for each pigment paste which gave a theoretical value of pounds of tinting required for each pigment to match the degree of lightness of the W-82 control pigment. "Duco" and "Dulux" metallics were then prepared for each pigment paste employing the theoretical pounds of aluminum tinting required for lightness equivalent to the W-82 control. (See Table III for enamel and lacquer compositions).

Panel Preparation:

The "Dulux" enamels were applied over 4" x 6" aluminum panels undercoated with 765-1676 baked at 40' at 280°F. and dry sanded. The enamels were applied according to T.M. 349-A "Spray Procedure for "Dulux" Metallics", and baked 30' at 240°F. "Duco" lacquers were applied over 4" x 6" aluminum panels undercoated with 475-1195 surfacer baked 60' at 200°F., according to TM-95-D, "Color Matching and Control of "Duco" Metall-Chrome Colors" and baked 20' at 180°F. The panels were then buffed and polished.

Properties:

Strength:

Panels were graded for lightness, "G" values, on the Colormaster (DuPont Differential Colorimeter) and from these the theoretical pounds of aluminum tinting required for each lot of aluminum pigment paste to match the W-82 control lightness were obtained, by locating these "G" values on the plots previously established for each pigment paste.

Assuming a straight-line relationship between lightness versus pounds of aluminum tinting, a parallel line was drawn through the "G" value obtained, and the point of intersection with the W-82 control curve was considered the actual amount of aluminum tinting that would be required for equivalent lightness. A strength value was calculated for each aluminum paste as:

$$\frac{\text{lbs. of tinting (control)}}{\text{lbs. of tinting}} \times 100 = \text{strength}$$

Leafing:

The individual tintings for each lot of aluminum were rated for leafing after one week shelf storage. The degree of aluminum float in the can was rated on a scale of 1 = no leafing to 4 = considerable.

Settling:

The degree of settling of the aluminums was rated after one week shelf storage of the tintings, by stirring gently with a spatula. The amount and denseness of the cake in the bottom of the can was rated on a scale of 1 = none to 10 = a hard cake.

Gloss:

Panels were rated for 20° gloss on the Glossmeter in accordance with A.S.T.M. standards, Test Method TM-204-B. In the case of "Ducos" the panels were rated after buffing.

Two-Tone:

Panels were also rated by an instrumental method developed at Marshall Laboratory. This method employs a goniphotometer to measure "lightness" or reflectance at two angles of viewing. The ratio of the "lightness" at the greater viewing angle to the smaller angle is expressed as a measure of the two-tone effect of metallic finishes.

Seed:

The tendency for the tintings to develop seed was determined after six weeks shelf storage. The enamels were reduced to constant viscosity and flowed out over glass:

Flow outs were examined visually under a constant light source and rated on a scale of 1 = none to 10 = severe. It is of interest that in the case of "Dulux" significant differences in seed development were observed between the various grades of aluminums. The fine grades of aluminum developed very little seed while the medium and coarse grades developed objectional seed. It is also of interest, that W-100 (Alcoa #1595) th preferred medium grade did not show objectionable seed. However, in the case of "Ducos" tintings very little seed was apparent even in the case of the coarse grades of aluminums.

FLINT LABORATORY

W. P. Kingsley
W. P. Kingsley

REF

WPK:emj

TABLE I

COMPARISON OF ALUMINUM SAMPLES "DUCO"

