Inspection Trip
Exposures - du Pont Pigment Division
Titanium Pigment Corporation
National Lead Company
June 30, July 1, 1949

J C Weaver AUG 15 1949

General Statement

On June 30 Mr. E. W. Fasig and the writer inspected the panel exposure tests of the du Pont Pigment Division at Wilmington, Delaware. On July 1 we inspected the panel exposures of the Titanium Pigment Corporation and the basic silicate white lead exposures of the National Lead Company, both at Sayville, Long Island.

As usual, a considerable portion of our time was spent on a review of the progress of exposures which had been inspected in previous visits. Therefore, certain details will be omitted where reference to earlier reports will provide necessary background data.

A re-reading of the general statements on page 1 of the 1948 report shows that all the points stated therein also hold for this year. Further emphasis has been placed on the following points, some of which are taken from the 1948 report:

1. du Pont continues to favor properly selected calcium carbonate extenders in tints but not in whites. They concede that the replacement of magnesium silicate by calcium carbonate in leaded zinc white formulations increases checking tendencies, and this is even further aggravated in lead-free paints.

2. du Pont appears to be wavering in their approach to formulation of paints. Their first move was to go from direct volume replacements to replacements on the basis of "binder requirements." Because of consistency difficulties they are now confusing the picture by correcting consistencies by changing pigment volumes or replacing binder by thinners, or changing the composition of the binder, etc.

   This seems to introduce too many variables. We should attack this problem from the standpoint of critical pigment volume concentration. As an example, total pigment plus extender volume could be held constant, then the CPVC determined for any change in pigmentation or binder, and the "free" binder held constant. Thus the ratio of pigment volume to free binder would be held constant and comparisons would be more valid and more interesting.

3. Lead-free paints cannot be considered as durable as paints containing appreciable amounts of lead pigments, provided both are formulated with the same ingenuity. At high TiO_2 levels at least 35% zinc oxide is required to control mildew.

4. du Pont continues to favor the use of chalk resistant titanium oxides in house paint primers.

5. The preferred position of bodied oil vehicles at the lower current levels is definitely established.

6. Trends toward higher titanium levels continue with a preference toward some control of chalking. 50% of the TiO_2 as free chalking anatase TiO_2 is a minimum requirement for clean-up for white house paints. As has been pointed out many times in the past, durability increases as the chalking rate of the TiO_2 decreases. So far no solution has been found to impart maximum durability to a white of highest sustained appearance qualities. Robertson of TPC suggests about 20% total TiO_2, half introduced as Titanox RC HT and half as Titanox A, at 33% PVC, using 40% of bodied oil of suitable viscosity.

7. The exposure progress of basic silicate white lead paints continues very satisfactorily. Robertson states that he would have no hesitation to use basic silicate as the reactive lead pigment in primers or top coats. Special attention is required to control flow and puffiness. Combinations with 414 dry give satisfactory durability, with appearance qualities dependent on the characteristics of the 414 dry.

8. The large number of new binders for house paints must be watched very carefully as some show very interesting possibilities.

du Pont Pigment Division - Wilmington, Delaware

(a) Ti-Pure FF in White House Paints - Cleaning

See (a) page 10, 1948 report. The basic pigmentations in this series are (1) 10% TiO_2/45% leaded zinc/22.5% BCWL/22.5% magnesium silicate, and (2) the typical Ti-Sil formula with 15% TiO_2/50% leaded zinc/35% magnesium silicate. In each group the titanium oxides used are successively Ti-Pure FF, Y-CR, R-110 and rutile titanium calcium Ti-Cal R-25. The pigmentations were used in both the pre-war vehicle of 92% alkali refined linseed and 8% Q bodied linseed, and in a bodied oil vehicle of 50% alkali refined and 50% X bodied linseed. Comparisons were available between paints with 3.75 pounds of oil per gallon (50/50 alk. ref. L.O./X body L.O.) and 4.25 pounds of oil per gallon (75/25 alk. ref. L.O./X body L.O.).

We inspected this series as painted out in 1944, 1946 and 1948. The general observations were that the free chalking anatase TiO_2, Ti-Pure FF showed better self-cleaning properties than the slower chalking Y-CR, the rutile R-200 and R-110 or the extended rutile calcium R-25. The differences were most pronounced on the north vertical exposures. The bodied oil formulations with less total oil showed better cleaning properties and better resistance to mildew than the pre-war high oil vehicles.

