Cleveland, Ohio July 30, 1947 MR. H. W. DELL

PRODUCT DEVELOPMENT REPORT

We are pleased to attach the consolidated Paint & Varnish Division Laboratory report for June, 1947.

This report merits your careful study in order to obtain the most value from the respective laboratory reports.

We are also looking forward to including interesting items from other divisions.

Kindly note the House Paint section which contains an excellent cooperative report on duPont and New Jersey Zinc House Paint tests written by Mr. H. C. Hayward and Mr. John F. Farner as a result of their visit to the respective test fences.

F. Schulte

rc/lms

GLD005163

GENERAL CONCLUSIONS DRAWN FROM OBSERVATIONS OF KREBS HOUSE PAINT EXPOSURES AND N.J. ZINC HOUSE PAINT EXPOSURES

1. Conservation vehicle formulae are equally durable and in many cases more durable than prewar high oil content paints.

2. Anatase TiO_2 is the type to use in first quality white house paints for self cleaning and appearance.

3. Rutile TiO_2 grades of any type chalk less than anatase, have a yellower color, but are more durable. They are indicated for tint bases, primers, and high hiding one-coat paints.

4. Lithopone paints of excellent durability and appearance can be supplied if TiO_2 is lacking. These paints, however, are poor for non-staining characteristics.

5. Fume-proof lead-free paints of economical price having durability equal to regular house paints can be supplied if lead becomes increasingly scarce and high priced. These paints, however, will demand slightly more TiO_2 than the normal paints.

6. Soyabean oil can be incorporated in the non-volatile vehicle of a paint to the extent of 25% without detracting from its durability. Slightly higher zinc-lead ratios should be maintained in these paints to prevent mildew.

7. #325 Mesh Water Ground Mica used in quantities such as 5 - 10% of the pigment markedly improve the life of a paint film. Higher percentages detract from application properties due to oil absorption.

8. Calcium carbonate of the York Whiting type may safely be used in first quality tint bases. Paints of low cost and good durability can be formulated in this way. Other whitings can be incorporated when non-chalking TiO_2 is used or when used in conjunction with #325 Mica as a fortifying agent.

9. One coat house paints of godd durability and very high hiding can be made over formulae given in this report. They show excellent possibilities in repaint work.

10. Any properly formulated first quality ready-mixed house paint is far superior to lead in oil or ready-mixed pure lead paints for durability and appearance.

11. Alkyd additives tend to decrease the life of an oil type house paint.

12. Alkyd porch and deck paints exhibit the best weathering tendencies, being markedly superior to phenolics or long oil spar types.

13. Mildew tendencies in conservation paints are less than in orthodox vehicle paints. However, the zinc-lead pigments should be maintained at approximately 50% of the total pigmentation in order to obtain good mildew resistant qualities.

14. Paints using bodied oils as the sole non-volatile vehicle constituent can be formulated that have excellent durability and a smooth surface relatively free of brush marks. One coat paints should be formulated along these lines in order to insure the application of a continuous film.

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GLD005164

N 2271.01

REPORT ON EXAMINATION OF HOUSE PAINT EXPOSURES AT WILMINGTON, DEL.
KREBS TEST FENCES

Paints of both orthodox vehicle and oil conservation vehicle combination were observed after one year, two years, and four years' exposure, both north and south in a vertical position. Paints were applied to white pine house siding at the rate of 500 sq.ft./gal. on the first coat and 650 sq.ft./gal. for the second and third coat. Three coats were used except where otherwise noted. Types of pigmentation compared are as follows:-

