DESCRIPTION OF L.I.A. VEHICLES

Vehicle No. 5

A long oil modified phenolic varnish formulated as follows:

Amberol #226	100 lbs.
China Wood Oil	34 gallons
Alkali Refined Linseed Oil	16 gallons
Heavy Bodied Linseed Oil	16 gallons
Mineral Spirits	45 gallons
V.M. and P. Naphtha	15 gallons
Dipentine	5 gallons

Cooking Procedure: Run Amberol, china wood oil and 10 gallons alkali refined linseed to 500° F. Hold for body(40 minutes for laboratory batch). Add 6 gallons alkali refined linseed oil and heavy bodied linseed and heat to 475°F. Hold for 10 to 15 minutes. Turn off fire, cool and reduce.

Properties:

Non-Volatile	= 60% by weight
Viscosity	= G - H (Gardner Holdt)
Color	= 6 L - 6
Acid Number	= 7.3

Vehicle No. 27

A dehydrated castor oil modified glyceryl phthalate alkyd formulated as follows:

Dehydrated Castor Oil Fatty Acids(Isolins)	366.5 lbs.
Glycerine	168.0 lbs.
Phthalic Anhydride	220.5 lbs.
Mineral Spirits	60 gallons

Cooking Procedure: Heat fatty acids, glycerine and phthalic anhydride under cover and CO_2 gas to 356°F in 40 minutes. Slowly increase to 475°F and hold for about 105 minutes. Cool and reduce.

Properties:

Non-Volatile	= 66% by weight
Viscosity	= Z(Gardner - Holdt)
Acid Number	= 10 (maximum)
Phthalic Anhydride Content	= 30% by weight

August 3, 1948

LOCATION OF TEST SITES

The paint systems are exposed to a wide range of climatic and atmospheric conditions. The panels are exposed on test fences in coastal and inland areas having both industrial and rural environments.

The test locations, types of specimens and remarks on environmental conditions are included in the following table.

TABLE I

Sites	Types of Specimens	Environment
Sayville, Long Island	Panels and Angles	Atlantic Coast, Rural
Cleveland, Ohio	Panels	Inland(Great Lakes) Industrial
Joplin, Missouri	Panels and Angles	Inland, Rural
New Orleans, Louisiana	Panels	Gulf Coast, Industrial
San Francisco, California	Panels	Pacific Coast, Industrial

TEST SPECIMENS

General Description

All of the paint systems in the project have been applied at the five test sites to flat 12" x 18" cold rolled steel panels. (ASTM 609 b6T, Carnegie #5). These were shipped to the cooperators laboratories in ordnance bags and wrapped in PK paper. The panels were left wrapped until just prior to painting when they were given three mineral spirit washes to remove the oil film and other foreign matter. These specimens were clean and rust free when painted.

Duplicate hot rolled structural steel specimens 4" x 4" x 1/8" x 12", are exposed at Sayville, Long Island and Joplin, Missouri. These are 4" x 4" x 1/8" x 12" and contain a normal amount of mill scale.

The angle specimens were solvent cleaned and wire brushed just prior to painting and contained less than 10% corrosion products.

Each specimen contains four test areas as illustrated. Thus four test areas are exposed on each panel and angle iron.

Since two topcoat paints, aluminum and low visibility gray, were used, each primer is exposed in quadruplicate on angle specimens and in duplicate on flat specimens.

All specimens are exposed on 45° test fences facing south.

IDENTIFICATION

The paint test specimens are labeled to indicate exposure site, paint number and composition of topcoat. The letters A and B designate aluminum and gray topcoat, respectively. The test site designations are:

Sayville	- A
Cleveland	- C
New Orleans	- D
Joplin	- E
San Francisco	- F

Example:

The panel marked A-203-B is exposed at Sayville, contains primer number 203 and the gray topcoat.

The panel marked F-315-A is exposed at San Francisco, contains primer number 315 and the aluminum topcoat.

