Research Report

KTC-92-8

SURVEY OF CURRENT BRIDGE PAINTING PRACTICES AND RELATED LITERATURE SEARCH

by

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16. Abstract

A survey on current bridge painting practices was conducted. Questionnaires were sent to all 50 state highway agencies concerning their present bridge painting practices, changes in those practices that they anticipate due to environmental regulations, and new or experimental painting practices they are investigating. Forty-three responses were received. Those are collated and presented in the appendices along with comments of the responders.

A literature search was conducted on publications related to painting of steel structures (since 1987). Forty-nine documents were identified as being relevant to the topic. Those documents are listed in bibliographic form in the appendices.

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INTRODUCTION

In February 1990, the Kentucky Transportation Cabinet (KyTC) requested that the Kentucky Transportation Center (KTC) perform a literature search of structural steel paints and bridge painting practices employed by state highway agencies throughout the U.S. Of special interest were items related to restrictions imposed by the various environmental protection agencies in those states. That request was prompted by hazardous waste restrictions KyTC officials encountered during maintenance painting operations and by indications that the KyTC paints and painting operations would be impacted by restrictions on volatile organic compounds (VOCs).

In response to that request, KTC personnel conducted a literature search and prepared and disseminated a survey questionnaire to all 50 state highway agencies. The literature search was completed within the time limit requested by the Transportation Cabinet. The literature search and survey have been completed and are provided in the appendices of this report.

This work was initially funded under quick response study, KYHPR 91-108, Subtask 15 "EPA-Compliant Paints." Due to the comprehensive nature of the questionnaire, the effort was continued under KYHPR 92-140, "Environmentally Safe Paints for Steel Structures."

LITERATURE SEARCH

A computerized literature search was performed by the KTC librarian using the Dialog Information Service. That system accessed a number of major literature files including TRIS (Transportation Research Information Services), NTIS (National Technical Information Service), Compendex Plus (Engineering Index - Engineering Information Inc.), CA Search (Chemical Abstracts Service), Enviroline (Environmental Abstracts- R.R. Bowker Co.), and SCISearch (Scientific Citation Index). The key words employed were 1) "paint," 2) "protective coating or seal coat," 3) "structural paint," 4) "structure, or "bridge," 5) "volatile organic coating," and 6) "steel." The literature search was extended back to 1970 or the beginning date of the particular literature file. The key words were used in different combinations along with the time constraint to reduce the reference list to a reasonable size. The final literature search identified 149 titles for which abstracts were obtained. Those were reviewed and 49 specific documents that were considered relevant to the needs of the Transportation Cabinet were identified. Those documents are listed in bibliographic form in Appendix I along with short descriptors extracted from the literature database abstracts.

KTC personnel attempted to identify those documents that were accessible at the University of Kentucky Engineering Library. Orders were placed for other relevant documents that were not available on campus. Several documents of foreign origin were not available even though they were listed in the literature databases. The ones obtained (and those accessible on campus) are identified in Appendix I by an asterisk beside their listing number.

KTC personnel also obtained several publications of relevance that were not provided in the literature. Those are listed in Appendix II along with brief commentaries on their content.

All literature identified and in the possession of KTC personnel or present at the University of Kentucky are available to KyTC personnel on request.

QUESTIONNAIRE

As a follow-up to the literature search, KTC personnel prepared a questionnaire on bridge painting for distribution to state highway agencies. Initially, the subject of the survey was to be limited to EPA-compliant (low VOC) paints. However, KTC investigators felt that a broader survey would provide useful guidance in planning work for study KYHPR 92-140. Questions were added concerning: 1) paint specifications, 2) encapsulation paints and coatings for covering existing lead-based paints on bridges, 3) alternate coating practices (e.g. diffusion bonding or metallizing), 4) job-site VOC restricting practices (e.g. complete shop painting or renewable paint systems) and 5) maintenance painting practices including topcoating and spot painting.

Survey responses were obtained by December 1991. Forty-three state highway agencies responded to the questionnaire. Those responses were collated and a copy of the completed survey was provided to the SAC chairman for KYHPR 91-108, Subtask 15 in March 1992 along with specifications and special provisions provided by the responding state highway agencies. A copy of the collated survey is contained in Appendix III.

The survey results have not been summarized in detail. Tabulations for results of most survey questions are provided in Appendix III. Comments by the various state highway agency responders are also provided.

FUTURE WORK

The information referred to in this report will be reviewed by KTC investigators. The subsequent findings will be reported to the Study Advisory Committee members and other KyTC personnel directly involved with structural steel coatings. Promising coatings and painting practices enumerated by the literature search and the survey will shall be investigated during the course of this study (KYHPR 92-140). The results of those efforts will be formally reported at a later date.

APPENDIX I

Literature Search Related to Bridge Painting
(* Indicates Documents Available within KTC or the University of Kentucky Engineering Library)

REFERENCES

1.* Appleman, B.R.; Weaver, R.E.F.; and Bruno, J.A. Jr., "Performance of Alternate Coatings in the Environment (PACE). Volume II: Five-Year Field and Bridge Data of Improved Formulation," Structural Steels Painting Council, Pittsburgh, PA, and Federal Highway Administration, Turner-Fairbank Highway Research Station, McLean, VA, Report No: FHWA-RD-89-235; SSPC-89-11, Sept. 1990.

Results from a 5-year field study on advanced formulations and surface cleaning techniques for coating systems for steel bridges are presented.

2.* King, P.L., "Evaluation of Alternate Coatings for Structural Steel Protection. Final Report," Georgia Department of Transportation, Forrest Park, GA, Federal Highway Administration, Washington, DC, Report No: FHWA-GA-90-8005; GDOT RP 8005, May 1990.

During the course of this project, several different types of coating systems were evaluated under a variety of application and exposure conditions.

3. Dravitzki, V.K., and Potter, S.M., "Maintenance Painting of Weathered Galvanized Steel," Works and Development Services Corp., Lower Hutt, New Zealand, Report No. 88-B7302, 1988.

A range of alternative generic paint types were tested to determine the most suitable system to maintain aged galvanized steel bridges. Thirty-one different systems were subjected to both accelerated laboratory testing and exposure to natural weathering.

4. Rogerson, A., "Structural Steel Coatings and Pretreatments for Use in Lieu of Blast Cleaning: Report," California Department of Transportation, Sacramento, CA, Report No. FHWA/CA/TL-88-04, June 1988.

No abstract provided.

5. Kogler, R., and Mott, W., "Transportation Department Surveyed for Coatings Specifications," Journal of Protective Coatings and Linings, Volume 7, Number 9, pp 27-29, September 1990.

This article reports a survey of 50 state departments of transportation, which assessed the current generic types of coating systems used by the various states for corrosion protection of steel bridge structures.

6.* Race, T.; Hock, V.; and Beitelman, A., "Performance of Selected Metallized Coatings and Sealers on Lock and Dam Facilities," Journal of Protective Coatings and Linings, Volume 6, Number 8, pp 37-44, August 1989.

An evaluation of the performance of eight coatings and sealers used in the *maintenance of lock and dam structures in the Ohio River is reported. The criteria used to select coatings and sealers for the evaluation are outlined, and the application procedures for each material are explained.*

7.* Kayser, J.R. and Nowak, A.S., "Capacity Loss Due to Corrosion in Steel-Girder Bridges," Journal of Structural Engineering, Volume 115, Number 6, pp 1525-37, June 1989.

In this study, a model of deteriorating capacity was developed by combining information on the location and rate of corrosion with the structural analysis of corroded members. The model was used to evaluate two typical structures in a corrosive environment.

8.* Raczon, F., "Specifiers Guide to Steel Bridge Coatings," Roads & Bridges, Volume 26, Number 11, p 78, November 1988.

Charts are presented which provide information on various types of coatings used for steel bridges and substructures.

9.* Culp, J.D, Reinke, J.W. and Tinklenberg, G.L., "Total Shop Painting of Steel Bridges," Public Works, Volume 119, Number 12, pp 48-50, November 1988.

This article discusses the extensive program undertaken by the Michigan Department of Transportation coatings laboratory which has resulted in the development of specifications for fully shop painted steel for new bridges.

10.* Peart, J.W., "Lead-Pigmented Paints - Their Impact on Bridge Maintenance Strategies and Costs," Public Roads, Volume 52, Number 2, pp 47-51, September 1988.

This is an examination of the problems associated with the removal of lead-based paint and an assessment of the impacts on maintenance strategies and costs. A National Cooperative Highway Research Program (NCHRP) project coordinated by the Transportation Research Board to investigate the problems associated with the removal of lead-based paint is reported.

11.* Hare, C.H., "Protective Coatings for Bridge Steel," Transportation Research Board, Washington, DC, Report No: SHP 136, December 1987.

This synthesis will be of interest to bridge designers, materials engineers, and others concerned with coating systems used to protect bridge steel from corrosion. Information is presented on the causes of steel corrosion and the types of surface preparation and coatings used to protect the steel.

12.* McNeil, S. and Finn, A.M., "Expert System to Cost Feasible Bridge-Painting Strategies," Transportation Research Board, Washington, D.C., Report No: TRR 1145, 1987.

A prototype bridge expert system building program is based on a decision network. The system allows the user to establish the facility condition, evaluate the need for bridge painting, identify appropriate painting strategies, and cost the strategies. The system and its operation are described and several areas for research to extend and enhance the system are identified.

13. "Improving the Field Reliability of Protective Coatings. Proceedings of the Steel Structures Painting Council 6th Technical Symposium November 2-5, 1987, Orlando," Steel Structures Painting Council, Pittsburgh, PA, November 1987.

Compendium of papers presented at the subject conference.

14.* "Innovative Practice. Steel Grit for Field Blasting," Journal of Protective Coatings & Linings, Volume 4, Number 9, pp 3-4,57, September, 1987.

It is claimed that one ton of tempered steel grit (hardness of 55-60 Rc) will do the same cleaning as 100-150 tons of sand, and that it may be recycled from 200 to 2,000 times. Steel grit has been used in field blasting operations inside ships, in toruses in nuclear power plants, and inside a land-based petrochemical storage tank. Recycling is made possible by portable blast systems designed to use steel grit.

15.* "SSPC to Survey Accelerated Tests - User Experience Sought," Journal of Protective Coatings & Linings, Volume 4, Number 2, pp 4-6,62, February 1987.

An SSPC (Steel Structures Painting Council) survey of accelerated test methods of anti-corrosive coating performance will (1) identify types of test coatings, (2) collect data, and (3) compile and analyze data.

16.* "Urethane Coatings Control Rust in Florida," Better Roads, Volume 58, Number 1, p 38, January 1988.

Tests made at the end of the first year in a 3-year test showed no signs of rusting in the steel supporting I-beams of a concrete bridge in Florida coated with urethane, zinc-rich coating systems.

17.* Smith, L., "Maximize Coating Life, Minimize Maintenance," Roads and Bridges, Volume 25, Number 11, pp 72-79, November 1987.

Lead-based primers with oil/alkyd binders have been the basis for most bridge coating systems. Paints in recent years have progressed to include high performance coatings based on zinc-rich primers in harsh environments. Regulations may mandate volatile organic content (VOC) compliant coatings that will limit the coatings that can be used. Alternative coating systems and their methods of protecting steel are described.

19. Lipfert, F.W., "Characterization of Painted Surfaces in the United States from the Perspective of Potential Damage from Acidic Deposition," Department of Energy, Washington, D.C., Report No: BNL-42768, March 1989.

Data on the types and applications of exterior paints used in the United States are reviewed from the perspective of potential damage by air pollution or acidic deposition.

20.* Race, T.D.; Hock, V.F.; and Beitelmen, A., "Evaluation of Abrasion-Resistant Metallized Coatings for Civil Works Applications," Construction Engineering Research Lab. (Army), Champaign, IL, Report No: CERL-TR-M-90/06, February 1990.

No abstract provided.

21. "Symposium on Anticorrosive Pigments, Binders and Paints, Held in London, England on March 11-12, 1987," Paint Research Association, Taddington, England, March 1987.

How paints protect from corrosion.

22.* "Zinc and Zinc Alloys as Protective Coatings. January 1975-March 1989," National Technical Information Service, Springfield, VA, March 1989.

This bibliography contains citations concerning the corrosion protection of materials by means of zinc coatings, exclusive of electroplating and electrodeposition. Zinc rich paints and metallization are discussed as well as polymeric coatings based on zinc.

23. "Zinc and Zinc Alloys as Protective Coatings. January 1970-March 1989," National Technical Information Service, Springfield, VA, March 1989.

This bibliography contains citations concerning the corrosion protection of materials by means of zinc and zinc rich paints and metallization are discussed, as well as polymeric coatings based on zinc.

24. Moran, P.; Simpson, T.; Davis, G.; and Arah, C.; "Analytical Techniques for Assessing the Effects of Acid Deposition on Painted Steel Substrates," Environmental Protection Agency, Research Triangle Park, NC, Report No: EPA/600/3-88/045, November 1988.

The report summarizes the outcome of studies performed for the period of October 1, 1987-May 15, 1988 of the first year of the program at the Johns Hopkins University and Martin-Marietta Laboratories.

25.* Hearst, P.J., "Performance Prediction for Coatings. Proceedings of a Workshop at the Naval Civil Engineering Laboratory, 15 September 1986," Naval Civil Engineering

Laboratory, Port Hueneme, CA, Report No: NCEL-N-1777, October 1987.

A Workshop on Performance Prediction for Coatings was held at the Naval Civil Engineering Laboratory (NCEL) on 15 September 1986. The workshop was held in conjunction with a task entitled Accelerated Testing of Paints, the objective of which is to develop test methods for assuring that the proper coatings, meeting the specification and performance criteria, are procured and properly applied at Naval shore facilities.

26.* Appleman, Bernard R., "Performance Standards for Low VOC Coatings," Journal of Protective Coatings & Linings, Volume 7, Number 11, pp 106-114, November 1990.

It is shown that for industrial maintenance coatings, the most widely accepted means for evaluating long-term corrosion protection is exterior performance testing. However, with traditional exposure techniques, 5 years or more may be required to evaluate new coating systems. The SSPC (Steel Structures Painting Council) is developing innovative performance standards, which provide a means of evaluating new systems having known performance histories.

27.* Rex, Janet, "Review of Recent Developments in Surface Preparation Methods," Journal of Protective Coatings & Linings, Volume 7, Number 10, October 1990.

The purpose of this article is to map out what's new in the field of surface preparation today: the issues, the arguments, and the various available methods.

28.* Allwood, R.J. and Cooper, C.N., "Use of an Expert System in Selecting Paint Schemes to Protect Structural Steelwork," Structural Engineer, Volume 68, Number 7, pp 133-136, April 1990.

The task of selecting an economic but effective paint scheme to protect structural steelwork is specialized and requires knowledge outside that of the majority of structural engineers. This paper describes how knowledge about collecting paint schemes may be expressed in a form suitable for the new computing technology of expert systems, resulting in an immediately available 'design assistant'.

