MEMO TO: W. B. Drake
Assistant State Highway Engineer

P.2.3.2

FROM: Jas. H. Havens, Director
Division of Research

DATE: June 15, 1968

SUBJECT: Bridge Paint Specifications,
Proposed Revisions

REF: Mr. Vansant's memo to you, November 2, 1966

During the past several years, I have devoted considerable attention and study to bridge-paint systems and specifications--in an attempt to keep abreast with developments and current practices throughout the country. My first proposal (July 30, 1958; copy appended) was motivated by development of a then-new rust-inhibitive pigment suggested by National Lead Company. The pigment had shown considerable promise as a substitute for red lead and appeared in many respects to be superior to red lead--one of which was economy.

Certain zones of bridges are recognized as being problematical: 1) the "splash" zone, 2) horizontal flanges, and 3) zones below deck-leakage areas. Linseed oil and oil-alkyd vehicles do not withstand continuous or prolonged moisture; they tend to soften and admit moisture; nevertheless, oil-alkyds suffice otherwise. Swimming pool or water tank paints such as vinyls, chlorinated rubbers, epoxies, phenolics, and others are employed in these critical zones of bridges when adjudged to be economical in comparison to "spot" re-painting critical areas as the need arises. Vinyls require cleaning to bright metal and pre-treatment and are generally considered to be prohibitive for re-painting work due to the tedium involved. Recourse to special vehicles is more compelling in corrosive, industrial atmosphere and severe fog or ocean-spray areas of the country. A lesser alternative is to provide a thicker build of conventional types of paint in the more critical zones. There are however distinct limitations on film thickness--6 to 12 mils is considered as optimum; less than 6 mils is vulnerable to invasion of moisture; greater than 12 mils is subject to peeling due to thermal

contractions; 6 to 12 mils generally allows for re-painting without removal of all old paint. Vinyl systems are notoriously thin; whereas, chlorinated rubber paints generally result in extremely heavy builds. Considering the fact that "spot" maintenance is to be expected with any of the vehicle systems, it appears the oil-alkyd systems are generally suitable; but this should not preclude future consideration of more moisture-resistant vehicles. Organic polyesters, alkyds modified with vinyls and silicone resins, acrylics, and various zinc-rich paints may be worthy of consideration in the future.

The green, finish-coat paint system covered by Article 661.4.8 of the Standard Specifications... evolved from my memorandum proposal of March 18, 1960 (copy appended). Special Specifications 14-56 and 15-56, approved April 26, 1960, were established for experimental use on the Clark Memorial Bridge in Louisville. Due to errors, these special specifications were revised and issued as 14-56a and 15-56a, approved May 12, 1960; 14-56a was again corrected and re-issued as 14-56b. The "Phenolic Resin Penetrating Liquid" vehicle system (15-56a) was used on two ocasions: 1) the northern-half of the Clark Memorial Bridge, and 2) the toll bridge at Louisa (Kroboth Engineers, Inc.). The 14-56b system was used on the southern half of the Clark Memorial Bridge and others--Boonesboro, Irvine, West Main Street (Lexington), Jackson, etc. During the second winter after the Boonesboro and West Main Street Bridges were painted, large sheets of paint peeled from the bridges and exposed either base metal or mill scale. The accumulated thicknesses of paint measured 15 to 25 mils, and the preceeding air temperatures had fallen to -28°F. Peeling was attributed to excessive buildup of paint and the glassy texture of the mill scale. The green, finish-coat has been observed to peel considerably on other structures, and the orange, intermediate-coat presents an unsightly contrast when so exposed (see color photo, appended). I have consulted with representatives of the National Lead Company regarding this matter and it appears that the zinc oxide (about 8%) in the green-coat pigmentation cannot be held blameless. It was incorporated in the paint to impart detergency (zinc soaps) to the film in order to wash away loose chalk and be self-cleaning. Zinc oxide was known to be detrimental to adhesion in the under-coat. Apparently, the pigment was too alkaline, too soluble, and too soapy in the concentration specified. The pigment formulation was revised to exclude the zinc oxide and submitted to you in my memorandum of December 13, 1967 (copy appended). This revision was proposed for "spot" painting planned in conjunction with deck repairs on the Clark Memorial Bridge and for other bridges scheduled to be re-painted during the 1968 season. This formulation does not admit chrome green pigments, but some manufacturers have indicated that they could control color better if some chrome pigments were allowed.

