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LEAD-FREE PIGMENTATIONS

Pigment reformulating by paint manufacturers has been necessary as the result of Government restrictions on the use of lead in coatings. Public Law 91-695, "Lead-Based Paint Poisoning Prevention Act," is a recent development applied to Federally financed housing. Although this law has been effective since January, 1971, no additional restrictions on the use of lead-based paints have yet been imposed. The extent and nature of these restrictions will be dependent on the implementing regulations to be developed by the Secretary of HEW.

This bulletin is being issued in answer to many requests for assistance in replacing lead-containing standards. It provides pertinent information concerning Imperial® colors that will meet the lead-free requirements when approximating coatings pigmented with chrome yellow, molybdate orange, and chrome green.

This bulletin is intended to give general relationships and to help familiarize you with Imperial pigments for lead-free coatings. The actual formulations and final decisions must be based upon the formulators' own tests. The following recommendations were based on color comparisons prepared from alkyd enamels. Approximate cost relationships were obtained from masstone enamels at similar hiding, and tint enamels at similar strength.

Experienced formulators are well aware of the problems involved in making these substitutions. In general, the organic pigment substitutes are higher in cost and lack the tint lightfastness, opacity, working properties, hue characteristics, and nonbleeding properties of the lead chromates. Deficiencies in organic pigment working properties are accentuated when working in the masstone ranges. These problems include high viscosity and puffiness. The masstone lightfastness of organic pigments will be as good as, or better than, lead chromate pigments in most cases, and chemical resistance will be improved in both masstone and tint applications.

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**COATINGS & SPECIALTY
PRODUCTS DEPARTMENT
HERCULES INCORPORATED
Wilmington, Delaware 19899**



**Lead-Free Pigmentations Versus Chrome Yellows
and Molybdate Orange (Masstone and Tint)**

Hansa-type yellows and dinitroaniline orange were selected as the basic components for these pigmentations. Some information is also included recommending diarylide yellows and oranges for more bleed- and heat-resistant, but less lightfast, coatings. Reasons for specific pigment selections can be summarized as follows:

1. Imperial X-1351 and X-1956 were selected for masstone pigmentations because they are the cleaner and more opaque standards. Tint comparisons are furnished for the formulator who wants to keep the number of standards at a minimum and is working only with interior finishes.
2. Imperial X-3051, X-2846, and X-2910 were selected for tints because of their superior tint lightfastness. They are among the most lightfast hansa types available, but they will fade on exterior exposure and must be checked carefully for this application. They will require some back-up with iron oxides to obtain even moderately good performance in light tints.
3. Imperial X-3410 provides an intermediate degree of tint lightfastness. It is less lightfast than X-2846 and more lightfast than X-1351. It is stronger and better in money value, at equal strength, than either X-2846 or X-1351. It is less red in tint hue, however, and loses this money value advantage when it is necessary to redden it with higher priced products.
4. Imperial X-2864 is a fairly lightfast, opaque diarylide yellow that lies, in redness, between light and medium chrome yellow. Shading with X-2065, diarylide orange, is recommended for redder hues. For greener masstones, X-2476 (opaque-type diarylide) can be used. For greener tints, X-2485 (high-strength diarylide) will provide the best money value.
5. Imperial X-881 (dinitroaniline orange) provides an approximate match for molybdate orange. It is fairly opaque but does bleed. It has very good lightfastness in masstone shade, but it must be evaluated for tint lightfastness where prolonged exposure is anticipated.

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**Lead-Free Pigmentations Versus
Chrome Greens (Masstone)**

1. Combinations of hansa yellow, titanium dioxide, and iron blue can be used for chrome green masstone shades. Cost will be higher at similar hiding, and film durability poorer, but lightfastness and acid resistance will be improved. Substituting phthalocyanine blue for the iron blue will give a more lightfast, more chemically resistant, but also a more expensive pigmentation.
2. Chromium oxide shaded with phthalocyanine green or blue offers a narrow range of depths, but provides excellent performance in both masstone and tint. Costs are higher at similar hiding. The phthalocyanine green combination provides the better color match at higher cost.
3. Zinc chromate plus iron blue will provide a very pale, clean green with moderately good lightfastness. Yellow oxide can be used for shading, but good color matches are difficult. Hiding is poor and costs slightly higher at similar hiding. Staining on white areas below the trim may occur because of the leaching of soluble chromate. Although this pigmentation is lead free, zinc chromate does not rate as well as lead chromate in Acute Oral Toxicity tests (AOT-LD₅₀).