29.* Van Rijn, C., "Technical and Economic Aspects of the Application of Duplex Systems," HSB International, Volume 38, No.2, pp 61-63, February 1989.

Hot-Dip galvanized steel may be treated with organic protective coatings such as paint systems, powder coatings and plastic coatings. This combination, steel plus coating, is known as the duplex system. Duplex systems are applied not only on steel which is present in a highly aggressive environment but also on a zinc coating which would not be able to protect the steel for a sufficiently long period.

30.* "Tape/Shield System Stops Piling Splash-Zone Corrosion," Ocean Industry, Volume 24, Number 11, pp 47-48, November 1989.

The well known offshore problem of tubular damage from corrosion in the splash zone where highly oxygenated salt water aggressively attacks steels became serious for operators of a 4-yr-old, three-mile long loading wharf at Abbot Point in Queensland, Australia.

31.* Matsumo, Masaru; Shiraishi, Naruhito; Rungthongbaisuree, Somkiat; and Kikuta, Tamito, "Corrosion of Steel Bridges. Its Long-Term Prediction and effect on the Safety," Proceedings of the Japan Society of Professional Engineers, Volume 410, Number 1-12, pp 59-67, October 1989.

Corrosion deterioration characteristics of the structural steel bridges, especially plate girder bridges are studied in this paper. The parts of bridges that are severely corroded are also investigated. Emphasis is placed on the prediction of corrosion (based on the steel exposure test, paint life, and corrosion ratio) of painted bridge members.

32. Xu, Guoping, and Albrecht, Pedro, "Primer/Fireproofing Compatibility," Modern Steel Construction, Volume 29, Number 4, p 18, July 1989.

No abstract provided.

33.* Appleman, Bernard R., "Coatings for Steel Structures: Regulations on Specifications and Procurement," Construction Specifier, Volume 42, Number 3, pp 88-93, March 1989.

During recent years, coatings have been severely influenced by regulations, most significantly those issued by the U.S. Environmental Protection Agency (EPA) and by state and local departments of environmental resources. To a lesser degree, occupational health and safety regulations have also influenced coating use. This article describes some of the most important restrictions on coatings, including the nature of the regulations, their impact, and how the industry is adapting to these regulations.

34. Morcillo, Manuel, "Comportement des Peintures Anticorrosion Formulees avec des Pigments non-Toxiques. [Behavior of Anticorrosive paints formulated with non Toxic Pigments]," European Coatings Journal, p 10, April 1988.

No abstract provided.

35.* Kihira, Hiroshari; Ito, Satoshi; and Murata, Tomomi, "Development of a Field Monitoring Method for the Protective Properties of Rust and Paint Films on Steel Structures," Key Engineering Materials, Volume 20-28, Number 4, pp 4023-4030, 1989.

In order to assess the protective properties of rust films formed on weathering steel, electrochemical A.C. impedance and harmonic current measurements were made mainly in 0. 1-m Na_2SO_4 solution.

35.* Schweinberg, D.Paul; George, Graeme A.; Nanayakkara, Asanka Kuruppr; and Steinert, Dale A., "Protective Action of Epoxy Resins and Curing Agents - Inhibitive Effects on the Aqueous Acid Corrosion of Iron and Steel," Corrosion Science, Volume 28, Number 1, pp 33-42, 1988.

Two epoxy resins examined for their inhibitive effects toward pure iron and mild steel in 0.5-m deaerated H_2SO_4.

36.* Tator, Kenneth B., "Coatings - The Challenge of the 1990's," Materials Performance, Volume 26, Number 11, pp 9-10, November 1987.

The author summarizes the yearly cost of metallic corrosion in the U.S. and the amount spent for protective coatings and services. The coatings industry has been responsive to enacted and proposed legislation limiting the use of potentially harmful or toxic raw materials of surface preparation and/or application techniques.

37.* Mitchell, Michael and Baldry, Ian, "Protecting Structural Steel," Civ Eng, pp 54-56, August 1987.

This is an article to help paint system specifiers arrive at effective economic specifications for protecting structural steel against corrosion.

38.* Smith, Malcom and Baldry, Ian, "Protecting Structural Steel," Civ Eng, pp 24-26, September 1987.

Because the reaction products of zinc, with rain water, are alkaline, they react with saponifiable vehicles (e.g., alkyds), which consequently cannot be used as binders for zinc primers. The most suitable resins are epoxy, polyurethane, silicate, or chlorinated rubber.

39.* Kirk, W.W., "Metallic Sheathing for Protection of Steel in Seawater," Materials Performance, Volume 26, Number 9, pp 23-28, September 1987.

A review of 37 years of experience with metallic sheathing to protect the splash and tidal zones of structural steel in seawater is presented.

40.* Caron, John, "State-of-the-Art Application Technology for Protective Coatings," Journal of Protective Coatings & Linings, Volume 4, Number 9, pp 44-48, September 1987.

There is little material in print about application equipment for protective coatings, except for a few general training guides from equipment manufactures and a brief chapter in the Steel Structures Painting Manual, Volume 1, Good Painting Practice. More information on application has been developed in the area of products finishing, particularly on new technologies such as air-assisted airless,

electrostatics, and automation. This paper attempts to translate some of those emerging technologies to field application of protective coatings on large structures.

41.* Morrow, Hugh III, "Economics of Thermal Spraying for the Long-Term Corrosion Protection of Steel Structures," Journal of Protective Coatings & Linings, Volume 4, Number 1, pp 39-47, January 1987.

Metallizing is one of the most cost-effective techniques available today for the long-term corrosion protection of large steel structures such as bridges. Structures in Europe and Canada have demonstrated that thermal spraying life-cycle costs are equal to or less than those of three-coat paint systems.

42.* Mori, Minoru; Yamamoto, Akitoshi; Takashima, Akira; Akao, Hiroshi; Nagamatsu, Yoshitaka; and Furukawa, Mitsuo, "Atmospheric Corrosion of Low-Alloy Steel Oversea Bridge," Transactions of the Iron and Steel Institute of Japan, Volume 27, Number 5, p B.153, 1987.

The object of this study is to confirm the corrosion resistance of a low alloy steel treated by a chemical conversion coating for a large non-painted bridge. The paper describes the corrosion loss and deterioration of the coating after five years. The coated steel exhibits superior anti-corrosion properties.

43.* McKaveney, J.P., "Synergism Between Chemistry and Metallurgy for Invention," Journal of Metals, Volume 39, Number 3, pp 42-45, March 1987.

This paper discusses the development of corrosion resistant and electronically conductive coatings based on physical property behavior learned from steel industry research.

44.* Pereira, D.; Scantlebury, J.D.; Ferreira, M.G.S.; and Almeida, M.E.; "The Application of Electrochemical Measurements to the Study and Behavior of Zinc-rich Coatings," Corrosion Science, Volume 30, Number 11, pp 1135-47, 1990.

No abstract provided.

45.* Bonora, Pier Luigi, "Characterization, Pretreatments and Protecting of Galvanized Steel," FATIPEC-Kongr., Volume 4, Number 19, pp 1-22, 1988.

No abstract provided.

46.* Robinson, Alan, "Environmental Testing of Paint Systems for Steel Structures by the Construction Group of the Department of Administrative Services 1962-1987," Surface Coat. Aust., Volume 25, Number 3, pp 15-18, 1988.

The paper summarizes results of exposing coating systems for Structural Steelwork protection by the Federal Department of Housing and Construction since 1962.

APPENDIX II

Publications Related to Bridge Painting Obtained by KTC Personnel

Painting-Related Publications

1. Hare, C.H., **The Painting of Steel Bridges**, Clive H. Hare Inc. Holbrook, MA, 1987.

2. Suzuki, I., **Corrosion-Resistant Coating Technology**, Marcel Dekker Inc. New York, NY, 1989.

3. "Advances in Accelerated Testing and Coating Characterization," Steel Structures Painting Council, Pittsburgh, PA, No. SSPC 91-15.

4. Drisko, R.W., "Painting of Facilities," Prepared for Air Force Engineering and Services Center, Tyndall AFB, Florida, September, 1983.

5. "Proceedings of the Seminars," Steel Structures Painting Council, Pittsburgh, PA, SSPC 90-10, 1990.

6. "Corrosion in Civil Engineering," Proceedings of the Conference Jointly Sponsored by the Institution of Corrosion Science and Technology and the Institution of Civil Engineers, Pub. Thos. Telford Ltd., London, England, 1979.

7. Ray, C.J; Henton, L.E. and Rideout, F.A., "Improved Field Reliability of High Performance Coatings, Phase I - Identification of the Technology Base," Georgia Institute of Technology, Atlanta, GA, and Federal Highway Administration, McLean, VA, Report No. FHWA/RD-82/118, September, 1986.

8. Starr, T.L.; Henton, L.E.; Lewis, W.S. and Rideout, F.A., "Improved Field Reliability of High Performance Coatings, Phase II - Develop Procedures and Criteria in Critical Performance Areas," Georgia Institute of Technology, Atlanta, GA, and Federal Highway Administration, McLean, VA, Report No. FHWA/RD-85/052, April, 1985.

9. Ray, C.J; Henton, L.E. and Rideout, F.A., "Improved Field Reliability of High Performance Coatings, Appendix A - Best Current Technology," Georgia Institute of Technology, Atlanta, GA, and Federal Highway Administration, Turner-Fairbank Highway Research Station, McLean, Report No. FHWA/RD-82/119, September, 1986.

10. Hazenstab, S. Ed.,"Shop Cleaning and Painting of Steel," Steel Structures Painting Council, Technology Publishing Co., Pittsburgh, PA, SSPC 90-05, 1990.

11. Appleman, B.R.; Weaver, R.E.F. and Bruno, J.A. Jr., "Performance of Alternate Coatings in the Environment (PACE). Volume I: Ten-Year Field Data," Structural Steels Painting Council, Pittsburgh, PA, and Federal Highway Administration, Turner-Fairbank Highway Research Station, McLean, VA, Report No: FHWA-RD-89-127; SSPC-89-03, Sept. 1990.

12. Robinson, R., "A New Look at Galvanized Bridges, Civil Engineering, New York,

NY, July 1991, pp. 52-55.

13. Vavarapis, K.E. and Laguros, J.G., "Maintenance Strategies for Corroded Structural Steel," Office of Research, University of Oklahoma, Norman, OK, ORA 158-266, February 1991.

14. Chong, C. and Peart, J, "Evaluation of Volatile Organic Compound (VOC) - Compatible High Solids Coating Systems for Steel Bridges," Federal Highway Administration, Office of Engineering and Highway Operations R&D, Report No. FHWA-RD-91-054, August 1991.

APPENDIX III

Bridge Paint Questionnaire Summary and Comments

KENTUCKY TRANSPORTATION CENTER
BRIDGE PAINT QUESTIONNAIRE
RESULTS

Alabama ... al	Hawaii .... hi *	Massachusetts .. ma	New Mexico .... nm	South Dakota .. sd *
Alaska ... ak	Idaho ...... id	Michigan .... mi *	New York ...... ny	Tennessee ..... tn
Arizona .... az	Illinois il	Minnesota ..... mn	North Carolina ... nc	Texas .... tx
Arkansas .. ar	Indiana .... in	Mississippi ..... ms	North Dakota ... nd	Utah .... ut
California .. ca	Iowa ...... ia	Missouri .... mo	Ohio .... oh	Vermont ...... vt *
Colorado ... co	Kansas .... ks	Montana ...... mt	Oklahoma .... ok	Virginia ...... va
Connecticut . ct	Kentucky ... ky	Nebraska .... ne	Oregon .... or	Washington .... wa
Delaware .. de *	Louisiana .. la	Nevada .... nv	Pennsylvania ... pa	West Virginia .. wv
Florida .... fl	Maine ...... me	New Hampshire .. nh	Rhode Island .... ri *	Wisconsin ..... wi *
Georgia .... ga	Maryland .. md	New Jersey ..... nj	South Carolina ... sc	Wyoming ..... wy

* States that did not respond to survey.

1. a. Does your agency currently specify paints by formulation or by performance-based qualified product lists or both?

FORMULATION	16	(ak)(az)(ar)(id)(in)(ks)(ky)(md)(mo)(mt)(ne)(nh)(ok)(or)(sc)(wy)
Q.P.L.	11	(ct)(fl)(nv)(nj)(nm)(nd)(pa)(tn)(ut)(va)(wv)
BOTH	16	(al)(ca)(co)(ga)(il)(ia)(la)(me)(ma)(mn)(ms)(ny)(nc)(oh)(tx)(wa)

COMMENTS:

(al) - We are presently in the process of changing from formulation specifications to performance based specifications and qualified products list.

(az) - Formulation based on acceptable historical evidence of performance in the field.

(ca) - There have been comments from some managers about changing to qualified products lists entirely. However, others oppose that concept.

(il) - Both our alkyds and inorganic zinc/vinyls are formulation-based, and our aluminum epoxy mastic is primarily performance-based.

(ks) - Paints are specified by formulation and are placed on a pre-qualified products list after laboratory testing.

(md) - We presently specify paints by formulation and do not plan to go to a performance-based qualified products list.

(nd) - Paints are performance based for primers and % solids and sag resistance for top coats.

(wy) - We currently specify paints by compositional formulation. A history of very good field performance coupled with a mild environment does not prompt change to qualified products list.

b. If your agency plans to eventually change from paint formulation specifications to performance-based qualified products lists, please indicate.

COMMENTS:

(al) - We are presently in the process of changing from formulation specifications to performance based specifications and qualified products list.

(il) - Because most new coatings are proprietary, future specs will unfortunately have to be performance based.

(ma) - We will eventually use a performance based qualified products list.

(mn) - The trend is towards performance based specifications.

(nh) - We may try performance based specs on some upcoming major painting contracts.

(wv) - We do not specify paints by formulation. Our specifications specify certain requirements which a paint has to meet. It is up to the paint manufacturer to formulate the paint to our specifications.

2. Does your agency currently develop and evaluate paint formulations for their eventual use in formulation-based paint specifications?

YES	12	(ca)(co)(ga)(in)(ia)(la)(mo)(mt)(nc)(tx)(wv)(wy)
NO	31	(al)(ak)(az)(ar)(ct)(fl)(id)(il)(ks)(ky)(me)(md)(ma)(mn)(ms)(ne)(nv)(nh)(nj)(nm)(ny)(nd)(oh)(ok)(or)(pa)(sc)(tn)(ut)(va)(wa)

3. a. Does your agency currently conduct or specify laboratory tests for physical properties and/or formulation characterization (fingerprinting) of paints?

YES	34	(al)(az)(ca)(co)(ct)(fl)(ga)(id)(il)(ks)(ky)(la)(me)(md)(ma)(mn)(ms)(mo)(mt)(ne)(nh)(nj)(nm)(ny)(nc)(pa)(sc)(tn)(tx)(ut)(va)(wa)(wv)(wy)
NO	9	(ak)(ar)(in)(ia)(ne)(nd)(oh)(ok)(or)

b. If so, identify the tests your agency performs or specifies and the sampling frequency.

