Guidelines for **Cost-Effective** Lead Paint Removal

Final Report

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Guidelines for Cost-Effective Lead Paint Removal

Final Report

Prepared for

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GUIDELINES FOR COST EFFECTIVE LEAD PAINT REMOVAL

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I. INTRODUCTION

A. Background and Objectives

Over the last 10 years or so, highway and bridge agencies have been increasingly concerned about the ability to maintain lead painted bridges. Environmental regulations restrict the dropping of lead containing debris onto roadways, into waste streams or waterways, or into the ambient air. Also, the exposure to lead dust of blasters and support workers has been shown to be a significant health risk, for which OSHA issued a comprehensive standard in 1993. The cost to maintain bridges while complying with these regulations has increased dramatically, with the cost in some cases exceeding $110/m^2$ ($10/ft^2$) compared to typical costs of $22/m^2$ to $32/m^2$ ($2/ft^2$ to $3/ft^2$) five or ten years ago. Agencies have been reluctant or unable to afford these prices and have sought alternative means to protect their bridges against corrosion and deterioration. Such alternatives include deferring maintenance, partial repainting (overcoating) or steel replacement. There are numerous technologies, equipment and materials available in the marketplace or in the research stage, many of which are touted to provide the ultimate answer to this critical problem. There are technical, risk, cost and other considerations regarding the effectiveness of these technologies in removing the coating; in providing effective, long-range protection; in preventing environmental releases; in controlling worker and public exposure to lead; and in complying with various peripheral regulations on air quality, training, certification and disposal. Unfortunately, while there are numerous studies and ongoing projects being undertaken by the highway, construction and corrosion industries, there are many unresolved issues requiring further study and analysis.

Because of the urgency of these issues and their impact on highway agencies and the public, FHWA determined the need to convene a group of experts to assess the current status of the issues and to outline future actions. Accordingly, a workshop was organized with the following overall objectives:

1. Objective: To develop guidelines and strategies for cost-effective compliance with lead paint removal regulations.

The guidelines were intended to be based on the consensus of best current practice, recognizing that in many instances, as noted above, definitive data on the effectiveness, costs and extent of compliance were not available. Thus, a second objective of the workshop was added:

2. Objective: To improve and facilitate exchange of information among highway agencies.

The overall approach, as defined in the statement of work, was as follows:

With FHWA assistance, assemble a team of highway, regulatory and technical experts. Hold a preliminary meeting with this group, then conduct an intensive structured workshop for the purpose of developing guidelines and strategies for cost-effective compliance with lead paint removal regulations. Develop the guidelines and strategies, send it out for consensus review by the team of experts and provide the document to FHWA upon completion.

B. Organizing and Presenting Workshop

The project was organized into the following tasks:

1. Preliminary planning meeting
2. Planning and conducting workshop
3. Preparing and reviewing critical issues
4. Developing guidelines and report

1. Preliminary Planning Meeting

A group consisting of seven state highway, two FHWA, three regulatory and six industry representatives was assembled during the SSPC Industrial Lead Paint Removal Conference (March, 1994 in Greenwich, CT). After general discussion of the intent of the project, the group ranked the various proposed topics for the workshop. The ranking [highest (a) to lowest (f)] of the six major topics is as follows:

a. Containment practices and standards
b. Environmental and health practices and standards
c. Field practice and data
d. Impact of regulations
e. Cost and performance
f. Material specifications

The group also ranked subtopics within each major topic. Table 1 shows the specific ranking of the various representatives.

2. Planning and Conducting the Workshop

The workshop was held in Charlotte, NC on July 10-11, 1994. (A list of attendees is included as Appendix A.). It was attended by forty-five individuals representing the following demographic categories:

a. Federal and state highway representatives
b. Federal and state regulatory officials
c. Industry specialists (suppliers, contractors, consultants)

The overall schedule was as follows:

- General Session: Overview of key issues. Approximately twelve brief presentations on selected technological and regulatory issues. (The written materials are included as Appendix B.)
- Breakout Session #1: Group was divided into two groups to address regulatory and technology issues. First session was designed to identify concerns, issues and current practices.
- Breakout Session #2: Each group reviewed and prioritized critical issues giving specific recommendations for action.
- General Wrap-up Session: The groups' findings and recommendations were presented and discussed.
- Leaders Follow-up Session: The group leaders and coordinators met to discuss organizing, writing and reviewing guidelines and report.

3. Preparing and Reviewing Critical Issues

A major output of the two breakout sessions was lists of critical issues, which had been prepared and analyzed by small working groups and then briefly discussed with the larger breakout group. With the assistance of the two group leaders the lists were assembled, organized and formatted and then sent to workshop attendees for review and comment.

4. Developing Guidelines and Report

Based on the comments on the critical issues and the notes from the conference and other published materials, the guidelines for cost effective regulatory compliance were prepared, along with the other portions of the final report. These were submitted to FHWA for review and editing.

The components of the report are as follows:

a. Introduction

b. Discussion of the technology issues, including analysis and recommendations regarding eight critical issues

c. Discussion of regulatory issues, including analysis and recommendations regarding eleven critical issues

d. "Guidelines for Cost Effective Lead Paint Removal." The guidelines are organized into the following topics:

(1) Developing Strategy and Specification Requirements

(2) Specifying Full Removal and Repainting

(3) Specifying Spot Repair and Overcoating

(4) Contracting and Inspection Practices

(5) Sources of Information

(6) Costs and Funding

NOTE: The guidelines include numerous examples of specifications and practices derived from existing highway agency documents and reports.

e. Summary and recommendations, including consolidation of workshop findings and recommendations on using what is currently available

II. TECHNOLOGY ISSUES

A. Procedure for Analyzing Technology Issues

Following several additional presentations, the group identified approximately thirty-five issues considered by one or more participants to be of interest. The group characterized each of the issues based on the following:

A—Data exists and needs to be compiled

B—Data needs to be developed (research/testing)

C—Information exchange needed

D—Standards/guides needed

E—Combination

The original list was analyzed to yield fourteen priority issues which have been consolidated into eight, as shown below. (These eight issues were not ranked by the group.)

- Procedure for Prioritizing Bridge Maintenance Painting Needs
- Evaluating the Effectiveness of Overcoating
- Evaluating Life Cycle Costs for Bridge Coatings
- Performance Criteria for Containment Structures and Systems
- Evaluating Productivity and Effectiveness of Surface Preparation Methods
- Guidelines for Renovation, Demolition and Other Activities Disturbing Lead Painted Steel
- Assuring Adequate Inspection of Lead Paint Removal Projects
- Safety and Health Guidelines for Lead Paint Removal

Several smaller work groups were established and assigned to determine the following for each issue:

- Brief Statement of the Issue (why it is critical)
- Specific Needs (for highway and bridge agencies, primarily)
- What Has Been Done?

A section on recommended actions was later added. The detailed analyses are presented in Section B.

B. Highest Priorities

1. Procedure for Prioritizing Bridge Maintenance Painting Needs

a. Statement of the Issue

State highway agencies must decide which bridges to repaint or maintain and what type of maintenance to perform, i.e., full removal and repainting or partial removal and overcoating. In some instances the consequences of inaction or deferral could be significant risk of loss of structural integrity. (Note: A related issue of how to perform emergency or other structural repairs in the face of the new lead regulations is discussed under critical issue number 7.) The costs of any maintenance have risen dramatically with no leveling off in sight. Thus, the availability of funds and life cycle cost considerations also enter into the decision-making process.

b. Specific Needs

(1) A straightforward means to establish priorities and recommend options for maintenance painting of lead coated structures;

(2) A standard paint evaluation form which records the paint properties (e.g., adhesion, thickness, brittleness, extent of degradation) most critical for extended protection;

(3) A means of estimating the cost for various maintenance strategies such as full and partial removal, and steel replacement (when deck is being rehabilitated). These costs will depend on the type of environmental and worker protection requirements which are set and on the type of removal and containment methods that are specified or permitted.

c. What Has Been Done?

(1) Several state DOTs have their own paint condition evaluation forms (NJ, IL, VA, PA, FL). They differ considerably in the amount of detail required (e.g., rust, delamination, sampling), in the extent of use in the field (e.g., by district maintenance personnel or inspectors) and in the accuracy of the data. The standard FHWA bridge inspection form has not included paint as an inspection item.

(2) At least two state DOTs (VA and IL) have used the Coating Assessment Painting Priority (CAPP) system developed by a consultant. This program provides a procedure to evaluate coating condition using a combination of reference photographs and physical measurement and suggests a means for determining bridge painting priorities.

(3) reviews the major considerations for selecting a maintenance painting option. The analysis is based on coating lifetime, risk of failure and cost.

(4) The FHWA has worked with a number of state DOTs to develop sophisticated bridge maintenance management programs. It may be possible to adapt one of these programs to address the complex issues of maintenance of lead coated structures. FHWA is presently developing methodologies and simple computer software applications to assist in determining the optimum life cycle maintenance options.

d. Recommended Actions

(1) Develop and evaluate a standard form for recording and analyzing the condition of paint on lead-coated bridges and painting history. Review experiences with existing forms. Note: This form to be based on current techniques for evaluating condition. Research on new techniques will be addressed under other issues.

(2) Compile data on costs of various maintenance strategies from DOTs, painting and environmental contractors, and consultants. These should cover a broad range of locations, conditions, removal and containment approaches, and environmental and worker protection practices.

(3) Develop a computerized model which analyzes the various types of input on costs (as described above), lifetimes (see critical issue 3) and other factors. The model would allow a highway or bridge engineer to examine a variety of approaches using different assumptions based on the agency's budget, condition of the structure's past and modified practice, stringency of regulatory enforcement and other criteria. The model would have some default parameters to allow simplified usage.