1. 45/40/15 - Lithopone, 35% loaded zinc, Mg.Sil.
2. 60/30/10 - Zinc Sulfide, 35% Loaded Zinc, Mg.Sil.
3. Dutch Boy Lead in Oil
4. Dutch Boy Ready-Mixed
5. 60/30/10 - BCWL, ZnO, MgSil.
6. 10/22-1/2/45/22-1/2 - FFTiO$_2$/ MgSil./35% PbZn/ BCWL
7. F-200 for FFTiO$_2$ in 6.
8. Y-CR for FFTiO$_2$ in 6.
9. R-110 for FFTiO$_2$ in 6.
10. R-25 (1) for FFTiO$_2$ in 6. - CaSO$_4$ off the MgSil.
11. R-25 (2) " " " 6. " " " "
12. Same as 6 - No Mg.Sil. - Add CaCO$_3$ (York) to 40% P.V.
13. 11/45/44 - FFTiO$_2$/ 35% PbZn/ MgSil./
14. 50/50 - TiSil/ 35% PbZn
15. F-200 for FF in 14.
16. YC-R for FF in 14.
17. R-110 " " " 14.
18. R-25 (1) for FF in 14. CaSO$_4$ off the Mg.Sil.
19. R-25 (2) " " " " " " " "
20. RCHT for FF in 14. CaSO$_4$ off the Mg.Sil.
21. R-C " " " " " " " "
22. R-60 " " " " " " " "
23. Same as 14. Mg.Sil replaced with York CaCO$_3$ to 40% P.V.
24. 18/36/46 FFTiO$_2$/Acicular ZnO/MgSil./

Note - 1-24 inclusive contain orthodox vehicle and approximately 28.5% P.V. except where noted.

44. Same pigment as 6. - Conservation Veh.* 35% P.V.
45. F-200 for FF in 44.
46. YCR for FF in 44.
47. R-110 for FF in 44.
48. Same pigment as 14. Conservation Veh.*. 35% P.V.
49. F-200 for FF in 48.
50. YCR for FF in 48.
51. R-110 for FF in 48.

*Cons.Veh. - 1/3 alkali ref. linseed, 1/3 "X" Body Linseed, 1/3 Thinner & Drier.

Observations - 1 year - All in good condition with exception of high lead paints which are extremely dirty. These have worst appearance of series - paints 3,4,5. Paints 1 and 2 are considerably better than the lead paints, are chalking moderately, have good appearance. Paints 6 to 11 inclusive are showing decreasing chalking and cleaning tendencies as TiO$_2$ is changed from chalking to non-chalking type. The rutiles are noticeably yellower than the anatase grades. The TiCal-Rutiles are poorest for self-cleaning. At this point paints 13 to 22 incl. are following the tendency noted in the 6 to 11 series. Paint 24 - lead free type - is

showing a slight amount of mildew but is otherwise very good. Paints 44 to 47 incl. and 48 to 51 incl. using conservation vehicle are showing slightly more chalking tendencies than orthodox vehicle paints but are in excellent condition with chalking decreasing as the TiO_2 is changed to more non-chalking types. These tests reaffirm the greater non-chalking qualities in the rutile grades as compared to anatase and also their yellower color. Even after 1 year exposure this difference is quite noticeable between FF Anatase and F-200 Rutile (most freely chalking type Rutile) For this reason the Krebs are recommending anatase in white house paint for best appearance.

Observation - 2 years - At this point the straight lead paints, #3 & #4, were showing checking. Paints containing anatase TiO_2 (FF) were best for appearance and self cleaning. #1 Lithopone Paint was also good. Color and dirt retention on the Rutile TiO_2 was again poorer and a tendency toward mildew was noted as rate of chalking decreased. The lead free paints were in excellent condition but were showing mildew on northern exposure. The paints containing calcium carbonate were still in good condition. Conservation vehicle paints were affected as to rate of chalk by the type of TiO_2 used in the same way that the orthodox vehicle paints were affected. No appreciable difference in comparable paints using the two different vehicles could be noted at this time other than less tendency to mildew with the conservation vehicle paints.

Observations - 4 years - The straight lead paints were very badly checked in this time. The #5 paint (60/30/10) was showing cracking. The lithopone paint was still good, showing a chalking type weathering. #2 paint (Zinc Sulfide type) was chalking moderately but was also good. Paint #6 was in excellent condition showing moderate chalking on both north and south exposures. The R-200, YCR, and R-110 MgSil paints were O.K. on south exposure but were showing moderate dirt collection on the northern exposure. The TiCal and R-200 $CaCO_3$ paints were equal on southern exposure to the R-200 MgSil paints but were showing mild mildew growth on the north as well as moderate dirt collection. These observations hold whether the pigmentations were of #6, #13, or #14 types using orthodox vehicle.