After one year's exposure all the south panels were reasonably clean but all showed definite dirt collection on the north exposures except FF where the dirt was less than slight. The 4.25# oil paint was equal to the 3.75# oil paint. At three years all the south exposures were clean but there were still differences on the north exposures. In the absence of basic carbonate white lead the FF paints were cleaner, but where more chalk resistant titanium oxides were used dirt collection and mildew are aggravated. Besides the reduction in dirt and mildew in the bodied oil formulas, the replacement of the magnesium silicate by calcium carbonate eliminates mildew up to five years.

(b) High TiO_2 House Paints - Ti-Pure FF and Blends - Cleaning

Both du Pont and Titanium Pigments continue to move in the direction of higher TiO_2 contents in house paints. du Pont placed on exposure on 8/19/1948 a series of paints based on two principal pigmentations:

(1) 27% TiO_2/41.4% Acicular ZnO/31.6% Magnesium silicate

(2) 20.9% TiO_2/49.2% leaded zinc, 29.9% Magnesium silicate

The vehicle carries 4.25 pounds of oil per gallon. The comparisons were:

(a) Ti-Pures FF, Y-CR, R-110 and Ti-Cal R-25 at 1.8 pounds TiO_2 per gallon in Pigmentation 1. (also at 3.75 pounds oil per gallon).

(b) 50/50 blends of Ti-Pure FF with Y-CR, R-110 and Ti-Cal R-25 in Pigmentation 2.

A second series of similar character has been on exposure since 4/27/1948 south and north vertical, using binder proportions of both 3.75 pounds and 4.25 pounds of oil per gallon. The pigmentation patterns were:

15% TiO_2/50% leaded zinc/35% magnesium silicate

10% TiO_2/45% leaded zinc/22.5% BCWL/22.5% magnesium silicate

18% TiO_2/36% acicular ZnO/46% magnesium silicate

The titanium pigments used were Ti-Pures FF, FF-CR, Y-FF, Y-CR, R-110, R-200 and Ti-Cal R-25 at normal, 1.60, 1.80 and 2.22 pounds TiO_2/gallon, also 50/50 and 75/25 blends of FF with Y-CR and R-110. Ti-Pure FF showed the best clean-up south and north, with the 3.75 pounds of oil formula best in all cases. The more chalk resistant types did clean up better at the higher TiO_2 contents, especially in the lower oil paints. 50/50 blends of FF and Y-CR cleaned up better than 50/50 blends of FF and R-110, but neither was equal to straight FF in appearance.

In the lead-free formulations, the FF paints were bright and clean, but the more chalk resistant TiO_2's still held some dirt and had a tendency toward mildew, especially at lower PVC's. Actually, the changes were not as marked as might have been anticipated from 1.27 to 2.22 pounds TiO_2 per gallon.

A series of washing tests was put out on 9/1/1948 comparing 100% FF, 50/50 FF/Y-CR, and 100% Y-CR in the "Ti-Sil" formulation, also in leaded zinc and lead-free paints at varying TiO_2 contents as described in the paragraph above. A black band was painted along the lower edge of each beveled siding panel to show how much the chalk was washing. In the "Ti-Sil" paints 100% and 50% FF showed some washing, with the cleaning of the 50/50 paint leaning more toward FF than Y-CR. 100% Y-CR shows more dirt collection and less washing.

If the paints are lead-free, then even at 1.27 pounds there is considerably more washing than with the lead containing parallel. In such paints it would appear that 50/50 FF and Y-CR would be safer than 100% FF (we do this in Rex 456 SWP Fume Resisting White). As the TiO_2 was increased the change from the leaded zinc pigmentation to the lead-free acicular zinc oxide pigmentation caused more increase in washing than did the increase in TiO_2. At 2.2 pounds TiO_2 perhaps a 25/75 FF-Y-CR combination would work out best.

In view of the better control of washing when lead is present, du Pont prefers the use of lead driers in otherwise lead-free paints, especially when painting under adverse conditions. This agrees with Lowe Brothers' type of approach to the same problem.

In supplementary tests the du Pont exposures consistently show almost complete control of mildew when calcium carbonate extenders replace magnesium silicate, even in lead-free formulas. The latter tend to mildew more than the leaded zinc parallels.

