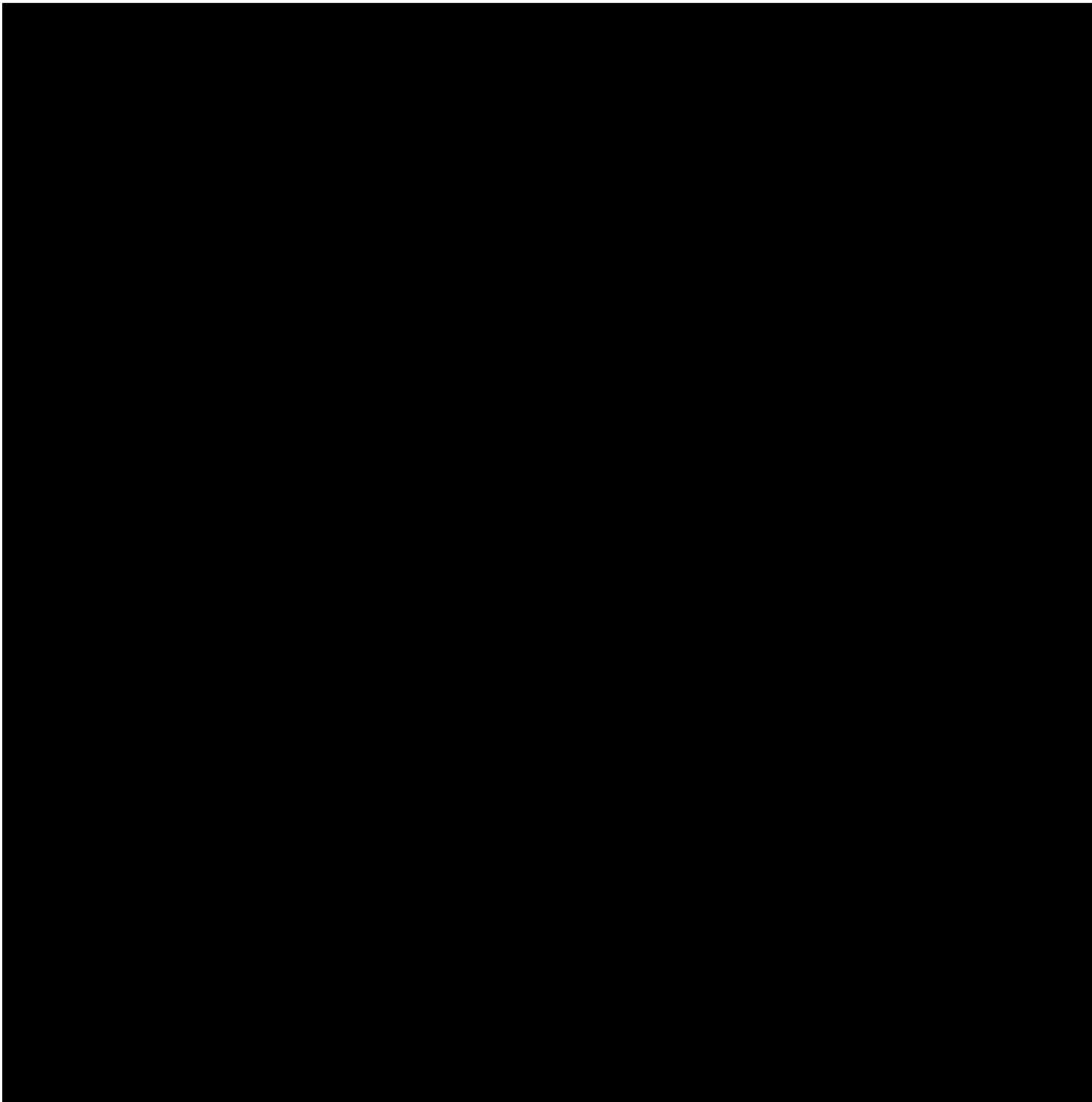


#187 - Physical Properties of Pigments

The CPVC of the samples of 1403 TiO_2 in raw linseed oil (2) exposed to various degrees of relative humidity as reported in last month's report were run again after 5 weeks of standing. The results obtained were all slightly higher than the original values, but no substantial change in the packing characteristics has occurred. The data for the original determinations and after five weeks is presented in the following table:

Relative Humidity	Per Cent Moisture	CPVC Original	CPVC After 5 Weeks
0% (dried)	0	37%	38%
20%	0.06%	32%	34%
50%	0.12%	31%	32%
75%	0.17%	29%	31%
100%	0.34%	25%	27%

From the table it can be seen that any tendency toward equilibrium of stability of the system 1403/moisture/(2) has apparently occurred before the first CPVC determination, which was made about two hours after the samples had been ground 16 hours on ball mills. Another series of CPVC determinations on the same samples is contemplated after further standing for several months.

The porosity of double draw-downs of the systems 20 F in (3109), (48) and (2) were studied at PVC above and below the CPVC. The double draw-downs were prepared by making a normal series of draw-downs of paints of increasing PVC, straddling the CPVC as determined previously for the pigment/binder system in question. These films were then thoroughly dried, after which a similar draw-down series was made over the first, in a perpendicular direction. In this system each sample of various PVC's is respectively above and below each of the other samples. The results for the porosity of these double draw-downs obtained by the static conductivity method are represented in the following tables for 20 F in (3109) at PVC's of 40%, 45%, 50%, 55%, 60% and 65%; 20 F in (48) at PVC's of the same values and 20 F in (2) at PVC's of 35%, 40%, 45%, 50%, 55% and 60% respectively. The CPVC for the 20 F/(3109) combination is 44%, for 20 F/(48) is 46% and 20 F/(2), 43%. The greater the conductivity, the more porous the film. The vertical headings indicate the first draw-downs, the horizontal headings the second draw-downs.

Charts follow.

#187 - Cont.

Conductivity - Amperes x 10^{-4}

20 F in (3109)

PVC %	Single	40	45	50	55	60	65
40	33	39	44	43	55	60	60
45	600	20	37	84	83	140	140
50	1500	55	120	215	500	270	250
55	1500	60	250	600	750	1000	1000
60	1500	52	270	670	750	1000	1000
65	1500	80	300	750	1000	1000	1000

20 F in (43)

PVC %	Single	40	45	50	55	60	65
40	79	10	9	21	25	39	51
45	25	9	10	17	17	27	33
50	1200	23	21	67	82	120	160
55	1700	27	27	100	135	185	220
60	2700	40	30	200	300	428	428
65	3000	57	29	300	440	625	715

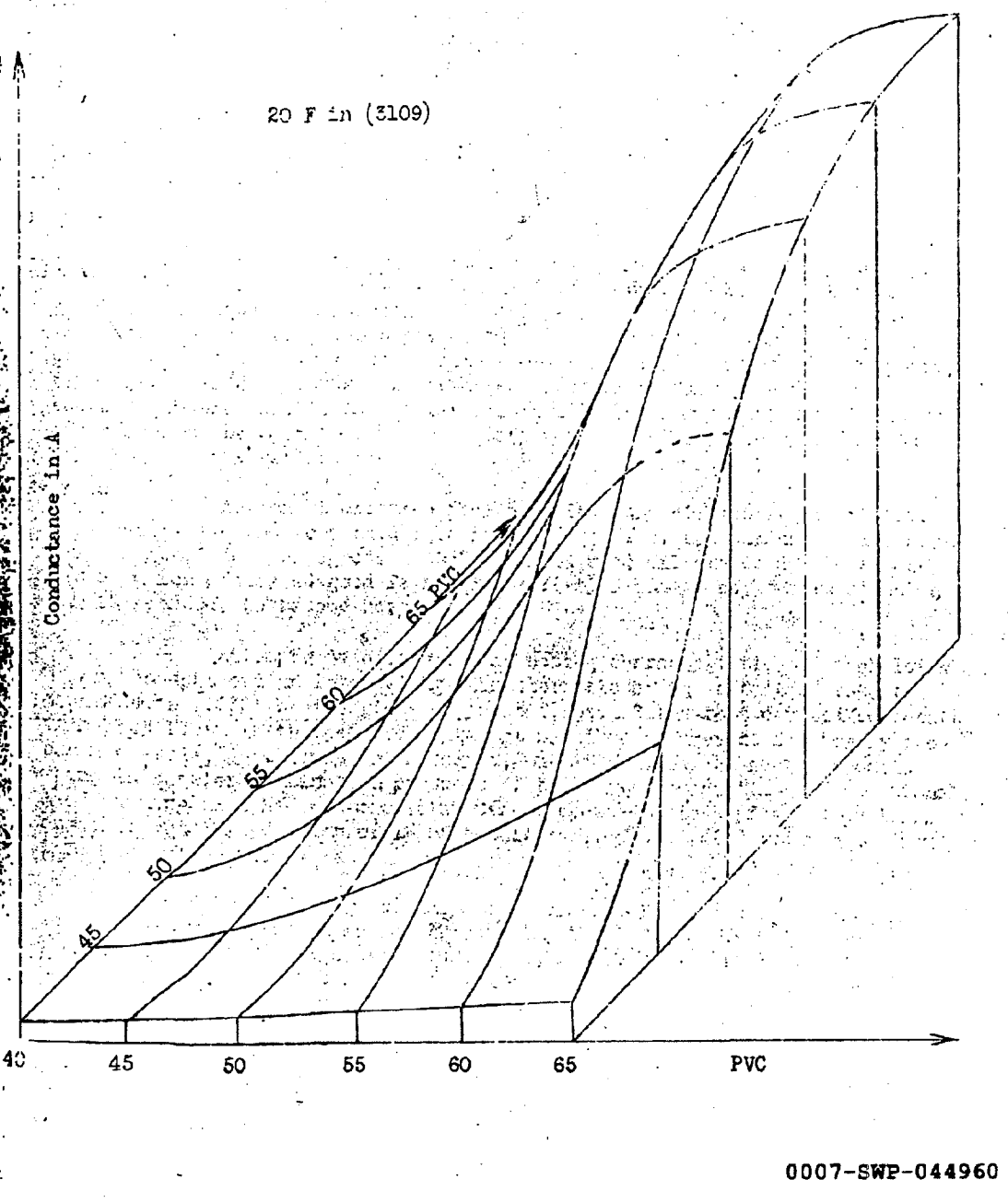
20 F in (2)

PVC %	Single	35	40	45	50	55	60
35	86	17	22	50	37	33	31
40	86	40	24	60	90	107	176
45	270	48	67	143	250	250	300
50	2000	86	136	260	460	430	545
55	2000	92	136	230	750	500	665
60	2000	107	176	250	1000	860	1200

A three dimensional representation of the data for 20 F in (3109) is shown in Figure I. It is obvious from the above data that a porous film is sealed to a great extent by subsequent application of a second coat, even if this film in itself shows porosity when applied singly. Data is being obtained for other pigment/binder combinations and a more explicit analysis will be presented when the results are obtained.

A paper was presented on December 26 at the A.A.A.S. meeting in Chicago on "Some Aspects of Critical Pigment Volume Relationships."

Figure I



#162 - Studies in Flat Wall Paint Formulation

Flat Wall Paints

Work has been under way to reformulate Flat-Tone White in order to conserve titanium calcium. Several variations have been made, replacing 100 and 200 pounds of 2132 dry with 1403 dry and/or 2228 dry. The difference in bulking value between the two pigmentations was corrected by the use of additional 2188 dry. The work to date has indicated that the higher amount of inert required to correct for pigment bulk has a tendency to decrease flow. Work will be continued.

Requests have been received from Cleveland for an evaluation of National Lead's One Coat Flat White and du Pont's Interior Flat Wall Paint, along with Flat-Tone and Paintercraft One Coat Flat Wall Paint #10. Samples of du Pont's and National's flat paints were obtained from the east coast and from the Chicago area, as material sold in the east may be somewhat different from that sold in and around Chicago. A sample of Pratt and Lambert's Lyt-All Flowing Flat was also included in this evaluation, since this material is quite popular in Chicago.

As indicated by the data below, the du Pont and Dutch Boy flats are quite low in sheen compared with Flat-Tone and Paintercraft One Coat Flat #10. However, due to the low sheen, they are less uniform in appearance. There appears to be some difference in formulation between the two Dutch Boy Flats. The sample purchased in the east is very good in washability, whereas the Chicago sample was found to be poor in this respect. The two du Pont samples were also somewhat different in formulation as shown by the difference in hiding.

As indicated by the data below, we believe that Flat-Tone is fairly representative of competitive flats such as Dutch Boy, du Pont or Pratt and Lambert's. Paintercraft Flat Wall #10 is equal to Dutch Boy for hiding and superior in brushing qualities, flow and uniformity of sheen.

Chart follows.

Flat Wall Paint Evaluation

Name	Wt./Gal.	Viscosity #5	Drying: Set-to-touch	Drying: O'Nite	Brushing	Flow	Uniformity	Sheen: De
Flat-Tone White Formula 3-12-47 Batch OJ 340 L	11.66	9.2"	42 minutes	Very good	Good	Good	Good -	Me
Paintercraft One Coat Flat Wall Paint #10 Rex 65310	13.01	21.3"	49 "	Very good	Very good	Very good	Very good	Me h
du Pont Interior Flat Wall Paint, cap stamping P 40104 - purchased at Newark	13.71	26.2"	35 "	Good	Good	Good	Poor	L
du Pont Flat Wall Paint White, cap stamping 375 - 750 C 452190 Purchased at Chicago	14.11	31.3"	39 "	Poor	Very good	Good	Poor	Me
Dutch Boy One Coat Interior Flat Wall Paint Purchased at Newark	12.63	19"	85 "	Fair	Fair	Fair	Fair -	I
Dutch Boy One Coat White Interior Flat Wall Paint Purchased at Chicago	12.43	48.7"	85 "	Good	Good -	Good	Fair -	I
Pratt and Lambert Lyt-All Flowing Flat White Cap stamping EB 25 7K570	11.73	35.0"	68 "	Very good	Too sticky	Very good	Very good	Me

Continued

Flat Wall Paint Evaluation
Continued

Name	Uniformity of Tint	Washability over Glue Size	Wet Edge at 10 Min.	Grind	Contrast Ratio over Black and White
Flat-Tone White Formula 3-12-47 Batch OJ 340 L	Good	Very good - film OK at 200 rubs.	OK	2-1/2 H	93.6
Paintercraft One Coat Flat Wall Paint #10 Rex 65310	Good	Fair - film broke at 100 rubs.	OK	3 1/2 H	97.3
du Pont Interior Flat Wall Paint, cap stamping P 40104 - purchased at Newark	Good	Very good - film OK at 200 rubs.	OK	1 H	93.3
du Pont Flat Wall Paint White, cap stamping 375 - 750 C 452100 Purchased at Chicago	Fair	"	OK	1-1/2 H	85.
Dutch Boy One Coat Interior Flat Wall Paint Purchased at Newark	Good	"	OK	0 H	97.6
Dutch Boy One Coat White Interior Flat Wall Paint Purchased at Chicago	Good	Very poor - film broke at 37 rubs.	OK	1 H	98.0
Pratt and Lambert Lyt-All Flowing Flat White Cap stamping EB 25 7K570	Very good	Good - film broke at 175 rubs.	Very good	3 H	95.5

#162 - Cont.

The following Semi-Lustres were made using the varnishes as indicated below:

Semi-Lustre	Varnish Under Observation	Viscosity - #3 Fresh	O'Nite	5 Days	27 Days	Brushing	Flow	Drying	Sheen
461 L	CV 7038	20"	23"	24"	20.8" 34 days	Good	OK	OK	OK
433 L	CVR 981	16.6"	22.2"	24"	18.7" 27 days	"	"	"	"
460 L	CVR 981-2	21.6"	-	26.2" 3 days	23"	"	"	"	"
498 LL	CVR 981-5	42.4"	53"	51"	-	"	"	"	"

Experimental Enameloid Batches

Enameloid	Varnish Under Observation	Viscosity - #3 Fresh	O'Nite	34 Days	Brushing	Flow	Drying	Gloss
430 L	(2848)E	37"	45"	40.8"	Good -	Good	OK	Good
431 L	CVR 981	23.8"	26.8"	26" 33 Days	Good	"	"	"
463 L	CVR 981-2	44.6"	48" 3 days	41.4" 19 days	Fair +	"	"	"
500 L	CVR 981-4	24"	28.8"	25.7" 4 days	Good	"	"	"
515 L	CVR 981-6	35.4"	46"	39"	Fair +	"	"	"

Based on these tests, it appears that a satisfactory varnish of this type can be made for Semi-Lustre and Enameloid tints. However, further work must be done to establish the correct body on these varnishes and to determine the after-body tendencies of enamels made with these liquids.

Porch and Floor Enamels

The Vehicle Research Department submitted the following "A" resin varnishes for evaluation in Porch and Floor Enamels. The varnishes coded CVR 894-2, 896-2, 903-2 and 906-2 are rechecks on small cooks originally submitted to this department for evaluation.

#162 - Cont.

Varnish	CVR 894-2	CVR 896-2	CVR 963	CVR 958	CVR 961	CVR 903-2	CVR 906-2
Viscosity	F-G	F	E	F	F	F	F
Color	10	12 +	11-12	11	12	8	10
A. V.	5.05	4.1	5.05	4.3	5.3	7.8	9.7
Oil length	18	18	25	18	18	15	15
N.V.M.	50%	50%	50%	50%	50%	50%	50%

Composition of "A" Resin Varnishes (On N.V.M.)