2. Evaluating the Effectiveness of Overcoating

a. Statement of the Issue

Increased cost due to regulations has caused owners to evaluate the overcoating of existing paint in lieu of complete removal. Performance of overcoated structures is highly variable and unpredictable. There are also various repaint practices which allow existing paint to remain on the surface. Many conflicting claims have been made about the effectiveness of certain practices, cleaning methods and coating materials. There is also a great deal of confusion regarding the type of environmental and worker protection controls required for overcoating existing leaded paint.

b. Specific Needs

(1) Method to evaluate adherence of old paint to substrate (adhesiveness) and to itself (cohesiveness);

(2) Method to determine compatibility of new coatings (compatibility of overcoat materials to existing paints and substrate [rust, millscale]);

(3) Method to determine future recoatability of overcoat systems being applied today;

(4) Method to evaluate extent of coating degradation;

(5) Assessment of methods for preparing surfaces for overcoating.

c. What Has Been Done?

(1) FHWA sponsored research:

(a) Ocean City Research conducting a three year project on laboratory and field evaluation of overcoating systems

(b) BIRL/ITI (Infrastructure Technology Institute) is nearing completion of an eighteen-month project to develop guidelines on overcoating of lead-coated bridges. This project also included comparison of laboratory and field evaluation and DOT practices. SSPC is a subcontractor for a portion of the project.

(2) DOT Research: IL, VA, NC, LA, KY, GA, Alberta Ministry of Transportation, etc.

(3) DOT Practice: Practically all DOTs have done overcoating experiments and many have bridges with overcoating at least five years old.

(4) Other government agencies including the US Navy (Annapolis Laboratory) and US Army (Corps of Engineers) have evaluated coatings for non-blast cleaned steel. Reports are available for some of this work.

(5) SSPC research and standards activity:

(a) SSPC has completed a project for the US Army on developing a standard rusty substrate for evaluating "surface tolerant" coatings. A second phase on developing salt contaminated rust is underway. A consensus standard is also under development for these procedures.

(b) SSPC is compiling DOT practices on environmental controls utilized by DOTs for overcoating projects (This is part of the BIRL/ITI project described above.).

(c) SSPC and *JPCL* produced a special report on overcoating which was published in the November 1993 *JPCL*. This report included a comparative review and analysis of overcoating versus full removal, case histories from DOTs and other agencies, a review of key technical articles over the last 20 years on coatings for non-blast cleaned steel and a review of available overcoating materials.

(6) Test Methods:

(a) Standard methods for adhesion are ASTM D 3359, tape test and ASTM D 4541, tensile adhesion.

(b) ASTM D 4064 is a standard method for a field patch test. However, it does not require a large test area or time for change in seasons.

(c) ASTM and US Navy have developed field kits for identifying coating generic type (e.g. alkyd, epoxy).

(d) Accelerated testing: Considerable progress has been made by SSPC, FHWA and others in developing and evaluating alternate test methods, particularly those based on cyclic testing. ASTM practices are under development.

d. Recommended Actions

(1) Develop and implement a means to acquire, compile and assess DOT practices and laboratory and field evaluations of overcoat systems on bridges. This information could be made available to DOTs through FHWA, AASHTO, SSPC or other information sources.

(2) Develop format, forms and procedures for documenting inspecting and monitoring use of overcoating systems on bridges. This would include information such as the condition of existing paint (based on current methods), surface preparation methods, materials and parameters (e.g., water pressure), presence of salt or other contaminants, type of exposure environment, weather during application, and environmental and worker protection controls utilized.

(3) Develop improved methods for compatibility of new and old coatings. A first step could be to review and critique existing methods, such as those described above. For example, special problems may arise when overcoating an aluminum-pigmented coating. The emphasis would be on new methods that could be utilized in the field. An accurate laboratory reference test would also be extremely valuable (e.g., a test that could accurately simulate the rapid change in temperature which has reportedly been the cause of massive delamination of relatively new overcoat systems).

(4) Develop procedures for assessing the condition of the coating and substrate to provide a database for decisionmaking on overcoating or full removal. A promising approach is the use of infrared and visual imaging techniques. Work on these techniques has been undertaken by BIRL, building on the experience of NIST and others. Visual imaging allows a rapid automatic computation of the extent of macroscopic degradation such as rusting, loss of topcoat, and delamination. Infrared imaging, in principle, permits observation of the underfilm condition such as blistering. It can also be performed rapidly over large areas of a structure with digital recording of the condition for future analysis.

(5) Evaluate the effectiveness and environmental emissions of various surface preparation methods. These include water washing/jetting (at various pressures), steam/hot water cleaning, chemical stripping, detergent/chemical/solvent cleaning, wet abrasive blasting, hand and power tool cleaning (with and without vacuum shrouding), vacuum blasting and other methods. As part of this evaluation, a check list of important parameters should be developed along with a standard procedure for agencies to conduct their own field evaluations of these methods (see related discussions under critical issue 5).

(6) Develop a short-term procedure to evaluate candidate overcoat materials. There is a considerable amount of work being undertaken to develop such methods for coatings evaluation in general. A standard practice could be prepared which describes best current technology for preparing substrates, applying coatings, exposing panels in the laboratory and on test fences or bridge patches, and evaluating based on standard properties (e.g., rusting, undercutting) and statistical methods. Other features would be use of appropriate control coatings, compatibility tests, testing for salts and other contaminants, and inspection procedures.

3. Evaluating Life Cycle Costs

a. Statement of the Issue

Bridge painting is becoming an increasingly expensive activity for highway agencies that are trying to make best use of tight budgets. There is greater emphasis on long term or lifetime costs of bridges and bridge maintenance. It is recognized that painting is one of the most significant maintenance costs incurred over the lifetime of a bridge. However, determining lifetime costs is hampered by the lack of accurate data on lifetimes and durability of bridge coating systems. Also, there is a need to accurately estimate costs for lead paint removal including full removal, overcoating or steel replacement. (Many agencies have been forced to modify maintenance plans by the high cost of current bridge repainting bids.) It is also important to distinguish between initial and life cycle costs of painting systems in deciding among options for maintaining lead coated bridges.

b. Specific Needs

(1) Identify elements for maintenance of a lead coated bridge. These include surface preparation costs, paint application costs, containment and ventilation system costs, waste treatment and disposal costs, air monitoring and soil and water sampling, worker health and safety costs, traffic control costs, costs to public (inconvenience, impact on safety and health), DOT training costs and others.

(2) Convert tons of steel (typical unit for bridge sizing) to area of steel to be painted (needed for accurate estimation of painting costs).

(3) Understand coating performance factors. The lifetime of a coating system depends on a number of factors including the quality of the surface (influenced by the original substrate and the method of preparation), the weather conditions during application, the exposure conditions (macro and micro) of the structure, the type of structure (e.g., lattice truss vs. rolled beam) and the coating materials.

It is necessary to determine the significance of each of the factors in the performance of coatings (e.g., effect on early failure, or long term durability prospects).

(4) Predict paint lifetime. Highway and bridge engineers need better information on the lifetime of bridge painting systems and the type and likelihood of failure (particularly early failure).

(5) Evaluate condition of paint on bridge. Methods are needed to assess the condition of coatings on bridges to determine the immediate and long term needs for maintenance.

c. What Has Been Done?

(1) Life cycle cost models

(a) BIRL under FHWA contract has developed a bridge painting lifetime model. It is currently undergoing further refinement and preliminary evaluation by one or two state DOTs.

(b) State DOTs have developed bridge maintenance cost models, but these have not been directed toward painting. About 15 years ago, FHWA developed a model which was evaluated by Florida DOT.

(c) Proprietary structural steel painting cost models have been developed. The most notable is that by Brevoort which provides data based on field experiences of contractors, material suppliers, consultants and owners.

(2) Data on coating system performance

(a) SSPC has conducted several workshops and surveys to acquire data on the various elements of repainting a lead coated bridge. These data are included in the SSPC industrial lead paint removal tutorial and some are published in the November 1993 issue of *JPCL*.

(b) Other cost data have been published in annual SSPC Lead Paint Removal Conference proceedings and JPCL over the last several years. The data are from DOTs, private owners, contractors and equipment suppliers. However, the relevance or accuracy of some of these data may be questioned.

d. Recommended Actions

(1) Lead paint removal costs: Survey DOTs, contractors, and others regarding costs for various types of lead paint removal (full removal, overcoating) under a variety of conditions, bridge types, locations, cleaning methods, materials, and containment approaches. Develop a matrix of cost ranges and discuss the origin of the variations. A second phase would be development of a cost model for use by highway or bridge engineers or others to estimate costs under various options and scenarios.

(2) Paint performance data forms and histories: Develop standard formats for documenting the performance of a coating system on a bridge. Items to include are percent of surface rusted (or otherwise degraded and needing refurbishing), percent of surface with loss of aesthetic properties (e.g., gloss, color, cleanliness). Several approaches would be allowed for developing percentages, including gross estimates (e.g., by span) or more detailed analyses (e.g., by individual structural

(3) Model development and enhancement: Existing cost models would be refined and evaluated or new models developed utilizing the data acquired above. Additional DOTs would be asked to evaluate the models as a tool for decision-making on lead coated bridge maintenance. The models could also be modified to serve as a database for cost and performance histories on maintaining lead coated bridges. This would provide important information to highway engineers and planners and allow further enhancements and continual updating of the model.

(4) Conversion kit for bridge weight to surface area: Data would be acquired on the surface area for different sized and configured bridges. Use would be made of existing tables and conversions. Simple software could likely be developed to perform this function for the vast majority of all steel bridges. For the remainder, an estimating guide would be developed.

4. Performance Criteria for Containment Structures and Systems

a. Statement of the Issue

Containment of lead paint and abrasive debris and dust is required on all lead coated structures undergoing maintenance painting. There are many types of containment materials, with configurations and designs ranging from very simple (e.g., ground and side tarps) to very complex (rigid enclosures with computer designed ventilation and waste handling). The degree of containment required depends on the extent of removal of existing paint and rust (i.e., full removal versus overcoating). Factors include the configuration of the bridge, the proximity of residences or businesses, the terrain and other factors. Little information is available on the extent of emissions as a function of the type of containment, yet the control of emissions is the objective of the containment. This makes it difficult for DOTs to specify the type of containment for a specific project. It is also difficult for a contractor to design a containment system which meets the environmental control objectives of the regulatory agencies and still be competitive.

b. Specific Needs

(1) Containment specifications

(a) Measurable performance criteria are needed for quantifying the extent of emissions.