Supplier	Supplier's Code	N-Code	Leafing	Settling	Strength	Gloss 20°	Two-Tone	Seed
Alcoa	1590 Lot 2-0-20-R-12	W-82	2	2	100	70	16.6	1
Alcoa	1590 Lot 2-0-21-R-11	W-82	2	2	100	75	18.8	1
Alcoa	1590 Lot 2-M-21-R-12	W-82	1	2	100	75	15.4	1
Alcoa	1581 Lot 1-C-3-A-6	W-163	4	1	105	70	14.4	1
Alcoa	1581 Lot 1-C-4-A-7	W-163	4	1	105	68	15.0	1
Alcoa	1581 Lot 1-C-5-A-2	W-163	4	1	105	69	16.7	1
Alcoa	1580 Lot 1-D-30-R-31	W-173	4	1	90	61	14.4	1
Alcoa	1580 Lot 1-D-31-R-31	W-173	4	1	90	60	15.0	1
Alcoa	1580 Lot 1-D-31-R-32	W-173	4	1	90	65	16.7	1
Alcoa	1570 Lot 1-M-8-R-32	W-136	4	1	77	70	15.8	2
Alcoa	1570 Lot 1-A-27-R-51	W-136	4	1	77	65	16.6	2
Alcoa	1570 Lot 1-C-2-R-51	W-136	4	1	77	68	16.5	1
Reynolds	511N Lot 4155	KW-1595	4	1	74	65	14.2	2
Reynolds	511N Lot 7181	KW-1595	2	1	77	69	15.2	2
Reynolds	511N Lot 7407	KW-1595	4	1	75	69	15.9	2
Reynolds	401N Lot 7375	W-42	3	1	71	68	19.7	2
Reynolds	401N Lot 7721	W-42	3	1	69	65	18.8	2
Reynolds	401N Lot 7725	W-42	3	1	80	64	19.4	2
Reynolds	501N Lot 5940	KW-1595	3	1	74	68	18.1	1
Reynolds	501N Lot 5912	KW-1595	2	1	71	71	15.2	1
Reynolds	501N Lot 7547	KW-1595	2	1	71	70	18.6	1
Alcoa	1595 Lot 1-L-10-R-3	W-100	2	2	60	70	25.3	1
Alcoa	1595 Lot 1-L-11-R-3	W-100	2	2	65	69	26.6	1
Alcoa	1595 Lot 1-L-11-R-9	W-100	2	2	60	69	24.6	1
Alcoa	222 Lot 1-A-7-R-21	W-80	1	10	54	59	27.5	2
Alcoa	222 Lot 1-C-5-R-21	W-80	1	10	53	70	29.3	2
Alcoa	222 Lot 1-C-16-R-21	W-80	1	10	53	72	28.4	2

TABLE I - Page 2

Supplier	Supplier's Code	W-Code	Leafing	Settling	Strength	Gloss 20°	Two-Tone	Seed
Alcoa	221 Lot 1-L-19-R-2	W-143	1	10	55	70	24.7	3
Alcoa	221 Lot 1-L-13-R-13	W-143	1	10	57	67	26.3	3
Alcoa	221 Lot 1-L-6-R-9	W-143	1	10	50	65	26.3	3
Reynolds	37 LN Lot 7246	W-94	2	1	53	68	24.7	3
Reynolds	37 LN Lot 7351	W-94	2	1	57	68	26.3	3
Reynolds	37 LN Lot 7361	W-94	2	5	46	59	26.3	3
Reynolds	49 LN Lot 7405	-	1	5	50	65	24.2	2
Reynolds	49 LN Lot 7442	-	1	5	55	65	25.6	2
Reynolds	19 LN Lot 6126	KW-5138	1	1	54	59	23.0	3
Reynolds	11 LN Lot 6219	KW-5138	2	1	53	67	28.3	3
Reynolds	19 LN Lot 6317	KW-5138	1	1	48	69	26.2	3
Alcoa	240 Lot 1-M-17-R-11	W-81	2	2	47	70	28.5	2
Alcoa	240 Lot 1-M-22-R-11	W-81	3	2	54	65	29.4	2
Alcoa	240 Lot 1-M-30-R-31	W-81	4	2	54	60	28.9	2
Reynolds	30 LN Lot 6862	W-64	1	10	46	57	26.9	3
Reynolds	30 LN Lot 7523	W-64	1	10	53	45	28.8	3
Reynolds	30 LN Lot 7636	W-64	2	10	50	57	29.5	3
Reynolds	39 LN Lot 7008	W-158	1	10	40	70	31.6	4
Reynolds	39 LN Lot 7189	W-158	1	10	38	70	30.1	4
Reynolds	39 LN Lot 7240	W-158	1	10	37	60	30.4	4

Key:

Leafing (Float in Can)

- 1 - None after 1 week
 2 - Slight after 1 week
 3 - Moderate after 1 week
 4 - Considerable after 1 week

Settling

- 1 - None after 1 week
 10 - Hard cake after 1 week

Seed (Flow Out)

- 1 - None
 5 - Slight
 10 - Severe

Strength

Relative to W-82

TABLE II

COMPARISON OF ALUMINUM SAMPLES IN "DULUX"

