



LEADED ZINC OXIDE

I. WHITE PIGMENT COLOR SCALE.

1. Introduction and Purpose. In order to facilitate rating and reporting the color of leaded zinc oxides and other white pigments, a color scale has been devised. The scale is purely arbitrary and standards, commonly used by the Auxiliaries Department, are used as the basis for rating the color.
2. Method. Ratings are made by comparing and matching visually the color of a given sample to standards. This is done by dispersing the pigment and the standards in oil to thick pastes and laying down the sample in juxtaposition between two standards of different color ratings. For accurate analysis standards, differing by no more than 5 points on the color scale, should be used.

Leaded zinc oxides range in color from about 40 to 90 on this color scale.

3. Color of Standards.
 - a. Protein Dispersions
 - aa. Visual Rating
 - bb. Instrumental Rating (Table IA)
 - b. Dried Paint Film
 - aa. Visual Rating
 - bb. Instrumental Rating (Table IB)

II. COLOR CHARACTERISTICS OF LEAD AND ZINC PIGMENTS - S-W AND COMPETITIVE.

1. Single Pigmentation in Protein Dispersions.
 - a. Visual Rating
 - b. Instrumental Ratings (Table II)
2. Single Pigmentation in Vehicle of SWP Gloss White.
 - a. Visual Rating (Table III)
 - b. Instrumental Ratings (Table III) —
3. Composite Pigmentation in SWP Gloss White.

Visual and Instrumental Ratings (Table IV)

III. COLOR CHARACTERISTICS OF HOUSE PAINTS. (Table V).

1. National Dutch Boy 110 Bright White C2410.
2. O'Brien TPO White 7102 9810.
3. Pittsburgh Titanic Outside White 1-54 A80579.
4. du Font 40 Outside White 301 864, C341639.
5. SWP Gloss White, Rx 471 C2258.
6. Ward Titanium White, 75-1 S-11 A-216 8.
- 7a. Sears (Old Formula) Master White, 143R F308R.
- 7b. " (New Formula) " " 143C I H30 9S.
- 7c. " (New Formula) with Ozlo 12/88 + B. S. W. L.

IV. PIGMENT COMPOSITION OF HOUSE PAINTS. (Table VI.)

V. EFFECT OF ADDITION OF CARBON BLACK OR ULTRAMARINE BLUE ON THE COLOR CHARACTERISTICS OF HOUSE PAINTS CONTAINING OZLO 12/88. (Table VII)

VI. EFFECT ON COLOR CHARACTERISTICS OF INCREASING THE TITANIUM CONTENT IN HOUSE PAINTS. (Table VIII).

VII. PHYSICAL AND CHEMICAL PROPERTIES OF OZLO 12/88 AND OTHER LEAD AND ZINC PIGMENTS.

- A. Analysis and Bulking Values. (Table IX)
- B. Particle Size and Texture. (Table X)
- C. Consistency Properties.
- D. Hiding Power. (Table XI)
- E. Crystal Analysis by X-ray Diffraction.

VIII. DURABILITY PROPERTIES OF OZLO 12/88 IN HOUSE PAINT.

TABLE I.

WHITE PIGMENT COLOR SCALEA. SOYA PROTEIN BINDER

Color Standard (In Oil)	Reflectance, %				Yellowness (A-B)/G	White- ness *
	Blue	Amber	Red	Green (Brightness)		
90	85.2	91.8	94.4	90.7	7.28	79
80	79.9	88.7	91.6	87.5	10.05	71
70	76.9	87.0	90.6	85.3	11.85	66
60	75.8	85.8	89.3	84.0	11.90	65
50	73.6	83.7	87.4	81.7	12.37	63
40	70.6	81.5	85.9	79.4	15.00	59

B. VEHICLE OF SWP GLOSS WHITE AT P.V.C. 36

90	75.5	81.9	84.0	81.0	7.9	76
80	71.2	79.9	82.8	78.6	11.1	67
70	68.0	78.1	81.4	76.3	13.2	60
60	65.2	75.2	78.8	73.2	13.6	58
50	62.6	72.5	76.1	70.4	14.3	57
45	60.6	71.8	75.7	69.6	16.1	51
40	57.8	68.7	73.4	66.2	16.5	49

$$W = 1 - \left\{ \left[30 \sqrt{\alpha^2 + \beta^2} \right]^2 + \left[\frac{(1.00 - Y)}{2} \right]^2 \right\}^{\frac{1}{2}}$$

$$\alpha = \frac{A - G}{A + 2G + B}$$

$$\beta = \frac{0.4(G - B)}{A + 2G + B}$$

TABLE II.