(b) Studies to determine the extent of emissions from various operations: To assist the specifier and contractor in specifying and designing containment, it is necessary to have data on typical levels of emissions from various operations.

(c) Training of inspectors: Bridge and independent paint inspectors need instruction on how to evaluate the air emissions and soil and water sampling. Most have not received any formal training in this area.

(2) Vacuum and ventilation system requirements

(a) General information on selection and use of vacuum and ventilation systems: There is a need for accurate information about the capacities and capabilities of vacuum and ventilation systems.

(b) Research on air flow in containment: Basic information is needed on the air flow patterns within various containment configurations.

(c) Training of inspectors (see above).

(3) Dust collector requirements

(a) A system for rating dust collectors based on CFM and static pressure is needed.

(b) Standardized test procedures for rating above factors must be developed.

(c) Collect basic data on air flow and air exchanges as related to containments (see description under vacuum and ventilation systems).

(d) Collect data on performance and ratings of filters.

(e) Training of inspectors (see above).

c. What Has Been Done?

(1) Containment specifications

(a) SSPC Guide 6 defines classes of containment.

(b) The SSPC Lead Paint Removal Tutorial (C3) presents examples of containments on bridges and other structures.

(c) DOT requirements vary considerably; some stipulate very specific designs and structures. Most reference SSPC Guide 6 classes.

(2) Vacuum and ventilation system requirements

(a) No standard or generally agreed upon practices have emerged.

(3) Dust collector requirements

(a) SSPC task force recently organized to develop guidelines.

(b) Some data available from private surveys.

(4) FHWA has commissioned a study entitled "Containment Efficiency Environment and Worker Exposure." This study will attempt to address many of these questions.

d. Recommended Actions

(1) Containment specifications

(a) Develop methods for measuring the extent of emissions directly or indirectly. For example it might be possible to use personal sampling monitors to verify that airborne emissions are not being violated, and visible criteria are also possible. However, new approaches are also needed because of the practical limitations of these methods.

(b) Conduct a study to develop data on typical levels of emissions from various operations. For example, determine the types of emissions that are generated when abrasive blasting inside a specific containment [e.g. Class 2 with 3 m by 3 m (8 ft by 8 ft) cross section, 566 m^3/min (20,000 CFM), 0.2 micrometer filter and linear air flow]. It is recognized that only limited scenarios can be researched but these would provide guidance on the extent of containment and ventilation needed.

components such as edges of flange, bottom of flange, etc.). The forms would include suggested "failure" points based on several criteria including "loss of appearance," "optimum time to repaint for long term costs," and "onset of loss of metal."

In a second phase DOT representatives would be asked to evaluate the forms by rating performance of various bridges.

In the third phase numerous DOTs would be asked to compile the data for coating systems applied under various conditions as described previously. These would include bridges which had been overcoated using various surface preparation methods and alternate materials, as well as structures which had been blast cleaned under full removal.

(2) Vacuum and ventilation system requirements

(a) Conduct a study and prepare guidelines on the capacities and capabilities of vacuum and ventilation systems. This includes the following: what the ratings mean, how to select appropriately sized systems, how to design a system for proper air flow, how and where to monitor the air flow.

(b) Conduct research to examine the influence on ventilation and air flow of obstructions, leaks in the containment, paint removal operations (e.g., blast cleaning), volume and cross sectional area of containment, number of operators, bends, direction of abrasive blasting, rigidity of containment and other factors. Prepare guidelines on practical use of this data in designing and monitoring ventilation and vacuum systems inside containment.

(3) Dust collector requirements

(a) Compile information on basic principles and parameters of dust collectors and available systems. The report would describe the components and operations of dust collectors. This would include means for rating the capacity of dust collectors, types, ratings, and other properties of filters, relation between air flow and air exchanges, guidelines on selecting, operating and maintaining dust collectors and capital and operating costs.

(b) Identify current practice for rating dust collectors based on CFM and static pressure. Identify deficiencies or improper use of current procedures. If warranted, develop and evaluate alternate procedures that would be relevant to systems used in containment.

(4) Training of inspectors: Develop procedures and criteria for field inspection of containment and ventilation systems. Identify needed skills to perform various operations ranging from setting up, calibrating and maintaining equipment to the lesser requirement of verifying proper operation. Prepare outline of curriculum for training inspectors to inspect for compliance with requirements of containment and ventilation specification and environmental emission regulations.

5. Evaluation of Productivity and Effectiveness of Surface Preparation Methods

a. Statement of the Issue

Because of the high levels of dust and waste produced from abrasive blast cleaning, alternate surface preparation methods have been developed. They include vacuum shrouded power tools, vacuum blasting, water washing and water jetting, chemical stripping and others. There are relatively little validated data on the production rates of these methods under field conditions and constraints for lead paint removal. Also, in question is the quality of the surface produced for both partial and full removal.

b. Specific Needs

(1) Documentation and dissemination of information presently available;

(2) Charts and tables showing the productivity, quality of surface, safety and environmental considerations, cost and other key parameters of the conventional and new methods;

(3) Studies to acquire additional data on above;

(4) Information and standards on containment, collection and treatment of water used for washing or jetting the surface;

(5) Compilation of current practice among DOTs for pressure, flow rates, level of contaminants left on surface and debris on ground or in water.

c. What Has Been Done?

(1) SSPC compilations for Navy and shipyards (recent reports)

(2) Photos and discussion in SSPC Lead Paint Tutorial (C3) and Industrial Lead Paint Removal Handbook

(3) Technical and trade literature from DOTs, manufacturers, and government agencies (e.g., US Navy, Air Force and aerospace industry studies on removal of paint from aluminum)

(4) FHWA and TRB reports summarizing major methods

(5) A recent FHWA report, FHWA-RD-94-100, "Lead-Containing Paint Removal, Containment and Disposal"

(6) Recent U.S. Navy sponsored studies on the containment efficiency of vacuum shrouded power tools.

6. Guidelines for Renovation, Demolition and Other Activities Disturbing Lead Painted Steel

a. Statement of Issue

Numerous construction and maintenance activities on bridges have the potential to expose workers and the public to lead paint. These activities include, but are not limited to, demolition, repair work (e.g., welding or mechanical work), and scraping of lead painted steel beams. In many instances, the project supervisors and workers are not aware of the potential hazard or regulatory requirements. In other instances, the levels of exposures and risks may be minimal, thereby not requiring special protection methods such as those mandated by 29 CFR 1926.62.

b. Specific Needs

(1) Information on legal and regulatory requirements and responsibilities for giving away, selling or disposing of lead painted steel members

(2) Information or guidance on the extent of hazard for different types of activities which disturb the lead paint (i.e., which of these will exceed the action level of 30 $\mu g/m^3$, triggering 29 CFR 1926.62?)

(3) Analysis of the types of repair of damaged steel needed based on the condition of the structural steel and the extent of damage. For these activities, what is the likelihood of lead exposures exceeding the action level?

c. What Has Been Done?

(1) Some bridge replacement cost analyses have been performed by CT DOT and others.

(2) FHWA-RD-94-100 "Lead-Containing Paint Removal, Containment and Disposal" addresses some of these issues.

d. Recommended Actions

(1) Regulatory and legal guidelines: Investigate legal and regulatory guidelines for handling, scrapping and recycling lead painted members. Prepare guidelines for use by DOTs, fabricators, contractors and specifiers;

(2) Guidance on disturbing lead paint: Identify various maintenance and construction activities which disturb lead paint. For each activity, determine how the lead will be disturbed, typical levels of lead containing dust and particulates released, typical practice by DOTs and regulatory, health and legal risks. Develop a recommended procedure for recognizing potential hazards and, if necessary, instituting control measures;

(3) Standard for disposal for lead painted steel members: Develop a standard procedure for removing and disposing of steel painted with lead.

7. Assuring Adequate Inspection of Lead Paint Removal Projects

a. Statement of Issue

Bridge agencies may not allocate enough resources for inspection of lead paint removal and abatement projects. Inspectors need to be knowledgeable on key issues and available during the critical aspects of the project.

b. Specific Needs

(1) Information on effectiveness of inspection as currently practiced and training and qualification needs for lead paint removal and abatement projects.

(2) Information on available training and other resources required.

c. What Has Been Done?

(1) Training presentation by NC DOT for lead paint inspectors;

(2) FHWA-planned training of DOT inspectors;

(3) National Highway Institute course on bridge paint inspectors (not specifically for lead paint removal);

(4) SSPC tutorial on industrial lead paint removal.

d. Recommended Actions

(1) Analysis of inspection needs: Acquired data on current practice of DOTs on inspection by in-house, third party personnel and by contractors. Include the number of inspectors, the responsibility of inspectors, the general paint training and lead paint removal training, record-keeping practices, and responsibilities. The latter would include the containment evaluation, environmental monitoring and worker health protection. Also, determine what types of skills, training and experience are necessary to effectively inspect lead paint removal projects. Prepare guidelines for a recommended practice.

(2) Training curriculum: Develop a detailed outline for a specific curriculum for training of individuals involved in lead paint removal projects. This would include DOT inspectors, project engineers and DOT workers who are in contact with lead from other maintenance and construction activities (see discussion under critical issue 6). The outline would identify the length of training required and its form (e.g., slides, video, hands-on training).

8. Safety and Health Guidelines for Lead Paint Removal

a. Statement of Issue

DOTs need to require specific health and safety guidelines for contractors and establish internal guidelines to protect DOT employees from lead hazards.

b. Specific Needs

Model documents and sources of information on developing and updating lead health and safety guidelines

c. What Has Been Done?

(1) Model specification to protect workers done by Center to Protect Workers' Rights (December 1993);

(2) AASHTO guide on bridge painting (expected to be approved in 1994);

(3) Specifications developed by various agencies, including CT DOT, Port Authority of NY/NJ and MD DOT.