COMMENTS:

(al) - Infrared identification of vehicle component, weight per volume at 77°F, consistency, Krebs units at 77°F, weight percent volatile liquid of the mixed coating, weight % of metallic zinc in the cured zinc primer coat dry film, weight % of metallic zinc in the zinc pigment component, and pot life of mixed coatings.

(az) - ASTM D262, G53; D2805, E97; Fed. Standard No. 141 Method D6221; ASTM D1475; D3723; D2369; D3359; Procedure B; D2697; D1210; D562; D1640; D3960-90; D480; D2354; F.S. 595B, TTP-19-D. The sampling frequency is at least one sample per lot and/or per project.

(ca) - Non-volatile content, pigment, density, viscosity, dry time, and routine on each batch. Grind, pH, IR, and X-ray diffraction occasionally.

(co) - Viscosity, dry time, % solids, % pigment, % alkyd, pigment composition grind, and other physical properties such as color.

(ct) - Weight per gallon (lbs.), % total solids by weight, % pigment by weight, % total solids by volume, viscosity, pot life, sag resistance, recommended mils dft, and maximum thinning fluid ounces and VOC. Sampling frequency is for each batch of paint.

(fl) - Tests include fingerprinting, viscosity, weight per gallon, and total solids and percent pigment. Sampling frequency is one quart sample per batch.

(ga) - North standard grind, krebs viscosity, and the following ASTM tests: D185, D1475, D1640, D2698, and D2832. Sampling frequency is 1 sample per batch (250 to 500 gallons)

(id) - Total solids, pigment solids, viscosity, color, and weight per gallon.

(il) - Each lot is sampled at the source. Routine tests include weight/gallon, viscosity, grind, pigment content, and drying time. Occasionally GC, FTIR, and X-ray are performed.

(ks) - Non-volatile material, pigment composition, weight per gallon, zinc in dried film, pot life, color, salt fog and water resistance (pre-qualification only). Samples are taken from each project for testing.

(ky) - Paints are tested in accordance with Federal Standard No. 141, Methods 4321 and 4331.

(la) - We specify numerous tests which depend on the coating being tested. Typical tests include: solids, weight per gallon, nonvolatile vehicle, drytime, fineness, epoxy equivalent weight, amine number, pigment, IR, X-ray diffraction. Paint is tested for qualification and then each batch is tested before use.

(ma) - Weight per gallon, fineness of grind, viscosity, pigment content non-volatile vehicle, and dryness time. All samples are IR identification of vehicle (random).

(me) - Viscosity, drying time, grind, pigment content, or non volatile in vehicle. No sampling frequency mentioned.

(md) - Tests include infra-red spectrographs, total solids by weight (%), viscosity, unit weight, X-ray pigment, pot life, dry time, and IR vehicle. All our paints must be pre-approved prior to shipping to the project or fabricator.

(mn) - Tests are viscosity, WPG, drying time, infrared spectrum, % pigment and % solids. One sample per lot (batch).

(ms) - Tests are salt water resistance, weathering resistance, weather and salt fog resistance. resistance to elevated temp. and thermal shock, and flexibility test. X-ray, GC, AA, IR & UV are used when called for. Sampling frequency is not used.

(mo) - Tests for physical characteristics: viscosity, % pigment, % total solids, % vehicle solids, weight per gallon and drying times. Each batch furnished is sampled.

(mt) - MT-410.

(ne) - Percentage pigment, percentage non-volatile, weight per gallon, pigment analysis, and dry time.

(nh) - Weight per gallon, viscosity, VOC and other basic properties for all paints to be used on projects. More complex testing such as with gas chromatograph are not usually done.

(nj) - Weight per gallon, viscosity, dry time, total solids, and infra-red spectrum.

(nm) - Infra-red testing is performed on all jobs with random sampling.

(ny) - Infra-red for fingerprinting, plus % pigment, vehicle weight per gallon, are performed for initial qualification and occasional quality control.

(pa) - Viscosity, weight per gallon, and total solids. Sampling frequency is one sample per batch.

(sc) - Basic physical properties concerning corrosion are required. No fingerprinting. No specific tests are made. Each shipment is certified.

(tn) - Total solids, weight per gallon, metallic zinc in zinc portion of pigment. Freshwater and salt fog resistance, elevated temperature and thermal shock.

(tx) - Sample each batch - IR, X-ray, galvitation, viscosity, % solids, % vehicle, dry, and grind.

(ut) - We use the fingerprint standard and then match each batch to it.

(va) - Wpg, total solids, % vehicle, % pigment, and X-ray.

(wa) - Viscosity, weight per gallon, sag, drytime, grind, and IR scan tests are run on every batch (1000 gallons). Other tests are conducted as needed.

(wv) - Viscosity, fineness of grind, drying time, gloss at 60°F, pigment % by weight, non-volatile, percent by vehicle, color shall be light gray, weight, and adhesion. Although no statistics are employed in our testing, the samples are set up on a random testing sequence. Approximately 5% fall under complete testing which includes accelerated tests. The remainder falls under reduced testing in which any or all of the remaining tests are conducted.

(wy) - Composition (Pigment and Vehicle), total solids, vehicle solids, viscosity, weight per gallon, dry time, fineness of dispersion, and chemical analysis of prime pigments. Each batch and type of paint to be used on the structure is tested.

4. a. Does your agency currently conduct or specify accelerated durability tests or field exposure tests for qualification paints? **If not, go to question 12.**

YES	27	(az)(ar)(ca)(ct)(fl)(ga)(il)(ia)(ks)(ky) (la)(me)(ms)(mo)(nm)(nj)(ny)(nc)(nd)(oh) (pa)(sc)(tx)(ut)(va)(wa)(wv)
NO	16	(al)(ak)(co)(id)(in)(md)(ma)(mn)(mt)(ne) (nv)(nh)(ok)(or)(tn)(wy)

b. If so, identify the tests your agency performs or specifies.

COMMENTS:

(az) - ASTM G53; ASTM D3359; FTM 6221 (TTP 19D). These tests are water-borne masonry stains. TTP-19-D is the basic qualification guide used for water-borne masonry stains.

(ar) - Salt fog test, accelerated weathering, humidity, and mudcracking test.

(ca) - ASTM G53, ASTM B117, outdoor exposure of test panels on rack at the Golden Gate Bridge, test panel exposure on San Francisco Bay Bridge, and limited full scale tests on various bridges in the state.

(ct) - Salt fog resistance, weathering resistance (UV exposure and moisture cycling), relative humidity resistance, abrasion resistance, slip coefficient, and adhesion.

(fl) - Our agency conducts both accelerated durability tests and field exposure tests. The Florida DOT specifications mentioned fresh and salt water tests and adhesion testing.

(ga) - The salt-fog test (ASTM B-117) and field exposure tests are performed.

(il) - Independent lab qualification tests for salt fog, QUV, and water resistance.

(ia) - Salt fog chamber, fresh-water test and thermal resistance test.

(ks) - Salt fog exposure ASTM B117 5000 hours.

(ky) - The following test are performed: resistance, fresh water resistance, salt water resistance, weathering resistance, salt fog resistance, resistance to elevated temperatures and thermal shock, and mud cracking resistance.

(la) - Salt fog, weather-ometer, QUV. Performance benchmarks are used.

(ms) - Salt water resistance, weathering resistance, weather and salt fog resistance, resistance to elevated temp. and thermal shock, and flexibility test.

(nm) - We accept QPL from other states. We also accept test results run by independent labs for paint producers. Test program is similar to Michigan program.

(mo) - Weatherometer tests and salt fog tests are conducted on paints for qualification.

(nj) - Salt fog testing and weatherometer testing.

(ny) - Salt spray for qualification.

(nc) - Tests include fresh water resistance, salt water resistance, salt fog resistance, and adhesion.

(nd) - Durability tests are required for primers. Tests are conducted by independent laboratories at the manufacturer's expense.

(oh) - Fresh water resistance - 30 days; salt water resistance - 30 days; weathering resistance - 3000 hrs; salt fog resistance - 3000 hrs; adhesion test - 400 psi min.

(pa) - We make use of Florida and New Jersey test decks.

(sc) - No exposure tests are performed. The following accelerated durability tests are performed: resistance tests (fresh water, salt water, salt fog, elevated temperature and thermal shock, weathering, and mud cracking).

(tx) - Test fence and sometimes actual structure.

(ut) - We use the Florida DOT QPL as developed by Dick Ramsey. The Florida DOT mentions fresh and salt water resistance tests and adhesion testing.

(va) - Fog, freeze-thaw, Cleveland condensing, and QUV.

(wv) - Accelerated weathering and/or salt spray tests are conducted on qualification paints.

c. Is statistical-based testing employed?

YES	0	
NO	19	(al)(az)(ca)(ct)(fl)(ga)(il)(ks)(ky)(la)(ms)(mo)(nj)(oh)(pa)(sc)(tx)(va)(wv)

5. a. Does your agency currently conduct field exposure tests of paints?

YES	20	(az)(ar)(ca)(fl)(ga)(il)(ia)(ky)(la)(me)(mo)(nm)(nj)(nc)(oh)(pa)(tx)(ut)(wa)(wy)
NO	7	(ct)(ks)(ms)(ny)(nd)(sc)(va)

b. If so, are those tests for developmental purposes or to qualify specific products?

DEVELOPMENTAL	10	(ar)(il)(ia)(la)(me)(mo)(nj)(oh)(wa)(wv)
QUALIFY	8	(az)(fl)(ga)(ky)(nc)(nm)(pa)(ut)
BOTH	2	(ca)(tx)

COMMENTS:

(nj) - At one time (1985) products were tested on a bridge on Route 37 over Barnegat Bay (marine environment) for the purpose to qualify specific products. Revised VOC regulations prohibited the use of these paints.

6. If your agency conducts field exposure tests, does it: 1) employ painted coupons, 2) paint test panels on actual structures, or 3) paint on entire bridges?

1. COUPONS	0	
2. TEST PANELS	7	(az)(nc)(nm)(ut)(wv)(fl)(wa)
3. ENTIRE BRIDGE	4	(il)(ia)(ky)(pa)
4. 1 AND 2	4	(ar)(oh)(tx)(mo)
5. 1 AND 3	1	(ga)
6. 2 AND 3	1	(la)
7. 1,2 AND 3	2	(ca)(me)

7. If your agency tests coupons or paints panels on bridges, have the test site environments been characterized and, if so, how were those sites characterized?

COMMENTS:

(az) - The job sites are characterized as being in sunlight or in shade and weather conditions are also noted.

(ar) - No characterization.
(ca) - Severe marine and moderate marine.
(fl) - All test sites are in a marine environment.
(ga) - Sites were characterized as coastal, industrial, and rural.
(il) - We do not test coupons or panels. Actual in-service coatings last approximately twice as long in rural versus urban/industrial environments.
(la) - No. We characterize as coastal, rural, urban, etc. - but corrosion rates at the sites have not been established. Various testing for NCHRP, SSPC, FHWA on coupons for paint and A588 steel have been made or are on-going.
(me) - Coastal marine environment.
(nm) - Test site is in worst winter type condition environment - moderate salting.
(nc) - Paint products inspected by the engineer and found to exhibit poor performance shall not be used. Poor performance shall be defined as any coating failing to meet ASTM D610, grade 5, or having greater than 3% rusting or disbonding before 5 years service is attained.
(oh) - Coupons must be subjected to salt spray; ie., attached to overpasses over freeways.
(tx) - Mostly two locations on coastline where we have been testing for 20 to 30 years.
(ut) - We have worked with Steel Structures Painting Council to select sites.
(wv) - We currently have two test sites. One is in a highly industrial area near a chemical company, power plant, and river. The other is in a residential area away from contaminants.

8. a. If your agency uses accelerated laboratory or field exposure testing to place paints on a qualified products list, what is the formal procedure for qualification of a manufacturer's product?

COMMENTS:

(ar) - Prior to use of any paint, the manufacturer shall furnish a certification for each lot certifying that the materials supplied conform to all the requirements specified and stating that the material is formulated the same as the material tested for manufacturer and brand name approval.
(az) - Letters are sent to vendors requesting submittals of unqualified products. Periodically, laboratory and field samples are prepared. Samples must meet minimum requirements of TTP-19-D both in laboratory testing and after 30 days exposure in the field.
(ca) - Satisfactory application and performance characteristics along with laboratory tests to determine or verify physical characteristics. Require approved material to meet physical characteristics.
(ct) - Qualification of a manufacturer's product shall include certified test reports verifying the products' conformance to the Department's standards, stated compositional and performance requirements, and a field history

documentation.

(fl) - Manufacturers or distributors seeking approval of the self-curing inorganic zinc coating system shall demonstrate the application characteristics of their products by painting approximately 500 sq. feet of steel girders under a bridge selected by the Department which shall be located in a coastal salt water environment zone. Each of the applied coating systems shall remain exposed to weathering for a period of three years at which time there shall be no evidence of blistering, cracking, peeling or loss of adhesion between coats and there shall occur not more than one percent of area in each of the sections painted.

(ga) - Criterion: 3 years of coastal exposure with an overall ASTM D610 rust rating of 8 or better.

(il) - We require independent laboratory and manufacturer certifications along with product samples for qualification. New independent lab tests and certifications are required if formulation changes.

(ia) - We provide the specs and ask for panels with the paints coated on them for accelerated tests.

(ks) - Manufacturer submits product. Laboratory physical and chemical tests are performed. If product passes these, salt fog exposure test is performed.

(ky) - The manufacturer submits resistance test data and the department performs additional physical tests.

(la) - The manufacturer must submit a standard "Qualified Product Evaluation Form," product data sheets, and samples whose labels show the manufacturer's brand name, lot number or batch number, date of manufacture, mixing ratio by weight and volume of each component. The manufacturer's product shall undergo accelerated testing on numerous test panels in a "Weather-O-Meter" apparatus, salt fog chamber, and QUV Weathering Tester. There is a minimum four month evaluation time period.

(ms) - The manufacturer is required to submit technical data sheets, certified test results on specified test, and samples for laboratory evaluation.

(mo) - The manufacturer shall submit in triplicate a certified test report from an approved independent testing laboratory showing specific test results conforming to all quantitative and resistance test requirements of these specifications.

(nj) - To qualify for the QPL, a candidate paint system shall meet the following criteria: 1. Must pass the specific composition criteria for the state, 2. Are required to be certified by the QPL of at least one other state DOT, and 3. Must pass the accelerated laboratory tests.

(nm) - All testing must be completed by a qualified independent testing organization selected by the supplier and approved by the Department. The supplier must bear all costs associated with testing of their products by the testing organization. A history of good field performance and/or accelerated test results must be supplied for any product not previously tested in the Department Program. All products must be lead and chromate free, except for trace amounts in dryers.

(nc) - All samples, panels, and reports shall be from the same batch of paint and shall be submitted for qualification at least 30 days in advance of anticipated need. Once qualified, a product will be placed on an approved list for a period of five years unless the formulation of the product or manufacturing process is changed, in which case, the product must be requalified before use.