Special Specification 14-56 and its revisions did not provide an aluminum finish-coat as an alternate to the green. Prior to submission of my first proposal (1958), desires were expressed that new bridges would continue to be painted aluminum but all bridges to be re-painted would be finished in green. Basically, aluminum paint systems are not rust inhibitive; however, the National Lead Company found that significant amounts of basic lead silico-chromate, which has a low tinting strength, could be incorporated into an aluminum paint and result in only a slight under-tone of orange coloration. The system was a non-leafing type of aluminum paint. I adapted this formulation into a special provision (September 19, 1962, copy appended; approved September 21, 1962, copy appended; revised, re-numbered No. 27, April 20, 1966, copy appended) for use as an alternate to the green finish-coat and also as a one-coat paint for Bailey bridge sections, guardrails, and general purposes. The system has been used to some extent by the Division of Maintenance--but not as a finish-coat on bridges.

As an alternate to the AASHO aluminum paint covered by Article 661.4.7, I drafted a special provision for a pre-mixed leafing-type, aluminum, finish-coat paint employing an oil-alkyd vehicle (proposed December 13, 1967, copy attached). This system currently covered by Special Provision 65, approved December 13, 1967 (copy appended). It is primarily intended for use as a finish-coat over the non-leafing, rust-inhibitive, aluminum used as an undercoat. This system was first used on the U.S. 62-641 bridge over the Cumberland River at the Lyon-Livingston counties line and reportedly worked quite well.

My purpose in relating this history is to provide a historical basis for a further proposal. Some time ago, I promised Mr. Vansant specific recommendations for a paint system for use on major new bridges to be built across the Ohio River. I propose the following type of system.

1. Specify commercial, blast-cleaning of all members (in shop or yard); SSPC-SP6-63

2. Prime in shop or yard within at least 24 hours after cleaning; paint to conform to PRIME COAT, attached hereto.

3. Second coat to be applied in shop or yard; paint to conform to SECOND SHOP COAT, attached hereto.

4. Clean and paint damaged and unpainted surfaces after erection; use paints as specified in 2 and 3 above.

5. First field coat to be non-leafing aluminum conforming to FIRST FIELD COAT, attached hereto.

6. Second field coat to be leafing aluminum conforming to FINISH COAT, attached hereto.

This system may reasonably be expected to provide 15 years of service-life except in persistent moisture zones--where spot-cleaning and re-painting would be required in the normal course of maintenance. Two shop and two field coats will provide about 8 mils of thickness, which is within the desirable range. The first field coat is functionally a reserve finish coat-which will prevent exposure of unsightly, contrasting colors of the base coats after loss of the topcoat. The second shop coat is considered as a bonus coat and provides extra thickness and moisture-proofing. Blast-cleaning enables use of higher percentages of alkyd resin in the primer coat, providing a harder film to permit handling of the steel with two shop coats--suffering little, if any, more scarring or other damage than may be incurred when a single coat of red-lead-in-linseed-oil primer is used. Additionally, there should be some economic advantage in application of a second primer prior to erection--that is, in comparison to application of three coats after erection. Incidentally and alternatively, there would be some advantage, over current practices, in specifying Type II and(or) Type III Red Lead (instead of Type I)(Article 661.4.2) in the event commercial blast-cleaning were required. Types II and(or) III would be compatible with the aluminum paints being proposed for the four-coat system.

Areas which are not to be shop or yard painted (bolt holes, gusset areas, field welds, etc.) should receive a coat of wash primer after surrounding areas have received the second shop coat. I suggest that the wash primer, or more specifically basic zinc chromate-vinyl butyral washcoat, be applied as outlined under SSPC-PT 3-64 of the Steel Structures Painting Council's Manual, Volume 2. The wash primer should conform to specifications for MIL-P 15328B (see Article 661.4.10, p617, Standard Specifications...) and be spread at a rate of approximately 250 to 350 square feet per gallon (dried film thickness of 0.3 to 0.5 mil). Plan notes should make it clear that the wash primer is to be used on all surfaces excluded from painting before erection. The wash primer is somewhat fugitive and will not interfere with friction at connections.