	CVR 894-2	CVR 896-2	CVR 963	CVR 958	CVR 961	CVR 903-2	CVR 906-2
A Resin	41.07	41.82	34.13	41.90	41.87	46.08	46.08
(44)	6.35	58.18	65.87	-	29.13	-	-
(48)	52.58	-	-	-	-	-	-
(140)	-	-	-	23.50	11.76	-	-
(1273)	-	-	-	34.60	17.24	-	-
(3017)	-	-	-	-	-	53.92	-
Kettle Dehydrated Castor	-	-	-	-	-	-	53.92

Porch and Floor Enamels were made with each "A" resin varnish listed above. These were compared with regular Porch and Floor Enamel (formula 7-2-47) based on (6173) and (4950)G and a similar formulation using AV 170 and (2841)G. The various enamels were checked for general performance and the experimental data is reported in the chart below. The enamels were made using a drier concentration of 0.2% lead, 0.02% manganese and 0.02% cobalt as recommended by the supplier of this particular resin. However, it was found necessary to double the drier concentration in a pigmented enamel such as Porch and Floor in order to obtain satisfactory initial drying and freedom from tack after drying over night.

The enamels are to be exposed on yellow pine panels at Chicago and Florida at 45° south.

#162 - Cont.

Porch and Floor Enamel Dark Gray
Formula 7-2-47

OJ No.	Varnishes Under Test	Viscosity - #3 Fresh	Viscosity - #3 4 Days	Set-to-touch	O'Nite Dry	Gloss
504 L	Reg. Porch and Floor Enamel - Rex 153, formula 7-2-47; varnishes (6173) and (4950)G.	53.5"	50.2"	69 minutes	Very good; very slight tack.	Good
505 L	Reg. Porch and Floor Enamel - Rex 153, formula 7-2-47; varnishes AV 170 and (2841)G.	26.8"	27.3"	57 "	Very good; very slight tack.	Good
506 L	(4100) - (4103)	82"	85"	35 "	Very good; very slight tack.	Good
507 L	CVR 894-2 ("A" Resin Varnish - 18 gallon varnish.)	36.8"	34.9"	63 "	Very good; slight tack.	Good
508 L	CVR 896-2 ("A" Resin linseed - 18 gallon varnish.)	33"	33.7"	76 "	Very good; slight tack.	Good
509 L	CVR 963 ("A" Resin Linseed (44) - 25 gallon varnish.)	28"	28"	110 "	Fair + Slight tack.	Good
510 L	CVR 958 ("A" Resin Chinawood, soya - 18 gallon varnish.)	33.2"	37.2"	110 "	Good - slight tack.	Good
511 L	CVR 961 ("A" Resin Linseed, CWO, soya - 18 gallon varnish.)	35.8"	39.5"	110 "	Good; slight tack.	Good
512 L	CVR 903-2 ("A" Resin (3017) - 15 gallon varnish.)	37.6"	37"	62 "	Very good; very slight tack.	Good
513 L	CVR 906-2 ("A" Resin Kettle Dehydrated Castor - 15 gallon varnish.)	31.7"	34.4"	71 "	Very good; very slight tack.	Good

Note: Brushing and flow characteristics were satisfactory on all "A" resin Porch and Floor Enamels listed above.

#162 - Cont.

Porch and Floor Enamel Dark Gray
Formula 7-2-47
Continued

OJ No.	Varnishes Under Test	1% Soap Test Whitening	1% Soap Test Recovery After 2 Hrs.	24 Hr. Water Test Whitening	24 Hr. Water Test Recovery After 2 Hrs.
504 L	Reg. Porch and Floor Enamel - Rex 153, formula 7-2-47; varnishes (6173) and (4950)G.	Very slight	No recovery	Very slight; slight blistering.	No recovery.
505 L	Reg. Porch and Floor Enamel - Rex 153, formula 7-2-47, varnishes AV 170 and (2841)G .	Slight +	" "	Very slight; no blistering.	Complete recovery.
506 L	(4100) - (4103)	Slight +	" "	Very slight; definite blistering.	Slight recovery
507 L	CVR 894-2 ("A" Resin Varnish - 18 gallon varnish.)	Slight	" "	Very slight; slight blistering.	No recovery.
508 L	CVR 896-2 ("A" Resin linseed - 18 gallon varnish.)	Slight	" "	Very slight; slight blistering.	No recovery.
509 L	CVR 963 ("A" Resin Linseed (44) - 25 gallon varnish.)	Slight	" "	Very slight; no blistering.	Complete recovery.
510 L	CVR 958 ("A" Resin Chinawood, soya - 18 gallon varnish.)	Very slight	" "	Very slight; no blistering.	Complete recovery.
511 L	CVR 961 ("A" Resin Linseed, CWO, soya - 18 gallon varnish.)	Very slight	" "	Definite; slight blistering.	No recovery.
512 L	CVR 903-2 ("A" Resin (3017) - 15 gallon varnish.)	Very slight	" "	Very slight; definite blistering.	Slight recovery.
513 L	CVR 906-2 ("A" Resin Kettle Dehydrated Castor - 15 gallon varnish.)	Very slight	" "	Very slight; definite blistering.	Slight recovery.

#162 - Studies in Flat Wall Paint Formulation

After one month's storage all samples of Flat-Rite Undercoater mentioned in the December, 1946 report on a study of settling, are in satisfactory condition except for one sample containing AM Ac 118.5 C. Determinations were made using our special penetrometer and by spatula.

The scale of the penetrometer, which reads from 0 to 100, is adjusted so that the lever arm pointer just passes the 100 unit graduation when the plunger makes contact with the bottom of the paint container. The rate of penetration of the plunger is in inverse ratio to the extent of settling. As there was no appreciable variation in the rate of penetration until the plunger approached very near to the bottom of the containers of all samples studied, the data has been lumped to show the rate of penetration over the scale ranges 24 to 94 and 94 to 100 as units.

The rate of penetration was reduced noticeably after the control pointer passed 94 on the scale. The control sample with three pounds calcium stearate showed the most settling, followed closely by the batches carrying Acto 450, and two pounds of aluminum stearate - 547 dry, respectively. Six pounds of calcium stearate showed definitely improved suspension properties, while the batches containing Armeen C and AM Ac 118.5 C show the best suspension. The latter two agents lack interest since they show low surface activity and cause unsatisfactory body characteristics.

The observations made by the spatula method tend in general to confirm those of the penetrometer test except in the case of the materials containing Acto 450 and 547 dry. On the spatula test, Acto 450 material appeared to have a bead of softer and more fluffy settled material which was washed away more completely by the flow of material down the blade. See experimental data below:

Settling Test - Rex 50 Flat-Rite Undercoater

Agent	Acto 450	Armeen C	AM Ac 118.5 C	Control 3# 1826	6# 1826	2# 547
Viscosity, #3 - fresh	35"	33"	38.5"	35.6"	38"	34"
Viscosity, #3 - 1 month	38"	32"	57"	39"	47"	46"
Penetrometer 24-94 units	172.6"	170.6"	197.6"	174.0"	171.5"	171.8"
" rate per unit	2.47"	2.43"	2.81"	2.48"	2.44"	2.45"
94 - 100 units	27.4"	18.4"	19.6"	32.7"	21.4"	24.5"
" rate per unit	4.57"	3.07"	3.27"	5.44"	3.58"	4.08"
" rating	5	1	2	6	3	4
Spatula test	Full bead	Bead	Bead	Large bead	Slight bead	Large bead
Spatula rating	4	2	2	6	1	5

Ratings show relative not quantitative values.
1 = least settled 6 = most settled

#182 - Cont.

Standard viscosity Semi-Lustre 25 - 30 seconds, #3 orifice.

Standard viscosity Enameloid, range from 26 to 36 seconds, #3 orifice.

#187 - Physical Properties of Pigments

A preliminary study was made of the methods available for the separation of pigments into particle size fractions. For this purpose, the Roller Analyzer of the Victor Chemical Company was placed at our disposal and several experimental runs were made. It was found that the method, although slow in operation, was satisfactory for the separation of pigments of larger particle size than about two microns provided no serious agglomeration of the particles occurred, while for fractionation of particles such as TiO_2, where the average size runs below this value and where dispersion of agglomerates is difficult, the method was not practical. This is chiefly because the agglomerates rather than individual particles were fractionated.

To avoid this difficulty, the Noebel liquid elutriator of the Auxiliaries Research Laboratory was tried to ascertain whether a more complete dispersion of individual TiO_2 particles in water was possible. The test runs using water, without a dispersing agent, indicated that serious agglomeration of the particles occurred, while the addition of 0.5% by weight of sodium pyrophosphate gave satisfactory results as far as dispersion was concerned. The flow rates must be so extremely slow, however, to obtain satisfactory separation of particles of the average size of TiO_2, that the method is impractical from this standpoint as far as larger quantity separations are concerned. The rate was about 1 cc per minute, using an elutriator chamber of 20 cm diameter. Using air instead of water, increases the flow rate from the above to about 6,000 cc per minute, so that from this standpoint the air elutriator would seem very much superior to the liquid elutriator, provided dispersion of the agglomerates can be achieved. Studies of the possible application of an electrostatic method for this purpose are under way.

A series of samples were made up, and runs made to determine by the permeability method the "critical" p.v.c. of two pigments, 1403 and 20 F, and a mixture of these, in two oils, (2) and (48) and a mixture of these oils. The samples were made up to 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60% and 65% by volume of pigment in vehicle, using (63) as thinner and grinding in ball mills for 16 hours. The samples so obtained were drawn down on the standard permeability paper base, dried, and the permeability determined, using Anhydrone as a desiccant inside the cups and 101° F. air of about 95% R.H. outside. The runs were carried out for about 4 hours and reductions made to milligrams moisture permeated per hour, no corrections being deemed necessary for the thickness of film due to the big differences in permeation obtained with increasing p.v.c. The gloss characteristics were also run. The results obtained up to the present time are set forth in the following table:

#187 - Cont.

Permeability and Gloss vs. P.V.C.

	1403 TiO_2				20 F Mg Silicate			
	(2)		(48)		(2)		(48)	
Volume % Pigment	Permeability	Gloss	Permeability	Gloss	Permeability	Gloss	Permeability	Gloss
25	85	3	76	93	57	63	66	85
30	307	0	75	90	54	38	64	85
35	363	0	77	63	57	18	54	71
40	355	0	175	57	67	8	61	28
45	366	0	280	52	129	5	62	11
50	360	0	331	53	228	6	102	8
55	374	0	337	54	327	6	189	8
60	372	0	337	49	307	7	270	8
65	370	0	341	53	375	8	370	9

Work on permeabilities is being continued, long drying times for the samples being necessary, however, as no drier was used in making up the samples.

Oil absorption data were obtained on the above pigments and oils in an attempt to correlate oil absorption with criticsl p.v.c. The data to date are not complete so that positive conclusions are not possible at the present time.

Work on the selective adsorption of drying oils from solution on pigments was continued. It was ascertained that the relative "wetness" of the pigments plays a large role in the amount of oil adsorbed and that probably an isotherm will have to be run for each oil and pigment concerned before a complete picture of the physical activity concerned can be determined.

#177 - Pigment Studies

At the request of the Raw Materials Standardization Committee we have tested a sample of Dicalite L-10 as an alternate for diatomaceous silica as 1552 dry in Rex 450 Undercoater. Test batches were found to give standard characteristics.

#177 - Cont.

Opacity Study

Research Bulletin RC-81 concerned itself, among other things, with the opacity of pigmented systems extended with 20 dry magnesium silicate. It was found that with magnesium silicate so long as there was sufficient liquid binder and the extender pigment was properly dispersed, the extender functioned as vehicle solids for hiding effects.

Work has now been completed which studied the effects obtained with other extender pigments. Results are given below.

Each paint is formulated with 1403 dry at an H.P.V.C. of 12.4% with a total p.v.c. of 20% using added extender pigment. Expressed in terms of 100 gallons of paint this would constitute a pigmentation of approximately 330 pounds 1403 dry and 150 pounds magnesium silicate. Substitutions were made as volume replacements of the magnesium silicate content.

Paint No.	Extender Pigment		Opacity Sq.Ft./Gal. at 95% C.R.
RB 1761	566 dry	Natural Ground Whiting	543
1762	1817 dry	Surfex - pptd. $CaCO_3$	536
1763	213 dry	Blanc Fixe	550
1764	2209 dry	Multifex MM	508
1765	20 F	Magnesium Silicate	540

It will be recognized from the above that, within the limits of experimental error, the opacities developed were similar, regardless of the extender pigment used.

Work also was carried on to study the effect of brightness upon the opacity development of white enamels. Separate batches of a standard Enameloid White were shaded with a methyl violet toner and with a lamp black base. The brightness was reduced in approximately 1% steps to determine what opacity change is effected.

Brightness	Sq.Ft./Gal. at 95% C.R. Lamp Black Series		Methyl Violet	
87.2% Base Paint	461			
86.7 Base Paint			463	
86.0	523	(100%)	485	(100%)
85.0	545	(104%)	512	(105.5%)
83.0	565	(108%)	536	(110.5%)
82.0	583	(111.5%)	556	(114.5%)
81.0	614	(117.3%)		
80.0	629	(120%)		

#177 - Cont.

As might be anticipated, there is a real opacity build-up with lowered brightness. Whether this is sufficient incentive to shade our whites is questionable. It was also found that an enamel shaded to 80% brightness with either of these bases could be readily used as a tint base for any of our standard shades.

The study of dispersion and milling effects on the opacity of flat wall paints was made. Results were negative, since it was not possible in these tests to determine any progressive change which practical tests have proved so definitely. Further work is contemplated.

- - -

No work was done during the month on the following projects:

#178 - Studies of Dark Colored House Paints

#148 - Examination of White Lead

#112 - Fire Retardant Paints

#183 - Pretreatment of Metal Surfaces for Painting

#103 - Cont.

Metal Protective Paints

A report has been written covering the first 21 weeks' exposure of the Exterior Alternate Immersion Cooperative Tests undertaken in conjunction with the group on Immersion Testing - Subcommittee VII, Committee D-1 A.S.T.M. This test has previously been outlined in the monthly report for August, 1946. To date all but five of the alternate immersion, refrigeration, exterior exposure panels have been retired with a rust rating of 5. Exterior panels will be continued on exposure until similar ratings are reached.

Panels 9511-9526 have been retired after 12 weeks' tide range exposure in Florida. These panels include tests of various whitings in 52P18 on HCl acid pickled panels and the same paints on Manganese Phospholene, Carborustex, or HCl - chromic acid treated panels. Of the whitings, Mineral Whiting - 566 dry and Southwark #1 Whiting are the best, Sno-Float and Atomite next best, with York Whiting, Surfex, and Multifex poorest. All whitings performed better than the regular inert - 20 F dry, magnesium silicate. All of the special cleaning and treating methods resulted in somewhat better performance than did the straight HCl acid pickling.

Panels have been exposed at Florida, at Chicago, and in accelerated tests in the laboratory comparing the performance of Pigment E to 12054 dry zinc chromate in both 52P18, the Navy's zinc chromate primer, and in Kromik, Rex 16174. Pigment E is a barium potassium chromate developed by National Lead Company Research Laboratories.

#177 - Pigment Studies

The study of white pigment opacities has been continued to determine the nature of vehicle effects on opacity and to lay some ground work for a theory to explain and to predict the effects of vehicle change on opacity development.

Working with two pigments - 461 L dry lithopone and 1403 dry titanium oxide, the opacities of these materials have been determined when dispersed in several vehicle systems. The results are as follows, expressing hiding as square feet per pound at 95% contrast ratio:

	461 L				1403 Dry			
	20% HPVC		35% HPVC		20% HPVC		35% HPVC	
Vehicle	Hiding	Brightness	Hiding	Brightness	Hiding	Brightness	Hiding	Brightness
(2)	40.6	85.9	30.2	89.8	132.0	91.1	97.3	89.0
(2)/(48)	49.6	85.3	45.6	87.5	127.0	89.2	89.4	89.1
(48)	47.0	84.3	39.4	86.3	146.0	90.1	100.0	89.0
(4100)	49.4	81.5	44.6	84.0	171.5	87.0	97.3	87.5
(3109)	51.2	82.9	39.5	85.8	175.0	87.2	122.5	88.2
(3109)/(4100)	47.2	81.2	41.0	85.8	165.0	86.3	92.5	87.0
(3880)E	65.4	72.3	50.5	78.1	191.0	81.2	107.0	85.1

#177 - Cont.

Work is under way to determine the refractive indices of the dry binders used above. Thus far there is no obvious theory to explain the opacity differences which have been found.

Evaluation of 1307 dry TiO_2

A comparative evaluation of the above pigment showed it to be quite similar to 1403 dry in chalking rate on our accelerated test. This test, in which the titanium oxides are ground in linseed oil and the films are exposed in the Weather-Ometer, is only indicative, but in the past it has served quite well to index titanium pigments for chalking rates. The water soluble salt content of 1307 dry is high as indicated by specific resistance measurements. There was some concern that this might cause nail rusting if the pigment were used in house paints and house paint primers. An iron corrosion test was made by making a 10% slurry of each pigment with distilled water. This was boiled 5 minutes, then a freshly sanded cold rolled steel panel was immersed in each slurry. At 20 hours' exposure results were as follows:

Slurry	Specific Resistance (Ohms)	pH of Slurry*	Panel Condition
1403 dry	6,050	8.4	Considerable rust
1307 "	1,490	9.0	Slight "
20 MSK dry	4,610	8.1	Very bad "
20 F dry	8,360	8.4	Bad "

*Measured after the panel exposure.

Paint tests were made in Rexes 450, 471 and 710. In all these tests 1307 dry appeared normal for viscosity, brushing, drying, and gloss.