COLOR CHARACTERISTICS OF LEAD AND ZINC PIGMENTS -

SINGLE PIGMENTATION IN PROTEIN DISPERSION.

Pigment	Reflectance, %				Yellow- ness	White- ness
	Blue	Amber	Red	Green (Brightness)		
412 Current	77.3	88.3	91.7	86.5	12.70	63.1
412 Standard	76.5	86.7	90.0	85.2	11.96	65.0
Eagle A, 350	79.8	87.6	90.6	86.7	9.00	73.6
Azo 35L	77.6	86.4	89.5	85.1	10.33	69.7
Lehigh 6	80.3	88.9	92.2	87.7	9.81	71.5
Lehigh 61	85.2	91.4	93.6	90.6	6.84	80.1
511 Current	77.9	88.7	92.1	87.2	12.39	64.1
414 (70)	76.0	88.3	92.1	86.6	14.20	58.9
414 (60)	75.9	87.3	90.9	85.5	13.34	61.2
414 (58)	71.7	83.0	86.7	81.2	13.92	59.1
414 (50)	73.1	85.3	88.9	83.0	14.70	56.7
414 (45)	72.1	83.6	87.4	81.4	14.12	58.2
414 (60) + 511	76.3	87.6	90.8	85.7	13.18	61.6
414 (60) + 9	76.3	87.2	90.7	85.4	12.76	62.8
414 (60) + 18	77.3	87.9	91.1	86.2	12.30	64.3
414 (50) + 511	74.7	86.4	90.2	84.5	13.85	59.5
414 (50) + 9	73.6	85.5	89.3	83.5	14.25	58.4
414 (50) + 18	75.1	86.5	90.1	84.5	13.50	60.6
414 (45) + 511	73.7	84.9	88.8	83.0	14.09	60.5
414 (45) + 9	72.6	84.3	88.3	82.1	14.25	58.0
414 (45) + 18	74.5	85.6	89.2	83.5	13.30	60.8

TABLE III.

COLOR CHARACTERISTICS OF LEAD AND ZINC PIGMENTSIN VEHICLE OF SWP GLOSS WHITE.(SINGLE PIGMENTATION AT 36 P.V.C.)

<u>Pigment</u>	<u>Reflectance, %</u>				<u>% Yellow- ness</u>	<u>% White- ness</u>	<u>Vis- ual</u>
	<u>Blue</u>	<u>Amber</u>	<u>Red</u>	<u>Green (Brightness)</u>			
412 Current	68.0	79.7	84.3	77.7	15.1	55.4	5
412 Standard	67.0	78.0	81.7	76.0	14.5	56.7	12
Eagle A, 350	66.7	75.3	79.3	74.0	11.6	64.4	9
Azo 35L	67.0	75.6	79.1	74.3	11.6	64.6	7
Lehigh 6	68.9	78.0	82.1	76.2	11.9	63.6	4
Lehigh 61	71.8	78.7	81.6	77.6	8.38	72.9	3
511 Current	66.4	78.8	84.1	76.6	16.2	51.9	6
414 (70)	65.9	78.8	83.6	76.4	16.9	49.4	10
414 (60)	63.7	75.0	79.7	72.8	15.5	53.2	14
414 (50)	62.0	74.0	78.1	71.8	16.7	50.1	16
414 (70) + 511	66.2	79.3	84.2	77.0	17.0	49.6	15
414 (60) + 511	65.8	77.9	82.6	75.6	16.0	51.7	11
414 (50) + 511	64.0	76.3	80.8	74.0	16.6	50.3	13
18 Dry	78.2	86.6	90.1	85.0	9.89	70.7	1
9 Dry	72.8	83.9	88.6	81.5	13.6	59.3	2
B. Sil. W. L.	65.0	79.0	85.4	76.2	18.4	45.4	8

TABLE IV.