APPLICATION OF PAINTS

Each set of exposure specimens were prepared at the site of exposure. All paints were applied by spray at a uniform dry film thickness of 1.5 mils per coat. The only exception was the aluminum topcoat which was applied at a film thickness of one mil. The paints were applied at calculated spreading rates to obtain the specified film thicknesses. The dry films were checked with a Magne Gauge to assure a uniform film over the entire surface of the specimens.

The low solid content primer and topcoat for the vinyl system, exposed as a control, were applied at 1 ± 0.1 mil per coat. The wash coat

primer(LIA #306) was sprayed on to a dry film thickness of 0.3-0.5 mil.

Sufficient time was allowed between application of coats and before exposure to permit thorough drying of the paint films.

PIGMENTATIONS

The following pigmentations were tested in each of five vehicles. These vehicles are described in detail in a later section.

Red Lead Base	Pigmentation Numbers							
Ingredients	114	115	120	121	122	123	147	158
Red Lead, 97% Grade	99.5%	75%	25%	55%	65%	80%	52%	30%
Zinc Yellow(Zn Chromate)	-	-	20%	10%	-	7%	-	-
Zinc Oxide	-	-	15%	-	-	-	-	-
Magnesium Silicate	-	-	19.5%	23.5%	14.5%	24.5%	23.5%	27.5%
Iron Oxide, 85% Fe_2O_3	-	24.5%	20%	2%	16%	28%	24%	34%
Mica, 325 Mesh	-	-	-	9%	4%	-	-	-
Aluminum Stearate	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%

Non Red Lead Base	Pigmentation Numbers					
Ingredients	116	118	119	124	157	158
Zinc Yellow(Zn Chromate)	25%	50%	25%	15%	35%	-
Lead Chromate, Basic	-	-	-	-	-	35%
Zinc Oxide	-	-	10%	10%	10%	10%
Magnesium Silicate	20%	10%	25%	25%	15%	15%
Iron Oxide, 85%Fe_2O_3	55%	40%	30%	50%	40%	40%
Mica, 325 Mesh	-	-	10%	-	-	-

FORMULATIONS

Each of the following pigmentations were tested in one specific vehicle. These vehicles are included with the complete detailed paint formulations in Section .

Pigmentation Numbers

Ingredients	97	114	125	126	127	128	129	130	132	133
Red Lead, 97% Grade	-	59.5%	-	-	-	-	-	-	-	-
Lead Chromate, Basic	-	-	-	-	-	-	-	25%	-	-
Blue Lead, Sublimed	-	-	-	-	-	-	-	-	60%	57.4%
Zinc Yellow(Zn Chromate)	-	-	55%	47%	55%	65%	25%	-	20%	19.1%
Zinc Oxide	25%	-	-	14%	-	-	-	-	-	8.5%
Zinc Dust	60%	-	-	-	-	-	-	-	-	-
Magnesium Silicate	-	-	25%	27%	10%	28%	15%	15%	15%	10%
Iron Oxide, 85% Fe_2O_3	-	-	-	-	-	7%	50%	50%	-	-
Iron Oxide, 76% Fe_2O_3	-	-	-	-	25%	-	-	-	-	-
Mica, 325 Mesh	-	-	-	-	10%	-	-	-	-	-
Silica	-	-	-	-	-	-	10%	10%	5%	5%
Aluminum Stearate	-	0.5%	-	-	-	-	-	-	-	-
Titanium Dioxide, Rutile	-	-	15%	12%	-	-	-	-	-	-
Raw Sienna	-	-	5%	-	-	-	-	-	-	-