(c) Lead Free House Paints - White - Cleaning

[redacted] time was spent in reviewing exposures of lead-free house paints. These were discussed on page 11 of the 1948 report. The first [redacted] exposed on 8/19/48 south and north vertical with the following formulas represented:

Pigment	PVC High Oil 4.8#	PVC Low Oil 4.25#	PVC Low Oil 3.75#
15% Ti-Pure FF/50% leaded zinc/35% mg. silicate	28.5%	31.6%	34.5%
17.2% Ti-Pure FF/57.3% Acicular ZnO/45.5% mg. sil.	27.4%	-	-
19.4% " " /42.3% " " /38.3% " "	-	26.0	-
17.2% " " /57.3% " " /45.5% " "	-	-	33.5%

The same paints except for the third in the above series were also exposed in August, 1947. Since the lead-free zinc oxides of the acicular type have higher binder requirements than co-fumed leaded zincs, the lead-free paints were formulated at lower PVC's to give equal free binder relationships.

The general comments are about the same as in 1948. The lead-free paints are whiter and brighter than those carrying co-fumed leaded zincs and the cleaning is at least equal.

In connection with the ultimate durability of lead-free paints we examined a group of panels which had been on south exposure for five years and then held for the past year on north exposure to preserve the status quo. In comparisons of Type A (high lead) and Type B (lead-free) paints of the old E-TT-P-101a Federal Specification, three coats, the lead-free paints are definitely inferior in durability. It should be kept in mind, however, that Z_6 bodied oils were used, now considered too high in body, and calcium naphthenate was used to promote drying. If lead driers or leaded oils were used it is presumed that durability would be affected beneficially. The "Ti-Sil" formula looked good in this same group. When the TiO_2 used is the non-chalking rutile R-610 the durability is practically perfect but the appearance is and always was poor. If the above had been two coats self-primed instead of three there would have been more erosion. One coat of the top coats over a coat of TT-P-25 primer did quite well.

It is evident that when du Pont addresses the various Production Clubs and suggests that lead-free paints can be made to equal the performance of lead containing paints, they actually have certain mental reservations. If a number of steps are taken to ensure good performance of the lead-free paints then they will do as well as the run-of-mine lead-containing paints. It would be assumed, however, that if the same improvements were made in the lead containing paints they would have the greater probability of giving uniformly adequate results.

(d) Calcium Carbonate Extenders in House Paints

Because of lack of time we did not give the usual attention to the special calcium carbonate extender studies, except as they were mentioned incidental to other series. In general, it appears that the conclusions given in earlier reports still represent their thinking, although it seemed to the writer that du Pont placed less emphasis on this item than in previous years. They prefer substitutions on the basis of equal binder requirements. In whites the durability is reduced compared with magnesium silicate. They still emphasize improved tint retention (which we find counteracted by greater dirt collection). They show good tint retention in lead-free paints using acicular zinc oxide and calcium carbonate with R-610, superior to leaded zinc and magnesium silicate.

(e) One Coat House Paints

The exposures of a 25% Ti-Pure FF/50% leaded zinc/25% magnesium silicate pigmentation at various PVC's and spreading rates have now been out for almost 3-1/2 years (exposed 2/28/45 south vertical). This pigmentation at 35% PVC is more durable than with high oil binder at 20% PVC when spread at 450 sq.ft./gal., and offers promise as a one coat house paint. The chief difficulty over new wood is flashing. It was said that Devoe and Raynolds One Coat House Paint does not flash, but it is not recommended for direct application on new wood as they prefer a zincless primer.

Durability is controlled to a large extent by film thickness. The paints spread at 450 sq.ft./gal. are mostly gone while those spread at 200 sq.ft. are still quite good. At low PVC the paints lack build. If the PVC is decreased by removing extender and increasing the binder than 20% PVC is better than 35%, according to du Pont, and therefore for brushing one coat on new wood it would be better to add oil than thinner. This must be scrutinized in light of our work on CPVC.

(f) Special Oils

The various series studying special oils include under pigmentations:

(1) 15% Ti-Pure FF/50% leaded zinc/35% magnesium silicate

(2) 17.5% Ti-Pure FF/37.5% acicular ZnO/45.4% magnesium silicate

Pigmentation (1) was put out in 1946, 7 and 8 and (2) in 1948 only. A wide variety of linseed, soya, tung and dehydrated castor oils were used, both individually and in combination or co-polymerized, including some P.E. and maleic treated oils. Archer-Daniels-Midland's 75-5, Ardol, Var 70 and ASV #4 deserve special attention. A-D-M describes these oils as follows:

75-5 - "A fast drying linseed oil, a modified glycerol ester... rapid dry, excellent water and alkali resistance, exceptional durability and extra hardness...attained through a fundamental modification of the fatty acids present in linseed oil."

Ardol - "Chemically modified soybean oils showing extremely fast bodying characteristics."