COMPARATIVE COLOR OF PAINT MADE WITH VARIOUS
TYPES AND BRANDS OF LEADED ZINC OXIDES.

FORMULATION:

SWP Gloss White, Card 47 - 14% TiO_2 .

Asbestine	290 #
Anatase TiO_2	136
Leaded Zinc Oxide, 35/65	480
B. C. W. L.	70
	976 #

P. V. C. 36%

Leaded Zinc Oxide	Reflectance, %				Yellow- ness	White- ness	Visual Rating
	Blue	Amber	Red	Green ¹			
Lehigh 61	77.6	82.9	85.9	82.1	6.5	79.7	1st.
Lehigh 6	75.7	82.2	85.4	81.0	8.0	75.3	2
Eagle A, 350	75.6	81.5	84.5	80.6	7.3	77.0	3
Ozlo 35/65, Cur.	74.6	82.4	85.8	81.0	9.6	71.0	4
Azo 35L	74.4	80.8	83.9	79.7	8.0	75.0	5
414 (60) + 511 ²	73.8	82.0	85.6	80.6	10.2	69.4	6
Ozlo 35/65, Std.	73.6	81.9	85.6	80.6	10.3	69.2	7
414 (70) + 511 ²	73.4	82.7	85.9	81.0	11.5	65.8	8
414 (58) + B.S.W.L. ²	71.8	81.0	84.8	79.4	11.6	65.4	9
414 (58) + 511 ²	72.6	81.1	84.5	79.8	10.6	68.2	10
414 (50) + 511 ²	71.8	80.8	84.7	79.2	11.4	66.0	11

¹ Brightness.² Blended to 35/65 type.

TABLE IV-A

COLOR CHARACTERISTICS OF 414 OF 45 COLOR
IN SWP GLOSS WHITE (SEE TABLE IV FOR FORMULA).

<u>Paint</u>	<u>% Reflectance</u>				<u>% Yellow- ness</u>	<u>% White- ness</u>
	<u>Blue</u>	<u>Amber</u>	<u>Red</u>	<u>Green</u>		
412 Standard	76.6	84.6	87.6	83.1	9.63	71.2
414 (45) + 511	74.3	83.3	85.8	81.3	11.1	66.5
414 (45) + 9	72.7	81.7	84.8	79.9	11.3	66.1
414 (45) + 18	73.4	82.0	85.5	80.3	10.7	67.7

TABLE V.

COLOR CHARACTERISTICS OF HOUSE PAINTS.

Brand	Reflectance, %				Yellow- ness	White- ness	Visual Rating
	Blue	Amber	Red	Green			
National	77.5	82.2	84.1	81.6	5.77	81	1
O'Brien	77.7	83.5	86.3	82.9	7.00	78	2
Pittsburgh	76.5	82.5	85.1	81.7	7.34	77	3
du Pont	74.5	81.1	83.5	79.9	8.27	74	4
SWP	74.4	81.1	83.3	80.0	8.37	75	4
Ward	73.9	80.8	83.4	79.7	8.65	74	4
Sears (Old)	75.5	83.5	86.3	82.3	9.72	71	5
" (New)	75.4	81.8	84.6	80.8	7.90	76	--
" (New) with Ozlo 12/88 + B. S. W. L.	75.3	83.2	85.4	81.9	9.60	71	--

TABLE VI.

PIGMENT COMPOSITION OF HOUSE PAINT.

(100 gallon net yield, 2% loss).

Pigment	National	Pitts- burgh	du Pont	SWP	Ward	Sears (New)
ZnO	204	203	295	312	300	285
B. S. W. L.	202		160	168	163	226
B. C. W. L.	228			70		
TiO ₂	184	181			156	167
Asbestine	204	288	72		312	306
Silicate			126			
Ti-Ba			185			
Ti-Mg				126		
	1022	672	1138	976	931	984

TABLE VII.

EFFECT OF ADDITION OF CARBON BLACK OR

ULTRAMARINE BLUE ON THE COLOR

CHARACTERISTICS OF HOUSE PAINTS.