Specific recommendations for approximating primrose, light, and medium chrome yellows; molybdate oranges; and chrome greens are listed on the following pages. Cost ratios are included and suggestions limited strictly to interior applications are indicated. Since titanium dioxide is an integral part of the masstone pigmentations, cost ratios are based on total pigment. Cost ratios of the tint pigmentations are based only on color pigment to give a truer cost relationship in a wide range of tints.

In summary, the information contained in this bulletin is intended to give the formulator a base for his study of lead-free coatings.

GLD012186

Pigments Used in Lead-Free Recommendations

Color Number	Color Name	Type	Color Index	
			Name	Number
X-3051	Empress™ Yellow 10G	Hansa	Pigment Yellow 3	11710
X-1351	Horicon Yellow	Hansa	Pigment Yellow 6	11670
X-2846	Empress Yellow	Hansa	Pigment Yellow 73	—
X-2910	Empress Yellow R	Hansa	Pigment Yellow 75	—
X-3410	Empress Yellow GS	Hansa	Pigment Yellow 74	11741
X-1956	Yellow Toner	Hansa	Pigment Yellow 6	11670
X-2864	Sahara Yellow	Diarylde	Pigment Yellow 76	—
X-2476	Sacandaga Yellow	Diarylde	Pigment Yellow 14	21095
X-2485	Amazon Yellow	Diarylde	Pigment Yellow 12	21090
X-2065	Oswego Orange	Diarylde	Pigment Orange 13	21110
X-881	Nippon Orange Toner	Dinitroaniline	Pigment Orange 5	12075
X-3163	C.P. Blue	Iron blue	Pigment Blue 27	77510
A-4433	Monarch™ Green	Phthalocyanine	Pigment Green 7	74260
X-3367	Monarch Blue CFR	Phthalocyanine	Pigment Blue 15	74160
X-1134	C.P. Chromium Oxide	Chromium oxide	Pigment Green 17	77288
X-883	C.P. Zinc Yellow	Zinc chromate	Pigment Yellow 36	77955
610	Yellow Oxide L	Iron oxide	Pigment Yellow 42	77492
630	Yellow Oxide DO	Iron oxide	Pigment Yellow 42	77492
1200	Red Oxide	Iron oxide	Pigment Red 101	77491
1203	Red Oxide	Iron oxide	Pigment Red 101	77491

Hue and Cost Comparisons

Lead-Free Pigment (Hansa Type) Versus Primrose Chrome Yellow

Lead-Free Pigmentation Versus X-3215 Regal™ Yellow Primrose	Hue	Cost Ratios (Lead-Free Pigment: Chrome Yellow)	
		Total Pigment (Similar Hiding)	Color Pigment* (Similar Strength)
<u>Masstone</u>			
76.3% X-3051	Slightly redder	2.25	—
3.7% No. 630 oxide			
20.0% TiO ₂			
<u>Tint</u>			
87.5% X-3051	Close redness	—	1.27
12.5% No. 610 oxide			

*Chrome yellow pigmentation:

10% X-3215
90% Titanium dioxide (rutile)

GLD012187



Hue and Cost Comparisons
Lead-Free Pigment (Hansa Type) Versus Light Chrome Yellow

Lead-Free Pigmentation Versus X-2548 C.P. Light Yellow	Hue	Cost Ratios (Lead-Free Pigment: Chrome Yellow)	
		Total Pigment (Similar Hiding)	Color Pigment* (Similar Strength)
<u>Masstone</u>			
60% X-1351 40% TiO ₂	Close redness; dirtier	1.96	—
<u>Tint (Interior Only)</u>			
100% X-1351	A little less red; cleaner	—	1.27
<u>Tint (More Lightfast)</u>			
76% X-2846 24% X-2910	Close redness; cleaner	—	1.45
<u>Tint (Intermediate Lightfastness)</u>			
50% X-3410 50% X-2910	Close redness; cleaner	—	1.45

*Chrome yellow pigmentation:
10% X-2548
90% Titanium dioxide (rutile)

Hue and Cost Comparisons
Lead-Free Pigment (Hansa Type) Versus Medium Chrome Yellow

Lead-Free Pigmentation Versus X-2541 C.P. Medium Yellow	Hue	Cost Ratios (Lead-Free Pigment: Chrome Yellow)	
		Total Pigment (Similar Hiding)	Color Pigment* (Similar Strength)
<u>Masstone</u>			
30% X-1956 40% X-1351 30% TiO ₂	Slightly redder; dirtier	4.18	—
<u>Tint (Interior Only)</u>			
100% X-1956	Slightly less red	—	2.73
<u>Tint (More Lightfast)</u>			
100% X-2910	Much less red	—	3.09
<u>Tint (More Lightfast)</u>			
1.4% No. 1200 oxide 98.6% X-2910	A little less red; dirtier	—	2.73