#187 - Physical Properties of Pigments

The January report introduced a study being made to determine by the permeability method the critical PVC of 1403 TiO_2 and 20 F magnesium silicate in the individual oils, (2) and (48), and in a mixture of the two. Data accumulated in the progress of this work is given below. WA2L represents a 1:1 mixture by volume of (2) and (48), while WAP1 is a 1:1 mixture by volume of 1403 and 20 F.

(Chart follows.)

#187 - Cont.

Vol. % Pigment	1403 in WA2L Permeability	1403 in WA2L Gloss	20 F in WA2L Permeability	20 F in WA2L Gloss	WAP1 in (2) Permeability	WAP1 in (2) Gloss	WAP1 in WA2L Permeability	WAP1 in WA2L Gloss
25	46	93	39	89	49	74	45	88
30	46	93	35	85	52	41	47	78
35	48	76	33	83	57	17	43	51
40	203	69	34	56	135	9	53	31
45	312	63	31	27	283	8	105	13
50	321	66	81	25	375	8	239	12
55	362	64	135	26	390	8	343	10
60	350	64	234	26	385	8	372	10
65	353	60	287	26			377	10

The CPVC (critical pigment volume concentration) was considered to be that point on the graph of the permeability and gloss vs. PVC curves where the permeability and gloss lines intersect, when the shanks of both are reduced to the same horizontal plane. The CPVC's for the material so far run are:

	(48)	WA2L	(2)
20 F	46.5%	46.5%	41%
WAP1	44%	44%	38%
1403	38%	38%	26.5%

The permeability work is being continued with various other combinations of pigments and vehicles.

Several preliminary runs have been made on other, shorter methods in attempting to obtain the CPVC of a pigment-vehicle combination but no definite conclusions have been reached to date.

#182 - Study of Improved Mixing and Grinding Practices.

AV-195, a temporary replacement vehicle for (3109) and (4100) in the Enameloid line, was tested as to its adaptability as a grinding vehicle.

#162 - Studies in Flat Wall Paint Formulation

Semi-Lustre

The Vehicle Research Department submitted the following varnishes for evaluation in Semi-Lustre tints:

CVR-755 (2957)E Standard formula "A" Body I

CVR-748 (2957)E Special. (3316) substituted for linseed. Body H-I.

CVR-753 (2957)E Special. Resin 50/50 Velsicol/ester gum and (3316) for linseed. Body H +.

CVR-754 (2957)E Special. Resin all Velsicol and (3316) for linseed. Body I.

CVR-753 was used in the vehicle formulation for Rex 16270, card #11, which consists of 21 gallons (2381) and 22 gallons (2957)E, with a special titanium calcium-zinc oxide pigmentation. Since the experimental varnish produced very thin bodied paint which was slow drying, no further work was done with these varnishes. Vehicle Research then submitted CVR-759 having R-body, which also gave a thin paint. Extra inert increased the body but reduced the sheen below standard.

CVR-761-2, an experimental tall oil-soya-CWO-maleic Velsicol varnish, body S-T, was also submitted by the Vehicle Research Department. It was compared with (2853)G in Semi-Lustre Ivory, Alternate C, 7-17-46, with the following results:

		Viscosities #3		
		Fresh	24 Hours	Sheen
OJ 615 K	Regular formula Rex 201	21"	23.2"	54
OJ 616 K	As 615 K but CVR 761-2	15.5"	16.6"	54
OJ 618 K	As 616 K but + 50# 2188	24"	27.6"	48

Work is continuing to achieve the right viscosity and sheen.

Seeding in Enameloid

Inspection of 0.000 to 0.003 inch films drawn down from a stearate-free Rex 710 enamel and two others, containing 3 pounds of calcium and aluminum stearate per 100 gallons respectively, shows aluminum stearate to be the most active in promoting seeding after aging one month at room temperature as well as at alternate cycling between room and below zero temperatures. The enamels carry 2147 dry TiO_2 in the regular (3109) - (4100) type vehicle.

#162 - Cont.

Age of Sample	Conditions	Stearate-free	3# Stearate/100 Gal. Calcium	3# Stearate/100 Gal. Aluminum
Fresh	-	1	2	3
2 weeks	Room temp.	1	2	3
	Cycled	1	2	3
1 month	Room temp.	1	2-1/2	4
	Cycled	1	2-1/2	4

Ratings: 1 = Very slight seeding
10 = Bad seeding

No work was done during the month on the following projects:

#163 - One Coat House Paint

#160 - Painting of Bricks

#148 - Examination of White Lead

#112 - Fire Retardant Paints

#183 - Pretreatment of Metal Surfaces for Painting

#103 - Cont.

It should be noted that the above "post-war" Kromik was a tentative formula in which the vehicle consisted of approximately 50% Dehydrol, 25% (48), 12-1/2% (2), and 12-1/2% Ester Gum (1157) based on solids. This approaches very closely the vehicle used in card #17, Rex 16174. The vehicle of Rex 16174, card #19, which shows much worse rusting and blistering under approximately the same exposure conditions is 75% (48), 11-1/2% (2), and 13-1/2% (2841)G based on solids.

After approximately 600 hours on accelerated exposure, definite advantages have appeared in favor of National Lead Company's Pigment E, barium potassium chromate, over zinc chromate in both Kromik and 52P18 with and without a top coat, particularly in the 52P18 formulation. In the salt spray cabinet the single coat of 52P18 has rusted very badly in the case where zinc chromate was used but only slightly where Pigment E was used. Here also, although the single coat panel with regular Kromik has begun to rust, the comparable one with Pigment E is in good shape. In salt water immersion, water immersion, and humidity cabinet tests the results were not so definite. In some cases the blistering was worse with those paints where Pigment E had been substituted for the zinc chromate and in others just the opposite. The advantage, if any, favors Pigment E.

#177 - Pigment Studies

Work is in process to correlate opacity relationships with film permeability and binder quantities. It is hoped that some evidence will be developed to enable the formulator to anticipate film characteristics, as well as hiding effects in and around the high dry hiding zone.

414 Dry

It will be necessary to substitute a blend of 414/511 dry for 412 dry in some Rex 471 SWP Gloss White production. Assuming 414 dry with a 90/10 zinc/lead composition and 511 dry at 50/50 zinc/lead, each 100 pounds of 412 was replaced with 37.5 pounds 414 dry plus 62.5 pounds 511 dry. Using normal 511 dry and various samples of 414 dry in this proportion it was found that the color of the 414 must be 45 or better to make acceptable Rex 471. For tints and Rex 450 Undercoater a 414 pigment with a 40 color or better is acceptable.

414 dry for blending with 511 dry to make Rex 471 should comply with all other specifications on 414 dry as outlined in the November, 1946 report, pages 7 and 8. A further check is being made of the composition of recent production of 414 dry to establish the exact lead/zinc ratio.

#187 - Physical Properties of Pigments

In the continuation of the permeability work of the last several months, a number of other factors besides the effect of particle size and average molecular size of the vehicle were studied for their effect on the change of the CPVC (critical pigment-volume-concentration).

Batches were made up at 25%, 30%, 35%, 40% and 45% PVC of 1403 TiO_2 in alkali refined linseed oil (44), (44) plus (2182) linseed fatty acids at 1% of the pigment volume, (44) + (2182) at 2% of the pigment volume and (44) + (2182) at 5% of the pigment volume, respectively. They were ground to about 6 Hegman grind in the 1/2 pint ball mills described previously, drawn down on standard permeability paper, and permeabilities determined for each batch. The results indicate that a definite shift of the CPVC toward higher PVC is achieved with increasing percentage of (2182) to about 2% of pigment volume, above which point, a further addition of the fatty acid seems to have no appreciable effect on the critical point.

Data obtained for the adsorption of (2182) in naphtha solution by 1403 TiO_2 indicated that linseed fatty acid corresponding to about 2% of the pigment volume was adsorbed from solution. These would coincide with the break in the CPVC versus per cent (2182) curve, the CPVC being obtained from the permeability-gloss data outlined below.

	0% (2182)		1% (2182)		2% (2182)		5% (2182)	
PVC	Perm.	Gloss	Perm.	Gloss	Perm.	Gloss	Perm.	Gloss
25%	31	89	23	91	46	93	38	92
30%	38	87	40	89	50	81	30	82
35%	30	12	42	32	59	59	55	39
40%	184	10	49	12	59	25	56	23
45%	357	10	272	11	88	20	65	23

Work in this direction is being continued with the study of the effect of various quantities of bodied linseed (48) in raw linseed oil (2) on the shift of CPVC, 1403 TiO_2 being used as the pigment.

To substantiate the hypothesis that the degree of dispersion of pigments in vehicles affects the critical pigment volume concentration, four batches of Kromik Primer with PVC's of 35%, 39.5% (which is standard for Rex 16174), 45% and 50% were made up and milled simultaneously in four laboratory ball mills, samples being extracted at 1 hour, 2 hours, 4 hours, 9 hours, 24 hours, and 48 hours. These dispersion periods correspond to a Hegman grind of 0, 1, 2, 3, 4 and 6 respectively. The samples so obtained were drawn down and the permeability and gloss characteristics determined on the dried films, with results as shown in the table below.

#187 - Cont.

Time of Grind	No grind		1 hr. grind		2 hr. grind		4 hr. grind		9 hr. grind		24 hr. grind		48 hr. grind	
Fineness	0 H		0 H		1 H		2 H		3 H		4 H		6 H	
PVC	Perm.	Gloss	Perm.	Gloss	Perm.	Gloss	Perm.	Gloss	Perm.	Gloss	Perm.	Gloss	Perm.	Gloss
35%	30	19	36	25	33	27	30	33	33	48	30	64	33	70
39.5%	32	13	28	14	35	18	36	19	28	27	32	47	30	60
45%	87	6	92	6	58	6	65	6	35	6	43	8	27	12
50%	166	6	154	6	145	6	134	6	97	6	32	7	30	11

#187 - Cont.

The results indicate that the degree of dispersion as determined on the Hegman gauge strongly affects the CPVC, moving this value toward higher PVC with increasing fineness of grind. The general trend is probably most clearly shown on the 50% PVC data which reveals that although the 48-hour grind shows no increase in permeability, the poorer grinds show substantial increases at this PVC. This trend is already well under way at 45% PVC and seems to start only shortly above the PVC of the regular formulation.

Similar work is being continued on 1403 TiO_2 in (2).

The rusting and blistering characteristics are being determined for the Kromik Primers tested above for permeability, but the data is not yet available.

#182 - Study of Improved Mixing and Grinding Practices

Special studies were made of the grinding properties of the vehicle components of SWP. Differences in consistency and flow of SWP had been observed where different lots of (2) raw linseed oil had been used. Two samples of (2) were obtained from the Oil Mill, one fresh from the presses and the second a well aged sample. Characteristics were as follows:

	Fresh (2)	Aged (2)
Heated Oil Foots Content (S-W Method)	0.4%	Trace
Iodine Number (Wijs one hour)	183.4	183.0
Acid Value	2.3	2.4
Color (Gardner, 1933)	10 - 11	10 - 11
Appearance	Cloudy	Clear

Laboratory batches of SWP Gloss White made with each of the above oils were ground, mixed and tested under identical conditions. Brush-outs of each showed no differences with respect to flow, brushing, body or in general appearance.

Wetting and grinding tests were run with both the fresh and well aged linseed oils as single oils in the mill pastes. Both samples showed identical wetting characteristics, producing mill pastes of equal consistencies at equal additions of oil. The mill pastes had to be made at lower consistencies than usual, as the pastes were thixotropic and gave some trouble on the apron of the roller mill. Also, if less oil was used there was a tendency to run dry on the rolls. The paste prepared from the aged (2) milled somewhat faster than that made with the very raw oil, which is perhaps contrary to expectations considering the usual beneficial effects of lecithin, etc.

#148 - Examination of White Lead

Panels 7186-9 F were examined after 30 months in Florida, testing S-W Rex 17 Soft Paste White Lead against Dutch Boy and Eagle-Picher Dutch Soft Pastes. The guide was two coats of Rex 450 and one coat of Rex 471. The white leads are all 3-coat work according to the directions for reducing Rex 17 as per label. Rex 17 is slightly best of the white leads, though the characteristic alligator checks are beginning to show many microscopic cracks and some visible ones. Dutch Boy is essentially the same as Rex 17 except a little more dirty, most of the dirt being mildew. The Eagle-Picher lead-in-oil is by far the poorest in appearance, due to dirt, but is only slightly more advanced in cracking than Rex 17 or Dutch Boy. The guides show no failure and in general look better than the tests.

#112 - Fire Retardant Paints

Introductory tests have been made on the testing procedure for fire retarding coatings. Work has been resumed on the formulation and testing of this type of product.

Exposures 7354-9 C were examined after 40 months at Chicago, vertical south, on cedar siding primed with Rex 450 Undercoater. Borax is tested in CH 3265 - Fire Retardant House Paint. The other materials tested are not in the same formula but in Rex 471 - SWP Gloss White of 7-21-43, which serves also as guide. The special materials are: lead borate from Kentucky Color Company, and zinc borates from Kentucky Color, New Jersey Zinc and Pemco. These are put in at 260 pounds (25%) for asbestine, leaving 60 pounds of asbestine, except in the case of lead borate, which is used at 300 pounds with 186 pounds of asbestine. There is little or no choice among the several borates as regards durability or appearance. There is no failure except slight erosion. A special Pemco sample, #FP-72, shows micro-checking and slightly more erosion, and also has a yellow cast. The regular CH 3265 is dirtiest of the group and shows a surface wrinkling or roughness. The panels will be fire tested to determine if fire retardance has been maintained during exposure.

#163 - One Coat House Paint

Panels 11471 - 11504 were exposed as two coat work on new wood south and north vertical at Chicago, and repaints south only, covering all SWP and One Coat House Paint house tests painted in 1946.

#12 - Exterior Primers

As in the case of SWP top coats, suggested alternate formulas were sent to Cleveland to afford possible substitution for magnesium silicate. Alternate extender combinations include 2/1 2203 Carbola Talc/ 2201 Metro-Nite and 1/1 2201 Metro-Nite/1989 Microne Talc.

#185 - Pretreatment of Metal Surfaces for Painting

An additional number of aluminum siding panels have been obtained to supplement earlier tests. The panels will be prepared for painting as follows:

1. No cleaning.
2. Solvent wipe with mineral spirits.
3. Solvent spray cleaned using 50/50 xylene/mineral spirits.
4. H_3PO_4 cleaned, using Deoxidine No. 412.
5. Vinyl butyral Resin Wash Primer WP-1 (see Project #103).

After this surface preparation, various primers will be applied, including oleoresinous zinc chromate primers OJ 539 K at 35% PVC and 540 K at 42% PVC, Kromik Primer and SWP 450 Undercoater. After an intermediate coat of 450 Undercoater, SWP Gloss White will be used as the top coat for all the panels.

#162 - Studies in Flat Wall Paint Formulation

Flat Wall Paints

With the prospects of having a limited amount of TiO_2 and some Dehydrol available for flat wall paint production this spring, we have been working on an alternate formula for Rex 810 based on pure TiO_2 and inert. Experimental formulas have been made using 200 pounds 1403 dry, 200 pounds 2188 dry and 200 pounds 566 dry, as well as 160 pounds 2173, 218 pounds 566 and 218 pounds 2188 dry. The experimental flats were too low and too uneven in sheen compared with the formula on Rex 810 dated 3-21-44 (based on titanium calcium pigment). Work will be continued on this problem.

Duringthe month we obtained a sample of Soya gel 70 from Archer-Daniels-Midland Company for test in flat wall paint formulations. Soyagel is offered initially only at 70% non-volatile in mineral spirits and has the following average analytical constants:

Acid No.	3 - 5
Color (Gardner)	10 - 11
Viscosity	Y - Z_1
Specific Gravity	.913 (7.60 lbs. per gal.)
N.V.M.	70 $\pm$ 1%

#162 - Cont.

Soyagel 70 was compared with Linogel - (2396) in the Paintercraft One Coat Flat Wall Paint #10 (OJ 692 K) for drying, brushing, flow and uniformity of sheen and tint. The present vehicle as used in the Paintercraft Flat #10 is composed of 30 gallons (3880)E and 9 gallons (2396). The experimental flat made with 30 gallons (3880)E and 11-1/4 gallons Soyagel 70 was found to be similar to the regular in all respects except for body, which was slightly on the low side. Soyagel could be used as a replacement for Linogel in the above formulation, but some adjustment would be required to increase the body by the reduction of thinner or by making some revision in the pigmentation.

Flat-Rite Undercoater

Mention has been made in the December, 1946, and January, 1947, Reports of Investigations of a study being made of the effects of additions of certain surface active agents, as well as aluminum and calcium stearates, on the suspension properties of Rex 50 Flat-Rite Undercoater. The penetrometer is used to check settling, as described in the January report. The various batches are now three months old, having stood undisturbed for two months prior to the current inspection.

The penetrometer data shows that all the batches except the excessively bodied 1% AM Ac 118.5 - C batch were the same in character from the top down to within 3/8 inch above the bottom of the package. This is equal to the point 92 on the penetrometer scale, so that the time consumed between 92 and 100 gives some indication of the firmness of settling.