Var 70 - "...a heavy bodied Var oil cut to 70% solids." "Var is the name given to a new group of copolymer oils based on vegetable drying oil products obtained in the manufacture of linseed and soybean oils...closely resembles 75-5 Oil."

ASV #4 - (Same description as Ardol.)

Ardol, ASV #4, and Spencer Kellogg's Driscy A look good up to 3 years. 75-5 is especially interesting in that while it shows checking in paints containing active pigments (lead and zinc) it looks very good with a pigmentation containing only TiO_2 and magnesium silicate (i.e., no active pigment). It shows no cracking. It is obvious that this would be a non-staining paint which, of course, would be very interesting. Copper and iron staining are bad problems on conventional house paints where zinc oxide has been a necessary and important part of the pigmentation. See (g) below. Since 75-5 causes checking in conventional paints and gives good performance when used with a pigmentation containing no active pigment, it would appear that 75-5 oil does in the vehicle what zinc oxide does in the pigment. This is important and will be investigated further. Var 70 will be studied also as it is like 75-5 but costs less. Use in trim paints is also suggested by these results. Ardol showed slightly earlier loss of gloss and development of chalk than linseed, but looks very good.

Untreated soya oil binders in this series do not do too well because of dirt collection and tendencies toward "cissing." Even Driscy A shows more mildew because of erosion which has exposed some wood. 100% basic carbonate white lead in A-D-M's Superb linseed is very dirty and mildewed.

100% Castung U-V looks good so far (nine months' exposure). In general soya-tung combinations such as 80/20 show improved performance when given more chance for ester interchange during the bodying process, with Z_2 body preferred. Note the similarity to (3318).

(g) Screen Staining

Several groups of panel studies of screen staining were examined which had been placed on exposure at times ranging from 1/24/1947 to 1/3/1949. Three types of pigmentation were used:

(1) 55% Ti-Pure FF/45% magnesium silicate

(2) 55% " /65% " "

(3) 30% " /70% " "

PVC's were 25% and 55%, using phenyl mercury oleate in the amount of 0.2% by weight of the total paint as a mildew inhibitor, since the above pigmentations carry no active pigment, especially zinc oxide. Pieces of copper and iron screen are attached to the panels to cause staining. Six months' exposure appears to be a critical point in staining.

To quote du Pont:

"Lead-zinc free stain resistant paints of promise were obtained with various alkyd vehicles (such as GE-2466, 2475, 2501, 2505 and 2502). Also with a waterproof spar (such as McCloskey's) lengthened with Archer-Daniels-Midland Company's 75-5 Special

in the amount of 25, 50 and 75 per cent by weight based on total binder.

"Other vehicles of promise for zinc-free paints were McCloskey's 175 Oil, Archer-Daniels-Midland Company's 75-5 Special and U. S. Industrial Chemical's X-239 and X-649."

It was pointed out that copper and iron compounds would be precipitated from solution at a pH of about 5. The pH of a normal zinc containing paint would be about 6.5 and therefore precipitation would occur. In the absence of zinc oxide the pH of the paint would be about 4, and therefore no precipitation. This would explain why chlorinated alkyds look good, and why the addition of alkali refined linseed oil to chlorinated alkyds spoils the stain resistance. Linseed soya combinations did not look too good. As mentioned before Var 70 or 75-5 Special showed considerable promise even in the absence of active pigments.

(h) Porch Paints

A brief inspection was made of a lengthy series of porch paints put out in February, 1948. There were a number of commercial controls, including S-W Porch and Floor Enamel (which is performing satisfactorily up to this point, and far better than du Pont's previous exposures of our former leaded zinc porch paint). The panels are exposed 45° south. (See page 14, 1948 report.)

Ti-Pure R-610 was used alone and with various extenders in a wide variety of vehicles. Best gloss is obtained by leaving out all extender, but Surfex is helpful in giving uniform gloss in one coat and does well in tint retention. The alkyd vehicles are generally superior in gloss and tint retention, but it should be kept in mind that alkyds tend to become slippery when wet.

Due to the limited time available, and the amount of time spent at the exposure farm, we had no opportunity this year to inspect any of the du Pont test houses. We have information available on the progress of houses described in earlier reports and can furnish this on request.

Titanium Pigment Corporation - Sayville, Long Island, New York

(a) Sherwin-Williams Cooperative Tests

Frank Smith of Titanium Pigment Corporation Technical Service had prepared a special report covering the results after three years' exposure of the paints in the cooperative series inaugurated in 1946. Both S-W and T.P.C. prepared a group of paints which were exposed simultaneously at Chicago and Sayville, as well as at supplementary locations for our own interest.