Pigmentation Numbers

Ingredients	151	149	150	151	152	153	154	162	163	164	165
Red Lead, 97% Grade		-	-	-		-	100%	95%	-		
Blue Lead		-	-	-		-	-	-	-		
35/65 Co. Fumed Leaded Zinc		75%	-	-		-	-	-	-		
Lead Carbonate, Basic		-	75%	-		-	-	-	-		
Lead Sulphate, Basic		-	-	75%		-	-	-	-		
Zinc Yellow(Zn Chrom.)		-	-	-		-	-	-	49.5%		
Zinc Chromate, Basic		-	-	-		65%	-	-	-		
Zinc Oxide		-	-	-		-	-	-	17.6%		
Raw Sienna		-	-	-		-	-	-	4.6%		
Titanium Dioxide		-	-	-		-	-	-	11.7%		
Magnesium Silicate		-	-	-		-	-	6.6%	11.7%		
Diatomaceous Silica		-	-	-		-	-	5%	-		
Soapstone		15%	15%	15%		-	-	-	-		
Talc		5%	5%	5%		-	-	-	-		
Mica, 325 Mesh		4.5%	4.5%	4.5%		-	-	-	-		
Carbon Black		-	-	-		14.4%	-	-	-		
Lamp Black		-	-	-		0.6%	-	-	-		
Aluminum Stearate		0.5%	0.5%	0.5%		-	-	0.4%	1.1%		

VEHICLES

The following five vehicles were used with each of the test vehicles on page .

Vehicle A

A Linseed Replacement Oil consisting of a blend of raw linseed oil, pale heat bodied linseed oil, mineral spirits and drier in the following proportions:

Raw Linseed Oil	- 50%
Pale Heat Bodied Linseed Oil	- 15%
Mineral Spirits and Drier	- 35%

Vehicle B

A combination of raw linseed oil and a linseed modified glyceryl phthalate alkyd.

Alkyd Resin Solution	- 56.3%
Raw Linseed Oil	- 28.1%
Mineral Spirits and Driers	- 15.6%

The alkyd resin solution in this vehicle has the following properties:

% Oil Acids	- 49
% Phthalic Anhydride	- 32
% Non-Volatile	- 50
Viscosity at 50% NV(Gardner-Holdt)	- S-W
Acid Number at 50% NV	- 3-5

Vehicle C

A combination of 60% by volume of a linseed modified glyceryl phthalate alkyd and 40% by volume of a 33 gallon linseed-tung oil para-phenyl phenolic varnish.

The alkyd resin in this vehicle has the following properties:

% Oil Acids	- 60
% Phthalic Anhydride	- 25
% Non-Volatile	- 70
Viscosity at 70% NV(Gardner-Holdt)	- T-Z1
Acid Number at 70% NV	- 5-7

The phenolic varnish in this vehicle has the following properties;

Oil Length	- 13 gallons
% Tung Oil in Oil Phase	- 60
% Linseed Oil in Oil Phase	- 40
% Non-Volatile	- 60
Viscosity at 60% NV(Gardner-Holdt)	- D

Vehicle D

This vehicle consists entirely of the alkyd resin solution described under Vehicle C.

Vehicle E

This vehicle is composed of a 25 gallon dehydrated castor oil-modified phenolic varnish, heavy bodied linseed oil and mineral spirits in the following proportions;

Modified Phenolic Varnish	- 56%
Heavy Bodied Linseed Oil	- 29%
Mineral Spirits	- 15%

The modified phenolic varnish has the following properties;

Oil Length	- 25 gallons
% Non-Volatile	- 43
Viscosity at 43% NV(Gardner-Holdt)	- C
Acid Number	- 5.2

Driers

Naphthenate driers were incorporated into the above vehicles to the extent of 0.5% lead, 0.02% manganese and 0.02% cobalt, based on the non-volatile contents.

GENERAL PAINT PROPERTIES

Pigment Volume Ratio;

All of the paints except specification paints were prepared with a PV of 35%. Specification paints were prepared at pigment volume ratios indicated in the applicable specifications.

Fineness:

The Primers were all ground to a fineness of 4(Scale)in a ball mill.

The gray topcoat paint was ground to a fineness of 7(Scale) in a ball mill.

Consistency:

Each paint was prepared for shipment to the test sites at a consistency of 75 Krebs Units.

PAINT FORMULATIONS

Paint No.	Pigment No.	Pigment Total Wt.%	Vehicle No.	Vehicle Total Wt.%	% PV	Pounds Per Gallon	Formulation Ingredients	Formulation Weight %	Formulation Pounds Per 100 Gallons	Remarks
206	11h	67.2	D	32.8	35	18.8	Red Lead, 97% Oxide	99.1	1240	
							Aluminum Stearate	0.3	3.75	
								100.0		
							Vehicle D (Alkyd Resin Solution)	65.0	396	
							Mineral Spirits	34.5	210	
							Driers	0.5	4.52	
								100.0	1851.27	
207	11h	63.7	E	36.3	35	18.0				

ATMOSPHERIC PROGRAM PUBLICITY

List of Illustrations

1. A painted panel on test fence.
2. A painted angle on test fence.
3. Painter spraying paint on test specimen.
4. View of test fence.
5. Checking thickness of paints with a Magne Gauge.