(4) The Laborers' Union under contract to FHWA is currently developing contractor health and safety guidelines for lead paint removal.

d. Recommended Actions

(1) Develop model lead health and safety guidelines for incorporation into specifications of DOTs. One approach is a minimal program which would be based on the minimum requirements of 29 CFR 1926.62. Also, an option should be presented for a more protective program along with justification for higher levels of protection. The guidelines should include requirements for contract employees as well as DOT employees (e.g., inspectors, project engineers, workers) if DOT forces are used. In addition, guidelines should discuss practical aspects of implementation and enforcement. These would be based on the OSHA compliance directive, OSHA's enforcement practice, and input from contractors. Provisions should be made for periodically updating the guidelines, particularly in light of the impending EPA Title X training and certification requirements.

C. Secondary Priorities

1. Bid and Pre-Job Submittals

There are many types of documents that may be submitted by contractors as part of a bid package or prior to starting a job. These range from detailed descriptions of containment and ventilation, to environmental monitoring plans, to lead health and safety plans. It would be very useful to have a guideline, standard, or other document describing these items and recommending which ones are required under various circumstances.

2. Utilization of Lead-Containing Waste

There are many types of documents that may be submitted by contractors as part of a bid package or prior to starting a job. These range from detailed descriptions of containment and ventilation, to environmental monitoring plans, to lead health and safety plans. It would be very useful to have a guideline, standard, or other document describing these items and recommending which ones are required under various circumstances. Lead paint removal, particularly when using expendable abrasives, generates very large quantities of waste. This waste must be disposed of and often requires treatment to render it non-hazardous. The lead can be stabilized using cementious/silicate type binders; in particular, portland cement has been shown to be effective. Beneficial uses of concrete blocks or other forms of stabilized lead waste should be sought in applications where the potential for leaching and environmental risk is low.

3. Future Hazardous/Regulated Materials

States are concerned that coating materials applied after lead-based paint is removed will be regulated in the future. States need to evaluate coatings materials currently being used so that those with the potential of being regulated in the future are not used. Replacing one hazardous material with another is not desirable. A list of materials, including pigments and resins, which are currently regulated, or known to be on a list of materials for which regulations are planned, needs to be developed and distributed. SSPC Regulations Subcommittees would appear to be the most appropriate group to develop this list.

4. Surface Preparation Standards

Surface preparation standards for coating-only removal exist for situations such as making modifications to a structure, when the lead-based paint must be removed for welding, burning, etc., but the surface need not be prepared to a high level of cleanliness. Currently, specifications exist for SP 2, 3 and 7 which remove only loose material and SP 11 which removes all materials including mill scale. A specification which addresses the requirements for total coating removal only (i.e., without a need for surface profile or for rust removal) needs to be developed. The SSPC Surface Preparation Committee is recommended as the appropriate avenue.

5. Real-Time Evaluation of Air Emissions

PM 10 and TSP air emissions monitoring require a minimum of a day before results are available. Other methods, such as time of visible emissions, have been suggested, but have not been correlated to PM 10 and TSP results. In addition, PM 10 particles are invisible to the naked eye and a visual method may not be appropriate. Research is needed to develop and evaluate "real-time" evaluation methods which can be used to determine if air emissions are excessive and thus require that the job be shut down until corrections are made.

6. Automated Blast Cleaning

The use of robotics for blast cleaning has the potential to remove the operator from containment, thereby eliminating one of the most critical problems in lead paint removal. There is considerable work underway sponsored by universities, contractors and equipment suppliers. Some prototypes have been developed and evaluated on portions of bridges, but systems need additional engineering and mechanical improvement before they can be considered practical for bridge application. In addition, the cost is currently very high per unit area. Federal and state agencies are encouraged to support the R & D in this technology and to evaluate it when it becomes available.

7. Cleaning Steel in the Shop Versus the Field

Maintenance painting has traditionally been accomplished by removing the old paint and rust, and applying a new system. Because of the greatly increased costs associated with lead paint removal in the field, some agencies have elected to remove the steel members and ship them to a shop facility for cleaning and repainting. This has normally been limited to instance where the bridge deck was being replaced. Information is sought on techniques, costs, case histories, and worker and environmental protection aspects of this approach. (Also see the discussion under critical issue 7 in previous section.)

8. Non-Destructive Coating Evaluation Methods

Conventional methods for evaluating coating condition--including adhesion testing, examination of under-film corrosion, and testing degree of brittleness--are destructive. They also require that the inspector have access to numerous locations on the bridge. Techniques are needed which allow rapid non-destructive evaluation of the condition of the coating and the substrate. (See related discussion under critical issue 3 in previous section.)

9. Information Hotline

An information hotline which can answer questions regarding regulations, technical requirements, and other general or field problems would be desireable. The individuals who work these hotlines must have information available to answer questions.

10. Formula Versus Performance-Based Coating Specifications

With increased emphasis on overcoating and regulations restricting VOC content in coatings, the materials which have commonly been used for overcoating lead-based paint systems cannot be utilized. Changes in coating formulations and new coating materials designed for overcoating have been developed by the coating manufacturers. The formulation of materials tested today may not be the same as the materials available tomorrow. Formula-based coatings specifications for VOC-compliant coatings are desired by states which prefer formula-based coatings materials. They may also be used as control coatings for use when evaluating the commercially available products. Formula-based coatings specifications will provide a consistent material with documented performance history.

11. Guidelines for Contractors

Contractors need more specific guidelines on all aspects of lead-paint removal. Specifications define what is required, and it is the contractor's responsibility to put these requirements into practice; more guidance would be helpful.

12. Work In Progress

Lead paint removal is a priority issue in many states. A great deal of work on a variety of topics is being performed. Information or data from these projects is needed. A centralized source such as FHWA or SSPC is needed to collect information about on-going studies for dissemination. This would include state studies, field evaluations, etc., in addition to FHWA, TRB and HP&R studies.

13. Contractor Qualifications

Because of the complexity, costs and risks of lead paint removal, the demands on a painting contractor have increased significantly over the last five to ten years. Bridge agencies need a means to insure that contractors are knowledgeable about advanced technologies, new OSHA, EPA and local regulations, training requirements, effective means of worker protection and environmental monitoring. Use of a standard program for prequalifying contractors, such as SSPC's certification program, should be encouraged.

III. REGULATORY ISSUES

A. Procedure for Analyzing Issues

1. Assumptions

Having heard all the "issue" presentations, the Regulations Breakout Group brainstormed the following assumptions which underpin lead paint management projects:

a. Lead is toxic.

b. Regulations exist that pertain to DOT projects.

c. Public protection is required.

d. Regulations are minimum standards of performance.

e. Contractors will take an approach that maximizes profits.

f. DOTs want the least costly approach.

g. Containment performance is quantifiable.

h. Monitoring results are accurate.

i. Containment reduces emissions.

j. DOTs can afford to comply with regulations.

k. Specifications are properly written.

l. There is a need for a uniform approach to lead based paint management among DOTs.

m. Local enforcement is variable.

n. 100% compliance with all applicable regulations is not achievable.

o. Definitive guidance on how to comply does exist.

p. Current regulations are applicable to DOT projects.

q. Regulators understand the issues.

r. Consultants and project designers understand the regulatory issues.

s. Contractors understand the regulatory issues.

t. DOTs understand the regulatory issues.

u. DOTs can influence future regulations.

v. Compliance is the contractor's responsibility.

w. "Pre-qualified" contractors have lead painting experience.

x. Lead is not the only problem. (Cd, Zn, etc., may also become problems.)

y. All parties act in good faith.

z. The public cares about lead exposures.

aa. DOT's have third-party liability exposure.

bb. Regulations are based on risk/science.

All assumptions were considered challengeable. They were used to prompt the identification of issues in the three general areas of concern developed in the "General" session [i.e., environmental issues (air, water, soil and waste), worker protection issues (feasible controls, respiratory protection, monitoring data), and training and education issues (workers, DOT inspectors, and the public)].

2. Defining Critical Issues

The subgroups assigned a priority to each issue, as being Critical (C) or Secondary (S). Critical issues were further prioritized as higher (+) and lower (-). The subgroup coordinator presented the prioritized issues to the entire Breakout Group for input. The subgroups then broke out to identify four "focus" issues from the group of Higher Critical Issues (C+) to develop further. For focus issues, subgroups were asked to develop a statement of the problem, describe why it is of concern (specific needs), and determine what has been done and what needs to be done. The results were reviewed with the entire Breakout Group to establish a general consensus on each focus issue plan. The results are given in Section B.

The critical issues are as follows:

a. Uniformity and Reciprocity of State Training Requirements

b. Quality and Content of Lead Paint Abatement Training Courses

c. Public Exposure to Lead Debris from Bridge Maintenance

d. Project Design Criteria Based on Risk Assessment

e. Air Monitoring Protocols

f. Applicability of Federal Air Quality Regulations

g. Soil Sampling

h. Specifications for Worker Protection

i. Medical Surveillance

j. Assigned Protection Factor for Abrasive Blast Helmets

k. Uniform Worker Lead Exposure Sampling and Assessment

B. Analysis of Critical Issues

1. Uniformity and Reciprocity of State Training Requirements

a. Statement of the Issue

Title X of the Congressional Hazardous Lead Based Paint Reduction Act (October 1992) requires that the accreditation and training programs be implemented by the states based on EPA guidelines. However, many contractors perform work in several states. It would be very inefficient and wasteful if such contractors, or their workers and supervisors, were required to undergo separate training and certification from each state in which they work.

b. Specific Needs

(1) Communicate to the state agencies the importance of reciprocity and uniformity to improve the quality and cost-effectiveness of worker and supervisor training and certification;

(2) Good model training programs which specifically apply to structural steel;

(3) Strong EPA incentives for states to accept training and certification by other states.

c. What Has Been Done?

(1) SSPC has developed course materials which could be utilized in worker or supervisor training.

(2) Some states have already developed or drafted rules on certification and training of workers and supervisors.