The formulations are rather numerous and varied, so details will be omitted until a separate report is prepared. The S-W white paints involved principally comparisons of titanium oxide anatase Titanox A against rutile Titanox RA-10-MO and blends, with Ozlo leaded zinc plus 14% BCWL in the pre-war and post-war vehicles, adding the "Ti-Sil" pigmentation for comparisons. Specials include use of the extended rutile Titanox RC HT, the same blended with Titanox A or anatase titanium calcium. Primers included SWP 450 Undercoater versus T.P.C.'s MW-401 type of zincless primer (actually MW-1178) and self-priming. The tints were principally based on the non-chalking rutile Titanox RA-NC, but include 1/3 leaded zinc-1/3 lead titanate-1/3 magnesium silicate and the "Ti-Sil" pigmentation with RA-NC. One special extender - Micro Velva A - was used in a tint.

The paints prepared by Titanium Pigment are more heterogeneous in character. They were largely in the pre-war vehicle at 29% PVC although some run as low as 21%. The comparisons include titanium oxides of different rates of chalking: A, AA, RA-10-MO and the extended RC HT in the whites, also combinations of the free chalking A and the other slower chalking titanium pigments. Their tints included studies of RA-NC and Titanox RC.

T.P.C. reported that at three years the only conclusions that can be drawn refer to appearance:

"Pigmenting paints at a high pigment volume (36%) with less than four pounds of oil per gallon of paint improves the appearance of the paint by always maintaining a clean white surface.

"Rutile oxides either pure or extended produce paints with relatively poor appearance unless some free-chalking anatase pigment is included in the pigmentation.

"There is some evidence that a special primer is needed in a two-coat system when the paint is to be applied over poor woods. The length of exposure seems to have been insufficient to form any definite conclusions on this point.

"Likewise, there is insufficient evidence to form any definite conclusions regarding the durability of the paints in this cooperative series."

We made some special notes which may be of interest. In a rather conventional T.P.C. formula with 15% TiO_2/35% leaded zinc/15% BCWL/35% magnesium silicate (Note - too low in zinc oxide - 23%) Titanox RA-10 showed considerable dirt and mildew collection, especially on the north. RA was even worse but AA better although it still showed considerably more dirt than A. If the TiO_2 was increased to 20% at the expense of the magnesium silicate there is some improvement over 15% AA. When the titanium is introduced as the extended rutile RC HT, at least half should be anatase TiO_2 to give clean-up and appearance. (A recheck at Chicago shows that even 50% Titanox A with RC HT has definitely more dirt collection than straight A, especially on the north.) The S-W paints with 15% Titanox A look very good, especially in the current vehicle. The Ti-Sil pigmentation has some tendency to "ciss" and crack.

The S-W formulas with titanium calcium compare 25.8% RC HT with a blend of 17.3% RC HT and 5% Titanox A, of equal parts rutile RC HT and anatase Titanox C, and all anatase C. At 36% PVC on the south all are clean, with the all C formula showing erosion. All are quite good on the north with straight RC HT showing only slight dirt.

The S-W tints are all cleaner than the T.P.C. tints with the S-W formula using Micro Velva A in a 56% PVC paint the cleanest of all. This formula, 11.9% Titanox RA-NC/58.5% leaded zinc/10.3% BCWL/29.3% Micro Velva A, looks much better than the old 1/3 lead titanate-1/3 leaded zinc-1/3 magnesium silicate tint.

There were evidences of definite superiority where the special primers were used on rather inferior white pine as compared with self-priming. Further exposure is needed to differentiate between the two types of primers.

The S-W Chicago set are at an interesting stage and a special report will be prepared.

(b) Decreasing Active Pigment Series

This series has been discussed in several of our previous inspection reports. The tests were run to determine how much extender could be introduced into house paints before durability was affected seriously. A set has been started each year for several years. The controls after 8 years of exposure showed lead-in-oil off entirely, 60/30/10 flaking very badly, and the "Ti-Sil" pigmentation eroding with some checking and cracking. Lowe Brothers' High Standard was still in very good condition after 8 years, and SWP Gloss White was in good condition, with a few cracks. The principal experimental pigmentations were:

15% TiO_2	- 46.0%	leaded	zinc	- 19%	BCWL	- 20%	magnesium	silicate
15% "	- 38.5%	"	"	- 15.7%	"	- 30.8%	"	"
15% "	- 34.6%	"	"	- 14.7%	"	- 35.7%	"	"
15% "	- 30.8%	"	"	- 12.8%	"	- 41.8%	"	"

The group started in 1944 compares the free chalking anatase TiO_2 Titanox - A with the semi-chalking anatase Titanox AA. At this point of 5 years' exposure it is very evident that the paints made with "A" are much less durable and show more erosion than those made with "AA." The former show increased checking, cracking and erosion as the extender goes up, while the latter show very little failure so far. Early dirt collection history must be considered.