Supplier	Supplier's Code	W-Code	Leafing	Settling	Strength	Gloss 20°	Two-Tone	Seed
Alcoa	1590 Lot 2-0-20-R-12	W-82	2	3	100	66	11.6	1
Alcoa	1590 Lot 2-9-21-R-11	W-82	2	3	100	72	11.2	1
Alcoa	1590 Lot 2-M-21-R-12	W-82	3	3	100	69	11.8	1
Alcoa	1581 Lot 1-C-3-A-6	W-163	3	2	98	66	9.6	1
Alcoa	1581 Lot 1-C-4-A-7	W-163	2	2	98	70	9.6	1
Alcoa	1581 Lot 1-C-5-A-2	W-163	3	2	99	73	9.8	1
Alcoa	1580 Lot 1-D-30-R-31	W-173	2	1	84	67	10.9	2
Alcoa	1580 Lot 1-D-31-R-31	W-173	2	1	84	64	11.0	2
Alcoa	1580 Lot 1-D-31-R-32	W-173	2	1	84	67	11.1	1
Alcoa	1570 Lot 1-M-8-R-32	W-136	3	2	78	60	11.3	2
Alcoa	1570 Lot 1-A-27-R-51	W-136	3	2	79	57	11.2	2
Alcoa	1570 Lot 1-G-2-R-51	W-136	2	2	78	52	11.4	2
Reynolds	511N Lot 4155	KW-1595	2	4	75	73	12.2	2
Reynolds	511N Lot 7181	KW-1595	3	4	76	73	11.9	2
Reynolds	511N Lot 7407	KW-1595	2	4	75	74	12.5	2
Reynolds	401N Lot 7375	W-42	2	3	74	68	12.8	2
Reynolds	401N Lot 7721	W-42	2	3	76	60	14.3	2
Reynolds	401N Lot 7725	W-42	2	3	74	60	13.8	2
Reynolds	501N Lot 5940	KW-1595	2	5	74	68	12.2	1
Reynolds	501N Lot 6912	KW-1595	2	5	75	76	11.9	1
Reynolds	501N Lot 7547	KW-1595	3	5	71	71	12.5	2
Alcoa	1595 Lot 1-L-10-R-3	W-100	2	2	52	54	16.1	3
Alcoa	1595 Lot 1-L-11-R-3	W-100	1	1	56	51	15.4	2
Alcoa	1595 Lot 1-L-11-R-9	W-100	1	2	52	55	15.0	3
Alcoa	221 Lot 1-L-19-R-21	W-143	1	4	50	53	15.0	6
Alcoa	221 Lot 1-L-13-R-13	W-143	1	4	54	55	16.4	6
Alcoa	221 Lot 1-L-6-R-9	W-143	1	4	52	54	16.0	6

TABLE II - Page 2

Supplier	Supplier's Code	W-Code	Leafing	Settling	Strength	Gloss 20°	Two-Tone	Seed
Alcoa	222 Lot 1-A-7-R-21	W-80	1	5	50	52	20.0	7
Alcoa	222 Lot 1-C-5-R-21	W-80	1	5	51	49	18.8	7
Alcoa	222 Lot 1-C-16-R-21	W-80	2	5	49	51	19.2	6
Reynolds	371N Lot 7426	W-94	1	5	50	49	14.4	5
Reynolds	371N Lot 7351	W-94	1	4	44	54	15.6	6
Reynolds	371N Lot 7361	W-94	1	5	50	45	14.7	5
Reynolds	491N Lot 7405	-	1	5	50	60	17.0	4
Reynolds	491N Lot 7442	-	1	5	48	64	16.5	4
Reynolds	191N Lot 6126	KW-5138	2	10	44	59	14.5	5
Reynolds	191N Lot 6219	KW-5138	1	10	45	54	16.3	5
Reynolds	191N Lot 6317	KW-5138	1	10	50	52	16.1	5
Reynolds	301N Lot 6862	W-64	1	10	44	60	16.5	9
Reynolds	301N Lot 7523	W-64	1	10	44	57	15.3	8
Reynolds	301N Lot 7636	W-64	2	10	48	51	15.4	9
Alcoa	240 Lot 1-M-17-R-11	W-81	2	5	45	48	20.1	8
Alcoa	240 Lot 1-M-22-R-11	W-81	1	5	45	56	19.3	8
Alcoa	240 Lot 1-M-30-R-31	W-81	2	5	43	56	18.2	8
Reynolds	391N Lot 7008	W-158	1	10	37	44	19.3	10
Reynolds	391N Lot 7189	W-158	1	10	37	30	19.0	10
Reynolds	391N Lot 7240	W-158	1	10	38	53	19.5	9