(3) SSPC has established a list of environmental and health agency contacts and sent a preliminary letter offering SSPC as a resource for lead paint removal on structural steel.

d. Recommended Actions

(1) Elicit support from DOTs, contractors, hygienists, suppliers and consultants to form a coalition of interested parties to inform and encourage states towards uniformity and reciprocity.

(2) Increase dialogue with EPA and states to encourage greater coordination among these agencies by correspondence, and regional and local meetings.

(3) Provide clearinghouse of information on what various states are doing as a resource to DOTs, SSPC members and other states.

2. Quality and Content of Lead Paint Abatement Training Courses

a. Statement of the Issue

Numerous training programs have been developed and presented for lead paint abatement, but the majority are for residential lead paint. There are major differences between residential and structural steel lead removal operations, such as the technological skills required, means of worker protection, means and extent of exposure, and consequences for improper work practice. Thus it is important that the agencies responsible for monitoring and approving training programs be aware of these factors.

b. Specific Needs

(1) Determine the appropriate training requirements and needs for both workers and DOT inspectors;

(2) Ensure a minimum standard of qualification to have confidence that these workers/inspectors have the appropriate level of expertise in control of contamination (containment), health and safety, and use of current technology (equipment and techniques).

c. What Has Been Done?

(1) SSPC has developed course materials which could be utilized in worker or supervisor training. In addition, several quality videos and other materials relevant to removal of lead paint from structural steel are available.

(2) Several three or four day lead abatement training programs have been developed or are under development with EPA or OSHA sponsorship.

d. Recommended Actions

(1) SSPC should take the initiative and prepare curricula for worker and supervisor categories.

(2) Review existing training materials to identify segments that could be used for bridge structural steel lead abatement training.

(3) Investigate the need for a training course for DOT inspectors or others not covered by EPA or state training requirements.

3. Public Exposure to Lead Debris from Bridge Maintenance

a. Statement of the Issue

There is a concern that the public may become exposed to hazards if they enter work sites, and it is considered the responsibility of the DOT to ensure public safety. In addition, DOTs need to protect themselves from potential liability.

b. Specific Needs

Guidelines for DOT policies and procedures to inform and protect the public are needed.

c. What Has Been Done?

DOTs have Public Relations Departments whose function is to educate the public. Public safety is maintained by traffic control, work zone designation, etc.

d. Specific Recommendations

FHWA should develop a program which will recommend steps that show DOTs, in conjunction with State Departments of Health, how to properly communicate the risk and potential impact on the community.

4. Project Design Criteria Based on Risk Assessment

a. Statement of the Issue

The design process for projects and specifications for lead paint removal does not take into account the type or extent of risk. Use of risk assessment techniques could result in significant improvement in efficiency and cost savings for DOTs.

b. Specific Needs

(1) Identify the basic principles and benefits of risk assessment techniques for lead paint removal.

(2) Determine the impact of factors such as percentage of lead by weight, size, ADT (average daily traffic), configuration of structure, and sensitivity of surroundings on project design criteria and specifications.

(3) Determine degree of risk incurred for different SSPC containment classes.

c. What Has Been Done?

(1) Draft protocols for risk management of lead paint removal projects have been developed by a consultant for EPA;

(2) Some bridge agencies (e.g., Port Authority of NY/NJ, NYC DOT) have undertaken risk assessment for lead paint removal projects.

(3) SSPC tutorial and the Industrial Lead Paint Removal Handbook, Second Edition (SSPC 93-02) have outlines and guidelines for specifications and submittals.

d. Recommended Actions

(1) Develop a consensus among bridge agencies on the basic components of project specifications and what the major gaps are in the agencies' ability to specify lead paint removal.

(2) Develop guidelines and techniques for risk assessment and improved procedures for designing and specifying lead paint removal projects.

5. Air Monitoring Protocols

a. Statement of the Issue

There is a lack of standard guidelines for air monitoring of lead paint abatement activities associated with surface preparation of steel structures. This activity can add significantly to the cost of a project, yet the usefulness and need for the data have not been adequately determined.

b. Specific Needs

(1) Guidance document on the measurement techniques, the interpretation and applicability of the data, and the relevance of CAA (Clean Air Act), NAAQS (National Ambient Air Quality Standards) and NESHAP (National Emission Standards for Hazardous Air Pollutants) regulations

(2) Guidelines for selection and evaluation of air quality monitoring firms and analytical laboratories

c. What Has Been Done?

(1) SSPC task group initiated development of protocols.

(2) Several DOTs (IL, MA, NYC) have specific monitoring procedures, but they have not been evaluated for effectiveness.

d. Recommended Actions

(1) Acquire and analyze data from DOTs and other specifications.

(2) Develop guidelines as indicated above. Among the key components of an air monitoring protocol are the following:

(a) Specification of Equipment (TSP and PM 10)

(b) Parameters to be Analyzed

(c) Meteorological Data

(d) Assessment of Visible Emissions

(e) Establishment of Background/Baseline Protocol

(f) Duration of Monitoring Program (Number of Days)

(g) Duration of Sample Collection (Hours)

(h) Specification criteria for site-specific monitoring (including review of work practices, location of sensitive receptors, site topography and structural dimensions)

(i) Selection/approval of monitoring firm based upon expertise and training

(j) Quality Control/Quality Assurance

(k) Certified laboratory requirements

6. Applicability of Federal Air Quality Regulations (CAA, NAAQS and NESHAPS)

a. Statement of the Issue

Currently there is a need to identify applicability of these regulations to lead projects. For example, were the NAAQS standards intended to measure background ambient air levels or point sources, such as containment? Is a short term (24 hour or 8 hour) lead standard needed to measure airborne levels?

b. Specific Needs

(1) Evaluate the applicability of these regulations to the current lead issues;

(2) Assess the need for a short term standard for lead.

c. What Has Been Done?

(1) Very little has been done in this area.

d. Recommended Actions

(1) SSPC's Environmental Monitoring Committee will evaluate and prepare a compendium of existing regulations.

(2) Establish the research availability of an EPA database that already has this information.

(3) FHWA should approach EPA on interpreting or amending existing policy.

7. Soil Sampling

a. Statement of the Issue

There are no definitive standards for determining an acceptable soil lead level. Regulations are mandated by state and local agencies and may be determined by various agencies (DOHs, EPA, DEPs).

b. Specific Needs

(1) Identify what levels of soil requires clean-up.

(2) Evaluate applicability of existing regulations.

(3) Assess value of sampling soil as a monitoring tool.

c. What Has Been Done?

(1) EPA has issued a document (July 1994) defining interim guidelines for abatement of lead in soil for residences and public areas. The applicability to bridge sites has not yet been ascertained.

(2) Several states have established or proposed guidelines for soil abatement (NY, NJ, MN).

(3) HUD/EPA has issued clean-up guidelines for superfund sites (1978).

(4) A few bridge agencies (Port Authority of New York and New Jersey, Golden Gate Bridge Authority) have done some soil remediation in highly contaminated areas adjacent to bridges.

d. Recommended Actions

(1) Develop guidelines for DOTs for soil monitoring for bridge maintenance and clean-up criteria based on EPA guidelines.

(2) Compile and analyze data from highway and bridge agencies.

(3) Determine the relationship between soil and lead levels near bridge sites and the adverse health effects on children and the public (recent study in NYC found little correlation).

8. Specifications for Worker Protection

a. Statement of the Issue

Worker protection is not routinely designed into specifications for lead paint removal, although worker protection has become a major component of a contractor's operation and cost. Failure to explicitly consider worker protection can adversely affect worker health, cost, liability and overall project success.

b. Specific Needs

Model specifications and documentation of need for detailing worker protection (e.g., including consequences of non-compliance).

c. What Has Been Done?

(1) Model specifications to protect workers done by Center to Protect Workers' Rights (December 1993)

(2) AASHTO guide on bridge painting

(3) Specifications developed by various agencies, including CT DOT, Port Authority of NY/NJ and MD DOT.

d. Recommended Actions

(1) Develop model specifications for worker health and safety on lead paint removal projects. (See Critical Issue 8 under Technology section.)

(2) Make worker protection a separate pay item.

(3) Establish procedures and criteria for submittals from contractors before, during and after jobs. This would document compliance with specification requirements, just as a contractor must comply with the painting specification.

9. Medical Surveillance

a. Statement of the Issue

Medical surveillance programs are relatively new and generally underdeveloped in the construction trades. Improper surveillance may result in inadequate worker protection. OSHA construction industry requirements are inadequate for the work performed on bridges. Improper management of employees adds costs and delays to projects, and exposes the owner and contractor to additional liability.

b. Specific Needs

(1) A system for collecting, analyzing and reporting data

(2) Better education and awareness of need and procedures for medical surveillance

c. What Has Been Done?

(Unknown)

d. Recommended Actions

(1) Develop standardized programs that address frequency of testing and lab certification.

(2) Implement programs to manage employees before maximum blood levels are reached.

10. Assigned Protection Factor (APF) for Abrasive Blasting Helmets

a. Statement of the Issue

The APF for Type CE blast helmets is overly conservative. 29 CFR 1926.62 downgraded the APF for Type CE respirators to 25. Since the lowest feasible lead concentration in most blasting containments exceeds this level, alternative protective measures must be used. Unfortunately, no other respirator affords the peripheral vision, integral head protection, protection from abrasive ricochet (neck, head and shoulders), and facilitates heat loss. The APF for Type CE respirators is fundamentally flawed. NIOSH grouped all loose fitting hoods and helmets together as a single category. This included the loose fitting PAPR air hats (e.g. RACAL air helmet) with the continuous flow, supplied-air type CE blast helmet. The PF of these devices varies greatly, with the loose fitting PAPR helmets have an APF of 25. There is substantial evidence that the latter can provide a protection factor of 1000 or greater. Note: Recently OSHA has approved certain type CE abrasive blast hood respirators to have an APF of 1000. This applies only to two specific models (supplied by Bullard) which were approved after rigorous testing conducted by an OSHA-approved third party.

b. Specific Needs

NIOSH-approved supplied-air respirator which provides integral head protection, peripheral vision, facilities heat loss and has a protection factor of at least 1000.

c. What Has Been Done?