The similar series started in 1948 (now three years old) compares 20% Titanox A-168, 15% Titanox - A, 15% Titanox RA-10, and 10% Titanox RA-10 plus 5% Titanox A. With Titanox A the panels are starting to show some checking and cracking at the 35.7% and 41.8% magnesium silicate levels. These conform to 22.5% and 20% zinc oxide, respectively. The addition of 5% anatase helps to free up the chalking of Titanox RA-10.

The panels put out in June, 1947 (now 2 years old) compare 15% Titanox A with 20% Titanox AA at the four extender levels, except that the extra 5% TiO_2 was introduced at the expense of the extender. All look good at this stage. These all carry 4.25 pounds of oil per gallon at 33% PVC, with 25% Z_2 bodied oil in the binder.

(c) Rutile Calcium Paints

This series was put out in June, 1946, south and north vertical, three coats self-primed. The pigmentations are:

(1) 50% Calcium Pigment/50% leaded zinc.

(2) 50% Calcium Pigment/40% leaded zinc/10% magnesium silicate.

(3) 40% Calcium Pigment/40% leaded zinc/20% magnesium silicate.

(4) 50% Calcium Pigment/25% zinc oxide/25% magnesium silicate.

(5) 35% Titanox RC HT/5% Titanox A-MO/50% leaded zinc/10% magnesium silicate.

(6) 35% Titanox RC HT/5% Titanox A-MO/25% zinc oxide/35% magnesium silicate.

(1) through (4) compare 100% RC HT with 50/50 RCHT/RC. The RC HT paints, of course, are cleaner than those with some RC but not as clean as when the 5% Titanox A is added. The lead-free paints (4) and (6) show more mildew than those carrying leaded zinc.

(d) 1948 Commercial Paints

This will be a very interesting series to watch for a period of years and therefore some detail is given here. All paints are three coats self-primed unless otherwise indicated, exposed vertical south and north on cedar and white pine.

Paints	South	North
100% BCWL	Gray, will check soon.	Gray, will check soon.
60% BCWL/30% XX-2 ZnO/10% Ext.	Dirtiest	Dirtiest
45% Cryptone MS-150/35% leaded zinc/20% magnesium silicate	Rather gray	Rather gray
Benjamin Moore	Dirty	Dirty
50% Ti-Sil/50% leaded zinc	Clean	Clean
Patterson-Sargent	Dirty	Dirty
National Lead #110	Clean	Slight dirt (more Titanox A)
National Lead #10	Slight dirt	Some dirt (more Titanox AA)
Fuller #2015	Slight + dirt	Some dirt
General #1005	Slight + dirt	Slight + dirt
Sears Roebuck #145	Somewhat gray	Somewhat gray
Sherwin-Williams 471 (12% BCWL on label)	Clean (one of the best)	Very slight dirt under overlaps.
Devoe and Raynolds #547	Somewhat gray	Gray
Pittsburgh 1-54	Somewhat gray	Gray -
Devoe One Coat*	Gray	Gray
Nuhide*	Clean	Cleanest and brightest
du Pont (lead-free)	Gray	Dull
du Pont #40	Gray	Gray

*One coat over MW-1178 primer (zincless)

It is anticipated that some of the paints now showing unfavorable dirt collection due to retarded chalking may show excellent durability. Both factors must be considered to have consumer acceptance.

(d) Grades of Titanox Pigments

This series was put out in June, 1948 three coats self-primed south and north vertical on cedar. The pigmentation throughout is:

15% Titanox/46% leaded zinc/19% BCWL/20% magnesium silicate. The Titanox pigments are respectively: A-24, AA, A-168, A, A-MD. Two vehicles were used; one, the full oil pre-war vehicle, and the second, a 4.25# 25% Z_2 bodied oil vehicle. At this point the high oil series all showed some dirt but the bodied oil series were cleaner. It should be remembered that at the time of this inspection Sayville had had no rain for over a month.

(e) Lead Free House Paints

One series, put out in 1945, is based on a pigmentation of 15% TiO_2/30% zinc oxide/55% magnesium silicate, in which the TiO_2 is respectively: (1) 15% Titanox RA-10, (2) 12% RA-10 plus 3% A-MO, (3) AA and (4) A-168. All are in the full oil vehicle. On the south all show slight cracking but otherwise the durability is quite good. The rutiles produce a yellow cast but the anatase show mildew on the north.