The conservation type formulae in this series are the oldest ones on test at Wilmington. They contain as vehicle 1/3 alkali ref. linseed, 1/3 Z-4 body linseed, and 1/3 thinner and drier. Pigmentations are the same as those in paints 6 - 9 incl. and 14 - 17 incl. These paints are all good but are showing typical dirt retention with the use of non-chalking TiO_2 especially on northern exposure. It was noted that the pigmentation of the #6 type (high load) shows somewhat less tendency to mildew than does the #14 type pigmentation. The R-110 panels showed this point particularly well.

7 Yr. Exposure Observations:

We observed the few panels remaining of a series exposed for seven years. These were the 3-coat self prime system used throughout all the tests we observed. #6 paint was eroded to the wood showing slight cracking. With anatase replaced by an early rutile pigment, the film was still in good condition but had the typical yellow color. In #14 paint using the above TiO_2 changes, the same observations held but these two paints appeared to weather slightly better than those using the #6 pigmentation. These tests again show that rutile pigments improve durability at a sacrifice in appearance.

Commercial Two-Coat Systems:

Several 2-coat house paint systems such as Devoe, Dutch Boy Ready Mix, and a Titanium Pigment recommendation were compared to the #14 paint (50-50 TiSil - 35% PbZnO) - 2 coats - after 4 years exposure. Generally these showed that 2 coats of any paint are not as good as 3 coats. The 50-50 was showing a tendency to line cracking, the Dutch Boy was checking badly, while the Devoe was similar to the 50-50. The competitive panels used as primers for the 50-50 in 2 coat systems showed no great advantage. When the 50-50 paint (#14) was applied over primers of 40, 35, & 28.5 P.V. using 12-1/2/ 45/42-1/2 R-610/ 35% PVZnO/ MgSil. and varying the oil body in a conservation vehicle, the paint film life was increased although there was no great difference in the appearance of the 50-50 paint over the various P.V. primers. The 50-50 paint erodes leaving the non chalking primer remaining which is quite durable. For 2 coat systems, this practice is recommended.

One Coat House Paints:

A series of these paints were observed after 2-1/2 years' exposure. The pigmentation was 25/50/25 of FF, 35% PbZnO, MgSil. This was used in both the orthodox vehicle and a conservation vehicle in P.V's of 25,25, & 28.5 with a 35% P.V. being included in the conservation type. When applied at 450 sq.ft./gal., the paints were in good shape after 2-1/2 years but were chalking considerably. Chalking increased and durability decreased with the rise in P.V. When the conservation paints were applied a 200 ftsq. /gal. on new wood, one coat, the 35% P.V. looked very good but tended to flash in drying. A life of 3 years seemed to be the durability that might be expected from this type paint. It would make an excellent one coat repaint product.

Two paints using the conservation vehicle containing 2-1/2 M OKO as the only oil and pigmented with 25 FF/50 of 35% PbZnO) 25 York Whiting to 20 P.V. and 40 P.V. showed good appearance. The 40 P.V. had a tendency to sag but was otherwise good. The 40 P.V. also had 10% 325 W.G. Mica replacing the Mg.Sil.

The above tests offer a good ground work for any one coat house paints we might wish to develop. However, we feel that they would be difficult to apply at the rates recommended for application to new wood and believe their largest use would be in repaint work and therefore recommend testing in this manner.

Inert Study

Panels exposed for 5 years have weathered so completely that only a few panels remain which show any film protection. The pigmentation was based on 15/50/35 - FF, 35% PbZn, $CaCo_3$ in a prewar vehicle. Following pigments were good of the 35 tested, which included representative samples of each type inert.

1. Dry ground York Whiting
2. Mg. Sil.
3. Motronite
4. Celite 110
5. Dicalite L.
6. Eastern Magnesia Talc
7. Pyro phyllite

For this type vehicle and pigmentation, the above inerts were found best. However in other type vehicles and pigmentations, some of the other inerts might be sufficiently good to do a particular job. This was proven in the same test series as that run above when the FF Anatase TiO_2 was replaced by R-510 Rutile TiO_2. In the same length of time the only pigments to fail were Multifex and two special $CaCO_3$ containing high amounts of free lime.

Tint Base Study.