COPY

EXHIBIT "B"

NORFOLK NAVAL SHIPYARD

Portsmouth, Va.

Refer to
File No. 4J52(17) (J7CF)

July 9, 1948.

Lead Industries Association
420 Lexington Ave.,
New York 17, N. Y.

Attention: Mr. C. J. Vander Walk, Technical Director

Subject: Test of Primer Paints

Gentlemen:

The copy of your letter of 30 June 1948 to the Navy Department (copy addressed to Mr. H.E. Adamson of this Naval Shipyard) and the samples of paints to which the letter pertains, have been received.

Since this Naval Shipyard has received no instructions from the Navy Department relative to the proposed tests, the samples are being held pending such instructions. The Bureau of Ships, Navy Department, is being informed of this situation.

Very truly yours,

/s/P. F. Brinsbruck

/s/ P. F. Brinsbruck
Lieutenant, USN

cc: BuShips
(Enc. to End-1)

August 11, 1948

AN INVESTIGATION OF PRIMERS FOR MARINE ENVIRONMENTS

INTRODUCTION

Many technical reports and papers have been published in recent years on paints for structural steel and other ferrous surfaces exposed to various marine atmospheres. Most of these publications, based on actual comprehensive test programs, clearly indicate the foremost position of red lead as a rust-inhibitive pigment for various atmospheric exposures.(1) It is not our intention to criticize or contradict in any way the well-grounded conclusions reached in these reports. Performance in the field throughout many decades confirms the fact that red-lead-in-oil paints remain unsurpassed as primers for the protection of structures where it is impractical or economically not feasible to remove all of the corrosion products.

It should be realized that the problems of corrosion protection and paint formulation are extremely complex; no single paint or type of paint will give the best possible protection under all conditions. In a search for improved red lead base primer paints for certain types of atmospheric and marine exposure, the Red Lead Technical Committee of the Lead Industries Association has carried out several projects embracing the various types of synthetic vehicles with a variety of red lead base pigmentations. The primary objective of the project discussed here was the attainment of improved primers for use in marine environments. A series of modern red lead base primer paints is presented. Typical practical applications for these primers would be on all parts of ships above the water line, docks and docks buildings, cranes, buoys, bridges located along the coast or over tidewaters, and machinery in marine installations.

Another project on red lead base primers for tide range and total immersion exposure was discussed in a previous paper.(2)

OBJECTIVES

In planning and carrying out this investigation the following problems were given particular considerations:

a. The determination of the best modifing pigments for use with Red Lead Base synthetic vehicle type paints. Included among these pigments were iron oxide, zinc oxide and zinc yellow(zinc chromate).

b. The effect on protective performance of variations in vehicle constituency. Included among the vehicles were phenolic, coumarone-indene modified phenolics and alkyds.

c. The effect of variations in pigment-volume ratios on protective paint performance.

d. The evaluation of micaceous pigments as modifiers of Red Lead Base Primers.

SCOPE OF PROJECT

This paper is based on exposure results obtained on twenty-one test pigmentations, nine test vehicles and two zinc yellow specification primers. Sixty-seven primers, including standards, were exposed. The pigment and vehicle compositions are included in Table I on page 3.

The systems comprised two coats of anti-corrosive primer with Maritime Specification low visibility gray (52-MC-6) as the finish coat.

DESCRIPTION OF TEST

The paints were all applied by brushing to 6" x 12" 12 gauge low carbon steel panels. These panels were free from rust and were thoroughly washed with mineral spirits prior to painting. Mill scale was allowed to remain on the panels and was smooth and intact. A period of twenty-four hours was allowed between successive coats and before exposure after the finish coat.