Key:

Leafing (Float in Can)

- 1 - None after 1 week
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 3 - Moderate after 1 week
 4 - Considerable after 1 week

Settling

- 1 - None after 1 week
 10 - Hard cake after 1 week

Seed (Flow Out)

- 1 - None
 5 - Slight
 10 - Severe

Strength

Relative to W-82

TABLE III

Pigment Dispersion Committee Classification

"DULUX"

<u>Pigment</u>	<u>Classification</u>	<u>Pigment Type</u>
W-42	C	Aluminum Paste #40 LN
W-80	C	" " 222
W-81	C	" " 241
W-82	A	" " 1590
W-94	C	" " 37 LN
W-100	A	" " 1595
W-158	C	" " 39 LN

"DUCO"

<u>Pigment</u>	<u>Classification</u>	<u>Pigment Type</u>
W-42	C	Aluminum Paste #40 LN
W-80	C	" " 222
W-81	C	" " 241
W-82	A	" " 1590
W-94	C	" " 37 LN
W-100	A	" " 1595
W-158	C	" " 39 LN
W-173	C	" " 1580

In process of Obsolescence

<u>Code</u>	<u>Pigment Type</u>
W-77	Aluminum Paste #1571
W-136	" " 1570
W-143	" " 221
W-163	" " 1581
KW-5047	" " 35 LN
KW-5138	" " 223

TABLE IV

"DULUX"

W-82 (Control)

32-5345	20.8
32-5243	9.3
42-785	4.7
RC-3083	38.0
VC-1000	1.5
RK-1701	2.7
VD-1846	0.6
VH-7552	0.8
T-4628	14.6
32-82	7.0

100.0

Experimental

20.8
9.3
4.7
38.0
1.5
2.7
0.6
0.8
14.6
Aluminum Base -
To equal lightness

"DUCO"

W-82 (Control)

253-0485	48.1
253-057	14.8
253-0785	12.7
B-613	9.0
B-614	4.5
C-159	0.9
282-082	10.0

100.0

Experimental

48.1
14.8
12.7
9.0
4.5
0.9
Aluminum Base -
To Equal lightness

TABLE V
ALUMINUM PIGMENTS

Grade	Solids	Mesh Size	Leafing Value	Covering Area
Reynolds 19 LN	66%	1% on 325	-	11,287 cm ² per gram
Reynolds 30 LN	66%	1% on 325	-	12,900 cm ² per gram
Reynolds 37 LN	73.5%	1% on 325	-	16,125 cm ² per gram
Reynolds 39 LN	66%	1% on 325	-	7,740 cm ² per gram
Reynolds 40 LN	66%	.1% on 325	-	21,285 cm ² per gram
Reynolds 50 LN	66%	Trace on 325	-	23,220 cm ² per gram
Reynolds 51 LN	60%	Trace on 325	-	23,220 cm ² per gram
Reynolds 49 LN	66%	.1% on 325	-	18,060 cm ² per gram
Alcoa #240	74%	99% through 325	85%	14,000 cm ² per gram
Alcoa #1570	65%	100% through 325 98% through 400	75%	27,000 cm ² per gram
Alcoa #221	65%	98% through 325	Non-leafing	-----
Alcoa #222	65%	-325	Non-leafing	-----
Alcoa #1580	65%	Extremely Fine -400	Partial leafing	-----
Alcoa #1581	65%	Finer than 1580	Partial-leafing	-----
Alcoa #1592	55%	100% through 325 98% through 400	Partial-leafing	-----
Alcoa #1595	65%	-325	Partial-leafing	-----

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June 29, 1954

MEMORANDUM REPORT F-101 SUPPLEMENT A

COMPARISON OF ALUMINUM PIGMENTS
IN "DUCO" AND "DULUX"

INTRODUCTION:

This report summarizes further results of basic laboratory work designed to define the properties of various grades of aluminum pigments used in "Duco" and "Dulux" metallics. The study was concerned with two major parts: (1) the colorimetric determination of the "brightness" of the commercially available aluminum pigments previously studied and discussed in the original memorandum report F-101, and (2) the preliminary investigation of the practice of blending the preferred grades of aluminum pastes to accomplish the optimum in brightness, two-tone, gloss and resistance to leafing, settling and seeding.