Agent	1826 Dry		547 Dry	Acto 450		Armeen C		AM Ac 118.5-C	
Amount Used	3#	6#	3#	1%	1/2%	1%	1/2%	1%	1/2%
Penetrometer Scale									
20	0	0	0	0	0	0	0	0	0
30	20.2	23.8	26.0	19.8	20.7	20.0	20.8	22.4	19.4
40	22.6	19.3	19.5	21.8	21.0	22.2	21.5	...7	22.0
50	20.2	19.3	19.5	22.5	21.4	20.0	20.0	23.6	21.2
60	19.0	18.9	19.0	19.0	19.0	18.7	19.0	23.9	19.0
70	19.3	19.2	19.4	19.7	19.5	19.7	19.4	20.5	19.2
80	19.2	19.0	19.4	19.3	20.0	18.8	19.0	19.1	19.5
86	12.2	12.0	12.0	12.4	13.5	12.2	12.0	12.3	11.7
92	11.7	11.7	12.5	13.0	17.7	11.2	11.4	11.8	11.8
96	12.6	11.3	14.7	9.0	22.6	10.0	11.7	9.0	16.5
98		8.0	12.2	15.8	14.1				15.9
100	36.8	16.0	20.0	17.0	19.6	21.9	30.6	11.2	32.8
92 to 100	49.4	35.3	46.9	41.8	56.3	31.9	42.3	20.2	65.2

Posted values = time in seconds required to penetrate from one scale position to the next.

#162 - Cont.

All the batches containing 1% of the surface active agents show better suspension than the control, which carries three pounds of 1826 dry calcium stearate. Those with 1/2% surface active agents settle harder than the control, suggesting that inadequate amounts may have an adverse effect on suspension. Three pounds of aluminum and calcium stearates are about equal, with six pounds of calcium stearate showing superior suspension. The 1% AM Ac 118.5-C batch shows superior suspension but is unsatisfactory due to excessive body.

Semi-Lustre

The Vehicle Research Department have submitted the following varnishes for evaluation in Semi-Lustre tints:

CVR 770 - #2	Tall oil, wood oil, soybean oil, Velsicol maleic pentaerythritol varnish.
CVR 741	Velsicol-Pentalyn M-maleic treated soya varnish.
CVR 787	Velsicol-maleic soya-P.E. tall oil varnish.
CVR 761-2	Tall oil-soya-C.W.O.-maleic-Velsicol varnish.

The sample of CVR 761-2 was reported in February as being OK for sheen but too low in viscosity for Semi-Lustre tints. Additional work indicated that a satisfactory viscosity can be obtained by the use of 7 gallons CV 4526 and 2 gallons (1273) for the 9 gallons of (48) normally used in Rex 201. We have found CVR 761-2 to be somewhat reactive as it has shown afterbodying tendencies in the above formulation.

Semi-Lustre Ivory made with CVR 770-2 and CVR 787 was too low in sheen compared with the present standard.

The Velsicol-Pentalyn M-maleic treated soya varnish - CVR 741 produced a higher sheen than CVR 770-2 and CVR 787 but it is also quite reactive with the lithopone-titanium calcium pigmentation.

Work is being continued on this problem.

See next page for chart.

#162 - Cont.

Batch	Vehicle		Pigment	Viscosity - #3 Fresh	24 Hrs.	Aged	Sheen
OJ 654 K	33 gals. 7 " 2 "	CVR 761 #2 CV 4526 (1273)	192# 461 L 475 2132 20 2188	28.8"	25"	60" (14 days)	OK
OJ 684 K	33 gals. 7 " 2 "	CVR 761-2 CV 4526 (48)	"	28.2"	41.6"	46.2" (14 days)	Low
OJ 683 K	33 gals. 7 " 2 "	CVR 770-2 CV 4526 (48)	"	26"	31"	33.4" (4 days)	Low
OJ 685 K	"		192# 461 L 475# 2132	20.8"	28.2"	29.2" (4 days)	Low
OJ 688 K	33 gals. 7 " 2 "	CVR 787 CV 4526 (48)	"	26"	27.4"	23.6" (3 days)	Low
OJ 689 K	"		192# 461 L 475# 2132 20# 2188	34"	46"	32.8" (3 days)	Low
OJ 710 K	34 gals. 7 " 2 "	CVR 741 CV 4526 Linseed (48)	192# 461 L 475# 2132	19.4"	-	37.4" (3 days) (Rex 201, C 377)	Sl. lower than stock

The factory has experienced low sheen on Semi-Lustre White made with (3848)E. The pigmentation was 75 pounds 2188 and 575 pounds 2132 dry and the vehicle as Alternate A formula dated 8-22-45. A number of laboratory batches of Rex 210, based on this formula were made to check on factory production. In the laboratory batch variations were made in the drier, anti-skinning agent and the type of (48) used. Minor changes of this type produced no increase in sheen and it was decided that the pigmentation would have to be revised to correct the condition. The formula has been referred to Cleveland for revision by Mr. Einbecker. Cleveland, however, has reported that their production of (3848)E give high sheen in Semi-Lustre so a sample of their (3848)E is being obtained for further tests.

#162 - Cont.

Enameloid

A series of (3109)-(4100) type Rex 710 enamels has been prepared to observe the effects of Soligen and Ferro calcium naphthenates on drier retention. The calcium naphthenates were present to the extent of 0.2% calcium based on the vehicle solids.

After seven months' aging at normal room temperatures, the material containing Soligen calcium naphthenate shows substantially improved drier retention while that containing the Ferro product shows no advantage. Both naphthenates induced excessive bodying and retarded settling completely. The control batch had settled appreciably during this period, but was readily dispersed by stirring.

A summary of experimental data is tabled below:

		Control	Soligen Ca.	Ferro Ca.
Fresh Enamel	Viscosity #3	66 sec.	79.2 sec.	86 sec.
	Dry-to-touch	58 min.	56 min.	80 min.
Aged 1 wee	Dry-to-touch	60 min.	39 min.	70 min.
Aged 7 mo.	Viscosity #3	81 sec.	108 sec.	110 sec.
	Dry-to-touch	120 min.	95 min.	130 min.

No work was done during the month on the following investigation:

#160 - Painting of Bricks.

#105 - Cont.

Panels 10452 F - 10461 F were returned from Florida for inspection after 12 months' exposure at 45° south. These are 6" x 12" cold rolled steel panels, primed with Rex 16174, card #19 and top coated by spraying with Metalastic Green and Black, formulated at P.V.C. variations from 10% to 50% by adjusting the quantity of inert in the pigmentation. In both the Green and the Black the 10% P.V.C. is best in general appearance and durability. Both chalking and flatting increase rapidly with increase in P.V.C.

#187 - Physical Properties of Pigments

Sufficient data on the rusting and blistering characteristics of the Kromik Primer series, the permeability curves for which were reported in the March report, have been obtained to substantiate the close relationship between CPVC, degree of dispersion and actual performance of the paint films. With increasing fineness of grind the CPVC has shifted substantially toward higher PVC giving, for instance, a non-rusting panel at 4 H and 6 H grinds for 45% PVC, whereas the 3 H grind and lower show substantial failure of the paint film at the same PVC.

The typical picture of the results of the 5% salt spray test is shown in the accompanying data. The humidity tests for blistering show the same characteristic trend that would be expected from both the permeability and salt spray data, i.e., those panels showing low permeability and absence of rust show the greatest amount of blistering, while those showing bad rusting show the least amount of blistering.

Kromik Primers

Rusting in 5% Salt Spray at 95° F. - 100 Hours

Time of Grind	No	1 Hr.	2 Hrs.	4 Hrs.	9 Hrs.	24 Hrs.	48 Hrs.
Fineness	O-H	O-H	1-H	2-H	3-H	4-H	6-H
35% PVC	(C)	(C)	(S)	A	A	A	A
39.5% PVC	S	S	S	(S)	A	A	S
45% PVC	VB	VB	B	B	(B)	A	A
50% PVC	VB	VB	VB	VB	VB	VB	B

It is interesting to note in the above data that the no-grind, 1 hr. and 2 hr. grinds in the 35% PVC and 39.5% PVC series, as well as the 4 hr. grind in the 39.5% PVC show a pin point type of rusting at those places where agglomerates of undispersed pigment occur. These did not increase substantially in extent or size from 100 hours up to 500 hour exposure, while those panels which rusted in the 45% and 50% PVC series showed bad progressive failure as the exposure period increased.

#187 - Cont.

In "Paint, Oil and Chemical Review" of September 5, 1946 Mr. H. Zahn describes a method for the rapid evaluation of the degree of rusting by measuring the E.M.F. of the rusting panel against a calomel half cell in ordinary tap water. A similar series of E.M.F. determinations was run on the above mentioned Kromik Primer panels exposed to salt spray, but the data obtained showed no relationship between the amount or degree of rusting and the potential developed as measured against a standard calomel cell.

The dispersing ability of (2), (2) + (48) 1:1, (48) and (3109) on 1403 TiO_2 was determined by grinding in ball mills under carefully controlled conditions. The results indicate that the dispersing effect runs closely parallel to the CPVC obtained in the same pigment-vehicle system. The dispersibility of (2) on 1403 was definitely the poorest. It also shows the lowest CPVC. The varnish (3109) shows the highest dispersibility as well as the highest relative CPVC. The (2) + (48) 1:1 and straight (48) showed the same degree of dispersing ability and they also show nearly the same relative CPVC to the pigment system involved, being slightly below (3109) and considerably above (2). Further work is being carried out in an attempt to simplify the process of dispersion by substituting a mill of the Premier type for the ball mills, so that operating conditions are more easily controllable. It is hoped that a system of dispersibility factors can be worked out for various pigment and vehicle systems that can be correlated to CPVC.

To shorten and simplify the permeability method for determining the CPVC of paint films, a new static method has been devised, which has the advantage of being very much faster and not requiring a delicate analytical balance. The method consists essentially of determining the electrical resistivity as measured by a Kohlrausch type A-C conductivity bridge, of an electrolyte soaked paint film. The paint to be tested is drawn down on the standard permeability draw-down paper as in the moisture method. After drying, it is placed into a conductivity cell which is very much like the moisture-permeability cups used so far, with the bottom cut out. The resistivity is measured directly on the A-C bridge. Whereas the moisture-permeability method requires almost 8 hours for a series of results, the same data can be obtained in less than an hour by the new method. A substantial number of checks run between the two methods showed that the CPVC values obtained checked within about $\pm$ 0.5%.

Where the resistivity bridge is not available, a colorimetric method can be used. The same cells are used, but instead of a salt solution electrolyte, $FeCl_3$ and $K_4Fe(CN)_6$ are placed on opposite sides of the film. With a porous film, where the PVC lies above the CPVC, the typical Prussian Blue precipitate will color the film, whereas below the CPVC no color reaction results. This method is not quite as delicate as the resistivity method.

#177 - Pigment Studies

The W. H. Loomis Company has supplied a special sample of Magnesium Silicate #151-B which they would be able to supply in larger quantities. To test the material, Rex 471 batches were made substituting the regular magnesium silicates normally used in the formula. The batches were ground on the stone mill. Results are given below:

Paint No.	Mg Silicate	Viscosity #3	Grind	Gloss	Flow	Grind Time	Mill Set
RB 1887	20 F	22.4"	3 H	49	Fair	65'	Initial
1888	20 MSK	17.2	3-1/4 H	47	"	40'	"
1889	Loomis 151-A	24.6	3 H	43	"	40'	Tightened
1890	Loomis 151-B	20.6	3-1/4 H	44	"	60'	Tightened further.

325 mesh residues on the above magnesium silicate samples are as follows:

20 F	4.8%
20 MSK	0.6%
Loomis 151-A	1.4%
Loomis 151-B	3.1%

The color of all the paints produced is satisfactory.

Damar chalking tests on various TiO_2 pigments have been repeated in the Weather-Ometer to establish more definitely the characteristics of 1307 dry relative to other established types. In this series we again found 1307 dry to be similar to 1403 dry. Comparing various pigments at the point that "considerable" chalking occurred we find the following:

	Days Exposure to Reach Considerable Chalk
1307 Dry	5
1403 "	5
2173 "	25
2174 "	31
Ti Pure LW	Not chalking after 31 days exposure.

#12 - Exterior Primers

In view of limited availability of 1552 dry formulas have been set up and submitted to Cleveland in which replacements are used in 450 Undercoater. Dicalite L-10 has been approved as an equivalent for Celite 110. From work to date, it appears that 2015 dry - Dicalite L may be used when 1552 dry is not available, with 2077, Celite #281, to be used only as an emergency alternate. 1552 dry is the standard and preferred material, but factories are urged to watch shipments to see that screen residues are kept within specification limits.

Panels 9234-7 CY, FY were examined after exposure for 21 months at Chicago and 18 months in Florida vertical south. These are pitch and knot sealing tests on low grade yellow pine, using shellac substitutes under the SWP two coat system. All sealed sections show more peeling than when 450-471 is applied directly on the wood. Orange Shellac is somewhat better than Zinnser's Zinlac, a zein-resin coating, or CAC 5-21, Vehicle Research's match for Zinlac.

#162 - Studies in Flat Wall Paint Formulation

Flat Wall Paints

A request was received from Dr. E. D. Witman, at Ohio State University, for approximately 20 gallons of Flat-Tone White containing 5% DDT based on the total weight of paint. A formulation of this type was developed and portions shipped to Ohio State University; Montreal, Canada; Bound Brook, New Jersey; Oakland, California; and Orlando, Florida.

An experimental Metropolitan Flat White - RL 321 A based on 100% lithopone pigmentation was received from Newark for inspection. The sample was checked for flow, drying, uniformity of tint and washability over glue size. It was found to be satisfactory for brushing and drying characteristics but poor in flow and uniformity of sheen. The uniformity of tint and washability over glue size were rated fair.

Some time was spent on the reformulation of Martin-Senour's #2652 Nu-Hue Flat White to improve the odors during its drying period. Variations were made on the standard formula using Shell's Special Mineral Spirits #8296 and Dispersol #8233 as thinners of improved odor. Other changes include the substitution of (2396) for (6063) and (5026) for (1767). In our opinion these changes have improved the drying odors. Work continues.

Work was also continued on the development of a flat wall paint based on pure TiO_2 and inert. To date we have tested 1989, 566, 1817, 2188, 2209, and various combinations of each inert in conjunction with 1403 and 2173 dry. The experimental flats were too low and uneven in sheen and/or too thin in consistency. Our present work indicates that a combination of pure TiO_2, lithopone and inert would be a more desirable pigment combination to use until 2132 dry becomes more available.

#162 - Cont.

Semi-Gloss Paints

The Vehicle Research Department submitted a number of phenolic-Velsicol tall oil P.E. tung oil soya maleic varnishes for evaluation in Semi-Lustre. Most of these varnishes produced paints of too low viscosity, but the principal difficulty was low gloss. The Velsicol resin was suspected, so an additional liquid (CVR 833) was supplied based on tall oil, ester gum, maleic, P.E., tung and soybean oils. This varnish gave a higher sheen Semi-Lustre, still somewhat below stock paints.

CVR 808 (tall oil-castor-P.E.) produced a satisfactory sheen. This varnish was used in conjunction with (48) since higher bodied oils gave a tendency to reduce gloss similar to the Velsicol varnishes. A plant batch of CVR 808 is being made, and will be used in a factory batch of Semi-Lustre based on Cleveland's suggested pigmentation (461 L, 1307, 2188 and 566 dries).

Enamels

Samples of Devoe's Mirrolac White and Jade Green Enamel were obtained from Devoe and Raynolds Company, Inc. during March for inspection. The two samples were evaluated for general performance with Enameloid White based on the alkyd formulation.

Enamel Evaluation
Devoe's Mirrolac White and Jade Green vs. Enameloid White

	Devoe Mirrolac White 7001-08-LM4Z	Devoe Mirrolac Jade Green	Enameloid White* GK 981
Vehicle	-	-	(3109) and (4100)
Type vehicle	72.5% modified alkyd varnish	64.7% modified alkyd varnish	Alkyd varnishes
Wt. per Gallon T	-	-	9.65
A	9.95	9.61	9.70
Viscosity at 75° F. #3	68.4"	55.2"	60"
Set-to-touch	50 min.	57 min.	1 hr. 15 min.
Condition after 4 hours	Slight tack	Very tacky	Slight tack +
" 6 hours	Very slight tack	Definite tack	V.V. slight tack
" 24 hours	No tack	Slight tack	No tack

(Cont.)

187 - Physical Properties of Pigments

The term "dispersability factor" has been used in this work to describe the relative efficiency of a given vehicle to disperse a given pigment. In further work on this topic a departure from the method of ball mill grinding was tried with success. The method consists of a direct determination of agglomerate size diameters in microns as well as the distribution curve of the agglomerated pigment particles dispersed in various vehicles. The preliminary runs were confined primarily to the evaluation of the dispersing ability of (2) and (48) and a 50/50 combination of these two oils on 1403 TiO_2 and 20 F magnesium silicate. In confirmation of the data obtained from the ball mill method it was found that (48) has a very much superior dispersability over (2) on 1403, while relatively little difference is found between these two vehicles on 20 F.

The sedimentation curves were obtained by making up 3% suspensions of the paints previously prepared for CPVC determinations, in naphtha (63), distributing the well agitated suspensions in ten Gardner-Holdt viscosity tubes and drawing off the upper portion to a previously determined level by means of a pipette after specific periods of elapsed time. The specific gravity of this material was then determined in a standard 5 cc weighing bottle and the amount of solids sedimented calculated. The particle size is calculated by Stokes' Law according to the equation:

$$d_3 = \sqrt{\frac{18\,nh}{(D_2 - D_1)\,gt}}$$

where d_3 = equivalent diameter of particle; n = viscosity of suspending medium; h = height of liquid column, D_2 and D_1 = density of solid particles and liquid respectively, and t = time in seconds. The particle (agglomerate) size distribution curve is obtained by the conventional tangential-intercept method.

Some of the typical data obtained for 1403 in (48) and (2) is listed below.

(See next page.)

167 - Cont.