The panels were exposed in a vertical position facing south at approximately thirty inches above the high tide level at the Marine Basin at Sayville, Long Island. The panels were fastened to wooden beams by 3/8" steel bolts through bolt holes drilled at the two upper corners. The panels were insulated from the bolt heads and shanks with plastic washers and sleeves.

The panels were inspected periodically for corrosion(edge and general), blistering, and chalking or eroding. The systems were rated from zero to ten in each category, the number 10 designating no observable failure and 0 designating failure of the paint or zero protection for the steel. In the case of corrosion, a panel with a rating of 5 would mean that approximately fifty percent of the surface was rusted.

The test specimens were exposed October 13, 1944.

DESCRIPTION OF EXPOSURE SITE

The Marine Basin is located at Sayville, Long Island, which is about fifty miles east of New York City on the south shore of Long Island, in a rural area.

The close proximity of the panels to the water at this location assures an atmosphere high in salinity at all seasons and a great deal of salt spray in stormy weather and throughout the winter months.

PRESENTATION OF DATA

The numbers, composition and complete exposure records of the test paints showing very little or no failure are included in Table II with comparable data on the standard or control paints.

Table III contains the performance ratings after 41 months on all of the test panels.

TABLE I - PIGMENT AND VEHICLE COMPOSITIONS

Composition	Composition Number																					
	14	18	20	26	27	28	29	30	31	32	33	34	35	36	39	41	42	43	45	46	72
Red Lead (97% Grade)	55	55	20	56	55	55	55	55	55	55	55	55	55	55	70	70	70	70	55	55	50
Lead Chromate, Basic	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Litharge	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead Sulfate, Basic	-	-	-	-	-	-	-	-	-	-	-	25	-	-	-	-	-	-	-	-	-
Zinc Oxide	10	10	-	-	10	10	10	10	10	20	-	-	10	10	-	10	-	10	-	20	10
Zinc Yellow (Zn.Chrom)	10	-	-	-	10	10	10	10	10	-	20	-	10	10	-	10	10	-	20	-	10
Iron Oxide, Siliceous	7	-	-	-	7	-	7	7	7	7	7	-	25	-	-	-	-	-	-	-	-
Diatomaceous Silica	8	5	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
Magnesium Silicate	10	10	-	-	-	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	20
Mica, Graphite	-	-	-	30	15	25	-	-	-	15	18	25	-	-	30	10	20	20	25	25	-
Mica (325 Mesh)	-	-	-	-	-	-	-	18	-	-	-	-	-	25	-	-	-	-	-	-	-
Mica, Micronized	-	-	-	-	-	-	-	-	18	-	-	-	-	-	-	-	-	-	-	-	-

Vehicle Number	Composition
19	60% 6 gallon tertiary butyl phenolic-coumarone linseed oil varnish; coumarone resin m.p. = 127-137°C. 40% Linseed oil modified glyceryl phthalate alkyd (31% phthalic anhydride.)
19a	60% 6 gallon tertiary butyl phenolic - coumarone linseed oil varnish; coumarone resin m.p. = 45-55° C. 40% Linseed oil modified glyceryl phthalate alkyd (31% phthalic anhydride.)
19b	60% 6 gallon tertiary butyl phenolic-coumarone dehydrated castor oil varnish; coumarone resin m.p. = 127-137° C. 40% Linseed oil modified glyceryl phthalate alkyd (31% phthalic anhydride.)
19c	60% 6 gallon tertiary butyl phenolic-coumarone dehydrated castor oil varnish; coumarone resin m.p. = 45-55° C. 40% Linseed oil modified glyceryl phthalate alkyd (31% phthalic anhydride.)
19d	60% 6 gallon tertiary butyl phenolic-coumarone tung oil varnish; coumarone resin m.p. = 127-137° C. 40% Linseed oil modified glyceryl phthalate alkyd (31% phthalic anhydride.)
19e	60% 6 gallon tertiary butyl phenolic-coumarone tung oil varnish; coumarone resin m.p. = 45-55° C. 40% Linseed oil modified glyceryl phthalate alkyd (31% phthalic anhydride.)
26	60% 10 gallon tertiary butyl phenolic varnish with equal parts by weight of linseed and dehydrated castor oils. 40% Linseed oil modified glyceryl phthalate alkyd (35% phthalic anhydride.)
27	A dehydrated castor oil modified glyceryl phthalate alkyd (30% phthalic anhydride.)
28	A phenolic modified linseed-glyceryl phthalate alkyd (8% phthalic anhydride; 8% phenolic resin.)