The majority of the commercially available aluminum pigment pastes from Reynolds Metals Company and the Aluminum Co. of America were examined as well as several experimental grades from these suppliers. Several blends of the preferred grades defined by the first phase of the work were examined in an attempt to demonstrate that such a system embodying the desired features of each grade is a commercially practical route toward simplification of the number of grades now required to formulate difficult to match metallic colors.

SUMMARY AND CONCLUSIONS:

1. Of the fine grades examined, W-82 (Alcoa 1590) returned a marginal advantage in brightness and the best balance of other properties in both "Duco" and "Dulux" (Tables I & II) and is classified as the preferred fine grade aluminum.

2. In the medium-coarse grades the use of W-100 (Alcoa 1595) results in a decidedly brighter metallic as well as returning the optimum balance of properties in "Duco" and "Dulux" (Tables I & II). In this connection three experimental "improved grades" of Alcoa 1595 (W-100) examined in the course

of this work showed a significant improvement in two-tone effect over W-100. Other properties were essentially equal.

Also a sample of Reynolds' improved 49-IN paste, No. DD-169, returned improved strength, gloss and two-tone over W-100 paste in "Dulux" with other properties including brightness being equivalent. This aluminum, on the basis of the one sample examined, appears to be a suitable alternate for the preferred W-100 medium-coarse grade.

3. Among the coarser grades W-81 (Alcoa 240) returned the highest order of brightness, and optimum balance of other properties with the exception of a high order of seediness in "Dulux". In this connection W-80 (Alcoa 222) although not as bright as W-81 is equivalent in other properties and less seedy than W-81. Both of these pigments have been classified in the "C" group i.e. restricted to existing products.

4. The results of the preliminary work done with blends of aluminum pastes indicates that brightness and two-tone is improved as the coarser aluminum content is increased in a given blend (Tables III & IV). Conversely, seed particularly in "Dulux" increases and gloss and strength decrease as the coarse aluminum ratio increases. From the limited data available it appears that any single property for a given aluminum blend is a linear function of the ratio of the grades of aluminums employed (Tables III & IV).

5. In the case of "Dulux" one encouraging result noted indicated that an equal blend of W-100 and W-81 aluminums returned good two-toneness, brightness gloss and strength; accompanied by a significant improvement in settling and seed over W-81 the aluminum which results in the best two-tone and brightness (Table IV). This combination of aluminums appears worthy of further and more detailed study.

ACTION TAKEN OR PROPOSED:

On the basis of this work the Pigments Dispersion Committee has classified W-82 as the preferred fine grade aluminum, and W-100 as the preferred medium-coarse grade for both "Duco" and "Dulux".

Recently encountered competitive metallic color matching problems have pointed up the advisability of blending different grades of aluminums in order to be 100% competitive. Our suppliers have advised that this practice is being adopted by our competitors. In view of the encouraging preliminary results realized with W-100/W-81 blends in "Dulux" it is proposed to investigate combinations of these aluminums on a broader and more detailed basis.

EXPERIMENTAL DETAILS:

Preparation of "Dulux" and "Duco" Metallics

The various grades of aluminum pigment pastes under study were formulated into 32 line mill bases and 282 line tintings at equivalent metal content. Using W-82 pigment paste (Alcoa 1590)

as a control for lightness, the aluminum tintings were let down into a complementary gray "Dulux" and "Duco" metallic shaded both lighter and darker than the W-82 control. Pearlboard spray-outs were prepared from these enamels and lightness values "G" determined with the Colormaster (DuPont Differential Colorimeter). Semi-logarithmic plots of "G" values versus pounds of aluminum tinting were prepared for each pigment paste which gave a theoretical value of the pounds of tinting required for each pigment to match the brightness of the W-82 control pigment. "Duco" and "Dulux" metallics were then prepared at equivalent lightness to W-82 controls. (See Table V for enamel and lacquer compositions.)