1403 TiO_2 in (2) Raw Linseed Oil

Size Range in μ	%
Below 2	2
2 - 4	4
4 - 6	10
6 - 8	15
8 - 10	15
10 - 12	10
12 - 14	10
14 - 16	9
16 - 18	7
18 - 20	4
20 - 22	4
22 - 24	2
24 - 26	1-1/2
26 - 28	1
28 - 30	1
Above 30	4-1/2

1403 TiO_2 (48) Bodied Linseed Oil

Size Range in μ	%
Below .2	0.1
.2 - .4	5
.4 - .6	15
.6 - .8	20
.8 - 1.0	20
1.0 - 1.2	15
1.2 - 1.4	8
1.4 - 1.6	7
1.6 - 1.8	4
1.8 - 2.0	2
2.0 - 2.2	2
Above 2.2	2

20 F Mg. Silicate in (2)

Size Range in μ	%
Below 3	2
3 - 6	5
6 - 9	12
9 - 12	10
12 - 15	8
15 - 18	6
18 - 21	5
21 - 24	5
24 - 27	4
27 - 30	4
30 - 33	3
33 - 36	3
36 - 39	2-1/2
39 - 42	2-1/2
42 - 45	2
45 - 48	2
48 - 51	1-1/2
51 - 54	1-1/2
54 - 57	1
57 - 60	1
Above 60	20

20 F Mg. Silicate in (48)

Size Range in μ	%
Below 3	4
3 - 6	8
6 - 9	8
9 - 12	9
12 - 15	7
15 - 18	6
18 - 21	5
21 - 24	5
24 - 27	4
27 - 30	4
30 - 33	3
33 - 36	3
36 - 39	2-1/2
39 - 42	2-1/2
42 - 45	2
45 - 48	2
48 - 51	1-1/2
51 - 54	1-1/2
54 - 57	1
57 - 60	1
Above 60	20

#187 - Cont.

From the above data, the diameters of the (48) dispersions are seen to vary from that of the single particles to about 10 times this value, while (2) dispersions vary from about 10 to 100 times the diameter of the average single particles of 1403. The aggregate volume of the agglomerates for (48) is from about 1 to 1000, while that for (2) varies from about 1,000 to 1,000,000 times the volume of a single particle.

It is interesting to note that commensurable agglomerate size distribution curves were obtained in each instance whether the original ground paste was chosen with a PVC above or below the CPVC.

The use of larger settling containers so that larger volumes of samples are available for specific gravity determinations and the use of a thermostat will probably give considerably more accurate results.

#177 - Pigment Studies

Rex 210 Pigment Opacity Studies

A series of Semi-Lustre Whites was compared for practical hiding by brush-out over gray-white Morest charts. These paints were also compared statistically according to the method set forth in Bulletin RC-81. It was found that the hiding power progression was in order statistically and practically, but that the magnitude of the differences was not as predicted statistically. This comparison is shown below:

Paint No.	Pigmentation No.	Pigmentation Lbs.	Theoretical Opacity	Gloss
RB 1904	2132	575	545 sq.ft./gal.	35
RB 1898	2132 461 L	475 192	366 + * "	46
RB 1900	2173	200	372 "	10
RB 1905	1307	250	365 "	39
RB 1899	1307	200	316 "	20
RB 1901	1403	200	316 "	10
RB 1906	1307 461 L	150 360	288 + * "	38

*Theoretical opacities bearing the + should be weighted higher due to the extension effect of combining low and high opacity pigments.

#177 - Cont.

The above paints are arranged in order as regards actual and theoretical opacity. It is outstanding that the difference between RB 1904 and RB 1898 appears small in view of the wide difference in the theoretical values. On the other hand, the opacity of paint RB 1906 is even poorer than we would have expected. Gloss differences undoubtedly affect the visual ratings of these paints.

414 Dry - Leaded Zinc

In an effort to evaluate the texture and dispersability of 414 dry, two paints containing 412 dry and 414 dry, respectively, were milled in steel ball mills side by side with the following results:

	Grind Rating		
Sample	Heavy Paste Mix	10 Minute Milling	90 Minute Milling
412 Dry	2 H	3-1/2 H	5 H
414 Dry	1 H	-	3 H

It was also found that definite discoloration due to abrasion of the steel has occurred with the 414 dry, whereas the 412 dry did not discolor.

Another characteristic which was found to be associated with 414 dry in comparison to 412 dry was the degree of oil retention of the pigment. It was found that when paints made with 412 and 414 were applied to primed paper the 412 dry paint dried glossy but the 414 paint was completely flat when dry. Inspection of the paper back showed that the oil "bled" away from the pigment into the paper.

Filter paper absorption tests served to illustrate this characteristic even more conclusively. Working with 18 dry - BCWL, 9 dry - BSWL, 1707 dry - Zinc Oxide, 412 dry, and 414 dry it was found that this characteristic appears to be associated with chemical composition since 1707 dry - zinc oxide loses its oil more readily than 414, 414 more than 412, etc., with the straight lead pigments retaining their oil very closely. All of the paints tested carried an excess of oil over the critical PVC requirements.

Lead Cyanamid

Dr. Grummitt obtained for us a sample of lead cyanamid from the I. G. Hochst plant in Germany through Mr. Robert Frye, of the Department of Commerce. As a yellow pigment it was compared with representative samples of zinc chromate and a light lead chromate pigment. It was found that the mass tone and shade tended to be similar to zinc chromate - 12054 dry, except that the color was somewhat greenish and the brightness was down. The tinctorial strength was about one-half that of the zinc chromate and the let-down emphasized the mass tone deficiency evident in the straight color rub-up. Oil absorption and texture characteristics of the pigment are comparable with the reference materials.

#12 - Cont.

Panels 4800-5 C were examined after five years' exposure at Chicago south vertical. These are tests of Rex 496 SWP Ivory over 450 Undercoater 1940 formulas with specials in which half the extender bulk is introduced as Celite #281. There seems to be a little more tendency toward erosion with the higher amounts of Celite #281, partly offset by better clean-up. This test may have some significance in connection with the replacement of 1552 dry in 450 Undercoater.

#178 - Studies of Dark Colored House Paints

Panel exhibits and our analysis of results on series 10436-43 F, C were sent to Cleveland to show the effects of the use of cuprous oxide and a semi-alkyd vehicle in four SWP dark colors, Hillcrest Green, Willow Green, Woodland Brown and Manor Brown. There is a very definite improvement in the browns, in color and gloss retention and in mildew control. Willow Green shows some color change but is clean and bright. There is too much color change in the Hillcrest Green to continue the use of cuprous oxide, and we have advised Cleveland to eliminate it from such greens until further work can be done.

#162 - Studies in Flat Wall Paint Formulation

Semi-Gloss Paints

During the month of April, the Vehicle Research Department submitted a number of phenolic-Velsicol-tall oil P.E.-tung oil-soya-maleic varnishes for evaluation in Semi-Lustre. Draw-downs (.003") made during the first part of April on the experimental batches of Semi-Lustre formulated with the submitted varnishes have become brittle. The varnishes under test were: CVR 784, 792, 794, 800, 801, 802 and 803. The regular Semi-Lustre Ivory (Alternate C formula based on (2853)G) and the Semi-Lustre White formula based on (3848)E were also somewhat brittle. A more elastic film would be preferred for this product.

The Vehicle Research Department has also submitted two tall oil-soya-tung-maleic P.E. ester gum varnishes CVR 833 and CVR 838 for evaluation in Semi-Lustre. Both produced paints having too low sheen to be usable.

Work was continued on the formulation of Semi-Lustre using the tall oil-castor-P.E. varnish CVR 808, leading to two formulas, one containing zinc oxide and the other containing Calcium Nuodex for improved drying. The Vehicle Research Department has provided three modifications of CVR 808 under the designation CV 7036, 7037 and 7038. CV 7036 is the small kettle cook using (2325), 7037 the small kettle cook starting with (113) and 7038 the large kettle cook starting with (2325). CV 7036 gave Semi-Lustre too high in body and 7037 slightly low viscosities. CV 7038 gave satisfactory results except in color which was dark due to the (4075) used.

#162 - Cont.

Semi-Gloss Paints - Cont.

It was decided to proceed with a large kettle cook of CV 7038, making 1500 gallons. This was done with entirely satisfactory results and the factory was asked to proceed with the manufacture of one or two batches of Semi-Lustre on the proposed formula carrying zinc oxide.

CTV 4746 and CTV 4748, P.E. esterified Neofat 19 varnishes, were submitted by the Varnish-Resin Laboratory for evaluation as Semi-Lustre vehicles. They are not usable for this purpose as both produced very low sheen paints and CTV 4746 gave very thin bodied Semi-Lustre. The varnishes were turned over to the Chicago Technical Service Department to test in railway paints.

Enamels

Devoe's Mirrolac White and Jade Green were compared with Enameloid (alkyd formula) for embrittlement on glass after aging for a period of eight weeks. At the end of this period no difference could be detected in the elasticity of the various films. All three enamels produced a good ribbon when scratched with a spatula.

- - -

No work done on the following projects during the month:

#148 - Examination of White Lead

#160 - Painting of Bricks

#183 - Pretreatment of Metal Surfaces for Painting

#103 - Cont.

A study of the comparative results of humidity and immersion accelerated testing has been undertaken in cooperation with a group in Subcommittee VII, Committee D-1, A.S.T.M. The premise is that if results are identical, then humidity testing can be dropped as immersion testing is much simpler. To date no appreciable results have developed in either method of testing after about three weeks of exposure.

#187 - Physical Properties of Pigments

A series of paints of increasing PVC's has been prepared to study the effect of moisture on the properties of pigment-vehicle combinations. 1403 TiO_2 was used in (2) and (48), with moisture contents varying from 0% (these pigments and vehicles were dried) to 5% water based on the weight of the pigment. The CPVC (critical pigment concentration) was determined in each case by the usual technique employed during this investigation; drawing the milled paints down on the standard permeability paper, drying, and determining the conductivity of the electrolyte soaked film on an AC resistivity bridge. The gloss characteristics and dispersibility of the vehicle-pigment systems were also determined.

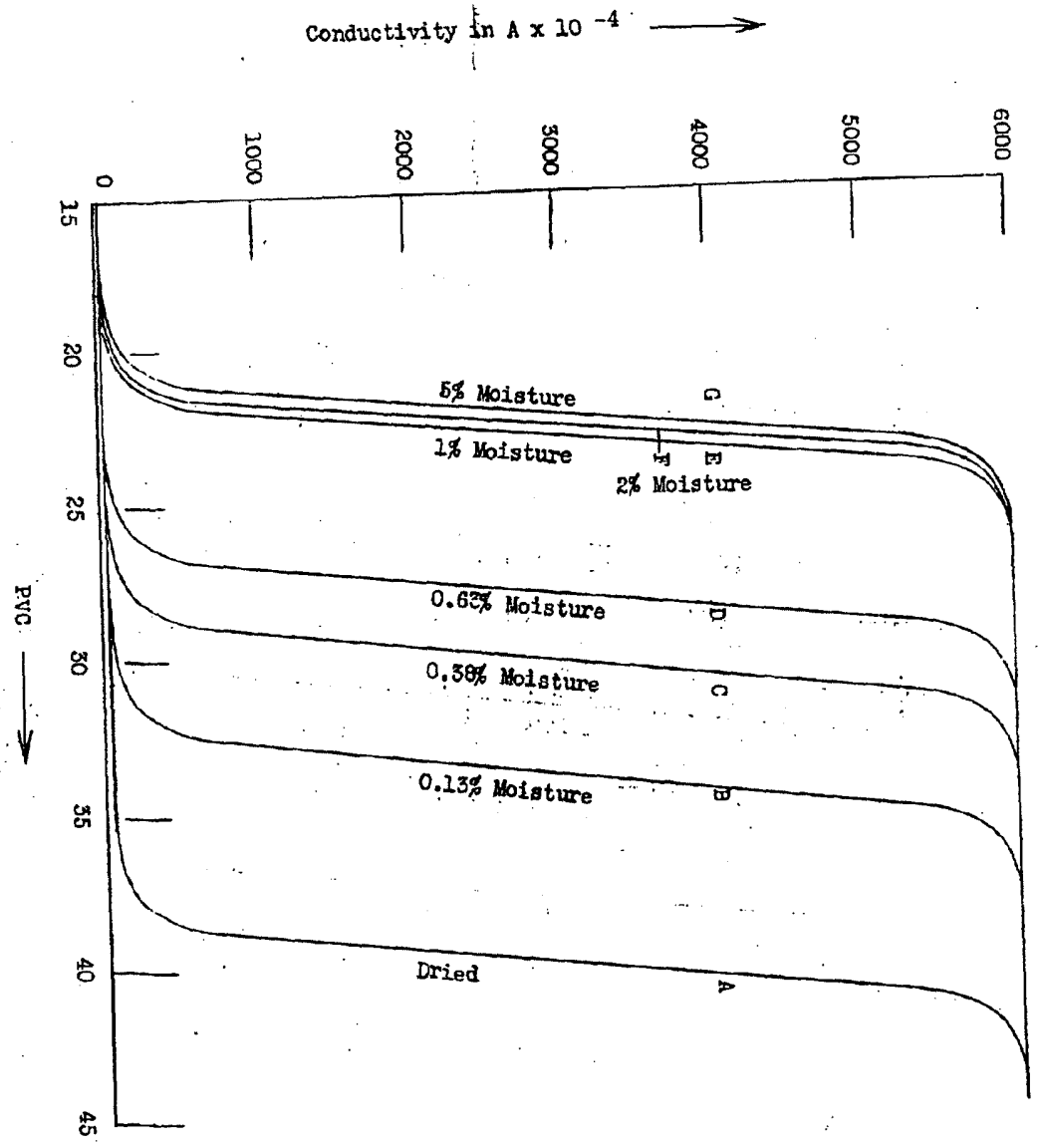
The results obtained are shown in the following curves and tables. Figure I shows the effect of increasing water content in materially lowering the CPVC of the 1403 - (2) combination. Curve A represents the values obtained for samples made with dried pigments and vehicles; B, the "normal" pigment and vehicles as commercially obtained; C, with a water content of 0.38% of pigment volume; D, 0.63% and E, F, and G, 1.1%, 2.1% and 5.1% of pigment volume respectively.

The very sharp drop in CPVC in the initial low water content samples is of extreme interest. While the dried pigment-vehicle system shows a CPVC of about 38%, the presence of only little more than 0.1% of moisture drops this value down to about 32%. The presence of additional moisture reduces the values of the CPVC still further - 0.38% to 28% CPVC, 0.63% to 26% CPVC and 1.1% to 22% CPVC. Beyond this point, more water introduced into the system seems to have no further disadvantageous effect on the CPVC. The values resulting for 2% and 5% moisture are substantially the same as that for 1%. A plot of moisture content against critical pigment volume concentration is shown in Figure III.

It is interesting to note that the dried sample of 1403 after exposure to normal atmospheric conditions over night reabsorbed substantially the same quantity of moisture it originally contained, namely about 0.1% .

Permeability of Film in Relation to Pigment Volume Concentration with Various Moisture Contents
System: 1403/(2)

Figure I



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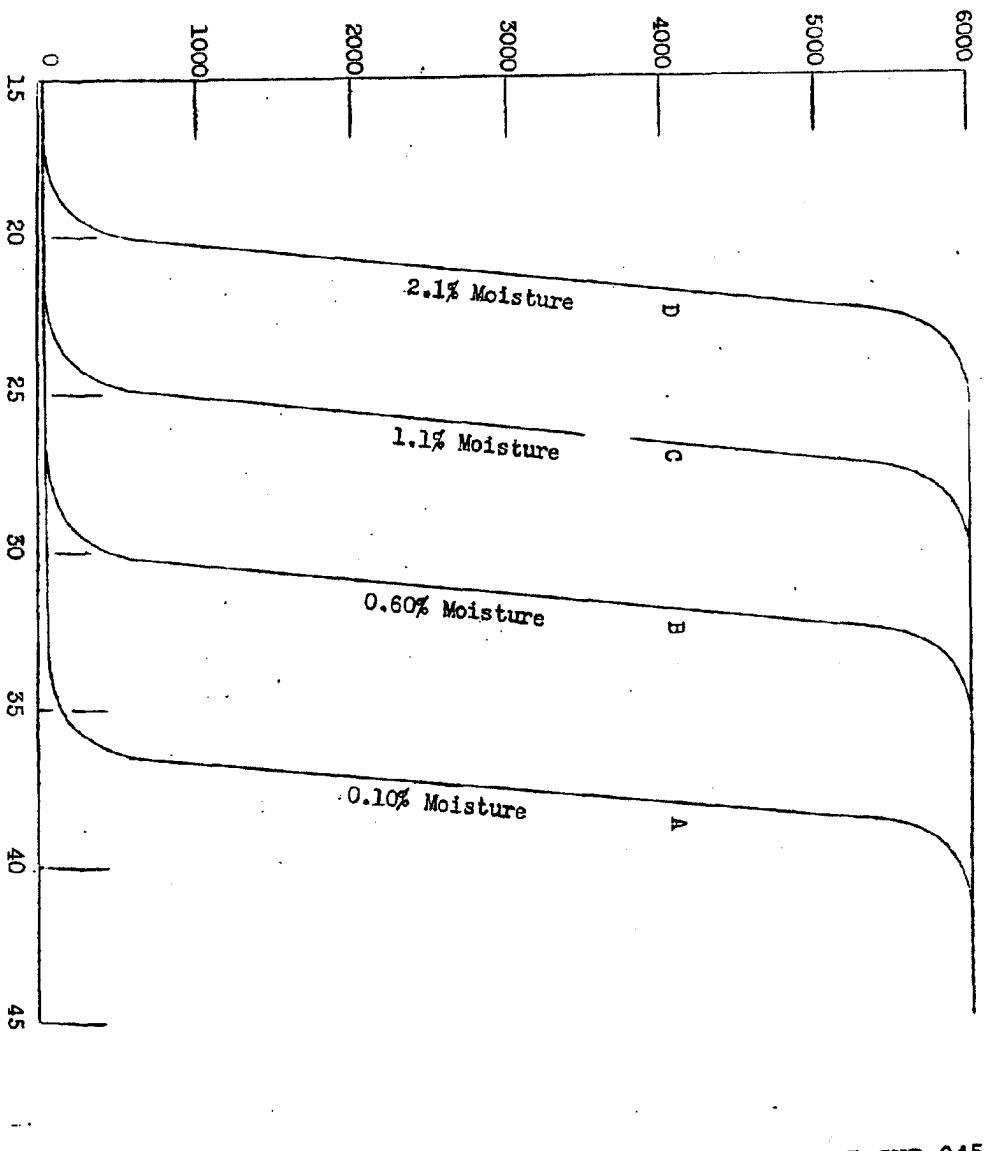
Permeability of Film in Relation to Pigment Volume Concentration with Various Moisture Contents
System: 1403/(48)