TABLE II
PERFORMANCE RATINGS OF CONTROLS AND OUTSTANDING PRIMERS

PANEL NO.	L.I.A PAINT NO.	PIG. NO.	PIGMENTATION	VEH. NO.	VEHICLE COMPOSITION	% PV	PERFORMANCE RATINGS																							
							BLISTERING							CORROSION										PEELING						
							MONTHS							MONTHS										MONTHS						
							6	10	13	17	23	32	41	6	10	13	17	23	32	41 EDGE	41 DEN		6	10	13	17	23	32	41	
495	183	36	Red Lead 55% Zinc Oxide 10 Zinc Yellow 10 Mica (325 mesh) 25	19	60% 6 Gallon Tert. butyl phenolic-cumarone lin. oil varnish 40% Alkyd Resin, lin. mod.	33	10	10	10	10	10	10	10	10	10	10	10	10	10	8	10		10	10	10	10	10	10	10	
488	118	26	Red Lead 56% Litharge 14 Mica, Graph. 30	27	Alkyd Resin, Castor oil mod. (30% phthalic anh.)	33	10	10	10	10	10	10	10	10	10	10	10	10	10	8	10		10	10	10	10	10	10	10	
484	132	42	Red Lead 70% Zinc Yellow 10 Mica, Graph. 20	27	see above	33	10	10	10	10	10	9	9	10	10	10	10	10	9	7	9		10	10	10	10	10	10	10	
459	34c	16	Red Lead 55% Zinc Oxide 10 Zinc Yellow 10 Iron Oxide 7 Mg. Silicate 10 Diatom. Silica 8	27	see above	40	10	10	10	10	10	9	9	10	10	10	10	10	9	7	9		10	10	10	10	10	9	9	
470	118	27	Red Lead 55% Zinc Oxide 10 Zinc Yellow 10 Iron Oxide 10 Mica, Graph. 25	27	see above	33	10	10	10	10	10	9	9	10	10	10	10	10	9	7	9		10	10	10	10	10	9	9	
472	120	28	Red Lead 55% Zinc Oxide 10 Zinc Yellow 10 Mica, Graph. 25	27	see above	33	10	10	10	10	10	9	9	10	10	10	10	10	9	7	9		10	10	10	10	10	9	9	
490	138	46	Red Lead 55% Zinc Oxide 20 Mica, Graph. 25	27	see above	33	10	10	10	10	10	9	9	10	10	10	10	10	9	7	9		10	10	10	10	10	9	9	
503	Navy Primer MIL-P-15	—	Zinc Yellow 55% Titanium Dioxide 15 Red Iron Oxide 5 Mg. Silicate 25	—	45% Phenolic Varnish (MIL-V-173) 10% Alkyd Resin (MIL-R-13) 25% Thinners & Driers	40	10	10	10	10	9	9	7	-	10	10	10	10	9	7	9		10	10	10	10	10	9	-	
504	Work-Limo Comm. Spec. MIL-P-	—	Zinc Yellow 60% Titanium Dioxide 11 Zinc Oxide 13 Mg. Silicate 27 Tinting Pig. 1.5	—	55% Alkyd Resin (MIL-R-21) 45% Thinner & Driers	40	10	10	10	10	10	10	8	8	10	10	10	10	9	8	4	8	10	10	10	10	10	9	8	

CONCLUSIONS

The following conclusions were reached after careful consideration of the data in Table II containing the complete inspection results on the ten best primers in the project and Table III containing the 41 months inspection results on all of the paints.