The shop primer and second coat are similar in many respects to the Type V of Federal Specification TT-P-615d, a copy of which is included in Vol. II, hereof. Other supporting documents and reference specifications are also included there. Special attention is directed to the photographic standards of surface preparation--which would become an integral part of these proposed specifications by requiring Commercial Blast-Cleaning (SSPC-SP6-63).

As mentioned before, oil-alkyds are not very resistant to sustained moisture. Vinyl-alkyd paints are vastly more resistant to both moisture and chemical attack. We may, therefore, in the future, revive and revise the vinyl-alkyd system which I first proposed July 30, 1958.

Attachments:

1. Proposed Specifications
   a) PRIME COAT
   b) SECOND SHOP COAT
   c) FIRST FIELD COAT
   d) FINISH COAT

2. December 13, 1967 Memorandum; RE: Specifications for Bridge Paints

3. November 2, 1966 Memorandum; RE: Improved Paint Protection for Structural Steel

4. Special Provision No. 25 for Maintenance Cleaning and Painting (approved April 7, 1966)

5. March 24, 1966 Memorandum; RE: Paint Systems for Structural Steel

6. Special Provision No. 27 for Non-Leafing Aluminum, Basic-Lead Silico-Chromate Oil-Alkyd Finish-Coat Paint for Guard Rails and Bridges (approved April 20, 1966)

7. Special Provision No. 27 for Non-Leafing Aluminum, Basic Lead Silico-Chromate Oil-Alkyd Finish-Coat Paint for Guard Rails and Bridges (approved Sept. 21, 1962)

8. September 19, 1962 Memorandum; RE: Proposed Specification for Non-Leafing Aluminum Paint for Guard Rail and Bridges

9. Special Specification No. 14-56b for Basic Lead Silico-Chromate, Oil-Alkyd Paint Systems for Iron and Steel Structures (Bridges) (approved May 10, 1961)

10. July 21, 1960 Memorandum; RE: Special Specs. 14-56a and 15-56a; BPR Comments, June 9, 1960

11. June 9, 1960 BPR Letter; RE: Kentucky Specifications

12. June 7, 1960 Letter to Vanguard Paints and Finishes, Inc.

13. Special Specification No. 14-56 for Basic Lead Silico-Chromate, Oil-Alkyd Paint System for Iron and Steel Structures (Bridges) (approved April 26, 1960)

14. Special Provision No. 15-56 for Phenolic Resin Penetrating Liquid Paint System for Iron and Steel Structures (Bridges) (approved April 26, 1960)

15. March 21, 1960 Memorandum; RE: Proposed Specification for Bridge Paints

16. July 30, 1958 Memorandum; RE: Proposed Specifications for Bridge Paints

17. Fundamental Principles in Paint Technology

18. Average Bulking Factors

19. An Engineering Approach to Improved Protection of Structural Steel, by H.B. Britton, New York State Department of Public Works