Figure II



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Variations of Critical Pigment Volume Concentration with Moisture Content

Figure III

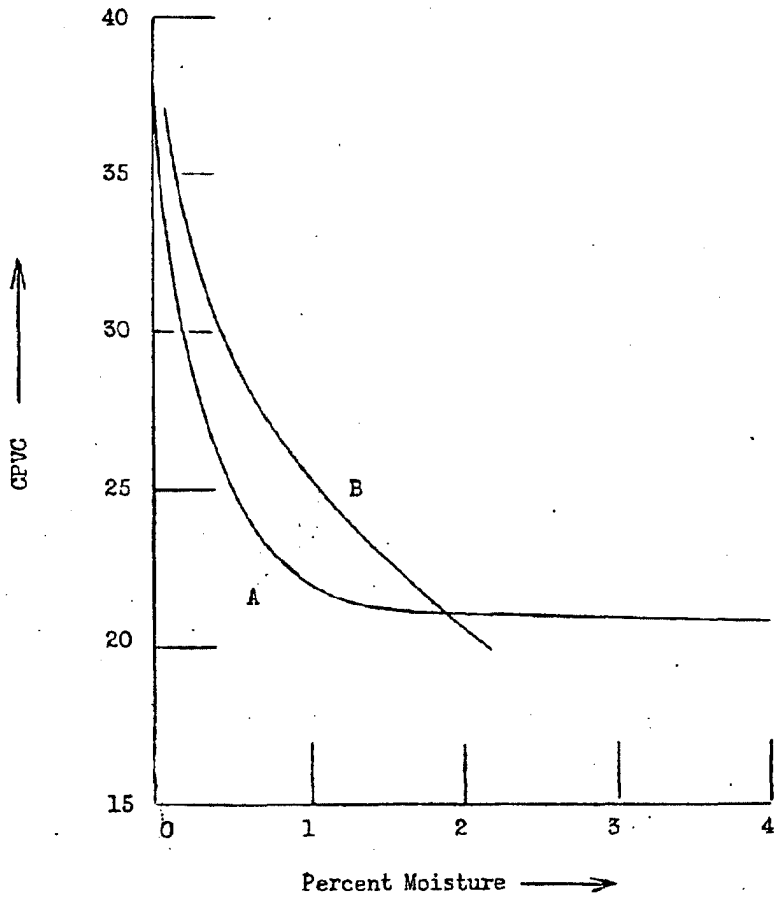

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Table I — Effect of Moisture on Gloss and H-Grind - 1403 in (2)

PVC	0% Moisture		0.13% Moisture		0.38% Moisture		0.63% Moisture		1.1% Moisture		2.1% Moisture		5.1% Moisture	
	Gloss	H-Grind	Gloss	H-Grind	Gloss	H-Grind	Gloss	H-Grind	Gloss	H-Grind	Gloss	H-Grind	Gloss	H-Grind
15					75	5	67	5-1/4			58	4-3/4		
20	66	3-3/4	58	5	50	3-1/2	45	4-1/4	30	3	23	1/2	20	0
25	54	5	3	5-1/2	4	1-1/2	2	1	7	0	0	0	0	0
30	32	5	0	5-1/4	0	0	0	0	0	0	0	0	0	0
35	14	5	0	3	0	0	0	0	0	0	0	0	0	0
40	14	3-1/2	0	0	0	0	0	0	0	0	0	0	0	0
45	15	5	0	0	0	0	0	0	0	0	0	0	0	0

Table II — Effect of Moisture on Gloss and H-Grind - 1403 in (48)

PVC	0.1% Moisture		0.6% Moisture		1.1% Moisture		2.1% Moisture	
	Gloss	H-Grind	Gloss	H-Grind	Gloss	H-Grind	Gloss	H-Grind
20					15	3	0	0
25	70	5-1/2	4	2	0	0	0	0
30	20	2-1/2	0	3	0	0	0	0
35	2	4-1/4	0	3	0	0	0	0
40	0	3-1/2	0	0	0	0	0	0
45	0	3	0	0	0	0	0	0

#187 - Cont.

That other factors, such as gloss and ease of dispersion are strongly affected by the presence of even small quantities of moisture is shown in Table I. The gloss of the film originally containing 0.13% moisture falls off sharply from the values obtained in the case of the film with the previously dried constituents, and with increasing moisture content a further loss in gloss is encountered. The dispersive effect of the vehicle on the pigment also decreases materially with increasing moisture content as can be seen in the data of Table I.

A substitution of (48) for (2) shows the same general trend, as is shown in Figure II and curve B of Figure III, although the initial slope of this curve indicates that very small quantities of moisture do not affect the CPVC as strongly as in the case of (2). Table II represents the values obtained for gloss and dispersibility determinations of 1403 in (48) with various moisture contents.

Similar determinations on the effect of moisture on the characteristics of paint films are being determined for various other combinations of pigments and vehicles.

A paper was presented before the Research Meeting on June 10, at Dayton, Ohio, on "Considerations of Pigment Surface Areas."

#177 - Pigment Studies

In the report for May, oil retention properties of 414 dry were compared with various other white lead and zinc pigments, with the conclusion that the chemical composition was the controlling factor. Zinc oxide appeared to lose its oil readily, whereas the lead pigments retained theirs closely.

Further work has now been done which illustrates that chemical composition is not the only controlling factor. Blends of pigments have been made to equal 412 dry composition. It was found that none of these blends had the oil holding property associated with 412 dry.

Oil penetration tests on filter paper show the following in millimeters penetration:

412 dry	7 mm
414 "	18 mm
414-9 dry blend	15 mm
414-511 blend	17 mm
1707 dry	16 mm
1707-9 dry blend	13 mm

#177 - Cont.

Introductory work was done to establish the characteristics of the pulp lead being supplied by the National Lead Company and to investigate what changes would be required before the product could be incorporated readily in current formulations. This study is being extended by the Cleveland Technical Service Department and a committee from the Auxiliaries Department. Their reports represent the latest information on this topic.

Work continues on the extension of the data presented in Research Bulletin RC 81 which discussed the opacity of white pigments. It has been found that the TiO_2 pigments shift to the high dry hiding zone above the range of 45% HPVC.

#182 - Study of Improved Mixing and Grinding Practices

Triton 773, a 20% aqueous dispersion of an aryl polyether sulfate supplied by the Rohm and Haas Chemical Company was tested for its effect on the dispersibility of anatase TiO_2 A-24, 2147 dry, in (3109), a soya alkyd type vehicle. The material was used on the basis of 1% of the weight of the pigment. It was compared with an agent-free control paste and one containing 1% of Acto 450 - CW (2343), all made up to 100 units Plastograph consistency. Dispersions were effected at a fixed setting of the 11" 3-roll Lehmann mill.

Triton 773 showed a slight effect upon the vehicle requirements of a paste of 100 units Plastograph consistency. It increased the mill output substantially but failed to measure up to the performance of Acto 450. See experimental data below:

Agent	Paste Volume	Grind	Gals. per Hr.	% Gain
None	33.9 gals.	6 H	19.1	-
Acto 450	29.1 "	6 H	27.6	44.4%
Triton 773	32.2 "	6 H	24.8	29.8%

A sample of Wallace Tiernan's Detergent S.P. was evaluated as to consistency effect and grind aid efficiency. 1% of this material, based on the weight of the pigment, caused an increase in paste consistencies as measured by the Stormer viscosimeter. This indicated a lack of efficiency as a wetting agent in the (3109) type of Enameloid White - Rex 710 paste system. However, it suggested the possibility that this material could have a favorable effect upon mill outputs by increasing the "tack" of the pastes on the rolls.

Mill rate tests show a very slight advantage in mill output through the use of this agent, but little in comparison with that from Acto 450. See experimental data below:

#163 - Cont.

A house test at 10446 Trumbull Avenue, Chicago, started in June, 1946 was examined. On the north side, CH 4697 One Coat House Paint with 50/50 1403/2173 titanium looked essentially equal in whiteness and general appearance to a straight 1403 formula. Chalk was rated "less than considerable," dirt at "considerable." The south side was similarly alike as regards 1403 versus 1403/2173, but the advantage of less shading was with the 50/50. The best test area, on the west showed the straight 1403 clearly cleaner and whiter, and looking very good considering the rather serious dirt known to have been present at 6 months (midwinter).

A total of 66 gallons of one coat house paints whites and tints were sent to Cleveland for house tests there.

#178 - Studies of Dark Colored House Paints

During the past few years a number of revisions have been made in barn paint vehicles, based on various oil substitutes, such as Petropon #2138, esterified tall oil, Brown Resin #90, etc. To check the effect on durability, barn paints were prepared for exposure, representing the last five regular revisions for Rex 54. The paints will be exposed on cedar and yellow pine at Chicago and Coffeyville.

#86 - Leaded Zinc Pigments (Reinstated)

Panels 11656-61 CS, CN, Cof. and F were prepared for exposure north vertical Chicago, and south vertical at Chicago, Coffeyville and Florida. The purpose of the test is to evaluate 414 dry for durability characteristics and whether the variations in composition influence the "co-fumed" durability performance. Rex 450 Undercoater, Rex 471 Gloss White and Rex 496 Ivory were all prepared using standard 412 dry, 414 dry AURL 397 minimum standard, and 414 dry AURL 398 average standard.

Panels 5581-5595 C, CD were examined after five years' exposure at Chicago south vertical. The paints were exposed on cedar and Douglas fir siding over Rex 450 and also self-primed. The paints were prepared during the titanium shortage of 1941 and carry 4% 1403 TiO_2 in the pre-war vehicle at 30% PVC. Because of the generally high zinc oxide pigmentation, 7% mica was used to reduce checking and cracking. The paints include:

(a) Low BCWL content, 16%, 7% mica.

1. Using 414 W leaded zinc - 49.5% ZnO, 8.7% BSWL, 15% 20 L.
2. Using 1526 leaded zinc - 35% ZnO, 23.3% BSWL, 15% 20 L.
3. Using 412 leaded zinc - 37.8% ZnO, 20.4% BSWL, 15% 20 L.

#86 - Cont.

(b) No BCWL, 7% mica.

4. Using 414 W leaded zinc - 59.8% ZnO, 10.4% BSWL, 19% 20 L.

5. Using 1526 leaded zinc - 41.7% ZnO, 27.9% BSWL, 19% 20 L.

6. Using 412 leaded zinc - 45.2% ZnO, 24.4% BSWL, 19% 20 L.

(c) Specials

7. 2 coats lead-in-oil.

8. Sears O. W. over Rex 450.

9. Rex 471, stock, over Rex 450.

Durability runs close to normal pre-war Rex 471 for the (a) and (b) paints, which is good performance for paints with such high zinc oxide content. All are too dirty to be acceptable, as chalking is inadequate. It is also worth noting that the "No BCWL" paints are definitely inferior used self-primed compared to their use over Rex 450, illustrating the beneficial effects of lead soaps in priming. Lead-in-oil is dirtiest and shows more cracking and flaking on Douglas Fir than any of the other paints, but shows good durability on cedar.

#12 - Exterior Primers

In line with Cleveland's request, a check was made on a number of laboratory and plant batches of Rex 450 SWP Undercoater for after-body tendencies. Cleveland had reported that a number of production batches of Rex 450 Undercoater were showing considerable after-bodying in the package. However, the results of our investigation did not show any general increase. There were a few laboratory batches made with 414 dry that were quite high in body but this was not evident with factory batches made with 414 dry. It may be that certain lots of 414 dry are more reactive than others, but the Auxiliaries Research Laboratory reports that there are only minor differences in the reactivity characteristics of 414 and 412 dry in house paint formulations. 450 Undercoaters will be made using 412, 414, 511, 2295, 2059, 108 and XX 505 dry to check on the after-body tendencies of these pigments having varying reactivity characteristics.

In connection with the recent trend to use more soya oil in paints to replace the higher cost linseed, a series of house paint undercoaters has been formulated using various percentages of soya, castor and tung oils. The oils used include (3316), (2325), (2381), (1273) and CVR-828, a bodied tung oil. Top coats of Rex 471 made with all linseed, and also using the maximum amount of soya will be used in exposures.

#187 - Physical Properties of Pigments

In the continuation of the study on the effect of moisture on CPVC, batches of 1403 TiO_2 in (3109) as well as 20 F magnesium silicate in (2), (48) and (3109) were made with moisture contents of 0% added ("as is" commercially available pigments and vehicles), 1/2%, 1% and 2% water added and the CPVC determined. Figure I shows graphically the results obtained. Curves A and B are again included, although previously reported, to show their relative positions to the other values. As can be seen from the figure, the use of (3109) as a vehicle with 1403 pigment materially reduces the deleterious effect of moisture on the CPVC as compared to (2) and (48), a reduction of only about 5% of CPVC resulting from the addition of 2% water to the batches.

20 F, on the other hand, acts entirely differently from 1403 in its response to CPVC change with moisture content. As curves D, E and F clearly show, the reduction of CPVC with increased moisture is almost negligible.

To study this apparently entirely different behavior of these two pigments with respect to water and the various vehicles employed, it seemed desirable to obtain a quantitative value for the different "wettabilities" of the liquids and solids involved.

Bartell and co-workers developed the Bartell cell to determine the contact angle and adhesion tension between liquids and powdered solids, such as pigments. In this cell, capillary action - a measure of the adhesion tension and contact angle - is balanced by the static pressure of a gas. The capillaries are pores produced by compressing the powder under hydraulic pressure. The Bartell cell is rather complicated and requires considerable technique for its manipulation.

A new method has been developed for the determination of wettability utilizing simple apparatus and technique. A dynamic flow method is employed, balancing the rate of viscous flow into a plug of compressed pigment against the capillary attraction causing imbibition. The apparatus, as shown schematically in Figure II, consists of a cylinder A of substantial thickness into which a plug of pigment B is compressed by a hydraulic press. The upper end of the cylinder is threaded to receive the cap C, inserting a rubber washer for airtight fit. A thin piece of metal tubing leads from this lid to a piece of rubber tubing D, the other end of which is attached to the bottom of a burette. F is a vent to permit the escape of the air when the liquid is first introduced into the pigment plug, and is closed during the testing period.

Figure I

Variations in Critical Pigment Volume Concentration with Moisture Content

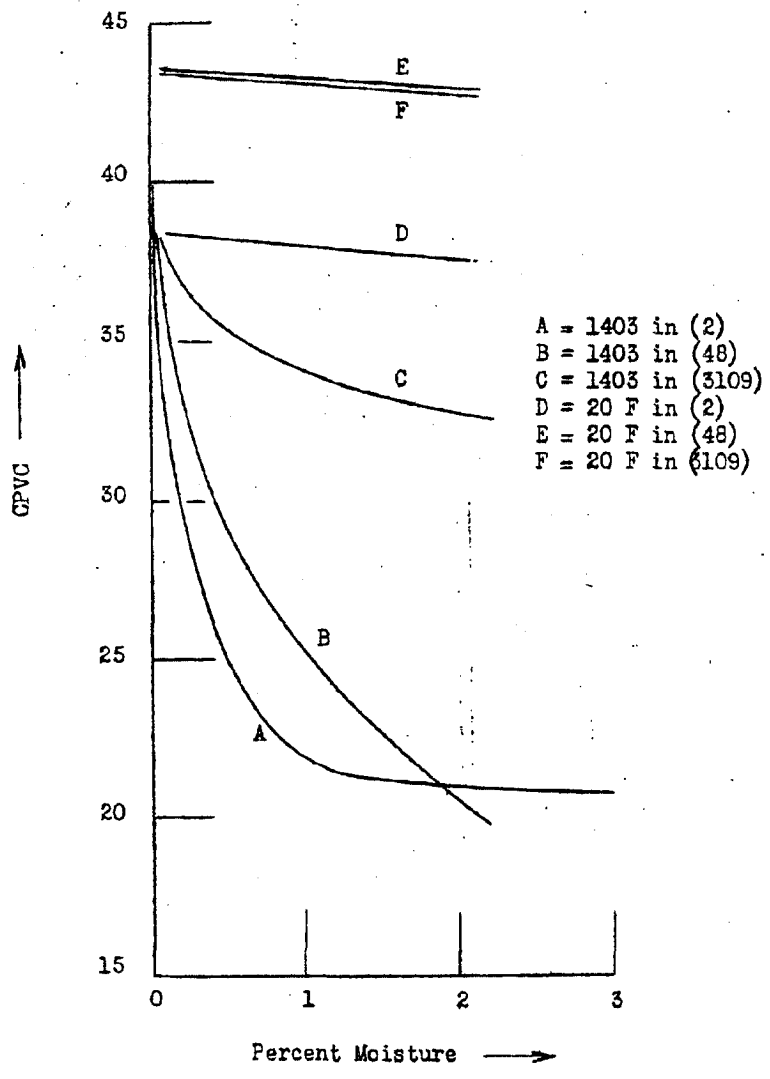

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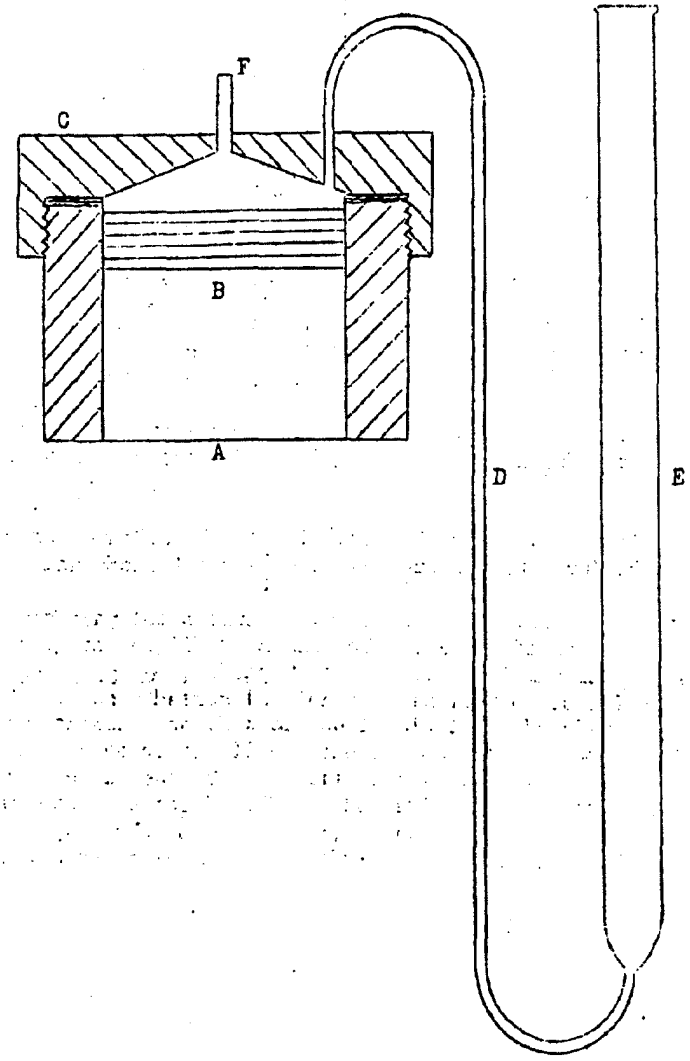
Figure II

Apparatus for Determining "Wettability"
of a Liquid Against a Powder



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#187 - Cont.