Panel Preparation

"Dulux" enamels were applied over 4" x 6" aluminum panels undercoated with 765-1676 baked for 40' x 280°F and dry sanded. The enamels were applied according to TM-349-A; "Spray Procedure for 'Dulux' Metallics", and baked 30' x 240°F. "Duco" lacquers were applied over 4" x 6" aluminum panels undercoated with 475-1195 surfacer baked 60' x 200°F, according to TM-95-D, "Dolor Matching and Control of "Duco" Metallic-Chrome Colors", and baked 20' x 180°F. The panels were then buffed and polished.

Properties

Strength

Panels were graded for lightness "G" values, on the Colormaster (DuPont Differential Colorimeter) and the theoretical pounds of tinting required for each aluminum to match the W-82 control lightness were obtained by locating these "G" values on the plots previously established for each pigment paste. Assuming a linear relationship between lightness versus pounds of tinting, a parallel line was drawn through the "G" value obtained and the point of intersection with the W-82 control curve was considered to be the amount of aluminum tinting required for equivalent lightness. A strength value was calculated for each aluminum as:

$$\frac{\text{lbs. of tinting (control)}}{\text{lbs. of tinting}} \times 100 = \text{strength}$$

Brightness

The property of brightness or percent saturation was determined for each aluminum in a blue metallic enamel formulated at equal hue and lightness. Using W-82 aluminum as a control for lightness and hue a "Monastrol" Blue (W-505) metallic was calculated for each pigment on the basis of the tinting strength of the various aluminums relative to W-82. (See Table VI for lacquer and enamel compositions.)

Red, Green and Blue reflectance values were obtained on panels prepared from these blue metallics, using the Color-master, differential Colorimeter. Tri-stimulus values X, Y and

Z were calculated from the R, G and B Colormaster data. The conversion factors used were those recommended by the Engineering Department Report DED-X-52-44.

$$\begin{aligned}X &= 0.784 R + 0.196 B \\Y &= 6 \\Z &= 1.18 B\end{aligned}$$

Trichromatic coefficients x and y were determined from the X , Y and Z tristimulus values according to formulae -

$$x = \frac{X}{X + Y + Z}$$

$$y = \frac{Y}{X + Y + Z}$$

The x and y coefficients were used to describe the degree of saturation or brightness and dominant wavelength of the metallics by means of chromaticity diagrams from the Handbook of Colorimetry, A. C. Hardy Technology Press, Cambridge, Mass., 1936.

Leafing

The individual tintings for each aluminum were rated for leafing after one weeks shelf storage. The degree of aluminum float in the can was rated on a scale of 1 = no leafing to 4 = considerable.

Settling

The degree of settling was rated after one week shelf storage of the tintings by stirring gently with a spatula. The amount and denseness of the cake in the bottom of the can was rated on a scale of 1 = none to 10 = a hard cake.

Gloss

Panels were rated for 20° gloss on the Glossmeter in accordance with ASTM standards, Test Method TM-204-B. "Duco" panels were rated after buffing.

Two-tone

Panels were also rated by an instrumental method developed at the Marshall Laboratory. This method employs a goniphotometer to measure "lightness" or reflectance at two angles of viewing. The ratio of the lightness at the greater viewing angle to the smaller angle is expressed as a measure of two-tone effect of metallic finishes.

Seed

The tendency for tintings to develop seed was determined after six weeks shelf storage. The enamels were reduced to constant viscosity and pour-outs made on glass.

Flow-outs were examined visually under a constant light source and rated on a scale of 1 = none to 10 = severe.