1. The use of limited amounts of zinc yellow(zinc chromate) as a modifier of red lead base primer is advantageous. From these tests approximately 15% of zinc yellow(zinc chromate) by volume(approximately 10% by weight) in the total pigment would seem to be the optimum. The red lead paints modified with zinc yellow were superior, as a group, to the control paints in which the corrosion inhibitive pigment consisted entirely of zinc yellow. Panels 487 and 488 show that greater volumes of zinc chromate tend to give earlier failure.

2. High concentrations of zinc oxide should be used with discretion since such use of this pigment in a short oil vehicle shows poor performance in two panels, 489 and 473. When these concentrations were used in long oil vehicle primers, this adverse effect was not experienced. See Panel number 490.

   The results also indicate the use of zinc oxide is detrimental when the red lead content is in the order of 70%, particularly in short oil vehicles. See panel numbers 481 and 435. A combination of zinc oxide(10%) and zinc chromate as modifiers in order of 10% of each, for red lead base primers is beneficial in all vehicles.

3. Iron oxide did not improve the performance of these primer paints. It did, of course, contribute to good hiding power.

4. Aside from their characteristics suspending properties and other properties specific to each, the other inert pigments used did not contribute significantly to primer paint performance.

5. Where litharge was used in one instance as a modifier of red lead along with a micaceous pigment, excellent performance results were obtained without the use of other modifying pigments. However, the use of litharge in the proportion employed in this test paint, would make it necessary to furnish it separately for admixture into the paint just prior to use.

6. A dehydrated castor oil alkyd was consistently outstanding in performance. Six of the seven best paints contained this vehicle. This is also substantiated by work previously reported by the Red Lead Technical Committee on a group of tide range panels.(2)

7. Another vehicle showing good performance was an alkyd modified short linseed oil phenolic- coumarone varnish. This was superior to the castor oil alkyd just mentioned in only one paint composition(Paint No. 153).

8. Modification of the alkyd modified short oil phenolic coumarone varnish(Vehicle 19)did not result in an improved primer performance.

9. Variations in vehicle and pigment composition seemed to mask the effect of pigment volume variations. A further study of the problem is indicated.

10. The use of micacious pigments as modifiers of red lead base primers has been shown to be effective in improving the performance of such primers.

11. The failure of the control paints was characterised by relative early appearance of blistering and by more severe ultimate edge corrosion failure. Many of the red lead base paints tested in this investigation surpassed in performance, the zinc chromate paints based on two government specifications and used as controls.

12. Paints 153 and 116 received the top ratings among the seven outstanding red lead base primers. However, before centering on these paint compositions, the user should subject them to further study.

13. In considering LIA Paint 116, containing a substantial quantity of litharge(PbO), the necessity of introducing the litharge into the balance of the paint just prior to its use must be emphasized. This introduces a practical limitation which may preclude its general use.

14. A review of the seventeen paints, giving due consideration to consistency of performance, leads us to conclude that L.I.A. Paints 132,34C,118, 120 and 138 all offer the paint manufacturer and consumer red lead base primers of the highest quality.

SUMMARY

After approximately three and one-half years test exposure to a rigorous marine atmosphere, a group of several red lead mixed pigment primers have been proven outstanding. This work has added to our knowledge of both extender pigments and synthetic vehicles for red lead paints. In addition to furnishing formulators, manufacturers and specifiers with several fast drying synthetic primer paints tested under conditions simulating actual field exposure, it is our hope that this work will also supply the experienced paint formulator with additional data that might prove valuable in designing anticorrosive paints for various applications not covered in this paper.

In choosing protective primers for specific applications, good performance in the type of atmosphere encountered is imperative, but other requirements, both of a technical and economic nature, must be considered. In this paper we have endeavored to demonstrate the many possibilities and some of the advantages of red lead pigmentations in synthetic vehicle paints. The paint formulator and specifier must exercise individual judgment in choosing the primer composition for specific applications.

Even though this series of paints has been on test for a sufficient period of time to permit the culling out of the mediocre and poor paints, much still remains to be learned by continuing periodic inspections of the paints showing little or no failure. We plan to do this and to publish subsequent papers on this and other series when sufficient additional data are available.