20. Aluminum Paints Containing Basic Lead Silico Chromate Pigments, Alcoa Research Laboratories

21. Oncor M50-Aluminum Pigment Coatings, National Lead Company

22. Standard Specifications for Aluminum Paint, AASHO: M69-54

23. Article 661.4.7, Aluminum Paint

24. Tentative Specifications for Basic Lead Silico-Chromate, ASTM: D 1648-59T

25. Federal Specification for Primer Coating: Basic Lead Silico Chromate, Ready Mixed, TT-P-615d

26. Federal Specification for Linseed Oil, Raw, (for Use in Organic Coatings), TT-L-215a

27. Federal Specification for Thinner; Paint, Volatile Spirits (Petroleum-Spirits), TT-T-291c

28. Federal Specification for Drier, Paint, Naphthenate, Liquid, Concentrated, TT-D-643d

29. Federal Specification for Pigment, Copper-Phthalocyanine-Blue, Dry, TT-P-355

30. Federal Specification for Pigment, Titanium Dioxide, (for Protective Coatings), TT-P-442

31. Federal Specification for Pigment; zinc Oxide, Dry and Paste-in-Oil, TT-P-463a

32. Federal Specification for Pigment, Magnesium-Silicate; Dry, TT-P-403a

33. Federal Specification for Varnish; Mixing, for Aluminum Paint, TT-V-81d

34. Federal Specification for Pigment, Aluminum; Powder and Paste, for Paint, TT-P-320a

35. Federal Specification for Resin, Alkyd; Solutions, TT-R-266a

36. Federal Specification for Pigment, Indian Red and Bright Red (Iron Oxide), Dry (for Use in Protective Coatings), TT-P-375

37. Surface Preparation Specifications, Steel Structures Painting Council

38. Pictorial Surface Preparation Standards for Painting Steel Surfaces, Swedish Standard: SIS 05 59 00-1962; ASTM: D 2200-63T; SSPC Visual Standard: SSPC-Vis 1-63T

39. Steel Structures Painting Manual - Volume 2 - Systems and Specifications, Steel Structures Painting Council

cc: G.F. Vansant (Vols. I and II, Copy 2 of 3) Research Division File P.2.3.2 (Vols. I and II, Copy 3 of 3)

PRIME COAT

	Per Cent by Wt.	
1. Composition of Pigment	Min.	Max.
Basic Lead Silico-Chromate (ASTM D 1648-59T)	64.0	...
Red Iron Oxide (Siliceous, 85% Fe_2O_3) (ASTM D 84-51 Class III, Type A)	...	35.0
Organo-Montmorillonite	.3	.6
2. Composition of Vehicles	Min.	Max.
Raw Linseed Oil, (TT-L-215a or ASTM D 234)	48.0	...
Alkyd Resin Solution (70% N.V.) (TT-R-266a; Type I, Class A)	35.0	...
Mineral Spirits, Heavy (TT-T-291c)	...	15.7
Lead Napthenate (24%pb) (TT-D-643d or ASTM D 600, Class B)	.6	.7
Manganese Napthenate (6%Mn) TT-D-643d or ASTM D 600, Class B)	.3	.4
Anti-Skinning Agent (Guaiacol)	.1	.2
Non-Volatiles	71.0	...
Phthalic Anhydride in Non-Volatile Vehicle	7.6	...
3. Composition and Properties of Paint	Min.	Max.
Pigment (% by wt.)	62.0	...
Vehicle (% by wt.)	...	38.0
Non-Volatiles (% by wt.)	88.0	...
Coarse particles and skins retained on a 325 sieve (based on the paint) (% by wt.)	...	1.0
Weight per gallon (lbs.)	14.8	...
Consistency (in gms*, mod. Stormer)	160	210
Equivalent K.U.	74	84
Fineness of Grind (Hegman)	4	...
Organic Dyes	None	
Drying Time (hrs.)	...	18

* The paint shall stand 24 to 48 hours after manufacture before the viscosity is measured.

SECOND SHOP COAT

	Per Cent by Wt. Min.	Max.
1. Composition of Pigment		
Basic Lead Silico-Chromate (ASTM D 1648-59T)	99.4	...
Organo-Montmorillonite	.3	.6
2. Composition of Vehicles	Min.	Max.
Raw Linseed Oil (TT-L-215a or ASTM D 234)	48.0	...
Alkyd Resin Solution (70% N.V.) (TT-R-266a; Type I, Class A)	35.0	...
Mineral Spirits, Heavy (TT-T-291c)	...	15.7
Lead Napthenate (24%pb) (TT-D-643d or ASTM D 600, Class B)	.6	.7
Manganese Napthenate (6% Mn) (TT-D-643d or ASTM D 600, Class B)	.3	.4
Anti-Skinning Agent (Guaiacol)	.1	.2
Non-Volatiles	71.0	...
Phthalic Anhydride in Non-Volatile Vehicle	7.6	...
3. Composition and Properties of Paint	Min.	Max.
Pigment (% by wt.)	60.0	...
Vehicle (% by wt.)	...	40.0
Non-Volatiles (% by wt.)	87.0	...
Coarse particles and skins retained on a 325 sieve (based on the paint) (% by wt.)	...	1.0
Weight per gallon (lbs.)	14.3	...
Consistency (in gms*, mod. Stormer)	160	210
Equivalent K.U.	74	84
Fineness of Grind (Hegman)	4	...
Organic Dyes	None	
Drying Time (hrs.)		18

