LEAD INDUSTRIES ASSOCIATION

60 EAST 42nd STREET

NEW YORK 17, N. Y.

April 1, 1958

SUBJECT: PROPOSED PAPER FOR BRIDGE DIVISION-AASHO

To Members of the Lead Pigments Technical Committee:

Attached please find a rough draft of a paper prepared by Owen F. Shobe for presentation at the Bridge Division meeting of A.A.S.H.O., to be held in Philadelphia at Hotel Benjamin Franklin, on May 21 and 22.

Will you please review this paper, letting me have your suggestions as soon as possible? If I do not hear from you by April 16, 1959, I will assume that the paper meets with your approval.

With respect to the attachments mentioned in the paper, the committee has already received copies of L.I.A. 2612, 2614 and 2628, and a copy of L.I.A. 2633 is attached.

In addition to the actual presentation of the paper at the Philadelphia meeting, copies will be distributed at other regional meetings of the Bridge Division of A.A.S.H.O. namely:

Hotel Utah Salt Lake City, Utah	May 11-12, 1959
Hotel Sheraton Jefferson St. Louis, Missouri	May 14-15, 1959
Hotel Redmont Birmingham, Alabama	May 18-19, 1959

Sincerely yours,

David M. Borsine
Secretary, Lead Pigments Technical Committee

PROPOSED DRAFT OF ADDRESS TO BE
PRESENTED BY OWEN F. SHORE BEFORE
THE BRIDGE DIVISION OF A.A.S.H.O.

AN INNOVATION IN PAINTING STEEL

Introduction

Advances in paint prices and labor costs during the past few decades have brought about a continuous effort to formulate better paints and to improve painting practice. H.H.Uhlig, in an article entitled "Costs of Corrosion in the United States," which appeared in "Corrosion," January, 1950 issue, estimated the total cost of corrosion in the United States to be 5-1/2 to 6 billion dollars per year. The need for greater efficiency in steel protection is reflected in the efforts of state and federal agencies, railroads, industries and associations to improve their steel protection by means of elaborate paint specifications covering every detail of a paint job.

The steel fabricating industry a few years ago under the sponsorship of the American Institute of Steel Construction established a national council for research on all phases of good painting practice. This led soon after to the organization of the Steel Structures Painting Council, which, under Dr. Joseph Bigos, Director of Research, has brought together in two volumes "Good Painting Practice" and "Systems and Specifications," a most useful store of information on paints and painting from surface preparation to the complete job. Helpful as the sections of these books on Pretreatment, Paints, Paint Systems and Paint Application are to architects and engineers in drawing up paint specifications for jobs, the emphasis given to Surface Preparation and Specifications for the methods listed has undoubtedly contributed most to an overall improvement in painting technique.

The American Iron and Steel Institute (Steel Facts, December, 1940) estimated from data accumulated that the average useful life of steel in 1940 was 35 years as compared to only 23 years in 1920. This period saw the greatest development of improved raw materials for paint making that have ever been placed on the market especially if you extend the period another 15 years beyond 1940. Greater stress on paint quality and having available synthetics of greater durability from which to draw in formulating, along with the gradual but steady increase in the importance attached to surface preparation must account for this increase in the life of steel in service.

Trade associations have been carrying on research programs continually in an effort to put into the hands of their customers better formulations of paints, using their products. The Lead Pigments Technical Committee of Lead Industries Association is at all times active in laboratory and field testing of special paints to improve lead pigmented paints currently recognized as the standard for painting bridge and structural steel.

The National Association of Corrosion Engineers is another group organized to study and solve corrosion problems with special emphasis on items of importance to the petroleum industry. V. B. Guthrie, "Measuring Plant Corrosion Costs," in Petroleum Processing 9 (5) 708-709, in 1954 reported corrosion to cost the petroleum refining industry 270 million dollars each year. Add to this the losses in all the other phases of the petroleum business and you have the compelling reason for NACE's corrosion research and control activities.