REFERENCES

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The Effects of Different Methods of Pretreating Iron and Steel before Painting, F. Fancutt, The Iron and Steel Institute - Special Report No. 31 (1946)

(2) Marine Primers, L.L. Carrick, Official Digest, Federation of Paint and Varnish Production Clubs, Vol. 267(1947)

TABLE III

Location-Sayville, L.I.
Type of Exposure-Atmos. Marine
Date Exposed- 10/26/44
Exposure Period- 41 Months

Panel No.	LIA Paint No.	Pigmentation No.	Vehicle No.	PV No.	Inspection Data-41 Months			
					Blistering	Corrosion		Peeling
						Edge	Gen.	
459	34c	16	27	40	9	7	9	9
424	36a	16	28	30	9	3	8	9
425	36b	16	28	35	8	3	7	8
426	36c	16	28	40	9	4	6	9
427	36d	16	28	43	7	4	6	7
420	35a	16	19	30	8	2	7	8
421	35b	16	19	35	-	1	4	-
422	35c	16	19	40	-	2	5	-
423	35d	16	19	43	8	4	7	8
416	33a	16	26	30	8	4	7	8
417	33b	16	26	35	8	4	7	8
418	33c	16	26	40	8	5	7	8
419	33d	16	26	43	7	4	7	7
449	49	16	19a	40	-	2	5	-
450	50	16	19b	40	-	0	3	-
451	51	16	19c	40	-	0	3	-
452	52	16	19d	40	-	3	5	-
460	37c	18	27	40	9	6	8	9
458	56	20	27	40	9	5	9	9
428	40a	20	19	30	-	1	3	-
429	40b	20	19	35	6	2	6	6
430	40c	20	19	40	6	2	6	6
431	40d	20	19	43	-	2	5	-
432	41a	20	28	30	8	4	7	8
433	41b	20	28	35	8	4	7	10
434	41c	20	28	40	9	4	7	9
435	41d	20	28	43	8	4	7	9
436	42a	20	26	30	7	3	7	7
437	42b	20	26	35	-	3	5	-
438	42c	20	26	40	-	1	5	-
439	42d	20	26	43	8	2	6	8
440	60a	72	19	40	8	4	7	9
441	64	72	19a	40	8	4	7	9
442	65	72	19b	40	9	5	9	9
443	66	72	19c	40	8	6	7	8
444	67	72	19d	40	9	4	8	9
447	68	72	19e	40	-	2	5	-
468	116	26	27	33	10	8	10	10

TABLE III (CONT.)

Panel No.	LII Paint No.	Pigmentation No.	Vehicle No.	PV No.	Inspection Data - 11 Months			
					Blistering	Corrosion		Peeling
						Edge	Gen.	
469	117	27	19	33	9	6	8	9
470	118	27	27	33	9	7	9	9
471	119	28	19	33	9	6	8	9
472	120	28	27	33	9	7	9	9
473	121	32	19	33	8	5	8	8
474	122	32	27	33	6	4	6	7
475	123	33	19	33	-	3	4	-
476	124	33	27	33	7	5	7	8
477	125	34	19	33	7	4	7	7
478	126	34	27	33	8	6	7	9
479	127	39	19	33	-	2	3	-
480	128	39	27	33	9	7	7	9
481	129	41	19	33	-	0	2	-
482	130	41	27	33	9	7	8	9
483	131	42	19	33	7	3	6	8
484	132	42	27	33	9	7	9	10
485	133	43	19	33	7	3	6	8
486	134	43	27	33	9	6	8	9
487	135	45	19	33	8	7	7	8
488	136	45	27	33	8	6	7	8
489	137	46	19	33	-	1	5	-
490	138	46	27	33	9	7	9	9
491	179	29	19	33	-	4	5	-
492	180	30	19	33	8	7	8	8
493	181	31	19	33	-	3	5	-
494	182	35	19	33	8	2	6	8
495	183	36	19	33	10	8	10	10
503	Navy Primer 52-P-13			60	-	3	6	-
504	Maritime Commission Primer 52-MC-23			60	7	1	7	7
505	Maritime Commission Primer 52-MC-29			60	8	4	8	8