* The paint shall stand 24 to 48 hours after manufacture before the viscosity is measured.

FIRST FIELD COAT

1. Composition of Pigment	Per Cent by Wt. Min.	Max.
Aluminum Paste, Non-Leafing (65% N.V.) (Typified by Reynolds Metal Co. No. 10LN and Alcoa No. 221), (Bulking value-.0820), based on dry pigment	54.0	56.0
Basic Lead Silico-Chromate (ASTM D 1648-59T)	43.0	45.0
Organo-Montmorillonite	.8	1.2

2. Composition of Vehicles	Min.	Max.
Raw Linseed Oil, (TT-L-215a or ASTM D 234)	30.0	...
Alkyd Resin Solution (70% N.V.) TT-R-266a; Type I, Class A)	50.0	...
Mineral Spirits, Heavy (TT-T 291c)	...	.5
Aromatic Solvents (incorporated in aluminum paste)	11.7	...
Phenyl Mercury Oleate (10% Hg) (48% N.V.)	2.9	...
Zirconium Catalyst (6% Zr.)	1.1	...
Cobalt Napthenate (6% Co) (TT-D-643d or ASTM D 600, Class B)	.7	...
Calcium Napthenate (4% Ca.)	2.1	...
Anti-Skinning Agent	.3	...
Methanol (for pre-wetting Organo-Montmorillonite)	...	.1
Non-Volatiles	71.2	...
Phthalic Anhydride in Non-Volatile Vehicle	11.8	...

3. Composition and Properties of Paint	Min.	Max.
Pigment (% by wt.)	28.0	30.0
Vehicle (% by wt.)	70.0	72.0
Non-Volatiles (% by wt.)	75.0	80.0
Coarse particles and skins retained on a 325 sieve (based on the paint) (% by wt.)	...	1.0
Weight per gallon (lbs.)	9.50	9.65
Consistency (Krebs Units)	72	80
Drying Time (hrs.)		
to touch	...	6
Dry hard	...	24

FINISH COAT

	Per Cent by Wt.	
1. Composition of Pigment	Min.	Max.
Aluminum Paste (65% N.V.) (TT-P-320a; Type II, Class B), based on dry pigment	100.0	...
2. Composition of Vehicle	Min.	Max.
Alkyd Resin Solution (70% N.V.) (TT-R-266a; Type I, Class A)	68.0	...
Mineral Spirits, Heavy (TT-T-291c)	...	28.0
Manganese Naptherate (6% Mn) (TT-D-643d or ASTM D 600, Class B)	.4	...
Zirconium Octoate (6% Zr.)	2.4	...
Mildewcide (Phenyl Mercuric Oleate, or equivalent)	.9	...
*Leafing Stabilizer	...	...
3. Composition and Properties of Paint	Min.	Max.
Pigment (% by wt.)	13.0	...
Vehicle (% by wt.)	...	87.0
Non-Volatiles (% by wt.)	53.0	...
Coarse particles and skins retained on a 325 sieve (based on the paint)	...	.2
Weight per gallon (lbs.)	8.1	...
Consistency (Krebs Units)	65	80
Drying Time (hrs.)	...	24
Paint shall exhibit satisfactory leafing qualities after 30 days		
The paint container shall show no gas pressure after 30 days		

* Leafing stabilizer shall be added to the vehicle at least 18 hours before mixing the vehicle with aluminum paste; driers shall not be added until after the stabilized vehicle and aluminum paste are mixed together. The proportions of the stabilizer shall be in accordance with the pigment manufacturer's recommendations.