FLINT LABORATORY

W. P. Kingsley
W. P. Kingsley

WPK:jlw

TABLE I

ALCOA ALUMINUM PIGMENTS

Grade	Code	Strength		Leafing		Settling		20° Gloss		Two-tone		Seed		Visual		Saturation %		Dominant Wavelength	
		Duco	Dulux	Duco	Dulux	Duco	Dulux	Duco	Dulux	Duco	Dulux	Duco	Dulux	Duco	Dulux	Duco	Dulux	Duco	Dulux
1590	W-82	100.0	100.0	1.6	2.3	2.0	3.0	73	69	13.6	11.5	1.0	1.0	6	5	41.8	43.0	4786	4798
1581	W-163	105.0	98.3	4.0	2.7	1.0	2.0	69	70	12.0	9.7	1.0	1.0	8	6	39.5	42.0	4792	4799
1580	W-173	90.0	84.0	4.0	2.0	1.0	1.0	62	66	12.0	11.0	1.0	1.6	8	5	38.5	42.6	4770	4796
1570	W-136	77.0	78.3	4.0	2.7	1.0	2.0	60	56	16.3	11.3	1.0	2.0	8	5	39.6	43.5	4776	4800
1595	W-143	62.0	53.3	2.0	1.3	2.0	1.7	69	53	25.5	15.5	1.0	2.6	3	3	45.5	44.6	4787	4781
221	W-80	54.0	52.0	1.0	1.0	10.0	4.0	68	52	25.8	15.8	3.0	6.0	2	2	45.8	46.5	4765	4731
240	W-81	52.0	50.0	1.0	1.3	10.0	5.0	67	51	28.4	19.3	2.0	6.7	3	4	45.2	44.3	4756	4783
1595-	---	68.0	61.0	2.0	1.6	2.0	5.0	67	50	28.9	19.5	2.0	8.0	2	1	46.0	47.6	4777	4770
5261	---	68.0	54.0	3.0	1.0	3.0	3.0	70	64	27.0	16.0	2.0	3.0	3	3	45.0	45.0	4776	4776
1595-	---	68.0	54.0	3.0	1.0	3.0	3.0	68	65	28.0	18.0	2.0	3.0	4	5	44.0	43.0	4768	4790
5262	---	72.0	56.0	2.0	1.0	4.0	4.0	70	60	31.0	19.0	2.0	3.0	6	5	42.0	43.0	4752	4785
1595-	---																		
5263	---																		

Key: Average of 3 lots

Leafing (Float in can)		Settling		Seed (Flow-out)		Strength	
1	- None after 1 week	1	- None after 1 week	1	- None	1	- None
2	- Slight after 1 week	10	- Hard cake after 1 week	5	- Slight	5	- Slight
3	- Moderate after 1 week			10	- Severe		
4	- Considerable after 1 week						

TABLE II

REYNOLDS ALUMINUM PIGMENTS

Grade	Code	Strength		Leafing		Settling		20° Gloss		Two-tone		Seed		Visual		Brightness %		Dominant Wavelength	
		Duco	Dulux	Duco	Dulux	Duco	Dulux	Duco	Dulux	Duco	Dulux	Duco	Dulux	Duco	Dulux	Duco	Dulux	Duco	Dulux
51 IN	WV1595	75.3	75.3	3.3	2.3	1.0	4.0	67	73	15.1	12.2	2.0	2.0	7	8	41.0	40.3	4803	4802
40 IN	W-42	73.3	74.6	3.0	2.0	1.0	3.0	66	63	19.3	13.6	2.0	2.0	8	7	40.1	41.0	4763	4790
50 IN	W-42	72.0	73.3	2.3	2.3	1.0	5.0	69	72	17.3	12.2	1.0	1.3	8	6	40.3	40.0	4769	4763
37 IN	W-94	52.0	48.0	2.0	1.0	2.3	5.0	65	60	25.7	14.9	3.0	5.3	6	6	41.0	42.3	4788	4797
49 IN	W-94	52.5	49.0	1.0	1.0	5.0	5.0	65	62	24.9	16.8	2.0	4.0	6	6	42.5	41.9	4761	4786
19 IN	WV138	52.5	46.3	1.3	1.3	1.0	10.0	65	55	25.8	15.6	3.0	5.0	5	5	42.8	43.0	4777	4770
30 IN	W-64	49.6	47.3	1.3	1.3	10.0	10.0	53	42	28.4	15.7	3.0	8.6	5	4	43.3	44.3	4784	4726
39 IN	W-158	38.3	37.3	1.0	1.0	10.0	10.0	66	42	30.7	19.4	4.0	10.0	3	2	44.5	46.0	4780	4780
49 IN	W-158	60.0	61.0	1.0	2.0	5.0	5.0	67	70	25.0	19.0	3.0	3.0	4	4	43.0	43.8	4767	4807
ND169	---	50.0	70.0	1.0	1.0	5.0	5.0	62	74	22.1	16.2	2.0	4.0	---	---	---	---	---	---
#257	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Key: Average of 3 lots

Leafing (Picat in Can)

- 1 - None after 1 week
 2 - Slight after 1 week
 3 - Moderate after 1 week
 4 - Considerable after 1 week

Settling

- 1 - None after 1 week
 10 - Hard cake after 1 week

Seed (Flow-out)