(nd) - We are a small bridge paint market. Our procedure is basic. Test reports from independent labs are submitted to the Materials Division who approve it for use on DOT projects.

(oh) - Manufacturer must pay to have testing done at an approved independent testing laboratory.

(va) - There is a weighted scale and the paint system has to achieve a certain number of points.

(wa) - We do not use a QPL other than QPL 23236-42 which we use for inorganic zinc primers.

(wv) - Paints are required to have all tests in our specifications for that material conducted.

b. How do you incorporate test data into the qualification procedure?

COMMENTS:

(az) - The field sample must meet ASTM D3359. Reports are sent to vendors by formal written report.

(ar) - Prior to use of any paint, samples from each lot will be taken and tested by the Department and shall show compliance with all quantitative and qualitative requirements of this specification.

(ca) - List the requirements and test routinely. Also, require material to meet accelerated testing requirement and occasionally verify by testing.

(ct) - The field history shall consist of certified documentation provided by the manufacturer verifying successful use of name brand coatings for the 3 coat system on 10 projects of more than 100 gallons in the field.

(fl) - Final acceptance of a paint will be based on test results of samples obtained after delivery of the paint to the job site. The test results must conform to the values and tolerances obtained for the products when they were initially qualified.

(il) - Control tests are performed on each batch.

(ia) - After testing, panels will be evaluated. For field tests, we will check yearly.

(ks) - The product must pass all tests to be placed on a qualified products list.

(ky) - The manufacturer submits resistance test data and the department performs additional physical tests.

(la) - Upon completion of the evaluation, the submitter will be notified in writing concerning the results of the evaluation and whether the product will or will not be added to the Qualified Products List. The Department reserves the right to reevaluate any product at any time.

(ms) - Having qualified, each shipment must be certified and is subject to being tested by the Department.

(mo) - The certified test report shall contain the exact ratio, by weight, of the pigment component to the vehicle component of the paint used or the tests, the lot tested, the manufacturer's name, brand name of paint, and date of manufacture. Upon approval by the engineer of this certified test report, further resistance tests will not be required, except as hereinafter noted, of that manufacturer for that brand name of paint.

(nm) - For qualified paints, the complete testing program must be completed within three years of the time of the initial application.

(nc) - Once qualified, a product will be placed on an approved list for a period of five years unless the formulation of the product or manufacturing process is changed, in which case, the product must be requalified before use.

(nd) - Each project requires submittal of certification from manufacturer that the batch supplied for the project is the same formulation as the tested product.

(oh) - Results are submitted to our laboratory for review and inclusion onto qualified products list.

(va) - Weighted scale and point system.

(wv) - Once a paint is on an approved list, the manufacturer is required periodically to submit certified test data for a specific batch of the material. The DOH also takes periodic monitor samples to ensure that the paint is of the same formulation as that approved.

9. If your agency uses performance-based qualified products lists for paints, are the lists limited to specific generic paint types?

YES	17	(az)(ca)(ct)(il)(ky)(la)(ms)(nj)(nm)(ny)(nc)(nd)(oh)(tx)(va)(wa)(wv)
NO	5	(fl)(ga)(pa)(sc)(ut)

COMMENTS:

(il) - Aluminum Epoxy Mastic.

(nj) - They are based on three basic primer types: inorganic zinc-rich, aluminum

(ny) - Epoxy mastic primers and intermediate paints, and polyurethane finish paints.

(oh) - Organic zinc primer, epoxy intermediate, and urethane top coat.
epoxy mastic, and organic zinc rich.

(tx) - Inorganic zinc, epoxy, intermediate and acrylic aliphatic urethane top coat.

(va) - Zinc rich.

(wv) - Traffic paints.

10. Does your agency rely on manufacturers data sheets to govern variables such as surface preparation, application rates, and dry film thickness or does your agency have its own requirements?

MANUFACTURER	3	(ar)(me)(nd)
OWN	18	(ct)(fl)(ga)(il)(ia)(ks)(ky)(la)(ms)(mo)(nm)(ny)(nc)(oh)(sc)(tx)(wa)(wv)
BOTH	7	(az)(ca)(ky)(nj)(pa)(ut)(va)

COMMENTS:

(az) - A reasonable combination of both are used to get the job done properly.

(ca) - We use information from manufacturers but usually change or add some additional requirements of our own.

(ky) - We rely on SSPC and our own experience. We may tighten requirements based on manufacturer recommendations. Normally we require contractors to follow these recommendations for items not covered by department specifications.

(nc) - We specify surface preparation and dry film thickness in the standard specifications and in specific contracts.

(va) - We have our own requirements for surface profiles and any film based on performance; application parameters are left to the paint company.

11. Does your agency consider test results or use by other highway agencies in selecting paints for adoption or product evaluation?

YES	21	(az)(ca)(ct)(ga)(il)(ia)(ks)(ky)(la)(me) (ms)(mo)(nj)(nm)(ny)(nd)(pa)(sc)(ut)(va) (wv)
NO	6	(ar)(fl)(nc)(oh)(tx)(wa)

COMMENTS:

(ca) - We may take the information into consideration, especially if it comes directly from the agency and not from the manufacturer. We prefer direct contact with agency performing the testing.

(ga) - We consider these items when selecting paints for product evaluation.

(ky) - In a general way.

(mo) - We contact other agencies as to what they are using and experimenting with.

12. a. Does your agency presently employ low VOC (3.5 lb\gal or less including water based) bridge paints on a routine basis? **If not, go to question 14.**

YES	21	(al)(ak)(az)(ca)(ct)(fl)(ga)(me)(md)(mn) (nh)(nj)(ny)(nc)(oh)(or)(pa)(tx)(ut)(va) (wy)
NO	22	(ar)(co)(id)(il)(in)(ia)(ks)(ky)(la)(ma) (ms)(mo)(mt)(ne)(nv)(nm)(nd)(ok)(sc)(tn) (wa)(wv)

COMMENTS:

(co) - We do not specify compliance with low VOC paints, but most of our bridge paints conform to that standard.

(fl) - Our agency uses paints that are both above and below the 3.5 lb\gal value.
(ky) - Low VOC paints are used primarily on new steel.
(la) - The coating system that we use more than 90% of the time is not VOC compliant. We have a compliant system but use it less than 10% of the time.
(md) - We specify low VOC or water based products for our shop primers.
(nm) - Some meet the 3.5 VOC. It is not a requirement.
(ny) - Low VOC solvent-borne products are used, but water borne products are not allowed. Paints are used for both fabrication and maintenance applications.
(or) - We use 3.5 lb/gal for VOCs on new steel and maintenance painting.
(wv) - We are using some water based inorganic zinc primers in some of the fabricating shops.
(wy) - The conventional alkyd-oil or alkyd bridge paints that we presently employ have VOC from 2.1 to 3.3 lb/gal.

b. If so, does your agency use those paints for both fabrication and maintenance applications?

FABRICATION	6	(ak)(ct)(ma)(mn)(nj)(ut)
MAINTENANCE	1	(oh)
BOTH	14	(al)(az)(ca)(fl)(ga)(me)(nh)(ny)(nc)(or) (pa)(tn)(va)(wy)

COMMENTS:
(ak) - Shop only.
(ct) - VOC (3.5 lb/gal or less) Used for new steel applications only.
(md) - We don't require low VOC products to be used for field painting.
(mn) - Fabrication applications only.
(oh) - Field painting only.
(or) - Looking at 2.8 lb/gal VOC.

13. a. Does your agency specify the same low VOC paint for both fabrication and maintenance applications?

YES	13	(az)(ca)(fl)(ga)(me)(nj)(ny)(nc)(pa)(tx) (ut)(va)(wy)
NO	8	(al)(ak)(ct)(md)(mn)(nh)(oh)(or)

COMMENTS:
(az) - 3.5 lbs./gal. and no halogenated volatile hydrocarbons. Also, lead compounds, soluble Barium compounds, or hexavalent chromium compounds are being banned.
(md) - We use vinyls for finish coats on new structures and we use SSPC-Paint 25 for older lead based structures. The vinyl system utilizes a tie coat 1-1.5 mils and a finish coat of 3-5 mils. The paint 25 is a 4-coat system requiring 2 mils minimum for each coat.

(nh) - New fabricated steel is painted with zinc rich primer epoxy polyamide intermediate and aliphatic urethane top coat. Maintenance painting is generally with a three coat oil alkyd system (zinc hydroxy phosphite).

(oh) - Inorganic zinc primer is used in shop with no VOC limit. We use organic zinc, epoxy, or urethane for field painting with less than a 3.5 VOC.

(pa) - New steel; IOZ primer [VOC compliant]; Existing steel - IOZ, epoxy mastic, zinc filled urethane.

b. Indicate what systems your agency employs for specific applications (i.e. number of coats, thickness, and generic paint type).

COMMENTS:

(al) - New steel maintenance work with SSPC-6 preparation - acrylic latex.
Field maintenance when using less than SSPC-6 - high solids epoxy mastic.

(ak) - Shop: first coat - waterborne inorganic zinc; second coat - epoxy
third coat - polyurethane
Maint: first coat - zinc rich urethane; second coat - epoxy; third - polyurethane.

(az) - Water borne acrylic systems are used: red prime coat (DFT not less than 2 mils and sufficient to cover blast profile); pink first field coat (DFT not less than 2 mils); finish coat shall be as specified (DFT not less than 1.5 mils, water borne aluminum, or white semi-gloss water-borne acrylic, or colored semi-gloss water-borne acrylic).

(ca) - We specify a different primer for application to new steel. Fabrication: new steel; 2 coats, 4 mil total dry film, water-borne potassium silicate, inorganic zinc primer. Maintenance: 2 coats, 4 mil total dry film primer; styrene acrylic latex, vinyl acrylic latex, or high solids phenolic tung oil (VOC 250 g/L). Use of each primer depends upon structure and location. Finish Paint: Fabrication (new steel) and maintenance painting 2 coats, 4 mil total dry film, acrylic latex and topcoat anything but urethane.

(ga) - We use a 3 coat system with 5 mil minimum total DFT and a 4 coat system (2 coats of primer) is used for heavy exposure conditions with 6.5 mils minimum total DFT.

(me) - We use a two coat epoxy mastic and a three coat oil alkyd.

(mn) - Low VOC system is 4 mils organic zinc-rich primer, 3.5 mil epoxy intermediate coat and 1 mil urethane finish for fabrication only. Maintenance painting would be non-lead to match present system (primarily oil based paints).

(nj) - Prime: aluminum epoxy mastic - 3-5 mils DFT.
Finish: aliphatic polyurethane - 2-3 mils DFT.

(ny) - A three coat system consisting of epoxy mastic primer and intermediate paints (4 mils, DFT per coat) and urethane finish (3 mils, DFT) paint is specified.

(nc) - Primer - Two component inorganic zinc silicate - 3-5 mils thick
Wash Primer - vinyl butyl - .3-.8 mils thick
Intermediate Coat - H.B. vinyl (white) - 3-5 mils thick (strip)
Finish Coat - H.B. vinyl - 3-5 mils thick

(or) - Fabrication - NASA formulated inorganic zinc 2 coats at 3 mil/coat at 0 VOC.
Maintenance - High solids epoxy 2 coats at 5 mils/coat at 1.8 lb/gal VOC.

Repair - Moisture cure polyurethane 3 coats at 3 mils zinc, 3 mils intermediate, 1.5 mils top coat (3.5 lb/gal and available in 2.8 lb/gal).

(tx) - Epoxy zinc and acrylate finish coat.

(va) - Maintenance if a total removal - zinc rich (3 mil); intermediate (3 mil), topcoat

(wy) - We employ conventional alkyd-oil primers and intermediate coat paints and alkyd top coats. We require a total of 3 coats with a minimum dry film thickness of 1.5 mils per coat.

c. If your agency specifies high solids paints, indicate the current VOC content (lb/gal). **Go to question 15.**

COMMENTS:

(ca) - VOC content is 250 g/L.

(ct) - VOC max is 3.5 lb/gal.

(ga) - The first two coats contain 2.0 lb/gal VOC and the topcoat contains 3.3 lb/gal VOC.

(nj) - The VOC limit is 3.8 lb/gal for all coatings except metallic coatings (zinc, inorganic or organic).

(or) - 1.8 lb/gal.

14. If your agency is not currently using low VOC paints for bridge applications, what paint systems do you employ (i.e. number of coats, thickness, and generic paint type)?

COMMENTS:

(ar) - Inorganic zinc solvent based 1 coat 3 mil DFT.

(co) - 3 coat alkyd (non-lead system, 1.5 mil DFT) minimum per coat and 2 coat zinc rich primer with high solids polyurethane top coat, 3 mils (DFT) each coat.

(id) - We use G.S.A. Spec. as TT-P-615, Type II primer modified to contain a non-toxic pigment. Topcoat is TT-E-529 semi-gloss enamel. Zinc primer meeting SSPC Paint 20, Type II organic is used for certain environments. Paint thickness is 5 mils minimum for a total system of prime and topcoat.

(il) - Aluminum epoxy mastic: 6-10 mils / vinyl 3-5 mils
SSPC Paint 25: 2-3 mils / Paint 25: 2-3 mils / Paint 21: 1-2 mils
Inorganic zinc: 3-6 mils / vinyl: 3-5 mils

(in) - Currently using inorganic zinc and vinyl.

(ia) - Zinc-silicate primer and vinyl topcoat (3 & 3 mils) and aluminum epoxy (4 & 4 mils).

(ks) - Inorganic zinc primer - 1 coat, 3 mils; vinyl topcoat - 1 coat, 3 mils; organic zinc primer - 1 coat, 3 mils

(ky) - 1 coat of inorganic zinc primer with 1 coat of vinyl finish; 1 coat of inorganic zinc, one coat of modified epoxy mastic

(la) - Two coats of a zinc rich epoxy and a vinyl topcoat. and five mils total zinc, 2 mils vinyl.

(ma) - Phasing out alkyd and vinyl type coatings.

(ms) - a. Inorganic zinc primer - one shop coat (2.5-4.5 mils); b. Vinyl finish coat -

(3-5 mils); c. Epoxy-polyamide mastic system - (5-8 mils) with vinyl finish coat - (3-5 mils).

(mo) - Prime coat - inorganic zinc silicate; finish coat - vinyl resin. Each coat has a 3.0 mil thickness.

(mt) - Primer: TT-P 6YSB 1st and 2nd coats are alkyd.

(ne) - Inorganic zinc primer and high build vinyl.

(nv) - Prime coat - inorganic zinc, 2.5 to 6.0 mils; intermediate coat - epoxy, greater than 4 mils; top coat - polyurethane, greater than 2.0 mils

(nm) - New bridges 1.0 zinc primer, epoxy top coat; polyurethane protective coat in regions exposed to sun.