Another lead-free series was put out in June, 1947. In the first group Titanox AA was used starting at 15% and increasing to 30% at the expense of the extender, which was half magnesium silicate and half calcium carbonate, all with 30% zinc oxide. The second group has 15% Titanox AA with from 25% to 35% zinc oxide, again from the extender and one at 20% Titanox AA and 25% zinc oxide. In the first group as the TiO_2 increases the paints clean better, with some mildew at the higher TiO_2 levels on the north. The second group shows that at least 30% zinc oxide is required in lead-free paints to control mildew, and even 35% at high TiO_2 levels.

(f) Vehicle Studies

Rather extensive vehicle studies were put out in 1947 and 1948. One 1947 group uses a pigmentation of 15% Titanox A/46% leaded zinc/19% BCWL/20% magnesium silicate, with the following vehicles:

Vehicle	NVM	PVC	Remarks
94% Refined Linseed 6% Bodied Linseed	85%	29%	O.K.
75% Refined Linseed 25% Z_2 Bodied Linseed	77	33	O.K.

(Cont.)

Vehicle	NVM	PVC	Remarks
50% Refined Linseed 30% Z_6 Bodied Linseed 20% Magnesia Oil	65%	35%	Brushed better and film smoother than above.
100% National Lead's Replacement Oil	65	35	-
33.5% Chinawood Oil 66.5% Soya	65	35	Dried fastest Looks O.K.
33.5% Chinawood Oil 47.5% Soya 19.0% Linseed	65	35	Looks O.K.
33.5% Chinawood Oil 31.7% Soya 34.8% Linseed	65	35	O.K.
33.5% Chinawood Oil 16.5% Soya 50.0% Linseed	65	35	O.K.

A second series was put out in 1947, three coats self-primed, using a pigmentation of 15% Titanox AA/58% leaded zinc/21% BCWL/ 26% magnesium silicate, at 29% PVC. The binders include many combinations of refined linseed and soya oils and Driscy with bodied oils such as linseed, dehydrated castor and Driscy. All look good and about the same at this point.

In 1948, exposures were prepared using 15% Titanox A/58.5% leaded zinc/15.7% BCWL/50.8% magnesium silicate in a number of vehicles at 33% PVC. The paints and their current condition are as follows:

100% W bodied linseed. O.K. south and north.

100% W bodied soya. Some dirt south, definite north.

100% Ardol. Slight dirt on south, slightly cleaner than above on north.

45% Refined linseed, 30% Driscy, 25% Z_2 bodied linseed. Very slightly cleaner than Ardol.

45% Refined linseed, 30% Ardol, 25% Z_2 bodied linseed. O.K. south and north.

45% Refined linseed, 30% Dehydrated Castor, 25% Z_2 bodied linseed. O.K. south, cleanest of all north.

(g) Primer Tests

This is an old series, put out in June 1941, which was examined to determine the performance of self-primed paints and primers on extended exposure. Comparisons may be summarized as follows:

Top coats used:

A. 60% BCWL/30% ZnO/10% magnesium silicate.

B. 15% Titanox AA/45% leaded zinc/15% BCWL/25% magnesium silicate.

C. 60% Titanox RC/40% leaded zinc.

D. 15% Titanox AA/30% leaded zinc/15% BCWL/40% magnesium silicate.

These top coats were applied as three coats self-primed, and as two coat systems over two primers having the following pigmentations, respectively:

1. 37.5% Titanox B 30/37.5% BCWL/25% magnesium silicate.

2. 52% Titanox RC/41% BCWL/27% magnesium silicate.

In the self-primed group Paint A is checked and cracked, B cracked, C gray but with good film and D checked and cracked. Over the titanium barium primer (No. 1) there is much more erosion as the primer erodes rather rapidly when the top coats are gone. There is more paint left on the titanium calcium primer (No. 2) with a tendency to develop mildew when the primer becomes exposed after six or seven years.

(h) Exterior Tint Base Paints

In 1946 two groups of tint bases were put out as three coats self-primed. The first carried 15% Titanox RA NC, 50% leaded zinc and 35% extender. When this extender was magnesium silicate the south exposure is clean but there is some dirt or mildew and slightly blotchy fading, when calcium carbonate the south exposure is cleaner as is the north but with slight mildew. When the extender is calcium sulfate the films are in good condition, and a blend of 15% magnesium silicate and 20% barytes is still good.