- 1 - None
 5 - Slight
 10 - Severe

Strength

Relative to W-82

TABLE III

COMPARISON OF ALUMINUM BLENDS IN DUCO

Aluminum	Blend	Leafing	Settling	Seed	Strength	20° Gloss	Two-tone	Brightness (% Saturation)	Hue (Dominant Wavelength)
W-82	100	2	2	1	100.0	61	14.7	43.2	4774
W-100	100	2	2	1	51.3	68	16.9	44.7	4776
W-81	100	3	2	1	44.3	68	29.5	46.2	4783
W-82/W-100	75/25	1	5	1	83.0	66	15.1	42.0	4770
"	50/50	1	3	1	74.0	61	15.9	44.0	4778
"	25/75	1	3	1	74.0	65	17.1	44.0	4776
W-82/W-81	75/25	1	3	1	73.5	67	19.3	44.9	4780
"	50/50	1	5	1	59.2	65	21.8	44.2	4772
"	25/75	1	5	2	48.7	62	26.4	45.4	4780
W-100/W-81	75/25	1	5	1	52.6	61	16.2	44.0	4750
"	50/50	1	5	2	46.4	67	23.6	47.0	4780
"	25/75	2	6	2	44.3	68	26.9	46.8	4780

Key:

Leafing (Float in Can)	Settling	Seed (Flow-out)	Strength
1 - None after 1 week	1 - None after 1 week	1 - None	Relative to W-82
2 - Slight after 1 week	10 - Hard cake after 1 week	5 - Slight	
3 - Moderate after 1 week		10 - Severe	
4 - Considerable after 1 week			

TABLE IV

COMPARISON OF ALUMINUM BLENDS IN DULUX

Aluminum	Blend	Leafing	Settling	Seed	Strength	20° Gloss	Two-tone	Brightness (% Saturation)	Hue (Dominant Wavelength)
W-82	100	2	3	1	100.0	65	12.6	35.2	4790
W-100	100	1	2	3	51.2	68	14.9	38.2	4790
W-81	100	2	5	8	48.3	48	18.7	39.0	4790
W-82/W-100	75/25	2	3	2	68.4	68	13.5	34.4	4790
"	50/50	1	3	2	65.0	65	13.9	37.7	4785
"	25/75	1	3	3	63.5	58	15.8	38.3	4788
W-82/W-81	75/25	1	5	3	65.0	65	14.2	35.0	4790
"	50/50	1	5	5	58.4	67	17.1	36.4	4790
"	25/75	1	4	5	44.7	59	17.8	37.2	4790
W-100/W-81	75/25	1	4	2	61.0	68	15.0	36.2	4792
"	50/50	1	4	5	53.8	65	18.3	38.3	4789
"	25/75	2	4	6	48.3	62	18.1	39.4	4787

Key:

Leafing (Float in Can)	Settling	Seed (Flow-out)	Strength
1 - None after 1 week	1 - None after 1 week	1 - None	Relative to W-82
2 - Slight after 1 week	10 - Hard cake after 1 week	5 - Slight	
3 - Moderate after 1 week		10 - Severe	
4 - Considerable after 1 week			

TABLE V

DULUX

<u>W-82 (Control)</u>		<u>Experimental</u>
32-5345	20.8	20.8
32-5243	9.3	9.3
42-785	4.7	4.7
RC-3083	38.0	38.0
VC-1000	1.5	1.5
RK-1701	2.7	2.7
VD-1846	0.6	0.6
VH-7552	0.8	0.8
T-4628	14.6	14.6
32-82	7.0	Aluminum base
	<u>100.0</u>	To equal lightness

DUCO

<u>W-82 (Control)</u>		<u>Experimental</u>
253-0485	48.1	48.1
253-057	14.8	14.8
253-0785	12.7	12.7
B-613	9.0	9.0
B-614	4.5	4.5
C-159	0.9	0.9
282-082	10.0	Aluminum base
	<u>100.0</u>	To equal lightness

TABLE VI

DULUX

<u>W-82 (Control)</u>		<u>Experimental</u>
122-0505	44	122-0505 44
122-082	56	Aluminum tinting
	<u>100</u>	To equal lightness --

DUCO

<u>W-82 (Control)</u>		<u>Experimental</u>
253-0505	46.5	253-0505 46.5
282-082	53.5	Aluminum tinting
	<u>100.0</u>	To equal lightness --