In tests run over a period of three years using tints of gray and buff in both prewar and conservation vehicles, it has been found that R-610 is the best type of TiO_2 to use and that York Whiting replacing the MgSil. on a volume basis improves tint retention considerably. The replacement of leaded zinc with acicular zinc oxide can be made and will maintain good color with no lead. An R-610, Acicular Zinc, and York Whiting formula proved an excellent tint base and could be used if lead becomes too high in price. The above observations hold with a 28.5 P.V. prewar vehicle paint or a 35 P.V. conservation vehicle paint. A P.V. as high as 40% may be used using York Whiting as inert in the prewar vehicle or as high as 50% in the conservation vehicle and still produce an excellent low cost tint base. $CaSO_4$ replacing York Whiting in the same series was not quite as good nor quite as low in cost.

These paints were superior in tint retention to lead titanate type tint bases and are considerably more economical.

Soya Bean Oil in House Paints.

The most complete series of soya containing paints have been placed on exposure in the past few months and it is too early to make any observations. One paint using the Dept. of Agriculture Soya as the sole vehicle in the 50-50 pigmentation showed very poor dry and bad dirt collection.

From several other tests observed in which treated soyas were used, it was noted that it was necessary to keep approximately 50% of the pigment as 35% PvZnO in order to combat mildew tendencies.

It is recommended that we institute a series of tests on soya oil paints as soon as possible because outside information is rather meager. This study should include VR-46100 and paint oils made from combinations of soya and wood oil.

Staining of House Paints:-

An extensive series of tests are being conducted on staining at Wilmington at present but conclusive results have not yet been reached. At present it is felt that ZnO induces staining. Low staining paints have been produced using solvent extracted linseed oil. The effect of alkyds and other additives to paint to prevent this is being studied. Staining is being studied by the use of both copper and iron screens attached to the paint tests.

Porch and Dock Paints:-

An extensive series of commercial and experimental porch and dock paints were observed. Those using an alkyd vehicle were outstanding even after 4 years at 45° South. Non chalking rutile TiO_2 R-610 along with different inerts in an alkyd vehicle (GE 2475) were far better than a 25 gal. phenolic vehicle, BR-254, Linseed, C.W.O.

We feel that any future tests of our own should include vehicles of this type as well as mixtures of the two because of the fact we supply one product for interior and exterior use.

House Inspection:-

We inspected the Wanner, the Dupont house, the Ball house, and the McKinley house. Test paints applied to these houses were weathering in the same way as the same paints on the test fences. It was notable on the Wanner house whose test panels of the 64.7 P.V. York Whiting paint have been exposed for approximately 3 years, that this paint was showing some signs of failure by cracking, although they were not serious. On the DuPont house after 20 months exposure, the 40% P.V.

17-1/2 44 38½
FF/ Acicular ZnO/$CaCO_3$ / paint using 2-1/2 MOKO conservation vehicle was outstanding for appearance at this point. This same paint was in excellent condition on the McKinley house after 2-1/2 years. The Ball house demonstrated that the 50-50 (#14 paint on page 1) was excellent for repaint use over both itself and other paints, no matter if checking failure was present.

REPORT ON EXAMINATION OF HOUSE PAINT EXPOSURES AT PALMERTON, PA.
N.J. ZINC CO. TEST FENCES

Paints at Palmerton were applied 2 coats over new pine wood and 2 coats over well weathered and checked white lead. They were not applied at a given spreading rate but were coated with normal amounts of paint.

Two basic formulae were used:-

1. 15/47/13/25 - F-200/35% PbZnO/BCWL/MgSil.
2. 15/47/38 - F-200/35%PbZnO/MgSil

These paints were all approximately 33% P.V. and the N.V. vehicle consisted of 3 pts. alkali refined linseed and 1 pt. Z-5 linseed. A conservation vehicle was used unless noted.

Following observations were made:

1. Type of ZnO whether acicular or nodular had no appreciable effect.
2. The replacement of 5%, 10%, & 15% of MgSil with 325 Mesh W.G. Mica markedly improved the film. Dirt retention was not noticeable in these films.
3. To use Anatase TiO_2 for the F-200 rutile increases chalking, improves color, but reduces film life.
4. The P.V. could be reduced to 28% without undue mildew or dirt retention but could not be increased to 38% without producing cracking failure.
5. Prewar vehicle with above pigmentation at 29 P.V. was not as good as the conservation vehicle using same pigmentation at 33% P.V.
6. The use of R-510 for R-200 improves durability but sacrifices color and cleanliness.
7. A series of paints pigmented in such a way as to have a range of PbZnO contents from 23% to 78% showed that below 35% mildew increased while above 55-60% cracking increased.
8. The inclusion of 10% mica in the inert controls cracking in high PbZnO content paints.