When the RA NC is dropped to 10%, leaded zinc to 45% and extender to 30% to permit the introduction of 15% BCWL the calcium carbonate tint is the cleanest, magnesium silicate plus barytes is clean, calcium sulfate shows some mildew and magnesium silicate is dirty. While this appears to conflict with our findings that calcium carbonate improves tint retention but increases dirt collection, the facts probably are that the T.P.C. carbonate panels look cleaner because calcium carbonate controls mildew.

(i) Basic Silicate White Lead (45 X)

T.P.C.'s exposures of house paints were again examined prior to the inspection of National Lead's exposures on the same location. The first groups were put out in August, 1945, with present condition as follows:

(a) 3 coats self-primed, vertical south and north, 29% PVC.

1. 15% Titanox A/46% leaded zinc/19% BCWL/20% magnesium silicate. Slight cracking south.

2. 45 X by volume for basic sulfate white lead only in 1. Very slight cracking, much better appearance than 1.

3. 45 X for basic carbonate white lead only. Good, slight cracking one panel only.

4. 45 X for both sulfate and carbonate. Good, somewhat thin looking. The volume replacement of both lead pigments has decreased opacity. TiO_2 should be increased.

5. As 1 but Titanox RA-10 for Titanox A. Some cracking on south exposure.

6. 45 X for basic sulfate only in 5. Very slight cracking.

7. 45 X for basic carbonate only. Slight cracking.

8. 45 X for both sulfate and carbonate. Good, very slight cracking.

(b) In a second group of whites and gray tints, also put out in 1945, 45 X was substituted for basic sulfate white lead in a 50% Titanox RC HT/ 50% leaded zinc in the white and 50% Titanox RC/50% leaded zinc in the gray tint. All panels are in good condition approaching the end of four years' exposure.

(c) A primer study put out in 1945 has a conventional 15% Titanox A/ 46% leaded zinc/19% BCWL/20% magnesium silicate top coat over two primers:

(1) MW-401. 37.5% Titanox B/37.5% BCWL/25% magnesium silicate. This panel is pretty well eroded.

(2) 45 X for BCWL in (1). Also pretty well eroded but fully equal to (1).

In June, 1948, additional tests were put out as three coat self-primed work. In the first pair 15% Titanox A/38.5% leaded zinc/15.7% BCWL/ 30.8% magnesium silicate is compared with a similar paint in which 45 X replaces by volume both lead sulfate and carbonate. These were in the pre-war vehicle at 29% PVC, and both are similar and in good condition. In the second pair the same two pigmentations are ground in a bodied oil type binder at 53% PVC. These two paints are somewhat dirtier than the 29% PVC paints, contrary to usual experience.

National Lead Company, Sayville, Long Island, New York

Early in 1948 a cooperative series was set up with National Lead Company to evaluate various replacements of 412 55/65 leaded zinc with basic silicate white lead 45 X and 414 12/88 leaded zinc. In our paints we followed three methods of substitution:

A. ZnO replacement by equal poundage - lead replacement by equal volume.

B. Maintain a 55/65 lead pigment/ZnO ratio - replacement based on total volume.

C. Maintain a 35/65 lead pigment/ZnO ratio - replacement on total pounds, adjusting volume with extender.

In the whites the base formula was that of Rex 471, card 47 plus modifications at 25% and 20% zinc oxide levels, also using Azo ZZZ-33 acicular zinc oxide plus 45 X to replace 412 and BCWL. The tints were based on Rex 465 card #4 using a similar pattern with replacements by Method A only.

The National exposures were placed on their fences on July 1, 1948 so this inspection was after precisely one year. National Lead had a well prepared report for us, illustrated with photographs. Since the exposures have been out for only one year we will not go into detail but simply comment on developments to date. In general, the basic silicate paints seemed cleaner than those with 55% leaded zinc in National's paints. In the S-W paints the base formula of Rex 471 using 412 leaded zinc was brighter than the 45 X/414 replacements by Methods A, B and C. This is probably due to the color of the 45 X and the 414 pigment used. The same holds true for the replacement of both the 412 and BCWL in the base formula, Method B giving a slightly brighter and cleaner paint. Azo ZZZ-33 plus 45 X give bright paints as compared to those with 414 dry and looks especially good at the 20% zinc oxide level, which partially substantiates National's formulative approach.

The tints are all close at this point so no important differentiations could be made.

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As always, du Pont, Titanium Pigment Corporation and the National Lead Company extended us every courtesy, and made our trip very pleasant and informative.

M. VAN LOO

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Director of Paint Research

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