CURRENT GOOD PRACTICE IN PAINTING BRIDGES

Let us now consider the practical aspects of present day painting of bridges and structures. A survey of the literature on painting bridges reveals the following factors to stand out as standard procedure:

1. The commonly used method of preparing bridge steel for painting is by hand or power wire brushing, chipping, scraping and sanding with removal of oil and grease deposits by solvent cleaning before hand cleaning. Certain states, especially those bordering the gulf and sea coasts, are more and more resorting to sandblasting to provide a better surface for painting on both new and repaint work. In one state, Missouri, bridges are erected unpainted, allowed to weather for removal of mill scale, and then sandblasted and painted before new corrosion develops. In still other areas where high humidity and condensation of moisture is prevalent, flame cleaning followed by wire brushing, hand dusting off and priming while still warm gives good results.

An economical method of removing grease, dust, soluble salts, dirt and much loose dead paint and other surface contaminants on maintenance painting is to do a thorough high pressure steam cleaning job before wire brushing, spot sandblasting or other specified surface preparation method is started.

2. The usual priming coat in the shop or on maintenance work in the field, unless the surface is prepared by sandblasting or pickling, is a paint having the best possible surface wetting property. It is almost an universal opinion that raw linseed oil or a vehicle with a high percentage of raw linseed oil is the only safe vehicle to use in formulating a priming paint for hand cleaned steel. The most widely used shop coat bridge steel primers are pigmented with red lead. These primers are covered by Federal Specifications TT-P-86a and TT-P-86a Type I which are also known by AASHO Specifications M-72-51 Types I and II respectively.

3. The first field coat after touch up on new bridges varies from a tinted shop coat primer to a red lead base primer containing a generous amount of alkyd resin solution blended with linseed oil. In some states a field coat with about 25 per cent of other pigment, such as lead chromate or iron oxide, with the addition of some inert pigment such as magnesium silicate, is specified. In other states, a coat of gray paint, based on white lead or white lead and zinc oxide, with or without a percentage of titanium dioxide, is used as an intermediate coat for better hiding of the finish coat which may be an aluminum paint or a gray, gray green, or green alkyd or alkyd and linseed oil type of paint. It is our opinion, a tinted shop coat primer or a heavy duty intermediate coat under a finish coat is a much better system than two coats of finish over a touched up single shop priming coat. This is for the reason that about 4 mils of heavy duty primer and intermediate over a properly prepared surface will mean a minimum maintenance cost if repainting is done on a proper schedule. This will be true because of fewer thin spots to break through to bare metal on areas not given the proper film thickness of shop coat primer.

A NEW APPROACH IN PAINTING BRIDGES AND STRUCTURAL STEELS

General

For many years, that is, since about 1930, paint technologists have become more and more aware that certain synthetic vehicles used in making primers and finish coats for steel gave much improved performance on exposure. This reflected itself first in phenolic resin tung oil varnishes having more life on exposure and many times the water and chemical resistance of a similar varnish made from low acid rosin ester. Soon phenolic vehicle primers and finishes began to be used on trucks, buses, gas pumps and as finishes for certain structural surfaces. It was soon after discovered that the new alkyd vehicles, while lacking in water and chemical resistance as com-

pared to phenolic vehicles gave much better adhesion, gloss retention on exposure, color retention and longer life on average exposure than could be obtained with any vehicles available prior to that time. Alkyd resin primers and finish coats with alkyd vehicle, used straight or blended with phenolic or other varnishes, quickly became and still are almost the standard type of finish for trucks, signs, tanks, refrigerators, automobiles, household enamels and wall surfaces.

It was only natural that with the many known good qualities of alkyd vehicle primers and paints, they would get used prematurely on many large mill scale structural jobs and fail miserably because of poor surface wetting. This merely showed up the fact that the paint testers and formulators probably had exposed test panels with far better surface preparation before painting than was given steel in the fabricating plant when the alkyd vehicle paints started to be used in production.

For the past several months, Lead Industries Association has been making a survey of paints and painting as done by state highway departments, oil companies, public utilities and industry.

It was soon found that some highway officials, especially on repaint jobs, feel the desirability of faster dry to recoat than can be done with the usual red lead and linseed oil primer such as TT-P-86a Type I. Such a fast drying primer must also be proof against crawling on recoating under certain weather conditions and have great resistance to blistering under exposure to moisture and prevailing high humidity atmospheres, essential to avoid premature failure from rust developing in the blistered areas. A high order of resistance to salt solutions is of great importance especially on the lower areas of bridges and hand and guard rails in states where salt is used freely in the winter to melt snow and ice. Also, longer durability of a shop coat of primer only on the steel without top coats is important.