Paint	Reflectance, %				Yellow- ness	White- ness	Visual Rating
	Blue	Amber	Red	Green			
Great Lakes *	73.3	81.0	84.9	79.6	9.67	70.6	2nd.
Ditto with Ozlo 12/88	76.6	84.2	87.2	83.0	9.15	72.7	1st.
American Marietta *	73.7	78.6	80.7	78.0	6.28	78.1	3rd.
Ditto with Ozlo 12/88	74.8	83.1	86.5	82.0	10.1	69.8	1st.
Ditto + Lamp Black	72.9	79.2	81.7	78.4	8.03	74.8	4th.
Ditto + Ultra- Marine Blue	74.6	79.2	83.8	79.0	5.82	80.0	2nd.

* Pigmentation (100 gal. net yield).

	<u>Great Lakes</u>	<u>American Marietta</u>
ZnO	168 #	276 #
B. S. W. L.	88	149
B. C. W. L.	221	
Ti-Alg.		425
TiO ₂	122	
Asbestine	285	
	884 #	850 #
P. V. C.	28.3	34

TABLE VIII.

EFFECT ON COLOR OF INCREASING THE
TITANIUM CONTENT IN HOUSE PAINT

Paints were made in the SWP Gloss White Formula (Card 47) containing 14% titanium dioxide and also in the same formula modified to contain, respectively, 8% and 18% titanium dioxide.

Formulas:

<u>Pigment</u>	<u>8% TiO₂</u>	<u>14% TiO₂</u>	<u>18% TiO₂</u>
Asbestine	300 #	290 #	320 #
Anatase TiO ₂	80	136	162
Leaded Zinc, 35/65	515	480	430
B. C. W. L.	105	70	
	<u>1000 #</u>	<u>976 #</u>	<u>912 #</u>

A. COLOR CHARACTERISTICS.

<u>Pigment</u> <u>(Leaded</u> <u>Zinc)</u>	<u>L. Z. Color</u> <u>In Oil</u>	<u>Brightness</u> <u>(G)</u>			<u>Yellowness</u> <u>(A-B)/G</u>			<u>Visual Color</u> <u>(Order)</u>		
		<u>8%</u>	<u>14%</u>	<u>18%</u>	<u>8%</u>	<u>14%</u>	<u>18%</u>	<u>8%</u>	<u>14%</u>	<u>18%*</u>
Lehigh 61	91	81.5	82.5	82.6	8.0	6.4	6.3	2	1	
" 6	78	80.0	81.5	81.4	9.8	7.5	7.9	4	3	
Azo 35 L	76	79.0	80.6	80.9	10.1	8.1	8.0	6	5	
Eagle 1, 350	74	79.6	81.2		8.8	8.2		3	1	
Ozlo 35/65, Cur.	77	81.0	82.3	81.8	10.2	9.0	8.9	5	6	
Ozlo 35/65, Std.	72	79.9	81.2		11.0	9.8		7	8	
Czlo 35/65, Ten. Std.	69	79.7	82.2		12.0	9.1		9	7	
hllw (60) + 511										
to 35/65	69	79.9	81.1	81.8	12.5	10.2		8	9	
hllw (50) + 511										
to 35/65	62	78.9	80.3		13.2	10.8		10	10	
ZZZ-33 + B.S.W.L.										
to 35/65		82.4	83.1		7.4	6.7		1	2	
hllw (60) + B.S.-										
W.L. to 35/65		79.3			10.1				9	

* At 18% Lehigh 61 is slightly whiter; Ozlo 35/65, Lehigh 6, Azo 35L and hllw (60) + 511 to 35/65 are very close in color.

TABLE VIII A.

EFFECT ON COLOR OF INCREASING THE
TITANIUM CONTENT OF HOUSE PAINT

Paints were made in the SWP Gloss White Formula (Card 47) containing 14% titanium dioxide and also in the same formula modified to contain, respectively, 8% and 18% titanium dioxide.