(nd) - New steel - 3 mil DFT inorganic zinc primer coat and 4 mil DFT polyurethane finish coat. Maintenance painting - 5 mil DFT aluminum filled epoxy mastic prime coat and 4 mil DFT polyurethane finish coat.

(ok) - Current paint system: a. Inorganic zinc primer and high-build vinyl topcoat; b. Basic lead silico chromate primers: M229, Type 5 shop coat, M229 Type 2, first field coat, with aluminum paint topcoat; c. Read lead primer M72 Type 1 or 2, shop coat and first field coat, aluminum paint topcoat. All systems have thicknesses of 6 mils.

(sc) - Inorganic zinc primer at 3.5 mils.

(tn) - Inorganic zinc ethyl silicate at 2.5 mils, intermediate tie coat at 2.0 mil., high build polyurethane at 2.0 mils.

(wa) - At this time, we are using phenolic vinyl systems for field painting. Also we use vinyl and inorganic zinc with urethanes over inorganic or organic for new construction.

(wv) - Epoxy mastic maintenance coating with flake metallic aluminum pigment - 5 mils dry; organic zinc rich primer; aluminum finish coat

b. Does your agency plan to use low VOC paints for bridge applications in the future?

YES	9	(ar)(in)(ks)(ky)(ma)(ms)(mt)(ne)(wv)
NO	4	(ia)(nm)(nd)(ok)
IF REGULATED	7	(id)(il)(la)(mo)(nv)(tn)(sc)

COMMENTS:

(ar) - We will probably try water based inorganic zinc in the future.

(id) - No plans to use low VOC paints in the future unless G.S.A. specs include this as a requirement. Paint system performance is not a priority right now. The main and biggest problem is the cost of red lead containment and disposal from existing steel.

(il) - We will use low VOC systems when required to do so. We have not decided on the type.

(in) - Plan to go to low VOC paints but do not know what type yet.

(ia) - No plans.

(ks) - We are currently evaluating water-borne inorganic zinc primers and water-borne acrylic topcoats for future use.

(ky) - Yes.
(la) - The good success with our zinc system has restricted the use of our low VOC system. We plan to use low VOC when regulated.
(ma) - We are in the process of adopting low VOC, non-lead chromate for all new contracts as of August 1, 1991.
(ms) - Yes.
(mo) - No plan for low VOC unless regulated.
(mt) - We will probably go to water base.
(ne) - We are considering use of low VOC paints in the future.
(nv) - We do not anticipate using low VOC paints unless required.
(nm) - No plans for low VOC paints.
(nd) - No plan for VOC paint.
(ok) - No plans for low VOC paints.
(tn) - Dependent upon EPA.
(sc) - We will when we are required to do so.
(wv) - As low VOC paints pass our specifications, they will be incorporated into the list of products acceptable for use on our projects. We do not foresee specifying only low VOC paints within the near future.

c. If so, has your agency identified the particular paint system(s) it will adopt? What are they?

COMMENTS:
(la) - Our low VOC system uses 2 coats of a waterborne vinylidene chloride and a hard modified acrylic topcoat
(ma) - We will be using high solids IOZ, and high solid epoxy with Poly U(rethane) top coat

15. a. What are your state EPA's current VOC requirements for paints (maximum/ minimum if regulations differ within the state)?

COMMENTS:
(al) - 3.5 lb/gal maximum
(ak) - No state VOC requirements.
(az) - 3.5 lbs./gal.
(ar) - 3.5 lb/gal.
(ca) - Rules vary within the state, depending upon local air board regulations. Generally, industrial maintenance paints are limited to 420 g/L and architectural paints are limited to 250 g/L. Stricter regulations on maintenance paint scheduled for 1992-1992.
(co) - Same as federal regulations.
(ct) - VOC maximum limit is 3.5 lbs./gallon.
(fl) - Our VOC requirements are consistent with the Federal EPA guidelines.
(ga) - None.
(id) - None.

(il) - At this time there are no requirements for field bridge painting. In state fabricators must follow regulations similar to "Rule 66." We expect Federal Clean Air Act mandates to impact in 2-3 years.
(in) - None for field applications.
(ia) - 250 tons/year.
(ks) - We currently have no VOC requirements.
(ky) - Same as federal.
(la) - No VOC requirements.
(me) - Do not know.
(md) - We allow a maximum of 3.5 lbs VOC per gallon.
(ma) - None.
(mn) - We do not have a requirement for paints at the present time.
(ms) - None at the moment.
(mo) - None.
(mt) - No specific restrictions.
(ne) - Do not know.
(nv) - No VOC requirements currently exist at the state level.
(nh) - 3.5 lbs./gal. as a maximum VOC.
(nj) - 3.8 lb/gal.
(nm) - None currently. However we expect stricter regulations.
(ny) - VOC's are limited to 450 cm/liter for bridge paint.
(nc) - Not aware of state requirement.
(nd) - None that we are aware of.
(oh) - EPA has not restricted VOC's yet.
(ok) - None.
(or) - We adhere to the 3.5 lb/gal VOC limit and we are looking at 2.8 lb/gal paint systems.
(pa) - Point source for fab shops only. VOC regulations on noncompliant [3.5] are regulated by tonnage.
(sc) - None.
(tn) - None at the present.
(tx) - 3.5 lb/gal
(ut) - None.
(va) - Less than 3.5 lb/gal in shop if more than 8 hour day, 40 hr week, or 7 times per year. There are no restrictions yet on field paint although our DOT restricts to 3.5 lb/gal.
(wa) - No VOC requirements at this time.
(wv) - We currently do not have a VOC regulation for paints, however, with the rapid changing of environmental conditions, we do anticipate stricter regulations at some time in the future.
(wy) - None.

b. Do you anticipate stricter regulations or enforcement of existing regulations in the future?

YES 21 (al)(az)(ca)(fl)(il)(ks)(ky)(la)(md)(mn)

		(ms)(mt)(nv)(nm)(ny)(nc)(sc)(ut)(va)(wa)(wv)
NO	11	(ak)(ct)(ga)(ia)(id)(mo)(nh)(nd)(oh)(ok)(pa)
POSSIBLY	3	(id)(tx)(wy)

16. a. Do you foresee future EPA restrictions on other paint components that you presently employ (e.g. zinc)?

YES	16	(co)(fl)(ky)(la)(md)(me)(ms)(mt)(ne)(nc)(pa)(sc)(ut)(wa)(wa)(wv)
NO	12	(ak)(ca)(ct)(ga)(il)(in)(mn)(mo)(nv)(nm)(nh)(nd)
POSSIBLY	12	(al)(az)(ar)(id)(ia)(ks)(ma)(ny)(oh)(ok)(tx)(wy)

COMMENTS:

(al) - Zinc will probably be restricted.

(az) - That possibility is always present. All of the current systems have been considered over the last decade. Promising systems are always being field tested on "small jobs," preferably by maintenance operations.

(ca) - State regulations already list antimony, cobalt, copper, molybdenum, nickel, vanadium and zinc as toxic substances and limit their extractable and total limits in waste.

(co) - I would anticipate more regulation changes in the solvents than pigments.

(fl) - Our agency continues to evaluate alternate paint systems in anticipation of further restrictions.

(il) - We do not foresee restrictions on zinc other than possible hazardous waste listing. We have not investigated alternate systems based solely on this anticipation.

(ks) - This is a possibility. We have not investigated anything except zinc systems.

(ky) - Other paints are being investigated for various reasons.

(md) - Zinc is probably going to be restricted in the future.

(mn) - We do not anticipate restrictions on current paint systems in the foreseeable future.

(ms) - Have investigated epoxy mastic paint systems.

(mo) - Investigating use of alkyd/calcium sulfonate system to replace lead paints.

(ok) - Possibly, but we have no plans to change on that basis alone.

(or) - We are always looking for better alternatives. A good performing water based paint that can be applied in inclement or non-ideal weather conditions is what we are looking for.

(tn) - Not having been addressed on this, we can't elaborate.

(tx) - We are continuously looking for alternate or improved systems and continuously looking at reformulation to improve our coating systems.

(wa) - We still use lead! We will replace lead with zinc this year on most of our projects.

(wv) - We are constantly watching the changes in the paint market and are keeping close contact with other states for possible new or alternate systems to try.

(wy) - Future EPA restrictions are certainly possible, however this agency is not investigating alternate paint systems in anticipation of such restrictions.

b. Has your agency investigated alternate paint systems in anticipation of such restrictions?

YES	21	(az)(ar)(co)(fl)(id)(ia)(ky)(la)(md)(ma)(ms)(mt)(nc)(oh)(or)(pa)(sc)(tx)(va)(wa)(wv)
NO	5	(ks)(me)(ok)(ut)(wy)

17. a. Do you anticipate that your agency will undergo a gradual transition from its current paint system(s) to high solids paints of lower VOC content and subsequently to water-based paint systems, or a transition from your agency's current paint system directly to water-based paints?

GRADUAL TRANS.	14	(al)(id)(in)(ia)(md)(ma)(mn)(mo)(nv)(nh)(nc)(or)(sc)(wv)
DIRECT TRANS	10	(ar)(ga)(ks)(la)(ms)(mt)(ne)(pa)(va)(wa)
ALREADY USING	5	(az)(ca)(co)(nj)(fl)
NEITHER	9	(ak)(ct)(il)(nd)(oh)(ok)(tn)(ut)(wy)
BOTH	1	(tx)

b. Why do you believe that particular transition will be followed? **If you responded to question 14, go to question 25 after responding to this question.**

COMMENTS:

(ak) - Already using hi-solids,low VOC for shop painting. New bridges are painted in the shop.

(az) - We have adopted a water-borne system to come into compliance with VOC requirements.

(ca) - Already changed to water-borne or high solids paint system. This transition was started in 1976.

(co) - We are already investigating water borne systems including acrylics and water borne zinc rich primers. We already use high solids polyurethanes.

(ct) - No transition anticipated at this time.

(fl) - For the past 6 years, maintenance painting work has included the use of high solids paints and water-base paints.

(ga) - Worker safety is the main reason.

(id) - Regulations and safety requirements.

(il) - Once the VOC limits are established, we will select the best system that complies. We presently favor high solids solvent-based systems over waterborne systems.

(in) - High solids will probably come first. Water-based paints are not proven in our state.

(ia) - It will create better worker conditions and a safer environment.

(ks) - We will probably make a change in the future. It will probably be to waterborne systems. The transition will occur when the EPA restrictions change.

(la) - Our testing has proven that the waterbase paints will perform well.

(md) - We are using some high solids low VOC paints on a job by job basis. We'll be forced eventually by EPA and State Regulations to go to all waterbased products. Until then, we will use whatever the regulations allow us. as our present system.

(mn) - No programs to restrict bridge paints.

(ms) - To reduce potential problems.

(mo) - Water base will probably follow high solids as they have been slower in development.

(mt) - Might as well get there in one step rather than two.

(nv) - Lower VOC paints are available for our present paint system. Water based systems do not perform as well as our present system.

(nh) - Gradual transition to high solids paint and possible transition to water base.

(nj) - Specifications allow both high solids paint of low VOC content, as well as water based paint.

(nm) - We do not know.

(oh) - We have no intention of going to water based paints at this time.

(ok) - Path followed will depend on our state EPA VOC regulations.

(or) - Because of the concern we have for the environment and our concern to protect the public and provide a safe transportation system, we would be looking for environmentally safe paint systems whether they are required or not. However, we also look at the cost involved to get the most out of tax dollars.

(pa) - We are presently using water borne paints. Air quality will require it.

(sc) - We do not feel that water-based paint is reliable as yet. We will comply with state regulations as they occur.

(tn) - It will be followed when we are compelled to change by the EPA.

(tx) - We are looking at both.

(ut) - We will follow the industry as it changes. The trend has been to increase protection of the environment and we support that.

(wa) - Ease of use, cost, and durability.

(wv) - Current paint technology provides various types of paints which perform satisfactory with a lower VOC content. As the EPA regulations on VOC paints are put into effect, then the changes in paint system will occur.

(wy) - Probably not, if the Federal EPA VOC limits are reasonable. This agency will probably continue with an alkyd-oil or alkyd type that meets the VOC requirements in this mildly corrosive environment.

18. Do the low VOC paints your agency employs pose any restrictions related to atmospheric conditions (e.g. temperature or relative humidity) that hinder their

application compared to conventional paint systems?

YES	9	(ak)(ca)(ct)(nj)(ny)(nc)(or)(pa)(va)
NO	10	(az)(fl)(ga)(me)(md)(nh)(oh)(tx)(ut)(wy)

COMMENTS:

(al) - Depends on manufacturer's recommendations.

(ak) - Paints are sensitive to temperature and humidity. Must be applied in shop with controlled environment (70°F).

(az) - There are no restrictions in our desert or mountain areas during the paint season (spring and summer time). There are humidity and temperature requirements for the air and surface to be painted listed in the application specification.

(ca) - Minimum application temperature is 50°F and maximum relative humidity is 75%.

(ga) - Same temperature and humidity restrictions as high VOC alkyd paints.

(md) - Temperature and humidity do cause some problems with drying, but most of

(mn) - We are just beginning to use low VOC paints. We have no experience at this time with need for limits on atmospheric conditions.

(nj) - It varies and is dependent on the manufacturer.

(ny) - Two component materials are temperature sensitive. These have been corrected by the paint manufacturers.

(nc) - Temperature restrictions.

(or) - Low end temperature is a problem and application of paint in the winter time in not possible without a significant cost increase.

(pa) - Temperature restrictions may be a slight problem.

(wy) - The conventional alkyd paint systems we employ (VOC 3.5 lb/gal or less) are applied on thoroughly dry, clean surfaces when the temperature remains above 40°F.

19. a. Do the low VOC paints your agency employs require significantly better surface preparation than paints your agency previously used?

YES	4	(ak)(md)(or)(ut)
NO	14	(az)(fl)(ga)(me)(mn)(nh)(nj)(ny)(nc)(oh)(pa)(tx)(va)(wy)

COMMENTS:

(ca) - No with maintenance painting with commercial blast clean (SSPC #6). Yes with fabrication (new steel) with near white blast clean (SSPC # 10).

(mn) - Surface preparation is the same requiring near-white sandblast.

(nh) - Same surface preparation as silico-chromate system previously used.

(nj) - Surface preparation is the same for low VOC coatings as it is for high VOC coatings.

(ny) - Epoxy mastic primers employ the same surface preparation as previews lead paint.

(or) - The NASA formulated inorganic zinc requires a near white blast SP-10.

b. What are your agencies surface preparation requirements for both shop and maintenance applications?

COMMENTS:

(al) - Generally we require an SSPC 10 on new work and much of the maintenance work. An SSPC 6 is required on the remaining work.

(ak) - Need good anchor profile SP 10 for shop blasting. Need additional blasting at flame cut edges.

(az) - Surface appearance of unpolished sand-cast aluminum with a dense uniform anchor pattern or profile of 2.0 to 3.0 mils SSPC-SP 10.

(ca) - Steel shot and grit has only been used to prepare new steel in fabrication shops at this time.