A.A.S.H.O.

Obviously, the essential properties listed in the preceding paragraph can only be obtained by using primers, intermediates and finish coats formulated with synthetic vehicles. Also it is just as evident that such primers and finish coats formulated with synthetic vehicles must have some special provision for wetting the usual hand cleaned steel bridge or tank surface, or be used on steel given a more nearly perfect surface preparation.

A NEW METHOD OF SURFACE WETTING

The Lead Pigments Technical Committee of Lead Industries Association has endeavored for several years to select an additive to incorporate in a synthetic vehicle primer which would provide improved surface wetting of hand cleaned steel. The work was also undertaken by the research department of a major paint company. This work utilizes a non-volatile film forming wetting agent which increases toughness, flexibility and other necessary chemical resistance properties of the film. The work by the paint company was primarily directed toward developing a paint system for use on gasoline and other oil tanks which would be proof against blistering and subsequent rusting from humidity and moisture of condensation.

When the survey by Lead Industries Association in January, 1958, discovered the need for an improved quick drying primer, utilization of the paint company's work with which the writer of this paper had been associated, was the only known way Lead Industries Association could provide improved primers and finish coats to state highway engineers.

Many accelerated weathering, humidity, salt spray and surface wetting tests had already been made which showed primer, intermediate and finish coat systems in which this wetting agent was incorporated to give results superior to anything previously known. In fact, it was the only way discovered, after many months of research, to provide a three coat tank paint system with adequate resistance to blistering from humidity and moisture

of condensation.

L.I.A. PRIMERS

Obviously exterior tank painting and bridge or structural steel painting are closely related. Consequently, Lead Industries Association has prepared L.I.A. No. 2614 Quick Drying Red Lead Primer, and L.I.A. No. 2612 Quick Drying Chromatised Red Lead Primer, in the vehicle of which is incorporated a wetting agent, pure phenolic resin tung oil varnish, alkyd resin solution and raw tung oil. The non-volatile vehicle of these experimental primers contains the following solids by weight:

Alkyd Resin Solids	43-44%
Phenolic Varnish Solids	19-20%
Non-Volatile Wetting Agent	30-31%
Raw Tung Oil	8- 9%

There is also incorporated in the total vehicle, 9 to 10 per cent ethylene glycol monoethyl ether (Cellosolve) to pick up traces of moisture on the surface when applied. Full details of these primers are covered in the attached data sheets. Thorough laboratory tests of these new primers show them to have the following physical properties compared to AASHO specification M-72-51 Types I and II:

1. Very much better wetting of loose rust, mill scale and other surface porosity.

2. Several times the resistance to humidity blistering.

3. Much improved salt spray resistance.

4. Two to three times the durability of primer only without finish coats.

5. Greatly improved intercoat adhesion of the complete paint system.

6. A positive 8 to 24 hour dry to take a succeeding coat under normal drying conditions.

7. Controlled gloss on primer and intermediate for better recoating.

You will note from the data sheets that they use a combination of the phenolic varnish and wetting agent as phenolic resin penetrating liquid on which there is being established several sources of supply.

Laboratory tests have quite well established the superiority of red lead pigment in these primers for prevention of humidity blistering and for resistance to attack in salt spray tests.

L.I.A. No. 2628 Buff Intermediate

Good bridge painting practice appears to be to use L.I.A. No. 2614 Quick Drying Red Lead Primer tinted brown on the job with a bit of lampblack in oil as an intermediate coat over a touched up shop coat.

On some jobs, it is desired to use a lighter buff intermediate coat. L.I.A. No. 2628 Buff Intermediate is intended for this application. About 20 per cent basic lead silico chromate is incorporated along with white lead and other pigments as shown on the attached data sheet to add further to protection against corrosion. Because of lower pigment volume (32.2), less phenolic resin penetrating liquid is required for surface wetting. The non-volatile vehicle in this intermediate coat is made up of the following percentages by weight:

Alkyd Resin Solids	64.3 - 65.0%
Phenolic Resin Varnish Solids	13.3 - 13.7%
Wetting Agent	22.2 - 22.6%

In this coat, a little over two-thirds as much of non-volatile wetting agent as is used in L.I.A. No. 2614, provides wetting of the surface porosity, be it loose rust or some unremoved chalky paint of a previous coat.