Fume-proof Series:

From a series of tests run over a 4-year period, the preferred formula is 15/40/35/10 - TiO_2/ ZnO/ MgSil/Mica. This was true in both conservation and orthodox vehicles.

Lithopone Paints:-

A number of panels were observed showing various lithopone paints which had weathered from 2 to 4 years. A paint of approximately 35% P.V. in a conservation vehicle of 50/35/15 - Lithopone, 35% PbZno, Mica - looked very good after four years' exposure on 2 coats. This formula should be excellent for 2nd grade paints.

Vehicle Study:

A set of panels exposed for 3 years was observed using the following pigmentation variations and the annotated oils as replacement for the Z-5 linseed in the conservation vehicle consisting 3 pts. alkali refined linseed and one pt. Z-5 linseed at 67% N.V. Each oil was used with the seven basic pigmentations given here:

A - 15/13/47/15/10 - R-200 TiO_2/BCWL/35% PbZno/MgSil/325 WGMica
B - 15/31/44/10 - R-200 TiO_2/ 35% PbZno/MgSil/325 WGMica
C - 15/47/28/10 - Same pig. as B.
D - 15/55/20/10 - " " " "
E.- 15/62½/12½/10 " " " "
F - 15/47/38 - R-200 TiO_2/ 35% PbZnO/MgSil
G - 50/35/15 - Lithopone/35% PbZnO/325 WG Mica

Oils 1 - Z-5 Linseed
2 - Dehydrated Castor
3 - Conjulin
4 - Conjusoy
5 - Q Kellin - held thinner for body
6 - Z-5 Kellin
7 - ADM Varnex - held thinner for body.
8 - Z-5 Varnex
9 - Atlas Oil - Sorbitol Ester - K Body - held thinner for body
10 - Atlas Oil - Z-5 body
11 - 710 Oil National Lead - Blown & Maleic linseed
12 - #1240 Aroplaz Alkyd lengthened to 200 gal. with alkali refined linseed for all of N.V. in vehicle.
13 - #869 Rezyl used same as 12.
14 - Heat blend of #869 Rezyland oil.
15 - Carbic - linseed - 150 gal. long.
16 - Carbic - Soya - 150 gal. long

These two coat systems were all in good condition showing moderate chalking type failure with no cracking except failures noted below:

- Lithopone paints in all cases were eroded considerably more than the others and needed repainting. Only cracking failure was in #15 oil (Carbic-Linseed) using lithopone pigmentation. The #16 oil (Carbic -Soya) was O.K.
- The alkyd type paints (12,13,14 vehicle) were showing slightly more erosion than the straight oil products indicating they add no life to the paint film.
- The Atlas-Sorbitol Ester oil was not quite as good as linseed, especially in the low viscosity grade. It was weathering much like the alkyd paints.

The above tests indicate in conclusion that any of the common drying oils as well as soya can be used for 25% of the N.V. vehicle in conservation formulae to produce a film that will give good four year protection in two coats of paint and will allow a wide latitude of pigmentations as noted above.

Single Pigment Study:-

A number of exposures showing single pigments ground into conservation vehicle were observed. Pigment was added until correct body was reached. Two coats were applied and tint tests in gray and buff were also run. Tests 1 year old, 2 years-9 mos. old, and 4 years.3-mox. old were noted with the following results:-
(See attached chart)