Formulas:

<u>Pigment</u>	<u>8% TiO₂</u>	<u>14% TiO₂</u>	<u>18% TiO₂</u>
Asbestine	300 #	290 #	320 #
Anatase TiO ₂	80	136	162
Leaded Zinc, 35/65	515	480	430
B. C. W. L.	105	70	
	<u>1000 #</u>	<u>976 #</u>	<u>912 #</u>

COLOR CHARACTERISTICS

<u>L. Z. Pigment</u>		<u>Brightness</u>			<u>Yellowness</u>			<u>Whiteness</u>		
<u>Brand</u>	<u>Color</u>	<u>8%</u>	<u>14%</u>	<u>18%</u>	<u>8%</u>	<u>14%</u>	<u>18%</u>	<u>8%</u>	<u>14%</u>	<u>18%</u>
Lehigh 61	91	81.5	82.5	82.6	7.73	5.70	5.32	75.9	81.4	82.7
Lehigh 6	78	80.4	82.0	81.7	9.70	7.56	6.73	70.7	76.7	78.8
Azo 35L	76	77.4	80.1	80.3	11.70	7.22	6.72	67.8	77.4	78.6
Czlo 35/65,										
Current	77	81.1	82.4	81.9	10.1	9.35	8.18	69.5	71.8	74.9
14% (60) +										
511	69	79.6	81.4	81.8	12.6	9.47	8.92	62.5	71.4	73.0

TABLE IX.

PHYSICAL AND CHEMICAL PROPERTIESOF LEAD AND ZINC PIGMENTS.

Pigment	Type Lead Pigment/ Zinc Pigment	Soluble Zinc as ZnSO ₄	Specific Resistance	pH	325 Res.
Ozlo 35/65, Standard	35/65	0.17	3,000	6.8	0.032
Ozlo 35/65, Current	35/65	0.16	2,880	6.8	0.020
Ozlo 50/50,	50/50	0.13	4,170	6.6	0.016
Ozlo 12/88, (50)	12/88	0.32	-1,280	6.4	0.036
Ozlo 12/88, (60)	12/88	0.62	960	6.7	0.096
Blend 1, 414 and 511 to	35/65	0.15	4,080	6.8	0.008
" 2, " " " "	35/65	0.13	2,880	7.0	0.009
" 3, " " " "	35/65	0.14	4,020	7.0	0.017
Lehigh 61	35/65	0.21	2,060	6.4	0.011
Lehigh 6	35/65	0.10	4,950	6.8	0.007
Azo 35L	35/65	0.06 *	4,950	6.8	0.012
Eagle A, 350	35/65	0.25	1,580	6.7	0.218
Azo ZZ2-33	Straight ZnO	0.04	5,270	7.1	0.074
Horsehead XX-50	" "	0.46	1,300		
" XX-503	" "	0.08	2,250		
B. C. W. L.			8,820	7.1	0.011
B. S. W. L.			14,100	6.7	0.028
B. Si. W. L.			17,300	6.9	0.009

	Oil Abs. (A.V. 2.95)	Specific Gravity	Bulking Value	Wt. Per Solid Gal.
Ozlo 35/65, Standard	12.5	5.82	0.0206	48.5
Ozlo 35/65, Current	11.6			
Ozlo 50/50,	11.4	5.97	0.0201	49.7
Ozlo 12/88, (50)	12.8	5.66	0.0212	47.2
Ozlo 12/88, (60)	15.3			
Blend 1, 414 + 511 to				
35/65	11.8	5.88	0.0204	49.0
Blend 2, 414 + 511 to				
35/65	12.7			
Blend 3, 414 + 511 to				
35/65	11.6			
Lehigh 61	21.2	5.82	0.0206	48.5
Lehigh 6	14.7	5.82	0.0206	48.5
Azo 35L	11.2	5.86	0.0205	48.8
Eagle A, 350	19.1	6.00	0.0200	50.0
Azo ZZ2-33	25.6	5.58	0.0215	46.5
B. C. W. L.	11.9	6.78	0.0177	56.5
B. S. W. L.	16.3	6.38	0.0188	53.2
B. Si. W. L.	17.2	4.00	0.0300	33.3

* Manufacturer claims 0.35% Zinc Sulfate as being typical.