(1) The Title X mandate required OSHA to issue an interim rule to protect workers equivalent to the protection afforded by the HUD guidelines. The HUD guidelines were based on 29 CFR1910.1025, which has an APF of 2000 for Type CE respirators.

(2) The most recent ANSI (American National Standards Institute) standard which has been used by OSHA for past comprehensive health standards, as well as 29 CFR1910.134 and 29 CFR1926.103, draw distinctions between loose fitting PAPRs (with an APF of 25) and continuous flow positive pressure loose fitting hoods and helmets (with an APF of 1000).

(3) Alternative respirators are being evaluated by NIOSH. OSHA is reviewing the APF for Type CE Respirators. NIOSH has recently assigned a protection factor of 1000 to a specially designed air fed hood type respirator with a tight face seal.

(4) FHWA is presently commissioning a study to determine the *in situ* (actual) protection factor afforded by type CE respirators used on lead bridge jobs.

d. Recommended Actions

(1) Petition OSHA, on behalf of FHWA and state DOTs, to classify Type CE continuous flow supplied air respirators as "positive pressure" respirators, when operated in compliance with the manufacturer's recommendations (i.e. in excess of 0.17 m^3/min (6 CFM) of air flow). Failure to operate the device in compliance with the manufacturer's requirements should result in a citation of the employer, not the downgrading of the APF for the entire class of respirators.

11. Uniform Worker Lead Exposure Sampling and Assessment

a. Statement of the Issue

The Lead in Construction Standard requires employers to monitor breathing air of workers to determine the need for protection measures. There are no uniform formats or procedures to sample, compile, record or analyze this data. Consequently, it is difficult to compare data from one job to another, or to make any general conclusions about the expected lead dust level from a given operation (e.g., vacuum blasting). Such data could be useful, for example, in identifying types of operations (e.g., shrouded power tool cleaning), which may not exceed the action level under certain circumstances.

b. Specific Needs

(1) Uniform forms, formats and procedures for collecting, recording and analyzing airborne lead samples;

(2) Data on how the worker exposure levels are influenced by type of operation, type of paint and other variables.

c. What Has Been Done?

NIOSH has funded Connecticut Road Industry Surveillance Program (CRISP) to develop a standardized program for worker protection and monitoring for all lead paint removal workers in the state.

d. Recommended Actions

(1) Develop guides or standard procedures for acquiring and analyzing worker exposure data.

(2) FHWA and DOTs should evaluate forms and procedures for assessing worker lead exposures. Contractor or consultant involvement is recommended.

(3) Set up a clearinghouse or database to accumulate data from various lead paint removal projects. The data would be analyzed to identify the activities producing high and low lead dust levels, the variability of cleaning operations (e.g., water-jetting) and general trends.

IV. GUIDELINES FOR COST-EFFECTIVE LEAD PAINT REMOVAL

A. Developing Strategy and Specification Requirements

1. Introduction

These guidelines are intended to:

a. Identify alternative approaches and strategies

b. Point out areas requiring particular care

c. Identify and annotate resource materials

d. Give examples of model language for specifications and other documents.

Highway agencies have a large number of bridges requiring various degrees of maintenance. While most agencies recognize the significant lifetime costs and the need for long term planning and execution of bridge painting, few have established effective programs to accomplish this. Maintenance painting is often viewed as a lower priority compared to other bridge and road maintenance and construction needs. As a result, the work is often deferred and inadequately funded.

Over the last five to ten years bridge maintenance painting has become more visible, controversial and expensive as a result of the environmental and worker health concerns that have been raised.

Bridge agencies must confront these issues and determine a strategy for maintaining bridges that are coated with lead containing paint. A strategy can have a very narrow scope (what action is needed on a particular structure for this year) or a broad scope (five year plan for all the bridges in a district). The approach for selecting an option for maintenance will vary depending on the agency's budget, types of funding available, planning policies, and political and community factors.

2. Identifying Options and Strategies

Whatever approach is used, for each structure considered there are five basic maintenance options. These have been described in the technical literature and are summarized below.

a. Full Removal and Repainting

This strategy entails completely removing the existing paint and applying a lead-free system designed to give long-term protection. It is normally intended to remove all the old paint and rust by at least a commercial blast. This strategy also involves the full range of environmental controls (i.e., containment, monitoring) discussed in previous units.

b. Spot Repair/Overcoat

This strategy is intended to retain intact sound paint. Workers first clean the corroded or deteriorated areas with hand or power tools or other methods. This is often followed by lightly cleaning the intact paint by power water washing or solvent wiping. The damaged areas are primed, and one or more full topcoats applied. Spot cleaning and priming may be permitted when degraded areas are limited or scattered, making it impractical to clean them separately. This strategy is generally abbreviated as "overcoating" in the subsequent discussions.

This analysis will entail describing the overcoat procedures, identifying the materials, discussing the environmental and safety concerns, and identifying the relative risks and costs.

c. Zone Repainting

This strategy is a hybrid approach, which combines some of the procedures for spot repair and overcoating and full paint removal to be discussed later. Entire sections or zones of a structure (e.g., the bridge bearing areas) receive greater protection than the remainder of the structure. These are areas which are corrosion prone because they collect moisture or salt. The remaining areas of the structure (i.e., the less critical areas) are treated by spot repair or overcoat, or in some cases are not repainted at all.

d. Defer/Ignore

Deferring and ignoring are actually quite different approaches, although the action is the same. Ignoring represents a lack of recognition of the problem, or an unwillingness to address it. Because of broad publicity on lead paint, it is difficult to claim ignorance of the problem. Deferring painting is a deliberate strategy. As with ignoring the problem, deferring the painting does not solve anything, but the decision is made with some knowledge of the consequences. For example, deferral may be part of a strategy that includes painting the most critical bridges in a district, and leaving the others for subsequent years. Deferral may also be a result of the recognition that there is not adequate funding to repaint. It should be kept in mind that risks, which will be discussed in more detail later, are also deferred to a future date. Painting may also be deferred if the conditions on the structure are not particularly corrosive. (The costs have risen to the point where we do not want to repaint for cosmetic or "lack of adhesion" problems. Corrosion damage to the structure is the key criterion.)

e. Steel Replacement

This strategy entails removing the steel beams or plate from the structure. The steel is replaced with newly fabricated members or with deleaded, cleaned and recoated old members. This is an option that is becoming more widely considered because of the difficulties and escalating costs for full removal and some of the risks of overcoating.

A recent article described a means to analyze these options on the basis of performance, cost and risk (JPCL, November 1993, p. 60). In each of these areas there is a degree of uncertainty and limitation on the data available. At the least agencies need to be aware of the available options and the limitation of the information on which the decision is based.

There are several types of information needed to make an informed decision on maintenance repainting:

(1) Cost data: It is essential to acquire or estimate the costs for any option under consideration. We saw there are several components to the overall cost. The costs for environmental and worker protection now make up a significant portion of the overall cost. The materials and the coating application are relatively small portions of this cost.

(2) Data on coating repairability: If the existing coating is too thick or brittle, or has low adhesion, overcoating may not be a viable option.

(3) Technical data: This includes info on the type of structure, the type and age of paint, and the exposure environment.

(4) Performance data: This is particularly important when considering new coating systems for overcoating or as replacements for conventional high VOC coating systems. It is important to verify the coating's application and durability properties.

3. Determining What Action or Strategy Is Needed: Recommended Procedure

a. Seek top level management commitment to addressing the need for maintaining or otherwise dealing with the issue of lead painted bridges.

b. Establish a DOT intra-agency task group to develop and implement any programs. This group should include representatives from the offices of the chief engineer or the bridge engineer, materials maintenance, construction, environmental, industrial hygiene, risk management, attorney's office, procurement/contracting and public relations (or equivalent). Identify the officials within the agency who will be involved in making the decision and implementing it.

c. Establish contacts with the state and local regulatory authorities, including OSHA, state departments of environment, health and labor, US Coast Guard (if bridges over water are included), and other relevant agencies.

d. Identify the structures for which action or decision is needed.

e. Determine the type of data or other basis for making the decision. This would include:

(1) budget factors (budget year, amount available, allocations to specific structures or districts, number of bridges targeted to be painted)

(2) agency policies (e.g., "prevent significant metal loss," "improve appearance of highly visible bridges," "eliminate lead hazard," "paint as many as possible for short-term protection," "avoid all but most critical bridges," "only repaint bridges for which federal money is available")

(3) technical data (e.g., condition of paint and steel and expected additional life, environmental sensitivity of nearby areas)

(4) cost and performance data (what is expected lifetime for proposed system? what is cost of application, including environmental and health controls)?

(5) risk factors (what are possible consequences to structure, paint, environment, workers?)

f. Acquire information on budgets and agency policies.

Record information on budgets and any guidance on the objectives, restrictions or other influential factors. Identify officials within the agency who need to review and approve the recommendations. Determine what funds are available (e.g., agency funds, FHWA funds) and any conditions (e.g., dedicated maintenance program) and if your agency qualifies.

g. Acquire data on environmental and community factors.

For each bridge under review, determine the proximity to residences, businesses, schools, waterways, and the potential impact of bridge painting operations (e.g., dust or debris fallout, lane closures, noise). Assess the potential reaction by community groups or local regulatory enforcement agencies.

h. Acquire structure and paint condition data.

These data are best acquired by specific paint condition survey; past records (e.g., recent bridge inventory inspections or paint application records) may also be used. Accurate assessment of the extent of rusting and coating degradation is critical if the agency is considering some type of partial repainting or overcoating.

i. Determine recommended strategy

Based on the data and resources identified above, develop a recommendation for the action for each of the structures. This may include an analysis of the various options with pros and cons for each, along with estimated cost, risks and uncertainties and expected performance (i.e., time until additional maintenance required). This analysis should include a life cycle maintenance painting cost analysis for each maintenance strategy considered.