Single Pigment	1 Year Exposure Appearance	Chalk	Tint	2 Years - 9 months Appearance	Chalk	Tint	4 years - 3 months Appearnace	Chalk	Tint
Dutch Boy WL in raw oil	V.dirty	None	Good	Fine check S.dirty	none	Fair	Checks-dirty Holds on	V.V. Sl.	no test
BSWL	White	Slight	Poor	V.Dirty	Slight	Poor	Checking White	Cons. chalking	no test
Acicular ZnO	Dirty	None	V.good	No Test			No Test		
Cofumed 35% PbZnO	S.dirty	None	Fair	Lime cracks S.dirty	Slight	Good	Cracking-White	Slight	No test.
Lithopone	S.dirty	V.sl.	Poor	Sl.checking White	Mod.	Poor		Chalked Away	
Cryptone MS	White	V.Sl.	Fair	Mildew-white	Sl.	Fair		Chalked Away	
ZnS	Sl.dirty	None	Good	Sl.checking White	Cons.	Poor		Chalked Away	
Titanated Lithopone	White	Heavy	Poor	Chalked Away				Chalked Away	
Anatase Titanium Barium	V.white	V.heavy	V.poor	Almost chalked away				Chalked Away	
Titanox RC	Mildew V. Dirty	N one	Poor	Mildew Dirty	Mod.	Poor		Chalked Away	
Anatase FF TiO_2	V.white	V.heavy	V.poor	Chalked Away				Chalked Away	
Rutile N.C. R-610 TiO_2	Yellow S.dirty	None	Dull-Flat color	No test - See R-510				No Test	
Lead Silicate	Darkens V.dirty	None	Darkens	No Test				No Test	

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Single Pigment	1 Year Exposure			2 Years - 9 months			4 Years - 3 months		
	Appearance	Chalk	Tint	Appearance	Chalk	Tint	Appearance	Chalk	Tint
Nodular ZnO	Dirty	None	V.Good	V.V.dirty	None	V.good	Cracking off dirty	None	No test
Acicular 35% PbZnO	Dirty	None	Good	No Test			No Test		
Titanox C	Mildew spotty	Heavy in spots	V. poor	No Test			No Test		
Chalking Rutile R-200	Sl. yellow White	Heavy	V.poor	No Test			No Test		
Cryptone BA19	No Test	No Test		Sl.check white	Mod.	Poor	No Test		
Rutile Semi-chalk R-510		No Test		Sl.check white	Mod.	Poor	No Test		
Rutile chalking R-110		No Test			No Test		Chalked Away		
Lead Titanate		No Test			No Test		Yellow slight Mildew - Fair condition		
325 I.G. Mica		No Test			No Test		V.good sapspots	None	
MgSil		No Test			No Test		Sl.mildew cracking - dirty	None	
Blanc Fixe		No Test			No Test		Chalked Away		
$CaSO_4$		No Test			No Test		Bad Mildew Film nearly gone		

Single Pigment	1 Year Exposure Appearance	Chalk	Tint	2 Years - 9 months Appearance	Chalk	Tint	4 Years - 3 months Appearance	Chalk	Tint
90% BCWL 10% #325 Mica	No Test			No Test			Good-white	Slight	
75% ZnO 25% #325 Mica	No test			No Test			V.good white	V.slight	

Tests in this series exposed 4 years - 3 months used a raw linseed pre-war vehicle.

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It is concluded that the zinc oxide pigments, particularly zinc oxide itself, are excellent for tint retention being superior to the rutile TiO_2 pigments or lead when used alone. They retain a clean full tint, do not chalk or mildew, but collect considerable dirt and fail by cracking. The titanium pigments fail by erosion in the order of their chalk resistance, starting with anatase chalking fastest to R-610 chalking least. Tints of the chalking grades are very poor while tints of the non-chalking grades are good, but do not retain a clean bright color. #325 Water Ground Mica is excellent as an inert in paint films. It lends strength to a film and weathers very well by itself, being superior to MgSil, Barytes, or Gypsum.

One Coat House Paints:-

Panels exposed for two years using the following formulae were observed. They were generally very good paints showing moderate chalking, typical rutile color, and no checking or cracking. The alkyd paints were slightly poorer than the oil paints in that they are eroding slightly more.

R-200 TiO_2	35% PbZnO	B.C.W.L.	MgSil	#325 Mica	#35 Vehicle
20	47	0	23	10	Conservation Linseed
20	47	0	33	0	" "
20	47	13	10	10	" "
20	47	0	23	10	Atlas Sorbitol Ester
20	47	0	23	10	200 gal.1240 Areplaz

Test had not progressed far enough to note ultimate durability but it appears that the mica will be advantageous.