The procedure for obtaining the adhesion tension of a liquid for a given powder consists of compressing a plug of the pigment to be tested at from 1,000 to 5,000 lbs./in.^{2}, depending on the nature of the pigment, assembling the apparatus as indicated in Figure II and placing the liquid to be used into the burette. The burette is now raised until the liquid flows into the cell above the porous plug. Vent F is kept open until this point, at which time it is closed. The time is now noted on a stop watch, and the volume of liquid imbibed by the plug recorded at various periods of elapsed time.

By plotting the volume of liquid taken up by the plug against the square root of the elapsed time, a straight line results, the slope of which, squared, and multiplied by the viscosity of the liquid being run at the temperature of the experiment is a direct measure of the adhesion tension according to the equation:

$$\frac{V^2\eta}{t} = A \cdot B \cdot \gamma \cos\theta$$

where V is the volume imbibed in time t; η is the viscosity of the liquid; A is a constant determined by the pigment; B is the instrument constant and $\gamma\cos\theta$ is the adhesion tension.

To minimize pressure losses due to hydrostatic head, the level of the liquid in the burette should be kept fairly closely to the level of the pigment plug.

For the benefit of those interested in the theory of the apparatus, the following short derivation of the principles involved is given:

The driving force causing imbibition of a liquid into a porous plug is caused by the capillary action of the thin channels and is equal to: $F_\gamma = 2\pi r \gamma\cos\theta$, where r is the radius of the individual pores and $\gamma\cos\theta$ is the adhesion tension between liquid and solid. The retarding force slowing the flow of the liquid into the plug is due to the viscous resistance of the liquid and is equal to: $F_\eta = 2\pi r \eta \frac{dv}{dt} L$ where η is the coefficient of viscosity of the liquid, dv/dt is the shear velocity and L is the length of the capillary. At equilibrium these forces must be equal and $F_\gamma = F_\eta$. By a series of integrations and substitutions it can be shown that the volume, V, of liquid imbibed in time, t, is equal to:

$$V^2 = \frac{1}{3} N \pi^2 \frac{\gamma\cos\theta}{\eta} R^5 t$$

where N is the total number of capillaries in the plug, R is the average radius of the capillaries and the remainder of the designations conform to those above.

#187 - Cont.

This equation can be reduced to the values already mentioned by substituting the pigment constant A and instrument constant B for $\frac{1}{3} N \cdot D^2 R^5$.

A more explicit form of the derivation will be presented in a research bulletin, which will be distributed at a later date.

The results obtained for the adhesion tension of water and various organic liquids including solutions of (2), (48) and (3109) in (63) against 1403 and 20 F gave values which substantiated the results to be expected from the moisture - CPVC experiments. The adhesion tension of water against 1403 was extremely high, being about 130 dynes, while all the values for the organic liquids run are considerably lower, running between 45 and 100 dynes. For 20 F, on the other hand, the adhesion tension against water is only about 35 dynes, and below any of the values for the organic liquids tested, which run from 55 to 75 dynes. Other combinations of pigments and liquids are in the process of being tested.

A Bartell Cell is under construction to test the compatibility of the two methods of obtaining "wettability."

#182 - Study of Improved Mixing and Grinding Practices

The Vehicle Research Department has submitted several samples of tall oil sludge extracts for evaluation as wetting agents. Mill rate tests on Enameloid showed unexplainable inconsistencies and irregularities in the performance of the various controls used in the several series of tests. Work on the tall oil sludge samples was suspended until the cause of such irregularities could be traced down.

A study of the mixing technique disclosed that in two control batches the 1826 dry calcium stearate had been introduced at different points in the mixing schedule. When the calcium stearate was added early the vehicle requirements for a 100 Plastograph units paste consistency were considerably greater and the mill output was less than when the 1826 dry was introduced into the paste with the last of the pigment. Compare the data on batches CC 122 and CC 124 given below.

Batches containing CW (2343) Acto 450 at 1% of the weight of the pigment showed the same consistency effects resulting from differences in the point of addition of the calcium stearate. This suggests the possibility that an efficient mixing technique can provide the same degree of wetting obtainable with an effective wetting agent. See CC 124 and 126.

#183 - Pretreatment of Metal Surfaces for Painting

Two proprietary products for treating rusted steel surfaces prior to painting were examined and placed on exposure tests. They are called Rustrem and Corodex. Rustrem is a bituminous-like liquid that is brushed or wiped on a rusted surface, allowed to dry, and then painted over. The sample under observation required a week to become tack-free and caused very bad cracking of both Kromik and Red Lead primers. It also bled to the surface of the primers and any subsequent top coats, causing very poor drying. It is a very unsatisfactory base for oleoresinous or oil paints. Corodex is some type of a liquid acid pickling solution. For best results the rusted surfaces should be immersed in the Corodex but repeated wipings can be used successfully. In either method water rinsing is necessary. Corodex actively attacks rust, even in the cold, and has an effective inhibiting agent so that the steel surface is not appreciably etched. With oleoresinous or oil paints no undesirable characteristics were noted when applied over Corodex treated steel but with baked vinyl finishes a dark, spotted discoloration occurs. Exposure tests will be reported when completed.

#187 - Physical Properties of Pigments

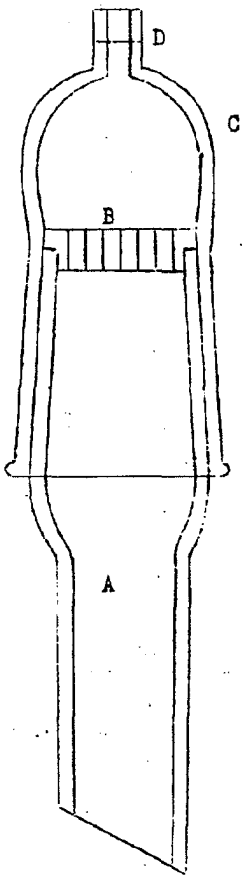
The critical pigment volume concentration of a paint has been recognized as the transitional point above or below which substantial differences in the appearance and behavior of a paint film will be encountered. It is that point at which just sufficient free binder is present to completely fill the voids left between the pigment particles incorporated in the film. Among other things, such qualities as gloss, rusting, blistering and hiding are intrinsically connected with CPVC, and differing characteristics can be imparted to a paint containing the same constituents by formulating above or below it.

The CPVC has been determined by making up batches of increasing pigment volume concentration, usually in 5% increments, covering the region in which the CPVC is expected. For normal purposes, PVC's of 25%, 30%, 35%, 40%, 45%, 50%, 55% and 60% fully cover the range. These batches are then ground to the desired dispersion, drawn down on "permeability paper," dried for a sufficient period to ensure a representative film, and the degree of porosity of the various films determined by the moisture permeability or the conductivity methods. The whole procedure requires considerable manipulation and is very time consuming, requiring from several days to several weeks, depending on the rapidity with which a completely dried film of the paint in question can be obtained.

To eliminate the disadvantages of the above cumbersome procedure, a new method has been devised in which the CPVC can be determined on a single sample of paint in the wet state.

#187 - Cont.

The method consists of making up a sample of the paint, the CPVC of which is to be determined, at a pigment volume concentration of about 30%, grinding to the proper dispersion, with or without the addition of thinner at this point. The ground paint is then diluted to a total pigment volume of about 10% by the addition of further thinner, placed in the CPVC cell, all excess liquid filtered off and the volume of the remaining paste cake determined. The ratio of the true volume of pigment in the paste to the apparent volume of the cake has been found to give substantially the value of the CPVC as determined by the draw-down method.



CPVC Cell

The CPVC cell consists, as the figure illustrates, of a standard ground glass joint, to the top portion of the male section "A" of which a perforated brass plate "B" has been firmly cemented. The female section is constricted shortly above the ground glass portion to a narrow opening around which a calibration mark "D" has been placed. A piece of filter paper, cut to the proper diameter is placed on top of the brass plate to act as the filter medium.

#103 - Cont.

In the A.S.T.M. study of comparative results of humidity and immersion accelerated testing reported in the Monthly Report for June, 1947, no definite or even tentative conclusions can be made. No blistering occurred on any of the humidity panels nor on one set of the immersion panels. Only the one remaining set of immersion panels blistered. Our thought is that the apparatus used for humidity testing did not produce a relative humidity of 100% and thus failed to duplicate standard humidity cabinets. This first test was run at 100° F. A second test is being conducted at 110° F.

#183 - Pretreatment of Metal Surfaces for Painting

A meeting was held to discuss the painting of aluminum clapboard siding, both production line finishing for prefabricated houses and when already on houses before painting. The minutes of the meeting have been stencilled and have been distributed to those receiving copies of this report.

#187 - Physical Properties of Pigments

Work with the new CPVC cell as described in last month's report was continued. The critical pigment volume concentration of a number of commercial paint samples were run and the relationship between the actual formula pigment volume concentration and the CPVC determined.

A certain amount of difficulty was encountered in the filtration of some samples, as the material seemed to run around the edges of the filter paper rather than through it, carrying some of the solid particles along into the filtrate. Various wetting techniques tried did not completely eliminate this, so we have resorted to a cell with a fritted glass plate. This seems to eliminate the difficulty completely. Filtration of about 30 samples through the same fritted plate without subsequent acid wash does not materially decrease the filtration rate, so the anticipated plugging of the filter pores with small pigment particles does not seem to take place. Further work is being conducted to simplify and to increase the general applicability of the method.

A centrifuge method for the same purpose was tried, but as was anticipated, packing volumes of lower values were obtained than by use of the CPVC cell or the draw-down method.

In an attempt to determine the reason for the decrease of CPVC in the presence of increased moisture as reported for the case of 1403 in (2), (48) and (3109) in a previous monthly report, the adsorption characteristics of the above binders on 1403 and 20 F were determined in the presence of an increasing amount of water.

#187 - Cont.

The method consists of "grinding" 20 grams of the pigment with 50 cc of a 5% solution of the vehicle in (63) in a glass container, after 0%, 0.5%, 1% and 2% of water (by volume of pigment) have been added to the various samples. The dispersion was carried out for 3 hours by rolling with steel balls, after which the pigments were centrifuged out and a 10 cc sample of the supernatant liquid carefully dried for 3 hours at 110° C. The difference in weight of the vehicle remaining to that of the original solution, represents the weight of vehicle adsorbed on the surface of the pigment. The accompanying chart shows the results obtained.

		Per Cent Moisture			
Pigment	Vehicle	0.1%	0.6%	1.1%	2.1%
1403	(2)	.005	.005	.006	.006
1403	(48)	.012	.012	.011	.011
1403	(3109)	.025	.025	.029	.023
20 F	(2)	.007	.006	.006	.006
20 F	(48)	.010	.010	.010	.010
20 F	(3109)	.017	.017	.017	.016

The figures represent the grams of vehicle adsorbed per gram of pigment. They are contrary to the differences which might have been expected from the CPVC data as to vehicle adsorbed with increased percentages of moisture. If water molecules would displace oil molecules adsorbed on the pigment surfaces, large differences might be expected. As it is, the differences between the vehicle adsorbed at low moisture content and high moisture content are small, scarcely greater than the experimental error. It is interesting to note that these differences are in the same order of magnitude for both 1403 and 20 F. 1403 showed a very large decrease of CPVC with increased moisture content, while in the case of 20 F this change was negligible.

In contrast to the above, it can be shown that (48) molecules almost completely displace previously adsorbed (2) molecules from the surface of 1403 and 20 F. 25 cc of 5% solution of (2) in (63) were placed in contact with 20 g. of 1403 and 20 F respectively, and "ground" for 3 hours in the previously described method. Then 25 cc of 5% solution of (48) in (63) were added and the samples subjected to an additional 3 hour dispersion. Subsequent drying and weighing showed that the amount of material adsorbed was almost quantitatively the same as that adsorbed from straight (48) solution.

Work on both the CPVC - moisture relation and adsorption studies will be continued.

#162 - Studies in Flat Wall Paint Formulation

Semi-Lustre

Two plant batches of CV 7041 (25 gallon CWO-Dehydrol-Tall Oil-P.E. Varnish) were made and tested in Semi-Lustre Cream. The characteristics were:

Plant Batch CV 7041	No. 1	No. 2
Body	T - U	W
Color	16-17	18
Acid Value	4.0	4.9

Batch No. 1 was slightly low in body and No. 2 appeared somewhat reactive in Semi-Lustre after three days. A factory batch of Semi-Lustre Cream will be made with batch No. 2 to check the sheen and body characteristics of this varnish.

		Viscosity - #3			Drying		Photovolt
Batch	Varnish	Fresh	O'Nite	7 Days	Set-to-touch	O'Nite	Sheen
193 L	CV 7038	23.8"	26.2"	26.6"	55"	OK	58
194 L	CV 7041	20.2"	24.4"	25"	55"	OK	63
214 L	CV 7041-#2	26.6"	-	42" (3 days)	62"	OK	60

Enamels

A plant batch of (2848)E based on the kettle dehydration of (113) was compared with standard (2848)E in Rex 710 Enameloid White. The enamel appeared to be standard in brushing, drying, etc., with flow slightly higher with the special (2848)E.

(Cont.)

#162 - Cont.

	OJ 191 L	OJ 192 L
Varnish	(2848)E	(2848)E Sp.
Viscosity #3		
Fresh	43"	35.2"
Over Night	48"	38"
Drying		
Set-to-touch	1 hr. 30 min.	1 hr. 25 min.
Over night	Good	Good
Water Spot Test		
for 24 hours	Sl. whitening	Sl. whitening
1% Soap Test		
for 3 hours	" "	Sl. + whitening
Brushing	Good	Good
Flow	Good	Slightly high

Check tests on Lowe Brothers' enamel LH 501 were made after two months' age. The conclusions at two months were identical with those at the one week stage. Enamel LH 501 is an excellent product compared with other brushing, air drying enamels but, as would be expected, does not compare in hardness with baked appliance finishes.

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No work was done during the month on the following investigations:

#178 - Studies of Dark Colored House Paints

#177 - Pigment Studies

#77 - Mildew Inhibitors

#86 - Leaded Zinc Pigments

#148 - Examination of White Lead

#187 - Physical Properties of Pigments

The recognition of the physical meaning of CPVC as being that point at which just sufficient binder is present to completely fill the voids left between the particles of a pigment/binder system, leads to a necessary change in the concepts of pigment/binder relationships. Until the present, the binder in a paint system has been classified into two general types, namely the "bound" oil and "free" oil. The bound oil has generally been considered to consist of an envelope of liquid molecules firmly adsorbed to the surface of the pigment particles and may physically be identified with the pigment. These molecules of binder are removed from the surface of the pigment only through considerable effort and can consequently be regarded as being truly "bound" to the pigment by strong physico-chemical forces. The quantity of such binder firmly adsorbed to the solid particles can be obtained from an adsorption from solution determination and varies between low values of less than 1% to well above 10% of pigment volume, depending upon the type of vehicle employed in the system. Some typical values are: 1403 in (2), 2.5%; 1403 in (48), 4.8%; 1403 in (3109), 10.3%; 20 F in (2), 2%; 20 F in (48), 3.1% and 20 F in (3109), 5% of oil by pigment volume adsorbed.