*Chrome yellow pigmentation:
10% X-2541
90% Titanium dioxide (rutile)

GLD012188



Hue and Cost Comparisons
Lead-Free Pigment (Diarylide) Versus Chrome Yellow
(Interior Only)

Lead-Free Pigmentation Versus: 40% X-2541 C.P. Medium Yellow 60% X-2548 C.P. Light Yellow	Hue	Cost Ratios (Lead-Free Pigment: Chrome Yellow)	
		Total Pigment (Similar Hiding)	Color Pigment* (Similar Strength)
<u>Masstone</u>			
35% X-2864 65% TiO ₂	Close redness; dirtier	2.26	—
<u>Tint</u>			
100% X-2864	Close redness	—	1.27
Lead-Free Pigmentation Versus X-2548 C.P. Light Yellow			
<u>Masstone</u>			
7.5% X-2864 67.5% X-2476 25.0% TiO ₂	Close redness; dirtier	1.98	—
<u>Tint</u>			
20% X-2864 80% X-2476	Slightly redder	—	1.09
<u>Tint</u>			
25% X-2864 75% X-2485	Close redness	—	.64
Lead-Free Pigmentation Versus X-2541 C.P. Medium Yellow			
<u>Masstone</u>			
60% X-2864 40% TiO ₂	Close redness; dirtier	4.66	—
<u>Tint</u>			
97% X-2864 3% X-2065	Close redness	—	1.45
<u>Tint</u>			
91.5% X-2485 8.5% X-2065	Slightly less red	—	.73

*Chrome yellow pigmentation:

10% Chrome yellow
90% Titanium dioxide (rutile)

GLD012189



Hue and Cost Comparisons
Lead-Free Pigment (Dinitroaniline) Versus Molybdate Orange

Lead-Free Pigmentation Versus X-2552 Red Orange	Hue	Cost Ratios (Lead-Free Pigment: Molybdate Orange)	
		Total Pigment (Similar Hiding)	Color Pigment* (Similar Strength)
<u>Masstone</u>			
90% X-881 10% TiO ₂	Close	2.49	—
<u>Tint</u>			
84% X-881 16% No. 1203 oxide	Close blueness; dirtier	—	1.27

*Molybdate orange pigmentation:

10% X-2552
90% Titanium dioxide (rutile)

Hue and Cost Comparisons
Lead-Free Pigment (Iron Blue Plus Hansa) Versus Chrome Greens

Lead-Free Pigmentation Versus A-4482 C.P. Sylvan Green Extra Light	Hue	Cost Ratios (Lead-Free Pigment: Chrome Green)	
		Total Pigment (Similar Hiding)	
<u>Masstone</u>			
9.3% X-3163 55.7% X-1351 35.0% TiO ₂	A little more olive; dirtier	1.44	
<u>Lead-Free Pigmentation Versus A-4483 C.P. Sylvan Green Light</u>			
<u>Masstone</u>			
17.5% X-3163 54.1% X-1351 28.4% TiO ₂	A little more olive; dirtier	1.68	
<u>Lead-Free Pigmentation Versus A-4484 C.P. Sylvan Green Medium</u>			
<u>Masstone</u>			
27.7% X-3163 48.7% X-1351 23.6% TiO ₂	Slightly more olive; dirtier	1.53	
<u>Lead-Free Pigmentation Versus A-4485 C.P. Sylvan Green Deep</u>			
<u>Masstone</u>			
33.5% X-3163 45.0% X-1351 21.5% TiO ₂	Slightly more olive; dirtier	1.80	

GLD012190



Hue and Cost Comparisons
Lead-Free Combinations Versus Chrome Greens

Lead-Free Combinations
Versus A-4484
C.P. Sylvan Green Medium

Cost Ratios (Lead-Free Combinations:
Chrome Green)

Hue

Total Pigment (Similar Hiding)

Masstone

4554
4554
1861 { 22% A-4433
78% X-1134

Close depth;
cleaner

3.00

Masstone

4.5% X-3367
95.5% X-1134

Close depth;
chalkier and dirtier

1.41

Masstone

11% X-3163
15% No. 610 oxide
74% X-883

Slightly bluer;
chalkier

1.06

6304 55% X 2846
20 X 2910 } med chrome.
25% 7102

x 3552

S. Johansen

4/25/72 2910 single qt.

GLD012191