L.I.A. No. 2628 Buff Intermediate and Finish Coats have incorporated a percentage of diacetone alcohol to give "bite" into a previous coat to insure tight bonding between coats.

L.I.A. Finish Coats

Lead Industries Association finish coats for state highway department bridge painting are based on long oil alkyd vehicle. The phenolic resin pentrating liquid is slightly less than half the quantity required in L.I.A. No. 2614 and No. 2612 primers because the low pigment volume finish coat requires less for thorough surface wetting. The non-volatile portion of the vehicle in L.I.A. No. 2633 Gray Green Finish Coat (data sheet attached) is as follows:

Alkyd Resin Solids	77.0 - 78.0%
Phenolic Resin Varnish solids	7.5 - 8.5%
Wetting Agent non-volatile	14.5 - 15.0%

These vehicle solids, because of the wetting agent, carry the low pigment content of the finish coat deeply into any loose rust missed in spot priming. These finish coats use as much basic lead silico chromate pigment as the color of the finish coat permits so as to have rust inhibition throughout the film. This pigment has excellent durability and good permanence of color on exposure. The attached data sheet for L.I.A. No. 2633 Gray Green illustrates the makeup of a finish coat widely used in the east and is similar to what can be offered in a quality matching any color desired.

There is also attached Red Lead Technical Letter No. 13 - L.I.A. Formula 9-2 A Single Red Lead Primer for Rusted, Weathered or New Galvanized Steel, which has been sent to all state highway departments. This galvanized iron primer uses 30 per cent red lead along with non-gassing zinc dust and iron oxide in its pigment. After about seven years of outdoor exposure on unweathered, phosphorous acid etched and rusty galvanized iron, it is the best paint being tested. All currently recommended primers being used for this application are included in the test.

The Bureau of Public Roads has been familiar with the development tests of the bridge paint systems covered in this paper and has suggested that the Lead Industries Association urge state highway departments to apply these paints to a number of new and repaint bridge jobs in as many states as possible to get experience in the field on what can be accomplished with these revolutionary new paints.

The Lead Pigments Technical Committee of Lead Industries Association is currently perfecting a line of one-coat machinery and equipment enamels based on alkyd resin vehicle and using phenolic resin penetrating liquid for surface wetting [illegible] and finish in one or two coats. These paints, like the bridge paints, will use basic lead silico chromate for rust inhibition insofar as color permits. They will come to your attention when completed.

Research on these projects is continuous to develop perfected products for your use.

Lead Industries Association greatly appreciates the opportunity to present this paper, bringing these products to your attention. We firmly believe their eventual adoption, after thorough field testing, will result in great savings to users of structural steel paints.

April 1, 1959

L.I.A. FORMULA 2633

Gray Green Finish Coat

Finish Coat for Use on Bridges, Tanks and Structural Steel

This new fast drying structural paint, because of its synthetic vehicle, has good chemical and exceptional humidity resistance. The phenolic resin penetrating liquid thoroughly saturates loose rust and porosity on any spots missed in touch-up priming. It may be applied by brush, spray or roller, and provides excellent durability on applications to a dry film thickness of 1-1/2 to 2 mils.

	Composition	Per Cent	Pounds	Gallons
Pigment:	Basic Lead Silico Chromate	77.0	390.2	11.43
	Titanium Dioxide (non-chalking)	14.20	72.0	1.95
	Lamp black	.40	1.9	.12
	Copper Phthalocyanine Blue	.77	3.8	.29
	Chromium Oxide	6.09	31.0	.73
	Nuact Paste (44% Pb)	.77	3.8	.28
	Bentone 38	.77	3.8	.26
		100.00		
Vehicle:	Alkyd Resin Solution*	68.0	450.3	57.00
	Phenolic Resin Penetrating Liquid **	14.4	95.2	12.83
	Mineral Spirits (Aromatic)	8.7	59.5	7.70
	Diacetone Alcohol	5.9	39.0	5.13
	Lead Naphthenate (24% Pb)	0.8	5.3	.52
	Manganese Naphthenate (6% Mn)	0.2	1.3	.16
	Zinc Naphthenate (8% Zn)	1.55	10.3	1.28
	Anti-Skinning Agent (Guaiacol)	.45	3.0	.33
		100.00	1170.4	100.00

Pigment		43.4%
Vehicle		56.6%
Wt. per gal.		11.7 lb.
PV		24.6
Non Volatile by volume		61.8
Non Volatile by weight		77.2
Viscosity		72-80 Krebs Units at 80° F.
Grind (Hegeman Gauge)		6.5 - 8
Dry to touch	-	3 to 5 hours
Dry to recoat	-	18 to 24 hours
Reduction for Spray	-	Spray 8 to 10 parts material to 1 part V.M. & P. Naphtha or Toluol.
Reduction for Brush	-	Brush full body.