The free binder has been considered to be all the rest of the oil present in the paint system at the formulated PVC. It is that oil which is easily removable from the system in the wet state by such simple methods as filtration and can consequently be regarded as being truly "free."

With the concept of CPVC this "free" portion of the binder must be subdivided into two major portions namely, I, that portion which is required to fill the interstices between the pigment particles when these are at their densest degree of packing commensurate with their dispersion, and II, that portion of the binder which is in excess of this amount to the formulated PVC. The first of this oil can be regarded as being "interstitial" free binder, and the second as "excess" free binder.

These relationships can probably be most adequately represented by Figure I.

#187 - Cont.

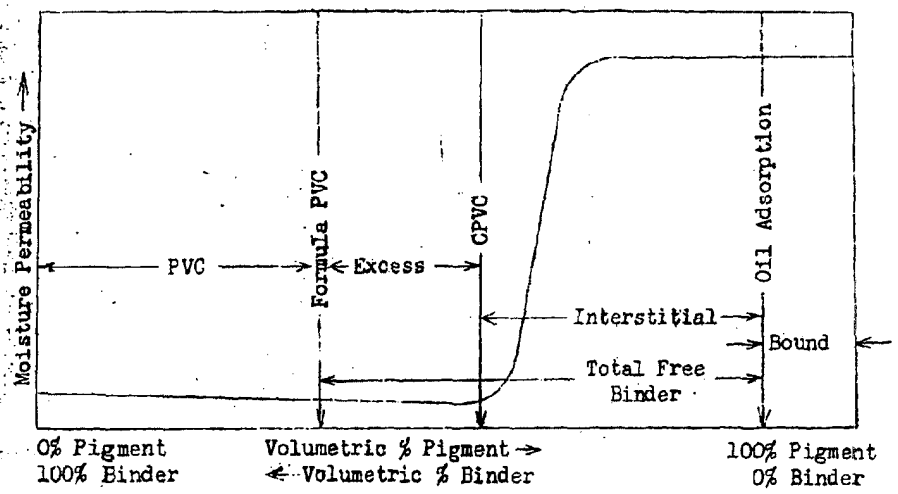

Figure I

If a permeability vs. PVC curve is determined for a given pigment/binder system, the results can be represented by a typical graph as above. The sharp break in the permeability represents the CPVC, or that percentage of pigment to oil where just sufficient binder is present to give a continuous solid/liquid phase after all thinner has volatilized. The PVC of the paint is determined by the formulation, while the bound oil can be evaluated by an adsorption determination. Mathematically, the system can be defined by the simple relation:

Total volume = PVC + excess free oil + interstitial free oil + bound oil

and: excess free oil + interstitial free oil = total free oil

Where agglomerated systems are encountered it is necessary to subdivide the interstitial free binder into two further groups, namely: 1, intra-agglomerate oil and 2, extra-agglomerate oil. The first represents that binder which is present inside the pores of the individual agglomerates, while the second is that which fills the spaces between them, or:

interstitial free oil = intra-agglomerate oil + extra-agglomerate oil.

#187 - Cont.

An evaluation of these two terms can be made with the assumption that the particles participating in an agglomerate are at their densest degree of packing. Consequently, in an isolated agglomerate the same pigment/vehicle ratio would exist as is obtained by a CPVC determination on a mono-disperse system of the same pigment. The arithmetical difference between the CPVC of the mono-disperse system and that of the agglomerated system then represents the extra-agglomerate oil, and the difference between this and the interstitial oil is the intra-agglomerate oil. These relations are represented in graphical form in Figure II, where the remainder of the values conform to those of Figure I.

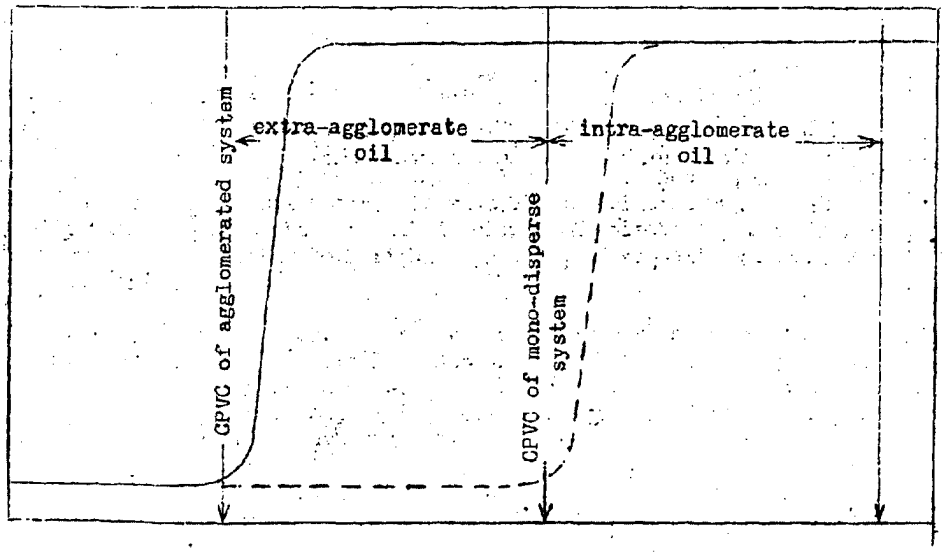

Figure II

#187 - Cont.

From Figure II, it can easily be perceived that the extra-agglomerate oil represents the difference in efficiency of packing between an agglomerated and a completely dispersed pigment system. For the latter, the intra-agglomerate oil simultaneously represents the interstitial free binder.

A consideration of these factors immediately raises the question, "Which portion of the vehicle is responsible for the wide divergence of pigment packing behavior?" By the use of various vehicles and agents the same pigment system can be induced to give high or low values of CPVC.

The answer can readily be found through the use of the CPVC cell. It is possible to completely substitute the free binder of a paint system by a solvent and still retain the same packing characteristics as characterize the original paint. The interstitial binder and excess binder consequently must be considered to play only a minor role in the establishment of the CPVC, while the bound oil is the main factor in determining this value.

The vehicle substitutions were carried out by diluting the original paint 1:1 by volume with naphtha or other suitable solvent and centrifuging out the pigment. The supernatant liquid is decanted and replaced with the same volume of solvent. The pigment is then redispersed into the solvent by rigorous shaking, and repetitions of this whole procedure made until only traces of binder can be detected in the solution. A CPVC determination by means of the CPVC cell is then carried out on this dispersion, while another is made on the original paint. The results obtained by these two methods check well within experimental error for systems exhibiting both highly agglomerated as well as highly dispersed states.

That the adsorbed or bound oil is not removed from the surface of pigment particles by simple dilution of this type has been pointed out by W. Ewing in "Symposium on New Methods for Particle Size Determination in the Subsieve Range" page 108 (1941), and has been further corroborated in the course of this investigation.

An attempt was made with the cooperation of the Oil Research Laboratory to separate 20 F magnesium silicate into various particle size fractions by use of a long elutriation column. Unfortunately, the results obtained were not very encouraging because of the inability to fluidize the material. The pigment packed very badly along the sides of the elutriator and even the use of pre-heated air had no advantageous effect in breaking up this packing. Further work in this direction has been halted for the time being.

#162 - Studies in Flat Wall Paint Formulation

Semi-Lustre

As stated in the September report, the first factory batch of CV 7041 produced Semi-Lustre which was too low in body, while the second batch was too reactive. A third batch was prepared under the supervision of the Vehicle Research Department to determine whether a slightly lower bodied varnish would be more stable. Batch No. 3 had a body of U to V and an acid value of 6. However, when used in Semi-Lustre Cream it was as reactive as Batch No. 2. No further work is contemplated.

Porch and Floor Enamel

In the August report reference was made to a number of "A" resin varnishes submitted by the Vehicle Research Department for evaluation in Porch and Floor Enamels. Enamels prepared with these varnishes have been evaluated for embrittlement and scrub resistance in comparison with ether resin and alkyd formulations as well as regular Porch and Floor Enamel based on (6173) and (2841)G.

Considerable difficulty has always been encountered in evaluating enamels for scrub resistance. As indicated by the data below, the regular Porch and Floor Enamel (OJ 152 L) made with laboratory prepared varnishes showed a definite break in the film after having been scrubbed for six hours, whereas an identical formulation made with factory varnishes (OJ 211 L) lasted only 3-1/4 hours. However, the results should be somewhat indicative of the comparative abrasion resistance of the varnishes tested. (See next page for chart.)

Panels 12009-17 C and F were prepared to expose these Porch and Floor Enamels. The panels are 8" x 24" yellow pine and will be exposed 45° south at Chicago and Miami.

Panels 7602-31 C and F were examined after exposure 45° south for 12 months in Florida and 40 months at Chicago, and a final report written. The panels were Douglas Fir. The paints tested were Porch and Deck grays of 1942, covering various types of varnishes with two types of pigmentation: (1) leaded zinc and (2) Titanox RC. As stated in previous reports the latter paints were far superior in durability and appearance to those made with leaded zinc. Selection of superior varnishes is made difficult because of pitch exudations. Possibly (6175), (3111), (2848)N and (2946)EA would be given preference, while (3848)E, (4850)N and (429)A seem inferior.

#162 - Cont.

Abrasion and Embrittlement Tests
on Porch and Floor Enamels After One Month
(0.003" Films on Glass)

Batch	Varnish Used	Elasticity	Hours Scrubbed Before Film Broke
OJ 152 L	(6173) - CVR 911 and (2841)G Laboratory varnishes	Good	6 hours
OJ 153 L	CVR 894 - 18 gal. (48) "A" Resin Varnish	"	4 hours 45 minutes
OJ 154 L	CVR 896 - 18 gal. (44) "A" Resin Varnish	"	2 hours
OJ 155 L	CVR 903 - 15 gal. (3017) "A" Resin Varnish	"	1 hour 20 minutes
OJ 156 L	CVR 906 - 15 gal. Kettle Dehydrated Castor "A" Resin Varnish	"	8 hours 15 minutes
OJ 157 L	CVR 910 - 15 gal. Solvent Process Castor "A" Resin Varnish	"	2 hours 45 minutes
OJ 184 L	Alkyd Varnishes (4103) and (4100)	"	5 hours 45 minutes
OJ 210 L	RB 7019 - Ether Resin Varnish	"	27 hours 50 minutes
OJ 211 L	(6173) - Factory Production (2841)G " "	"	3 hours 15 minutes

#187 - Physical Properties of Pigments

The study of the effect of moisture on CPVC has been continued, 1403 TiO_2 was exposed to atmospheres of 20%, 50%, 75% and 100% relative humidities at 85° F. for 24 hours. Under these conditions the percentages of moisture retained in the pigments are:

Relative Humidity	Per Cent Moisture
0% (dried sample)	0%
20%	0.06%
50%	0.12%
75%	0.17%
100%	0.34%

The relative humidity was established by the use of solutions of potassium fluoride, calcium nitrate, and sodium acetate in water in the presence of excess salts for 20%, 50% and 75% R.H. respectively, while the 100% R.H. was obtained in the presence of water alone.

The pigments treated as above were made up to a PVC of 30% in (2) raw linseed oil, ground over night on ball mills and the CPVC determined by means of the CPVC cell. The results obtained check well with those resulting from the addition of water to the batches as set forth in previous reports, and are represented in the following table.

Relative Humidity	CPVC of 1403 in (2)
0% (dried)	37%
20%	32%
50%	31%
75%	29%
100%	25%

It is obvious from the above that 1403 TiO_2 exposed to differing atmospheric conditions can result in substantial differences in the CPVC and consequently can cause erratic behavior of paint batches of this pigment in (2). That this behavior is not due, as might be suspected, to differences of adsorption of (2) on the pigment, can be shown by selective adsorption from solution determinations. The 1403 exposed to the various conditions of relative humidity all showed substantially the same amount of adsorption of raw linseed oil as the dried sample, indicating that the cause for this phenomenon is probably not to be found directly at the pigment/liquid interface.

A paper was written and graphs and slides prepared for presentation at the A.A.A.S. meeting in Chicago, December 26, 1947, on the subject "Some Aspects of Critical Pigment Volume Relationships."

#86 - Leaded Zinc Pigments

Leaded zincs 1526 dry and 414 W are compared in exposures 7380-7 F, exposed 36 months at Florida, vertical south, cedar beveled siding primed with Rex 450. The paints used are SWP bodied oil tint bases of 7-21-43, Cream and Slate. There is no failure greater than microscopic, hence the 414 W is standing up fully as well as 1526 so far. 414 W is represented by both a routine sample from Coffeyville, lot #251, and a special "Canadian fume composite" supplied by G. E. Prewitt as representative of production for the period July 7 - September 13, 1943. There is no difference between the two samples to date. Past results show a slight disadvantage in appearance due to slow chalking of 414 W, but this effect is no longer noticeable.

#177 - Pigment Studies

Panels 12078 - 12120 CS, CN and F have been prepared to study the relationship between the reactivity of special lead pigments and the film durability obtained. It has been suggested that due to the relatively higher PbO contents of Basic Silicate White Lead and Tri-base (highly basic lead sulphate) these materials should be formulated into paints using smaller increments.

In panels 12078 - 12120 a variety of lead pigments are studied at various lead content levels from 12% down to 1.5% in five steps. Exposures are at Chicago north and south, vertical; Coffeyville south, vertical; and Florida south, vertical.

#162 - Studies in Flat Wall Paint Formulation

Flat-Tone

A sample of Mineral Spirits Deodorant #65 was submitted by Fritzsche Brothers, Inc., New York, N. Y. for evaluation as a deodorant for paint products. Mineral Spirits Deodorant #65 is priced at $1.25 per pound in 400 pound drums, f.o.b. New York.

The sample was compared with (3082) in Flat-Tone and Enameloid at their suggested concentration of 1/4 pound per 100 gallons and on an equal cost basis with (3082). When used at the recommended concentration the Deodorant #65 was better from a masking standpoint than (3082). However, when introduced on an equal cost basis with (3082) we could not detect any improvement over (3082) from the standpoint of masking typical paint odors.

The Metro-Nite Company have suggested the use of Metro-Nite - 2201 dry for lowering cost and conserving hiding pigment in flat wall paint formulations. To check these claims, flat wall paints have been made by replacing the present inerts (2188 dry and 20 F) on an equal volume basis with 2201 dry. In a second variation 50 pounds of 2132 dry and all inert was replaced with 2201 dry.

The paints were compared with regular Flat-Tone for brushing, flow, drying, washability and hiding, as well as uniformity of tint and sheen. The results of the tests indicated that 2201 dry is too low in consistency compared with the present inerts to obtain proper body and suspension properties in the finished paint. Paints made with 2201 dry were less uniform in tint and sheen compared with the standard formulation. Where 2201 dry was used for hiding pigment the paint was lower in hiding, as would be expected. There seem to be no advantages and some disadvantages in the use of this extender in flat wall paints.

Semi-Lustre

The Vehicle Research Department has prepared a factory batch of CV 7043 for evaluation as a Semi-Lustre vehicle. This varnish is a variation of AV 170 in which half of the linseed has been replaced with (4055) fish oil acids and esterified with polyhydric alcohol. The factory batch of CV 7043 had the following characteristics:

Body - J
Color - 16
A. V. - 9.6

Semi-Lustre - Cont.

In line with Cleveland's request, a formulation was developed for Semi-Lustre tints and copies of the proposed formula OJ 368 L has been sent to Cleveland. The new formulation appears to be satisfactory for brushing, flow, sheen and drying characteristics. However, the raw material cost is approximately 25¢ per gallon higher than the present production and we do not feel that this increase should be absorbed if it is possible to dispose of the (4055) overstock in some other way.

A small plant batch of Semi-Lustre Cream will be made with the new varnish CV 7043 and samples of the new production will be sent to Cleveland for their inspection.

Enameloid

The Vehicle Research Department has submitted three 25 gallon P.E.-Rosin-C.W.O. varnishes prepared by the solvent process and a 25 gallon Pentalyn A - Chinawood Varnish - CVR 975, made by an open kettle cooking procedure.

	% (141)	% (348)	
CVR 973	4	41	Coffey-Lukas Solvent Process
CVR 974	22.5	22.5	" " " "
CVR 975	-	45	Open kettle - regular
CVR 976	-	45	Coffey-Lukas Solvent Process

The varnishes were compared with (2848)E in the Enameloid Cream formula dated 5-21-47. The enamels were compared for general performance with the regular (2848)E formulation.

The solvent processed varnishes compared quite favorably for drying with the so-called regular CVR 975 which was made in the open kettle from Pentalyn A and chinawood oil. However, it was found that a 25 gallon Dehydrol-rosin varnish such as (2848)E produces a higher gloss and a tougher film after drying over night. All four experimental varnishes when pigmented showed some tendency to bloom, which apparently is due in part to the kerosene content of CVR 973 and 974.

The four varnishes were also used in a Semi-Lustre formulation but in all cases were found to be too low in sheen.

The Vehicle Research Department is now planning to make a 25 gallon P.E.-Rosin-Dehydrol-C.W.O. varnish by the solvent process for use in Enameloid and Semi-Lustre formulations. The use of part Dehydrol may improve the gloss characteristics of this varnish.

#162 - Cont.

Porch and Floor Enamels

A sample of ether resin varnish - RB 7019, submitted by the Resin Research Department, was used in a formulation for Porch and Floor Enamel. The enamel based on this liquid had excellent scrub resistance and elasticity after one month. The ether resin enamel, however, was very short in flow, and any improvement that can be made in the flow characteristics of RB 7019 would be advantageous.

No work was done during the month on the following projects:

#77 - Mildew Inhibitors

#160 - Painting of Bricks

#183 - Pretreatment of Metal Surfaces for Painting

#148 - Examination of White Lead Discontinued