TABLE X

PARTICLE SIZE - SEDIMENTATION METHOD

Pigment	microns	Accumulative Wt. %						
		21	15	9	7	5	3	2
Ozlo 35/65, Standard		0.6	1.0	1.9	2.4	3.6	7.3	13.0
Ozlo 35/65, Ten. Std.		0.6	1.2	3.6	6.2	7.3	10.0	18.2
Ozlo 35/65, Current		0.1	0.2	0.6	1.0	1.7	4.4	8.0
Ozlo 50/50,		0.2	0.6	1.6	2.6	3.8	7.5	14.0
Ozlo 12/88, (71)		3.2	5.1	8.0	9.4	12.6	18.2	23.0
Ozlo 12/88, (60)		4.6	6.7	13.0	15.5	18.0	22.3	28.1
Ozlo 12/88, (50)		5.8	7.0	9.3	10.0	11.2	16.9	31.5
Ozlo 12/88, Min. Color 414 W		12.0	14.9	18.3	20.3	22.9	28.4	38.9
Blend 1, 414 (71)+ 511 to 35/65*		1.4	2.4	4.2	5.3	7.3	11.8	17.6
Blend 2, 414 (60)+ 511 to 35/65*		2.0	3.0	6.2	7.8	9.5	13.3	19.6
Blend 3, 414 (50)+ 511 to 35/65*		2.4	3.2	4.7	5.6	6.8	11.3	21.0
Lehigh 61		1.5	2.0	3.2	4.9	6.3	8.5	13.2
Lehigh 6		0.2	0.5	1.0	1.6	2.4	7.2	15.0
Azo 35L		0.2	0.7	1.6	2.3	3.2	5.5	9.7
Eagle A, 350		1.8	3.4	7.0	7.7	8.1	16.4	32.3
B. C. W. L.		0.1	0.2	0.8	2.7	5.7	18.6	31.0
B. S. W. L.		3.5	4.3	8.4	11.1	15.0	20.6	31.8
B. Si. W. L.		0.4	0.7	3.2	7.1	22.8	44.5	60.0

* Calculated values.

TEXTURE - HOOVER MULLER TEST

Pigment	Revolutions to Obtain a Grind of						
	3-1/2	4	4-1/2	5	5-1/2	6	6-1/2
Ozlo 35/65, Standard	10	13	15	25	40	80	155
Ozlo 35/65, Ten. Std.			10	15	35	125	350
Ozlo 35/65, Current		10	13	25	50	155	+ 400
Ozlo 50/50,				13	30	75	200
Ozlo 12/88, (71)			10	30	90	235	+ 400
Ozlo 12/88, (60)		10	15	40	125	+ 400	
Ozlo 12/88, (50)			10	25	75	235	+ 400
Ozlo 12/88, Min. Color 414 W	8	20	45	100	200	+ 400	
Blend 1, 414 (71) + 511 to 35/65			8	13	35	140	+ 400
Blend 2, 414 (60) + 511 to 35/65			10	25	80	230	+ 400
Blend 3, 414 (50) + 511 to 35/65			8	13	40	155	+ 400
Lehigh 61		10	13	20	30	55	125
Lehigh 6	15	20	30	50	75	130	225
Azo 35L			10	15	25	50	130
Eagle A, 350	25	40	70	105	175	400	
B. C. W. L.				13	65	210	+ 400
B. S. W. L.		10	13	25	45	105	205
B. Si. W. L.			10	20	75	245	+ 400

TABLE XI.

Hiding Power. The hiding power of the various leaded zinc oxides, both composite pigments and blends, was determined in the regular SWP Gloss White formula. Results are given for contrast ratios of 93, 95 and 98%.

Regular SWP Formula

<u>Pigment</u>	<u>Hiding Power in Sq.Ft./Gal.</u>			
	<u>Contrast Ratio</u>	<u>93%</u>	<u>95%</u>	<u>98%</u>
Lehigh 61, Blend		460	402	298
Lehigh 6 , Cofumed		488	415	303
Azo 35L , "		500	426	315
Eagle A, 350 "		481	407	297
Ozlo 35/65, Current		480	405	288
Ozlo 35/65, Standard		495	412	289
414 (60) + 511 to 35/65		500	426	315
414 (50) + 511 to 35/65		500	426	315

Single Pigmentation

Ozlo 35/65, Current	445	373	268
Ozlo 12/88, (60)	505	418	292

Ozlo 35/65 (Standard), blends of Ozlo 12/88 and Ozlo 50/50 and Azo 35L show slightly greater hiding power than the other leaded zinc oxides.

In the modified SWP formula, containing only the single pigment substituted on a volume basis, Ozlo 12/88 shows distinctly greater hiding power than Ozlo 35/65 current. There is definitely no drop in hiding power in using Ozlo 12/88 in house paint.

Auxiliaries Research Laboratory

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