L.L.A. FORMULA 2633

Specifications shall be as follows:

Basic Lead Silico Chromate - This is a chemical combination of its constituents. Mechanical mixtures to approximate its composition are identifiable and will not be acceptable.

Properties	Min.	Max.
Chromium Trioxide (CrO_3)	5.10%	5.60%
Course Particles (325 mesh)	-	0.20%
Ignition Loss	-	0.20%
Lead Monoxide (PbO)	46.20%	48.70%
Oil Absorption (gms. per 100 gms.)	10.00	18.00
Silicon Dioxide (SiO_2)	45.90%	46.90%

Titanium Dioxide - Federal Specification TT-T-425a, Type III.

Nuact Paste - This is a paste "feeder drier" containing 44 per cent lead. Its use aids paints on long standing to retain their drying property. Its use in this paint is desirable but not obligatory. This ingredient is made by Nuodex Products Company.

Mineral Spirits (Aromatic) - Federal Specification TT-S-97 (2) Type II, Grade A. Boiling range 350° to 410°.

Driers: Federal Specification TT-D-643b or Class B of A.S.T.M. Standard Specification D-600-43.

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* Alkyd resin solution is TT-R-266 Type II, Class A, held strictly to the zinc neutrality test called for in the specification. A typical formula for an alkyd resin solution which works properly in this formula is processed as follows:

Alkyd Resin Solution	
Alkali Refined Linseed Oil	2,944 lb.
Penta Erythritol	336 lb.
Glycerine	314 lb.
Phthalic Anhydride	1,290 lb.
Litharge	1-3/4 lb.
Mineral Spirits	1,900 lb.

Run in a covered agitator kettle with CO_2 blanket.

Run alkali refined linseed, penta erythritol and glycerine to 200° F. Add litharge and gain 450° F. Hold for monoglyceride (1-1/2 to 2 hours) until clear in denatured alcohol. Add phthalic anhydride, gain 300° F. and hold for acid number and viscosity. Off fire, cool and reduce.

Body - Z to Z 1, NV 69-71%, acid no. (reduced) 4; color 5 (Nellige); Wt. 7.8 - 8.0.

oo Phenolic Rosin Penetrating Liquid: This is Rustmaster Penetrating Liquid which may be purchased from The Glidden Co., Union Commerce Building, Cleveland 14, Ohio. The Glidden Co. has a patent application covering this type of wetting agent. Other suppliers of this wetting agent are being established and details may be obtained by writing to the Lead Industries Association.

Phenolic Rosin Penetrating Liquid should have the following properties:

Wt. per gal.	- 7.40 to 7.44
Viscosity	- A - one bubble
Iodine No.	- 110 to 120
Saponification No.	- 135-150
Non Volatile by Weight	- 82 - 83%
Rosin or Rosin Derivative	- absent
Hydroxyl Value	- 1.3 to 1.5
Acid No.	- 10 to 12

Suggested Directions for Use:

Surface Preparation: Prime or spot prime with L.I.A. 2612, L.I.A. 2614 primers, or with L.I.A. 2629, Buff Intermediate if the finish coat is to be white or a pastel color.

Apply a heavy coat or coats of selected L.I.A. Finish Paint to a dry film thickness of at least 2 ± 1/4 mils. by roller, brush or spray. Reduce if necessary with not more than one pint of V.M. & P. Naphtha or Toluol to the gallon of finish coat. Dry 18 to 24 hours between coats.

L.I.A. Finish Coat colors other than black, white and aluminum, may be modified by intermixing or tinting with permanent colors ground in oil.

Where L.I.A. 2615 Aluminum is to be the finish coat, apply to a dry film thickness of 1-1/4 ± 1/4 mils. Dry 18 to 24 hours between coats.

For additional information, write to Lead Industries Association, 60 East 42nd Street, New York 17, N.Y.