(ct) - SSPC-SP 10, near white metal blast coating.

(fl) - Shop: Steel surfaces shall be either blast cleaned with silica sand, or centrifugal wheel blast cleaned with cast steel shot, cast steel grit, or appropriate mixtures of the shot and grit.
Field: During all cleaning and painting operations, the contractor shall isolate the work area with appropriate containment devices. Steel surfaces in the work areas shall then be blast cleaned with silica sand to a near white condition.

(ga) - All structural steel surfaces to be painted or weathering structural steel to be unpainted shall be thoroughly cleaned. The extent of cleaning shall be SSPC-SP6, commercial blast cleaning. In addition to the shop cleaning, unpainted weathering steel shall be field cleaned to the SSPC-SP6 finish.

(me) - Shop-SSPC SP-10: Maintenance-SSPC SP-6.

(md) - Inorganic zinc requires near white SSPC-SP 10 cleaning in order to adhere properly; organic zincs need a good commercial blast SSPC-SP6. We require SP 10 in shop and SP 6 in the field.

(mn) - Near white sandblast, anchor pattern or profile of 2.0 to 3.0 mils. (SSPC-SP10)

(nh) - SP10 is specified on shop applications and SP6 is specified on maintenance painting.

(ny) - Commercial blast is used in shop and field.

(nc) - All steel surfaces to be painted shall be prepared by "Commercial Blast Cleaning" in accordance with SSPC surface preparation specification SP6. The anchor profile shall be angular between 1 to 2.5 mils.

(oh) - Sa 2 1/2 on both.

(or) - Maintenance application is SP-7 brush-off blast. We used SP-6 commercial blast cleaning but went to SP-7 to reduce cost.

(pa) - New steel SP10. Existing steel IOZ - SP10, mastic SP6.

(tx) - We have required good surface preparation for 20 years or more using either brush blast or near white depending on system.

(va) - We require near white.

(wy) - The conventional alkyd-oil paint primer systems we employ for both shop and maintenance applications (VOC - 3.5 lb/gal) or less) are applied to new structural steel which has been blast cleaned in accordance with Steel Structures Painting Council's surface preparation SP6 - Commercial Blast Cleaning, before any new rusting occurs. Field maintenance applications require cleaning the structural steel in accordance with SSPC's surface preparation specifications SP1, SP3 and SP6 before spot priming.

c. Do low VOC paints perform acceptably on surfaces blast cleaned using steel or iron grit?

YES	12	(az)(ca)(ct)(fl)(md)(ny)(nc)(oh)(pa)(tx)(ut)(va)
NO	0	

COMMENTS:

(ak) - Do not use for maintenance SP 6 blasting applications.
(ca) - No problems noted.
(ct) - Perform acceptably on both steel and iron grit surfaces.
(md) - Low VOC paints, particularly zincs need a more angular surface profile for better adherence. The state allows the use of steel, cast iron, malleable iron or synthetic shot for cleaning steel. Low VOC paints should perform acceptably with either steel or iron grit.
(mn) - An anchor profile requirement is necessary when steel shot is used. Maintenance requirements vary as various paints are used.
(ny) - Paints perform equally well on surfaces prepared with either non-metallic or steel abrasives.
(or) - We don't use or specify steel or iron grit.
(tx) - No problem if properly cleaned.
(va) - Mandate only steel and grit recyclables for field use.

20. a. Have you experienced any problems with low VOC paints?

YES	11	(al)(ak)(ca)(me)(md)(nj)(nc)(or)(pa)(ut)(va)
NO	9	(az)(ct)(fl)(ga)(nh)(ny)(oh)(tx)(wy)

b. If so, describe those problems and any remedial steps employed.

COMMENTS:

(al) - Application is a problem for painters not experienced with them. Quick build and non-self-leveling characteristics can cause problems for some coatings.
(ak) - Need good anchor profile SP 10 for shop blasting. Need additional blasting at flame cut edges.
(ca) - Drying conditions, when painting near minimum requirements,

familiarization of applicators and inspectors with new materials, and close involvement with technical staff during early stages are problems we have encountered.

(me) - Epoxy mastic is hard to apply in the field.

(md) - Mud cracking at snipers on stiffeners and at flange to web welds. We had the painter apply a thin mist coat to those areas and then apply full wet coat. This eliminates the problem.

(mn) - Minimal experience.

(nj) - High solids create some application problems - difficulty in spraying with greater tendency towards sags and runs.

(nc) - Some insignificant application over-build and surface preparation related problems.

(or) - Surface preparation is critical. The inspector should be on site even on the smallest shop painted jobs. An electrical cabinet support structure was not sandblasted prior to application of NASA inorganic zinc. The system failed miserably almost immediately. The entire structure required on site surface preparation and repainting.

(pa) - Not ready to publicly talk about it.

(ut) - We stopped using vinyl because of U.V. We switched to polyurethane.

(va) - Have had some problems but no more than other paints when improper procedures were followed.

(wy) - The conventional alkyd paint system we employ (VOC 3.5 lb/gal or less) do not normally present problems in the mildly corrosive environment of this state.

21. How are low VOC paints used by your agency applied?

COMMENTS:

(al) - Airless spray.

(ak) - Spray application. Repair is by brush.

(az) - Sprayed with limited use of hand brushed or rollers, except that paint No. 5 (aluminum) shall be sprayed.

(ca) - Conventional air atomized spray, some roller and brush work.

(ct) - Spray equipment.

(ga) - Airless spray.

(me) - Spray.

(md) - Spray in shop and brush or roller in field. Spraying in the field is allowed for vinyl only, unless permission is granted by the District.

(mn) - Spray - air or airless.

(ny) - Brush, roller, and spray.

(nc) - Brush, roller, and spray.

(oh) - Airless spray.

(or) - By spray and brush to touch up.

(pa) - Primarily by spray.

(tx) - Spray.

(ut) - Airless spray.

(va) - Spray generally.
(wy) - Primarily by spray but can also be applied by brush.

22. Does your agency require any special field inspection procedures when using low VOC paints?

YES	1	(ut)
NO	20	(al)(ak)(az)(ca)(ct)(fl)(ga)(me)(md)(mn)(nh)(nj)(ny)(nc)(oh)(or)(pa)(tx)(va)(wy)

COMMENTS:

(ca) - We try to make sure that the inspector is aware of temperature and material costs.
(nc) - Field inspection is required for all paints including low VOC paints.
(ut) - We qualify the contractor and the local state inspector.

23. a. Has the use of low VOC paints effected the cost of bridge painting for your agency?

YES	7	(al)(ca)(ga)(md)(nj)(ny)(ut)
NO	7	(fl)(nh)(nc)(oh)(or)(tx)(va)

b. If so, estimate the cost difference compared to conventional coatings and explain that difference.

COMMENTS:

(al) - Hard to tell since removal of old lead paint is usually lumped into the cost of many projects. Overall cost has probably increased.
(ak) - Just began specifying low VOC. It is difficult to extract painting costs from bids of structural steel.
(az) - Various "guess-timates" have been given from no change to double the cost due to difference in solids contents between solvent-based and water-borne coatings. Competitive bidding will determine cost.
(ca) - Material painting - slight decrease in preparation and material costs. Fabrication (new steel) has a slight increase in preparation and material costs.
(ct) - Unknown.
(me) - Do not know.
(md) - There is some increased costs when using the high performance VOC compliant systems versus the 4 coat alkyd system. But, due to less time required to apply 3 coats versus 4 coats, the overall costs are very close.
(mn) - No information at present time. Anticipate slightly higher cost.
(nh) - No significant difference.
(nj) - Material costs are higher because high performance coatings are used.

(ny) - Higher initial cost, but cost per SF per year is lower because service life is longer.

(pa) - Not able to comment.

(wy) - The conventional alkyd paint systems (VOC 3.5 lb/gal) have been employed for 25 to 30 years. We have not found it necessary to lower the VOC further, therefore we cannot make any cost difference comparisons.

24. a. What is the typical service life you anticipate for low VOC paints (both shop and maintenance applications)?

COMMENTS:

(al) - 20 years.

(ak) - 20 years shop application.

(az) - Present formulations have been in continuous use for at least 8 years in a coastal environment.

(ca) - Too soon to tell.

(ct) - Unknown.

(ga) - 10 years.

(me) - Unknown. We only started last year.

(md) - 12 to 15 years.

(mn) - 25 years for initial painting.

(nh) - Shop: 15 to 20 years and Maintenance: 8 to 12 years.

(nj) - No long term results are available as yet.

(ny) - Epoxy mastic/urethane system = 20 years on new steel and 15 years for repainting.

(nc) - 30 years in-land.

(oh) - We anticipate no change.

(or) - Low VOC paints have the same service life as higher VOC coatings. However, surface preparation and inspection are critical or catastrophic failures will occur in a short time frame.

(pa) - The same.

(tx) - 20 to 40 years.

(ut) - 20 years.

(va) - 25 years for zinc rich.

(wy) - 20 to 25 years.

b. How does that compare with conventional paints?

COMMENTS:

(al) - The same.

(ak) - The same.

(az) - Expect at least same service life as solvent alkyd types.
comparison with any conventional system.

(ca) - It appears that maintenance painting will be similar and fabrication (new steel) should be greater.

(ga) - Same as old paint.
(md) - Conventional paints would be expected to last 8 to 10 years. This applies both shop and field applications.
(mn) - Same life as conventional systems.
(nc) - It should compare favorably with conventional paints.
(oh) - The same.
(or) - Same.
(pa) - The same.
(tx) - The same.
(ut) - Double conventional paints.
(va) - At least twice as good as alkyds.

25. a. Does your agency use (or plan to use) encapsulation coatings over lead-based paints on bridges?

YES	23	(ak)(az)(ca)(co)(ga)(il)(in)(ky)(la)(md)(ma)(nm)(ne)(nh)(nj)(ny)(oh)(ok)(or)(pa)(tn)(ut)(wy)
NO	19	(al)(ar)(ct)(fl)(ks)(me)(mi)(mn)(ms)(mo)(mt)(nv)(nc)(nd)(sc)(tx)(va)(wa)(wv)
UNDECIDED	1	(id)

b. Explain your agency's history with (or plans for) the use of encapsulation paints over existing lead-based paints. **If your agency has never used encapsulating paints and has no plans to do so, go to question 31.**

COMMENTS:
(ak) - Plan to use on bridge this summer.
(az) - We can encapsulate if needed. Red primer acts as a tie-coat to old alkyds and alkyd phenolics. Except for hazardous waste considerations, it is preferable to blast clean structure.
(ca) - Encapsulation procedure has been used for a number of years where lead and zinc primers were previously applied. The existing paint system should be in relatively good condition with the corrosion limited to specific areas. The encapsulation process is used whenever possible.
(co) - We use our non-lead alkyd system over existing lead based alkyd systems after removal of unsound or damaged coating.
(ga) - We plan to use encapsulation coatings over lead-based paints in the future. We will power vacuum clean all rusty areas and overcoat with our standard bridge paint system.
(id) - If you mean recoating over old paint, then encapsulating is a possibility. However, we have a lot of steel with old, brittle, thick alkyd paints including the hazardous red lead which are disbonding from the metal substrate. Any recoating will be a problem and costly, especially while following the EPA guidelines.

(il) - We have used SSPC paints 25 and 21 over existing lead paints for about 5 years with good success. However, most applications have been over SP6 spot cleaning and SP7 brush-off blast. We soon intend to try the calcium-sulfonate-based coatings on several bridges using only hand-tool cleaning followed by low-pressure water washing.

(in) - We have used calcium sulfonate on one bridge and think it is a good alternate on truss bridges.

(ky) - Bridge maintenance plans on using encapsulating paint systems on our smaller bridges.

(la) - Initially we intended to do this with water base paints as it would be compatible with all existing paints we have. We utilized all types of cleaning (hand, hand tools washing, various types of brush off sandblast, waterblast, waterblast with grit, injection, etc.) and then would add two coats overall. The examples we tried still look good after 9 years. We have also used mastic paints for this and it will work. We have discussed using high pressure (3,000 psi-hold nozzle within one foot of steel) to clean and repaint with three coats and to waterblast on repairs of structural steel by contract. To date however, higher authorities believe it is better to get rid of any red lead now by removing steel and replacing it with concrete where possible.

(md) - We are presently trying epoxy mastics to encapsulate lead based coatings. Our only concern is with compatibility of the two coatings. We are requiring the painting contractor to paint a 25 square foot test area approximately 30 days prior to the start of painting to check for compatibility and adhesion problems. To date, we have had five bridges with no apparent problems.

(ma) - We have been using high build epoxy mastic for several years as an alternate to lead based alkyd paints. We will fully employ it as of January 1992.

(mn) - We have not used encapsulation but may be forced to if environmental restrictions increase costs of lead paint removal to levels reported in recent trade magazines. We have no history of use of encapsulation.

(ne) - Too soon to tell.

(nh) - Little experience with encapsulation paints, although it is anticipated to be a standard practice in the near future.

(nj) - Use aluminum epoxy mastic.

(nm) - We have tried to encapsulate old system.

(ny) - We routinely use epoxy mastic type paint over existing lead paint.

(ok) - Encapsulating paints have not been used routinely - only on a research basis. Nine coatings were tested for 50 days in a salt fog chamber. Visual observations were made on a daily basis to obtain data on blister size and frequency, rust rating, and scribe rating.

(oh) - We are trying a few projects where we are spot coating with epoxy mastic, full second coat with epoxy mastic, and top coating with urethane. This is an idea that was used several years ago except without the urethane top coat.

(or) - We plan to use them to reduce the environmental impact to the surrounding area, to our bridges, and to reduce cost of containment and disposal. Containment costs will be reduced because the amount of material to be contained will be reduced.

(pa) - We are just starting to use encapsulation paints.

(tn) - We have used epoxy primer and urethane top coat over basic lead silico chromate for four years. We are now using a universal primer with urethane top coat over aluminum top coat with red leaded primer.

(ut) - We have just started. Our experience is limited but we will probably use more of it.

(wy) - The plan includes solvent cleaning of the structural steel, utilizing steam cleaning methods, removal of loose material (rust, mill scale, paint) using power tool cleaning and limited blast cleaning in power tool inaccessible areas. Spot priming and top coating entire structure with alkyd-oil and alkyd primers and paints containing non-lead and non-chromate pigments.

26. a. If your agency has used encapsulation coatings, did they perform satisfactorily?

YES	9	(ca)(co)(il)(in)(la)(ma)(nj)(ny)(tn)
NO	3	(nm)(oh)(ok)

b. What problems were experienced?

COMMENTS:

(ak) - Plan to use on bridge this summer.

(ca) - Prior to use of low VOC coatings, intercoat compatibility was a problem. Excess paint buildup could become a problem.

(co) - They have worked well to date.

(il) - Paints 25/21 have performed satisfactorily except for some minor delaminations on southern fascia beams. Delamination at the mill scale interface is a common mode of failure for old oil and alkyd coatings. Adhesion tests on the old coating are recommended before attempting to recoat. Aluminum Epoxy Mastics were applied over existing lead paints resulting in severe delamination at the mill scale/old coating interface within the first year.