4. Determine Components of Lead Paint Removal Specification

The specification needs to address the specific requirements for environmental and worker health protection as well as the conventional requirements for paint removal and reapplication. A suggested outline for a specification is as follows:

a. Scope/description

b. Reference documents/definitions

c. Special requirements (e.g., traffic control, seasonal limitations, contractor qualifications, training)

d. Requirements for coating materials

e. Requirements for coating application

f. Requirements for paint removal and containment

g. Requirements for control of dust, debris

h. Requirements for handling waste

i. Requirements for worker protection

j. Method of measurement/basis of payment

k. Submittals

Other approaches may be used to organize the items in the specification. The above enables the agency to establish separate pay items for the environmental and worker protection portions of the contract.

Some agencies issue special provisions which are supplements to the standard specification, as the latter may be revised only every few years, whereas techniques and approaches for lead paint removal have been changing very rapidly over the last several years.

Other items which may be include in the specification or the contract document are as follows (state DOTs with good examples of these provisions are shown in parentheses):

a. Insurance (KY)

b. Stenciling (MI)

c. Equipment/facilities (MI, MD)

d. Incentives/bonus (OK, NC)

e. Test for lead paint, compatibility (NC)

B. Specifying Full Removal and Repainting

1. General

When a decision has been made to fully remove the paint, the following items must be included in the specification:

a. Method of paint removal

b. Type and class of containment

c. Ventilation and dust collection

d. Waste collection and handling

It is important to clarify the freedom the contractor has in devising means to meet the requirement. Some specifications are based on "performance;" the contractor is instructed on what the results should be, but not how to achieve them. Alternatively the specification may spell out precisely what type of equipment and operational parameters shall be used and the specific design of the containment.

2. Method of Removal

The major choices are:

a. Abrasive blasting with recyclable abrasive

b. Abrasive blasting with disposable abrasive

c. Power tool cleaning (with or without vacuum attachment)

d. Vacuum blasting

e. Chemical stripping to remove lead, followed by abrasive blasting

The selection of removal methods will have a significant impact on the extent of emissions and the type of containment and ventilation required. Abrasive blasting is the most productive method, but also produces the greatest amount of debris and dust, and the greatest potential for environmental contamination and worker exposure. Due to the difficulty in comparing labor costs, equipment costs, quality of surface, effectiveness of containment, and disposal costs among the different removal methods, it is recommended that the agency decide on the type of method and not leave this up to the contractor.

The following are examples appropriate for specifying abrasives:

- Example: MN DOT
  Staurolite (Starblast) with 5-8% steel grit or mineral aggregate plus 15% Blastox
- Example: CT DOT
  Steel grit, max 20% breakdown after 100 uses
- Example: DC DOT
  Recyclable steel, to meet profile, no more than 110 ppm chloride or sulfate
- Example: GA DOT
  Non-dusting mineral abrasive with 10% by weight G-80 steel grit, no more than 100 ppm chloride or sulfate, five gradation sizes (sieve ranges) for Type A (copper and coal slag) and Type B (Staurolite), test for aggregate gradation by GA DOT

3. Containment and Ventilation System

The requirements for containment depend on the type of removal method, the sensitivity of the bridge environment (e.g., proximity to residences) and the agency's policy regarding thoroughness of environmental protection (which, in turn, may be influenced by the activity level of regulatory officials).

SSPC has established four containment classes from the most rigorous (Class 1) to the least rigorous (Class 4) for several removal methods, including blast cleaning, power tool cleaning, water jetting, and chemical stripping (see SSPC Guide 6). For each class the guide describes the following features:

(1) rigidity of containment construction materials

(2) air permeability

(3) extent of seal for joints and entry ways.

For the ventilation system, the guide specifies the type of air input, means of verifying air pressure, need for air filtration and minimum air flow. Note that the classes are primarily based on performance. The guide also identifies specific materials and components, but these are not inherently part of the containment classes.

Many agencies have used the SSPC containment classes (or modifications of these classes); many also provide more specific requirements regarding materials and details of construction. Examples are shown from IL and IA in Appendix B2.

- Example: NJ bridge painting contract 93-6 (1993) requires contractor to furnish a detailed containment plan, including the following:

  (1) types of materials

  (2) structural element sizing and connections

  (3) maximum loading permitted with load analysis by licensed PE

  (4) maximum deflection permitted

  (5) design of hangers and supporting members

  (6) assembly and disassembly procedures

  The specification also designates eight items which must be included in the drawings and plans, including material and design of solid floor, run-off route from drains, type of dust collection, make up air and air flow, lighting, and sequence of operations to construct the containment.

4. Specifying Environmental Monitoring

Lead paint removal has the potential to emit debris and dust to the ambient air (area in vicinity of bridge), into waterways and to contaminate adjacent soils and properties. So it may be necessary to institute monitoring to verify compliance with environmental regulations. There is a wide variation in the highway agency practices for air, water and soil monitoring. The need for monitoring depends on several factors including the potential for environmental contamination, and the proximity and sensitivity of the surrounding area. The cost can be significant and there is uncertainty as to the effectiveness or benefit of currently used procedures. Standard procedures have not been established which are relevant to bridges and other steel structures. Suggested procedures are presented in Project Design, Volume 2 of the Industrial Lead Paint Removal Handbook (SSPC 95-06).

a. Air Monitoring

Paint removal, particularly blast cleaning, generates dust which remains airborne and is subject to air quality regulations. Under the National Ambient Air Quality Standards (NAAQS), Federal EPA regulates lead dust and PM 10 (particles smaller than 10 microns), both of which are produced during lead paint removal. The EPA rule (40 CFR part 50.6) defines specific tests and equipment for collecting and analyzing the dust levels. However, the guidance on monitor placement is not applicable to bridge painting operations, as it was developed with permanent fixed site facilities (e.g., battery manufacturing or smelting operations) in mind. Some agencies (e.g. NYC DOT, CT DOT) have specified the use of two types of monitors, one for total suspended particulates (TSP) of lead and one for PM 10 particulates. Other agencies (e.g., IL DOT) require only TSP monitors. This is based on the experience that the likelihood of exceedance is greater for TSP than for PM 10 (i.e., if there is excessive dust, it will more likely be detected by the TSP monitors). Additional data should be compiled to verify if this approach, which could substantially reduce the cost of monitoring, is valid. The ratio of the level of TSP to that of PM 10 might depend on the percentage of lead in the paint. This strategy can also be justified on the basis that the long term effects of lead in the atmosphere are of more concern than the respirable dust particles, which are not harmful after they settle on the ground.

To reduce the cost associated with ambient air monitors (estimated at $5000 to $10,000 per week), use of personal air monitors has been proposed. These are the monitors used to sample the air in the breathing zone of workers. These monitors have been used by NC DOT to determine the levels of exposure to workers at various locations inside and outside the containment; these will also be considered by the SSPC task force.

Visual assessment is a possible alternative to instrumental monitoring. Tentative criteria for this approach are described in SSPC Guide 6. Several visual emission levels are defined including zero emissions (level 0) and emissions of 1% (level 2) to 10% (level 4) of the work day (i.e., five minutes in eight hours to 48 minutes in eight hours). This approach has been used with success by NC DOT. It requires an observer to monitor regularly for any sign of visible emissions.

A proposed standard protocol for ambient air monitoring is being developed by an SSPC task group.

b. Soil Monitoring

Soil monitoring consists of collecting soil samples at precisely defined locations around the bridge prior to mobilization and after completion. The primary purpose is to determine if the bridge paint removal operation has increased the levels of lead in the soil. EPA has not established any rules on the acceptable total amount of lead in soil or acceptable increase in soil lead concentration.

One approach used by MD and several other DOTs is to establish a maximum increase in soil lead from a paint removal project. A typical level permitted is 500 ppm. If the soil lead level increases by more than this amount, the contractor is required to remediate back to within the 500 ppm increase.

Recently, some guidelines have been issued by EPA for total acceptable lead levels for residential settings based on their proximity to public use, particularly by children. ("Guidance on residential lead-based paint, lead contaminated dust, and lead contaminated soil" was issued by the EPA office of prevention pesticides and toxic substances on July 14, 1994.) For levels up to 2000 ppm, measures are needed primarily to limit exposure to children. Between 2000 and 5000 ppm, EPA recommends implementing interim controls even if the area is not frequented by children. For soil lead levels greater than 5000 ppm, EPA recommends abatement either by removal and replacement or a permanent barrier such as pavement.

A major concern for soil monitoring is the number and source of samples. The lead levels may vary quite considerably within a small area. Data from the Port Authority of New York and New Jersey and New York City DOT have verified this variability. Typically, highway departments require contractors to collect four samples around the bridge. Without additional analysis of existing data or further guidance from EPA or states, this approach seems adequate.

c. Water Monitoring

There has been very little evidence that rivers and streams are being damaged by lead paint residues. Nevertheless, in some instances it may be necessary to collect and analyze samples of the water and the sediment. Reference 2 presents a suggested protocol for conducting the sampling. Many highway agencies require that a containment boom be placed in the water downstream of the bridge. These booms must be regularly cleaned, maintained and repaired to prevent becoming clogged or breached. In addition, during storms or other periods of high flow, they are often ineffective in preventing debris from passing.

- Example: NJ DOT

  (1) Air/water quality: The engineer may require the contractor to conduct air quality or water quality testing to determine if any debris has escaped from containment.

  (2) For any environmental monitoring not included in the contract, the DOT will pay the direct cost without overhead or profit. The contractor shall be required to pay the cost of any cleanup or other corrective action.

- Example: CALTRANS

  (1) Air sampling: Contractor to use CIH to develop and carry out testing at four locations to be determined by engineer (sampling time to coincide with blasting time, and at least eight hrs). Samples are to be analyzed for PM 10 and then same samples measured for heavy metal.

  (2) Soil sampling: 20 samples are taken by the CIH prior to the job and within 36 hrs of completion of abrasive blasting. Samples to consist of five plugs at corners and center of 1 sq ft template. No increase in soil lead content permitted.

- Example: District of Columbia

  (1) Soil sampling and testing: At six locations set by CIH; one prior to job, one at midpoint, and one at end (references SSPC Guide 6).