(in) - We have used encapsulation coatings on two bridges about 1 year ago and have had no problems yet.

(md) - To date, we have had no problems but paint has only been on approximately 60 days.

(ma) - Sometimes we have problems with the top coat being incompatible with epoxy paint.

(nh) - No experience.

(nj) - None.

(nm) - Our biggest problem is that the existing aluminum paint (topcoats, M-69) sometimes do not adhere well to existing red lead primer. The plane of weakness is the interface between the old primers and topcoats.

(oh) - The spot painting program used several years ago using epoxy mastics did not perform very well. This was primarily due to lack of workmanship by the contractors.

(ok) - One coating has been tried on two separate structures. Problems achieving thickness requirements and adequate coverage. Coating had a tendency to run and sag on vertical faces.

(pa) - No comment at this time.

(or) - We have not used them yet.

(tn) - Only one failure when we used an epoxy primer over the aluminum top coat.

(ut) - Too soon to tell.

27. a. What service life do you anticipate for encapsulation coatings you are presently using?

COMMENTS:

(ak) - 10 years.

(ca) - Too soon to tell. If properly done, it should be similar to maintenance painting. We are always looking for improved coatings.

(co) - We expect 15 to 20 years.

(ga) - We would anticipate 15 years.

(il) - We are anticipating a minimum service life of 8 years using calcium sulfonate coatings. We do not recommend the wide use of Paint 25 over hand-tool cleaning.

(in) - 10 years.

(ky) - 5 to 8 years.

(la) - Would expect 10-15 yrs.

(md) - 8-10 years.

(ma) - 15 years.

(nm) - 15 years.

(ne) - Too soon to tell.

(nh) - No experience.

(nj) - 5-8 years.

(ny) - 15 years service.

(oh) - 6-7 years.

(ok) - Unknown. This is one of the purposes of the research.

(or) - No experience yet.

(pa) - 7-10 years.

(tn) - 8-10 years.

(ut) - 8-10 years.

(wy) - This agency would anticipate 20 year service life for encapsulation coatings.

b. Are you seeking alternate coatings that provide longer service?

YES	7	(ca)(ga)(ky)(la)(pa)(tn)(ut)
NO	7	(il)(in)(md)(nj)(nm)(oh)(wy)

COMMENTS:

(tn) - We are now writing a specification for containment on lead removal.

28. a. Please briefly describe the application process your agency specifies for encapsulation paints.

COMMENTS:

(ak) - SP7 - Brush blast clean aluminum top coat.
SP6 - Spot blast clean rusted areas.

(ca) - Steam clean structure 100% - spot clean corrosion by abrasive blast or hand cleaning - apply primers to spot cleaned areas - 2 coats 4 mil total DFT. Apply 2 finish coats over structure - 2 coats 4 mil total DFT. If paint is generally thin on structure, an additional coat of primer may be applied to entire structure prior to finish paint.

(co) - All flaking, peeling, or rusted areas are removed to bare metal. The remainder of the structure is cleaned.

(il) - We intend to specify only hand-tool cleaning followed by low-pressure water washing before recoating with calcium sulfonate.

(in) - We are capturing the lead paint and cleaning the surface to an SP-2.

(ga) - We would use a vacuum power tool cleaning process where all lead paint is removed and placed in drums and properly disposed.

(ky) - a. Water pressure cleaning; b. Hand or power tool cleaning; c. Spot painting hand and power tool cleaned areas (modified epoxy); d. Full primer coat (modified epoxy); e. Finish coat (urethane).

(la) - Initially we intended to do this with water base paints as it would be compatible with all existing paints we have. We utilized all types of cleaning (hand, hand tools washing, various types of brush off sandblast, waterblast, waterblast with grit, injection, etc.) and then would add two coats overall. The examples we tried still look good after 9 years. We have also used mastic paints for this and it will work. We have discussed using high pressure (3,000 psi-hold nozzle within one foot of steel) to clean and repaint with three coats waterblast on repairs of structural steel by contract but to date higher authorities believe it is better to get rid of any red lead now by removing steel and replacing it with concrete where possible.

(md) - The epoxy mastic system used shall be applied as follows: Primer coat with a minimum dry film thickness of 5 mils...Intermediate coat with a minimum dry film thickness of 5 mils...Finish coat with a minimum dry film thickness of 2 mils.

(ma) - SP1, SP2, and SP3 are used for cleaning.

(nh) - We have no experience with encapsulation paints. To date, hazardous waste and worker safety issues have not been addressed. We have just hired a consultant to review our entire procedures and to revamp our specifications in these areas.

(nj) - This system is intended for use in the field over existing rusty steel. The old

(nm) - We have tried to encapsulate the old system using epoxy mastic primer and a polyurethane topcoat.

(ny) - Application by brush, roll, or spray.

(oh) - High pressure washdown on all surfaces; hand tool cleaning on rusty areas;

spot paint using epoxy mastic; full intermediate using epoxy mastic; full top coat using urethane.

(ok) - For the research report: Removal of scale and grease by rough sanding. Removal of tight rust not required. Beams were cleaned with high pressure water blast.

(or) - No experience yet.

(pa) - Hand and power tools only. Paint substrate of the rusty steel is usually composed of basic lead silico-chromate, black graphite, red lead, vinyl or urethane paints. Surface preparation calls for hand or power tool cleaning (SSPC SP-2, 3) and/or spot blast, commercial (SSPC SP-6).

(tn) - We have used epoxy primer and urethane top coat over basic lead silico chromate for four years. We are now using a universal primer with urethane top coat over aluminum top coat with red leaded primer.

(ut) - We prefer power and hand tool cleaning with minimal blasting.

(wy) - All of the structural steel will be cleaned in accordance with specification SP1 Solvent Cleaning utilizing steam cleaning methods. Any areas exhibiting rust, loose mill scale or loose paint will be further cleaned using the SP3 Power Tool Cleaning method. The structural steel that has been mechanically or blast cleaned will be field-painted with one coat of shop primer. Then, all the structural steel will be painted with one field coat of gray bridge paint, and one final coat of blue bridge paint.

b. Does your agency employ hazardous waste disposal procedures for any loose lead paint removed during surface preparation?

YES	19	(ak)(az)(ca)(co)(ga)(il)(in)(la)(md)(ma)(nm)(nj)(ny)(oh)(or)(pa)(tn)(ut)(wy)
NO	3	(ky)(nh)(ok)

c. Does your agency require special worker protection during surface preparation?

YES	15	(az)(ca)(co)(ga)(la)(md)(ma)(mn)(nh)(nj)(ny)(or)(pa)(ut)(wy)
NO	7	(ak)(il)(ky)(nh)(oh)(ok)(tn)

COMMENTS:

(ga) - The operator would wear a respirator.

(il) - We are in the process of developing a worker protection policy.

29. a. What specific coatings (by generic type and manufacturer) is your agency presently employing for encapsulation coatings?

COMMENTS:

(ak) - Dupont 25P epoxy, Ameron 400 FA epoxy, Wasser MC-Ferrox B, and Carboline Rustbond 8HB.

(ca) - Styrene acrylic latex, vinyl acrylic latex, phenolic tung oil primers, and acrylic latex finish paints.

(co) - We employ a number of non-lead alkyd paints available from a number of manufacturers.

(ga) - We plan to use a nalzin pigment - alkyd system.

(il) - Field trial calcium sulfonate coatings were manufactured by Watson Protective Coatings in St. Louis, Missouri. Paints 25 and 21 have been manufactured by Sherwin Williams and Jordan Paint.

(in) - Calcium sulfonate by Witco.

(ky) - Modified epoxy mastic primer and urethane finish coat.

(la) - Our existing waterbase paint and mastic coating (Carboline Carbomastic 15).

(md) - Epoxy mastic and SSPC paint 25 with alkyd topcoats. We allow Contractors to submit manufacturers' paint to their choice as long as it is the type specified.

(ma) - We are presently using epoxy/aluminum mastic such as Chromastic 15 and 90 and Amerlock 400.

(ne) - Carbomastic 90.

(nh) - No experience.

(nj) - Aluminum epoxy mastic.

(nm) - Epoxy mastic primer, polyurethane topcoat.

(ny) - Epoxy mastic type.

(oh) - Epoxy mastic - Carbomastic 15, Amerlock 400, and Alumapoxy.
Urethane - Ameron or Carboline.

(ok) - The product tested on the two bridges is called "Black Gold" by Tri-F Dupont 25P/Imron performed in laboratory testing. (Imron was one of the nine coatings tested in the lab as was Black Gold.)

(or) - We have not used encapsulation paints yet.

(pa) - Mastic and urethane.

(tn) - Epoxy's and universal primers. Epoxy's do not work good over aluminum coating.

(wy) - This agency will employ alkyd-oil generic type encapsulation coatings.

b. If you have experienced better performance with one specific coating, please identify it.

COMMENTS:

(ca) - Compositional formulations developed by Caltrans.

(md) - Epoxy mastic has performed much better than alkyds based on drying time problems.

30. a. What is your current application cost for encapsulation paints?

COMMENTS:

(ak) - \$4 per foot^2.

(az) - We do not encapsulate if at all possible.

(ca) - Same coatings used for encapsulation as for total maintenance painting. However, costs are lower as a result of less blasting and corresponding disposal.

(co) - Unknown.

(in) - $50 per ton of steel.

(il) - No application or life-cycle costs are available at this time. Most painting has been halted until environmental and worker protection policies are implemented.

(ky) - Unknown.

(la) - Insufficient personnel for workload.

(md) - At this time we don't have enough data on the epoxy coatings to make a comparison.

(ma) - Not available.

(ne) - Not available.

(nj) - $1.50-2.00/s.f.

(nh) - No experience.

(nm) - $2 per foot^2.

(ny) - $1.75/s.f.

(oh) - Cost not available at this time.

(pa) - Too early to tell.

(tn) - 8 to 10 cents per pound of steel.

(ut) - We just know that so far it cost too much for total removal and containment and disposal. We are trying to leave on as much possible.

(wy) - Insufficient experience to comment.

b. Have you performed life-cycle cost comparisons with conventional maintenance painting operations (including containment and disposal of blast-cleaning debris)?

YES	1	(ca)
NO	9	(ak)(az)(in)(la)(md)(nm)(ny)(tn)(wy)

COMMENTS:

(az) - Our auditors compare costs on a routine basis. However, environment impact takes precedence over cost differentials.

31. a. Has your agency employed alternate coating practices such as diffusion bonding, hot-dip galvanizing, or metallizing (thermal spraying) for shop or maintenance applications?

YES	14	(az)(ca)(co)(ct)(ga)(ky)(ma)(nj)(nc)(oh) (or)(ut)(va)(wa)
NO	29	(al)(ak)(ar)(fl)(id)(il)(in)(ia)(ks)(la) (me)(md)(mn)(ms)(mo)(mt)(ne)(nv)(nh)(nm) (ny)(nd)(ok)(pa)(sc)(tn)(tx)(wv)(wy)

b. Please briefly summarize your agency's use of those coatings. **If your agency has never used encapsulating paints and has no plans to do so, go to question 34.**

COMMENTS:

(az) - Hot-dip galvanizing is used for overhead sign structures, wire fencing, guard rails, corrugated metal pipe, as well as any other components called for in the Special Provisions.

(ca) - Hot-dip galvanizing is used for some purposes such as signs, light standards, guard rails and other miscellaneous metal. Galvanized surfaces usually are not painted. Metallizing was tried unsuccessfully about 20 years ago. Currently we are doing some limited testing on test panel exposure.

(co) - We have specified galvanized bridge rail for a number of years to replace painted rail. We have also started specifying galvanized bridge sign structures. Metallizing is allowed as an alternate to hot dip galvanizing - it is commonly used on bridge bearings.

(ct) - Use of metallizing primer has been very limited.

(ga) - We tried metallizing once on an experimental basis and found it to be too time consuming. We routinely use galvanized guardrail, bolts, and lighting poles. We have never tried diffusion bonding.

(ky) - One galvanized bridge has been constructed and its performance has been outstanding to date. No others have been contemplated due to high cost.

(ma) - Presently new bridges, diaphragms, cross frames and bottom lateral bracing shall be hot dipped galvanized.

(ne) - Minor structure parts such as cross frames or separators for prestressed concrete bridges have been hot-dip galvanized.

(nj) - We used hot-dipped galvanizing for diaphragms, armored joints, bolts, but are slowly moving away from this practice.

(nc) - No information given.

(oh) - We have used metallizing on five bridges in the field and have had good results. ($10 - $14/s.f.)

(or) - Specialty coating systems are used for specific applications and circumstances and then they are only applied in a shop environment.

(pa) - Only metallizing on one experimental job.

(ut) - We have used hot dip galvanizing and metalizing. It works well in specific areas.

(va) - Have metalized three new bridges.

(wa) - We have used some hot-dip galvanized bridge members. We have also used metalizing.

32. a. Is your agency presently investigating the use of any alternate coating practices?

Yes	8	(ca)(co)(ma)(nc)(oh)(ut)(va)(wa)
No	6	(az)(ct)(ga)(ky)(nj)(or)

b. Please specify which methods you are considering.

COMMENTS:

(ca) - Hot-dip galvanizing.

(co) - We use self weathering steel in some locations.

(ma) - Calcium sulphonate and other type formulations.

(oh) - Water based zinc coating in shop - no top coat.

(ut) - More metalizing.

(va) - Metalizing.

(wa) - We are looking at water based primers and top coats for A-36 steel structures and low viscosity epoxy for A-588 steel structures.

33. a. Will your agency continue to use those coatings?

YES	7	(ca)(co)(ct)(ga)(nc)(oh)(ut)
NO	2	(ky)(nj)
UNDECIDED	1	(va)

b. Indicate the reasons for those decisions.

COMMENTS:

(ca) - Best available alternative to removing previously applied lead and zinc coatings that are still providing good corrosion protection.

(co) - Cost comparisons were done to initiate their use.

(ct) - All indications are that the systems perform satisfactorily.

(oh) - We are continuing to use metallizing and water based zinc on a case by case basis.

(ut) - Probably more abrasive resistant.

(va) - Depends upon how tight regulation gets. We are presently getting ready to adopt hot tip zinc coated specifications.

(nj) - The use of conventional lead-based paints are no longer used as part of our DOT policy. The use of high performance coatings that are lead-free and low VOC has become our standard system.

c. Have you compared life-cycle costs of those coatings with conventional paints?

YES	1	(co)
NO	2	(ca)(ut)

COMMENTS:

(ca) - Anticipate life cycle costs to be similar.

(ut) - We have not compared cost.

34. a. Does your agency employ complete fabrication shop painting of bridge steel?

YES	16	(ak)(ct)(ga)(ks)(la)(md)(mn)(ms)(ne)(nj)(nm)(ny)(nc)(nd)(oh)(pa)
NO	27	(al)(az)(ar)(ca)(co)(fl)(id)(il)(in)(ia)(ky)(me)(ma)(mo)(mt)(nv)(nh)(ok)(oh)(sc)(tn)(tx)(ut)(va)(wa)(wv)(wy)

COMMENTS:

(ga) - Done by steel fabricator.
(md) - Prime coat only.
(ne) - On a very limited basis on one or two structures.
(oh) - We have tried complete shop coating on 3 or 4 bridges.
(pa) - Only one job.

b. How many years experience does your agency have with complete shop painting?

COMMENTS:

(ak) - Two years.
(ct) - It has only been during the last several months.
(ga) - Over 30 years.
(la) - We have employed complete fabrication on two projects. These type projects were very successful and should be continued.
(me) - 4 years.
(md) - None.
(mn) - We are just beginning to use this method. We have done a few bridges in the last two years.
(nj) - Not given.
(nm) - Shop painting or field application of topcoats is only an option.
(ny) - Three years.
(nc) - 15+ years.
(nd) - Two years experience.
(oh) - Four years maximum.
(pa) - Two years.

c. Is it used exclusively for all new steel bridges? **If your agency does not use complete shop painting, please go to question 38.**

YES	6	(ak)(ct)(mn)(nj)(ny)(nd)
NO	6	(ga)(me)(ne)(nc)(oh)(pa)

35. Does the selection of a fabrication shop affect the choice of paint system your agency employs for complete shop painting (or whether you employ complete shop painting)?

YES	0	
NO	13	(ak)(ct)(ga)(ks)(la)(mn)(ms)(ne)(nm)(ny)(nc)(nd)(oh)

36. Explain the advantages your agency has derived by employing complete shop painting.

COMMENTS:

(ak) - Paint is applied in a controlled environment and a better bond is achieved than in field applications.
(ct) - Not enough experience to comment.
(ga) - Cheaper and less time consuming. Greater safety.
(ks) - Ease of inspection, uniform application, assurance that the paint is properly applied and cured before use.
(la) - Better adhesion of top coat - eliminates lots of overspray dry spray thin paint because on structures high in air and adverse weather. Also, bad scaffolding conditions cause the workers to not adequately clean and paint. Coordination of painting and inspection in field is greatly reduced which eliminates many construction problems.
(me) - No environmental effect on the environment.
(mn) - We do not have enough experience to respond to this question.
(ms) - Not enough experience.
(ne) - Eliminates field painting.
(nm) - Most contractors have chosen the field application of top coats. On bridge railings, we require either complete shop painting or complete field painting.
(nd) - Properly prepared surfaces and cleanliness of intercoat surfaces.
(oh) - Better quality control and accessibility.
(pa) - Not enough experience.

37. a. Please list the problems your agency has encountered with complete shop painting.

COMMENTS:

(ct) - Not enough experience to comment.
(ga) - Handling roughly requires more field touch-up.
(la) - If you do not have good inspection during the handling, construction, and transportation of steel members, many workers will not take necessary precautions to protect painted surfaces.
(ks) - Damage to paint when steel is handled. Improperly applied and cured paint.
(me) - Fabricator was inexperienced. Some reblast and recoating were required.
(mn) - We do not have enough experience to respond to this question.
(ms) - Not enough experience.
(ne) - Touch-ups and matching of color.
(nm) - Improper handling and shipping procedures.
(nd) - Some damage occurs during erection operations.

(oh) - Inadequate cure time between inorganic zinc prime coat and subsequent coats.
(pa) - Damage due to handling.

b. What steps have you taken to overcome those problems?

COMMENTS:

(ct) - Not enough experience to comment.
(ga) - Extra care is taken in handling painted steel.
(ks) - We have not found an answer to paint damage caused by improper handling of steel. Good inspection would solve the problem of improperly applied and cured paint.
(la) - Good inspection procedures.
(nm) - Improve shipping and handling procedures.
(nd) - No countermeasures have been taken because problem is not considered to be significant.
(oh) - Caution shops about cure time.
(pa) - Still working on it.

38. a. Does your agency perform spot painting operations? **If not, go to question 43.**

YES	30	(ak)(az)(ar)(ca)(co)(fl)(id)(il)(in)(ia) (ks)(ky)(la)(me)(md)(ma)(mn)(mo)(mt)(nh) (nj)(nc)(oh)(or)(pa)(tn)(ut)(va)(wv)(wy)
NO	13	(al)(ct)(ga)(ms)(ne)(nv)(nm)(ny)(nd)(ok) (sc)(tx)(wa)

COMMENTS:

(az) - That is a maintenance procedure.
(id) - We use it for maintenance repainting of existing structures.
(ia) - Aluminum epoxy with commercial blast.
(ma) - Epoxy mastics and SP1, 2, and 3.
(mn) - Coating systems used to match existing system except lead based paints are not used.
(nh) - Not on contract work; state forces may occasionally just spot paint although usually a full top coat will be applied after spot priming.
(nm) - We are considering spot painting to maintain larger structures.
(oh) - Very little.
(pa) - Not used very much.
(tn) - Our regional maintenance personnel do spot painting.
(tx) - Very seldom.
(ut) - We are starting to use some.

b. What coating systems and surface preparation does your agency employ?

COMMENTS:

(ak) - Same as systems listed in question #29 except Wasser uses MC-Zinc (urethane).

(az) - The normal acrylic coats now in use. The minimum preparation would be hand brushing, sanding and feathering, and then application. (examples: red tie coat, colored semi-gloss finish coat or aluminum finish coat)

(ar) - Epoxy system with brush-off blasting or hand tool cleaning.

(ca) - Steam clean all surfaces, spot blast areas with corrosion. Styrene acrylic latex, vinyl acrylic latex, phenolic tung oil primers with acrylic latex finish paint.

(co) - Maintenance does some spot painting with non-lead alkyd system paints. Normally, hand cleaning is used to prepare steel. The old coating is collected, tested, and properly disposed of.

(fl) - Damaged surfaces shall be spot painted per the written recommendations of the paint manufacturer prior to applying any intermediate coats or finish coats.

(id) - Steel cleaning specs. are SSPC-SP 7 brush-off blast followed by spot priming with TT-P-615, type II primer modified with a non-toxic pigment with a topcoating of TT-E-529 enamel.

(il) - SSPC Paint 25 primer, Tinted Paint 25 intermediate, Paint 21 topcoat has been used over SSPC SP2, SP6, and SP7.

(in) - We spot blast inorganic zinc and vinyl to an SP-6. We recoat with organic zinc and top coated everything with vinyl.

(ks) - Spot painting of inorganic is done with organic zinc.

(ky) - a. Water pressure cleaning; b. Hand or power tool cleaning; c. Spot painting hand and power tool cleaned areas (modified epoxy); d. Full primer coat (modified epoxy); e. Finish coat (urethane).

(la) - Depends on existing system.

(me) - Alkyd and epoxy mastic.

(md) - Four coat alkyd with SSPC-SP 6 surface preparation.

(mo) - We spot clean vinyl systems, prime with epoxy mastic and topcoat with vinyl. On lead coatings, we have tried hand cleaning and painting with alkyd/calcium sulfonate system only the cleaned areas to prolong the life of lead coatings without total removal.

(mt) - We use a wire brush and lead silico chromate primer with no top coat.

(oh) - Sand blast and paint with lead-free alkyd.

(or) - Commercial blast to SP-6 and re-apply existing coating type. Existing coatings are red-lead based paints and we also use moisture cured polyurethane.

(tn) - Some of the regions prepare by sandblasting and paint with epoxies; others do minimum preparation with universal primers.

(ut) - We use hand tool cleaning with alkyd system and water-borne.

(va) - Near white blast and SSPC paint 25 as primer with two coats of micaceous iron oxide intermediate and topcoat.

(wv) - We blast to a minimum of a commercial blast up to a near white blast and coat with an alkyd or epoxy mastic system.

(wy) - This agency employs alkyd oil and alkyd systems. Surface preparation includes solvent cleaning and minimal power tool cleaning.

39. If your agency performs topcoating or spot painting to maintain old lead-based paints, what systems are you using?

COMMENTS:

(ak) - Dupont 25P epoxy, Ameron 400 FA epoxy, Wasser MC-Ferrox B, and Carboline Rustbond 8HB.

(az) - Solvent-based alkyds are being phased out and being replaced with a water-borne alkyd-styrene-acrylic.

(ar) - Our epoxy system can be applied over lead system.

(ca) - Styrene acrylic latex, vinyl acrylic latex, and phenolic tung oil primers with acrylic latex finish paint.

(co) - Non-lead alkyd system.

(id) - We use spot priming with TT-P-615, type II primer modified with a non-toxic pigment with a topcoating of TT-E-529 enamel. Also, hand cleaning or solvent wipe down so as not to disturb the sound paint.

(il) - SSPC Paints 25 and 21. We plan to try calcium sulfonate over hand-tool cleaning.

(ks) - Barium metaborate primer with an intermediate and topcoat of Silicon Alkyd.

(ky) - a. Water pressure cleaning; b. Hand or power tool cleaning; c. Spot painting hand and power tool cleaned areas (modified epoxy); d. Full primer coat (modified epoxy); e. Finish coat (urethane).

(la) - Oil base, lead and chromate free paints, waterbase paint, and mastic paints. Also, we test products that manufacturers claim produce superior results to what we are already using.

(me) - Alkyd and epoxy mastic.

(md) - SSPC-25 primer and first field coat.

(ma) - High build mastic epoxy.

(mo) - Encapsulation using an alkyd/calcium sulfonate system is under evaluation.

(mn) - Red iron oxide, raw linseed oil, and alkyd primer.

(nh) - Non lead, low VOC oil alkyd system.

(nj) - Epoxy mastic coatings (lead-free).

(nc) - BMU SS16 and AASHTO M69 Aluminum.

(oh) - Sand blast and paint with lead-free alkyd.

(or) - Spot painting is done on a very limited scale and the area must be pretty bad for us to spot paint. Use same system or a compatible system when re-coating.

(pa) - Mastic and urethane.

(tn) - We are not presently topcoating over old lead-based paints.

(ut) - Water-borne alkyd.

(va) - Near white blast and SSPC paint 25 as primer with two coats of micaceous iron oxide intermediate and topcoat.

(wv) - Alkyd or epoxy mastic systems.

(wy) - SSPC-25 spot priming and intermediate coat with alkyd top coat.

40. If, in the future, the EPA agency in your state limits paint VOC content to 2.8

lb/gal, what coatings would your state agency probably use to maintain chlorinated rubber, vinyl, or alkyd painted bridges?

COMMENTS:

(az) - Water-borne acrylics.
(ar) - Don't know.
(ca) - Compositional formulations developed by our DOT.
(co) - We will probably use non-lead alkyd systems or water borne acrylics. We have no chlorinated rubber or vinyl systems to replace.
(fl) - Waterbase systems, high solids epoxies and high solids non-leaded oil base.
(id) - Alkyd.
(in) - Do not know.
(il) - We would have to consult with industry if and when this happens. Normally there is some time gap between the final regulations and the date they become effective.
(ia) - High solid content epoxy waterborne paint.
(ks) - Possibly calcium sulfonate systems.
(ky) - Unknown.
(la) - Our waterbased system.
(me) - High solids coating.
(md) - High build epoxies, waterbased acrylics and VOC compliant urethanes.
(ma) - Encapsulation coatings.
(mn) - We do not expect this limitation.
(mo) - High solids inorganic zinc, water based inorganic zinc, and waterborne topcoats.
(mt) - Unknown.
(nh) - Not sure.
(nj) - Not sure.
(nc) - BMU SS10, 12, and 13.
(or) - Moisture cured polyurethane or a high solids epoxy.
(oh) - Do not know.
(pa) - Mastic and urethane.
(tn) - We do not know.
(ut) - 100% solid inorganic zinc - epoxy mid coat - urethane top coat.
(va) - Acrylics.
(wy) - This agency will probably use alkyd-oil and alkyd generic systems with less than 2.8 lb/gal VOC.

41. a. Does your agency employ paint systems with renewable topcoats?

YES	8	(az)(ca)(fl)(in)(la)(md)(mo)(wy)
NO	10	(ak)(ar)(il)(ks)(oh)(or)(pa)(tn)(ut)(va)

b. What has been your agency's experience with those paint systems?

COMMENTS:

(az) - Good.

(ca) - When properly prepared by steam cleaning to remove dirt, soot, and chalk, the performance has been good.

(fl) - Renewable topcoats applied over inorganic zinc primers have provided satisfactory service.

(id) - Not sure about question. Presently, we use alkyd systems which are compatible and easy to recoat. Experience with these coatings has been very good.

(il) - Our inorganic zinc/vinyl system has been in service for only 7 years, and no new topcoating has been required.

(in) - We have top coated bridges with vinyl and have had no problems.

(la) - They appear to extend life 5 to 10 years. This depends upon the time of the recoating condition of the existing coating. Also, the worst conditions are under open joints.

(md) - With the exception of epoxies, most of our paint systems have renewable topcoats. We don't have a system to repaint bridges before the paint system has deteriorated to the point where spot blasting and complete repainting is required.

(nm) - We do not have a long enough history to know.

(wy) - In this dry mildly corrosive environment we regard and employ alkyd generic systems as renewable topcoats. With proper surface preparation (solvent cleaning and minimal power tool cleaning), spot priming, and application of an intermediate and top coat this system provides many more years of satisfactory performance.

42. a. How does your agency manage spot painting operations?

COMMENTS:

(ak) - Manufacturer's recommendations with construction inspection.

(az) - Before the project is closed, the contractor does it. After the project is closed, it belongs to maintenance.

(ca) - The maintenance engineer determines when to spot paint.

(fl) - Spot painting operations are managed per the written recommendations of the paint manufacturer.

(id) - Each district determines the need for repainting.

(il) - We have our own requirements that are based on manufacturer's recommendations.

(ks) - Paint condition is monitored by yearly inspection. When complete painting is not required, spot painting is done.

(la) - Manufacturer's recommendations.

(md) - We provide an SHA inspector to designated areas to be spot blasted and painted.

(mt) - In-house.

(nh) - Generally by in-house paint crews.

b. Is it integrated with a bridge management system?

YES	7	(ca)(fl)(ga)(ia)(or)(pa)(ut)
IN PROCESS	3	(la)(nj)(tn)
NO	2	(il)(ks)

COMMENTS:

(fl) - Within each district, the paint management system is an integral part of the bridge management systems.

(il) - Our state has a Coating Assessment and Painting Priority System. We do not have a formal bridge management system.

(ks) - Our paint ranking system is not integrated with the bridge management system.

(la) - Our department has started a BMS Group and PMS will be incorporated. Since 1970 we maintained a computer data base of paint and corrosion ratings by bridge inspectors. Usually these ratings were listed by computer runs from our Bridge Inspections to list and show various bridge conditions. In addition, we could see the total numbers-location of bridges requiring painting. We would also notify higher authorities with listings and pictures in effort to obtain funds.

(nj) - In the process of being integrated.