  (2) Air monitoring: Begin one week prior to project start-up, for first two weeks of blast cleaning, and one month later (downwind of containment). Criteria from Level 1 of Guide 6 (no visible emissions), air monitoring using personal monitors (Method C).

- Example: MN Pollution Control Agency

  Several classes of pollution control established based on sensitivity of receptor properties, distance of properties to structure, risk factor (% of lead in paint X height X exterior surface area).

5. Specifying Waste Handling, Treatment and Disposal

The environmental regulation having the greatest impact on lead paint removal is the Resource Conservation and Recovery Act (RCRA). This is the law which prohibits depositing any lead-contaminated debris on the ground or in the water and has resulted in the need to contain bridges to prevent such fallout. Of significance is the fact that the bridge owner (e.g., DOT) is defined by EPA as the waste generator, so it is critical that bridge agencies exercise proper controls. DOTs have been cited and fined by EPA for RCRA violations. The requirements for the generator have been summarized in Industrial Lead Paint Removal Handbook and SSPC Guide 7. The following should be addressed in the specification:

a. EPA identification number and manifest

b. Collection of debris

c. Containers, packing and labeling

d. Job-site handling and storage of debris

e. Sampling and testing of debris

f. On-site treatment, transportation and disposal

g. Off-site transportation, treatment and disposal

h. Emergency plan for spills

i. Hazardous waste worker training

- Example: Georgia DOT

According to the 5/24/93 revision to the Special Modification to Section 535 Painting Structures (Painted with Lead Based Paint Systems), the contractor is directed as follows regarding handling of spent materials:

(1) Non-dusting mineral abrasive with 10% by weight G-80 steel grit, no more than 100 ppm chloride or sulfate; gives gradation sizes (sieve ranges) for Type A (copper and coal slag) and Type B (Staurolite); test for aggregate gradation by GA DOT.

(2) If waste is not hazardous per TCLP, blend with 20% portland cement and solidify, then dispose at licensed solid waste landfill.

(3) If waste is hazardous per TCLP, then submit plan to treat on site as for non-hazardous waste to EPA and to Georgia Environmental Protection Division.

(4) Notification and certification of the EPA entails the following:

(a) Name of facility

(b) Description of waste as initially generated, including EPA ID number

(c) Applicable treatment standard, in this case 5.0 mg/l (4 x 10^{-5} lb/gallon)

(d) Authorized contractor signature

Note: If waste is still hazardous after this treatment, it is to be disposed at a licensed hazardous waste facility.

- Example: Kansas DOT

(1) As defined in special provision to Kansas DOT standard specification of 1990 (90-P-8-R1), all waste materials are to be collected daily and stored in drums, bins or roll-offs. Within 90 days of collection, the waste shall be cast into concrete blocks.

(2) Concrete blocks are 9 m x 0.5 m x 0.3 m (3 ft x 1.5 ft x 1 ft). Mix contains 136 kg (300 lb) of waste [approx 0.1 m^3 (3 ft^3)], 1 sack of cement and 28 L (7.5 gallon) water. Blocks shall be tested by TCLP.

(3) DOT requires sampling of one of every 30 blocks by a certified testing lab. If found to be non-hazardous by TCLP, the blocks are to be disposed at a sanitary landfill. If hazardous, the blocks are to be disposed at a licensed hazardous waste landfill. Specific instructions for authorization and notification are also given.

- Example: Michigan DOT

  As described in Michigan DOT Bureau of Highways Special Provision of Protection of work and environment during the blast cleaning of structures for complete field coating (1/5/93) [SP5.10(L)], the contractor must have a written training program. This includes:

  (1) Worker training in handling hazardous waste: Contractor is required to have written training program in handling and storage of hazardous waste. All workers are to be trained in the management of hazardous waste per RCRA 42 USC 6901 et seq. and 40 CFR 265.16.

  (2) Hazardous waste contingency plan, per 40 CFR 265: This plan must address how accidental spills or releases will be contained and cleaned up. The plan must be on site at all times.

  (3) Storage and disposal: Dispose of within 90 days of start date.

  (4) Records kept on site: Training, contingency plan, inspection log, waste characterization reports, manifests.

- Example: Indiana DOT

  Training required: Contractor is the "operator" of waste generation. Labeling, storage specified; split samples at three locations, remove and dispose of within 90 days of accumulation.

6. Specifying Worker Protection

High exposure to lead dust and subsequent lead poisoning is a major occupational risk for bridge paint workers. This problem has been intensified by the use of containments which keep the lead dust particles in a confined space. Traditionally the health and safety of the employee has been the employer's (i.e., contractor's) responsibility; however, bridge owners are now taking a more direct role in establishing specific requirements. Some states (e.g., CT, MN and NJ) have more stringent controls than those in 29 CFR 1926.62 (OSHA's 1993 Interim Final Lead in Construction Standard). A model specification recently issued by the Center to Protect Workers' Rights is also more restrictive than OSHA in areas such as frequency of blood monitoring and the blood lead levels at which workers must be removed. The rationale behind such requirements is that recent data have shown workers to be at risk at lower levels than previously considered, and that technology is readily available to achieve reduced worker blood levels. On the other hand, some states (e.g., OH) specify only that the contractor shall comply with the applicable OSHA standards. It has been argued that by including specific requirements of the OSHA standard (e.g., lead health and safety plan, hygiene facilities), these become enforceable under the contract, rather than by an OSHA inspection.

Some bridge owners are requiring that the contractor hire or have on site an industrial hygienist. This also goes beyond the OSHA standard, which requires that a competent person be available, but it does not specify when that person is required to be on site or that person's specific educational credentials. In addition some bridge owners have hired industrial hygienists to oversee the contractor's health and safety program. In a recent report to FHWA, the Alliance to End Childhood Lead Poisoning recommends that each bridge agency acquire in-house expertise on industrial hygiene relating to lead paint removal.

As a minimum, the bridge owner should identify the specific portions of the OSHA lead standard and incorporate some means of verifying or evaluating compliance. One recommended approach is to require that the contractor submit to the agency the written lead health and safety plan and identify the competent person. As noted elsewhere, by including lead health and safety as a separate pay item, owners can better insure a level playing field for worker protection.

Samples of worker protection specifications are available in CPRW model specification, ILPRH (Chapter 9) and in Project Design, Volume II of the Industrial Lead Paint Removal Handbook. Specifications from CT or MD DOTs may also be used as models for more restrictive requirements.

7. Specifying Materials and Application of Coatings

For projects where full removal is specified, the requirements for coating materials and application are not expected to be significantly altered, although they should be reviewed to ensure that the materials are still available.

C. Specifying Spot Repair and Overcoating

1. General

Greater attention is needed to specify materials and procedures for overcoating and other types of partial repainting. The components required are as follows:

a. Defining surface to be prepared

b. Surface preparation methods and criteria

c. Application of primer and topcoat

d. Selection and qualifying of materials

e. Containment and environmental monitoring

f. Waste collection and handling

g. Worker protection

2. Defining Surface to Be Prepared

Normally the intent is to retain the intact paint. In order to determine the amount of intact paint and the feasibility of overcoating, the following data are needed:

a. Percent of surface requiring mechanical surface preparation. (This would include rusted and degraded areas. This data should describe approximate patterns [i.e., isolated or large areas of rust] and distinct ratings for different structural members [e.g., by beam or at least by span].)

b. Thickness and adhesion of existing intact paint. This can be acquired by random sampling of these areas, using statistically valid sampling methods.

c. Patch test for proposed overcoat systems:

The new material should be applied on two or three test areas (including edges) for a minimum of six months to minimize the risk of catastrophic early failure by delamination. Only the rusted and degraded areas are mechanically prepared. It is important to provide a means for the contractor to determine which areas of the bridge are to receive which treatments, as this will markedly affect the scope and cost of the project. One approach is to give the contractor an estimate of the percentage of the surface to be mechanically cleaned. Alternatively the contractor may be paid based on the amount of surface which is mechanically cleaned as directed by the project engineer. To avoid having the contractor do more preparation than is intended, the engineer should mark off or otherwise clearly define the area to be cleaned.

- Example: NYS DOT, in a special provision for a 1994 experimental project, defines two categories as follows:

(1) Category I: A surface which has become visibly corroded or upon which the existing paint has peeled, flaked, blistered, or otherwise become deteriorated is to be prepared to SSPC-SP 11 with all residue to be vacuumed using a HEPA filtered vacuum.

(2) Category II: A surface upon which the existing paint is tightly adhered, and otherwise in good condition. Adherence will be considered satisfactory if the paint cannot be removed by lifting with a dull putty knife. The Category II surfaces are to be cleaned by SSPC-SP 1.

- Example: Maine DOT

(1) Removal of the old paint shall be carried back around the edges of a spot until an area of completely intact and adhering paint system, with no rust or blistering underneath, remains.

(2) Edges of tightly adherent paint system remaining around the cleaned area shall be feathered so that the repainted surface will have a smooth appearance.

(3) The remaining old paint system shall have a sufficient adhesion that it cannot be lifted as a layer by inserting a blade or putty knife under it.

3. Surface Preparation Methods

Items of concern are the specific method used and the treatment of the interface between the degraded and intact areas. The method selected depends on the type of coating to be applied, the level of dust and debris acceptable, and the overall size of the area to be cleaned. Among the most common techniques are:

a. Vacuum blasting: This produces the best surface for painting (i.e., commercial or near white blast) and a profile for improved primer adhesion. The vacuum in principle allows for excellent control of dust.

b. Vacuum shrouded power tools (e.g., needle guns or rotary peening tools): This method allows achievement of an SSPC-SP 3 or SSPC-SP 11 degree of cleaning. Dusting can be controlled with proper usage. In addition, the amount of debris to be treated or recycled is even less than for vacuum blasting because there is no abrasive residue.

c. Power tools without shrouding: This will generate substantial dust and paint chip fallout. These must be collected to avoid RCRA violations and will likely exceed the PEL for lead, necessitating the full enforcement of the applicable provision of the Lead in Construction Standard.

d. Hand tool cleaning: This method is very labor intensive. It will remove loose paint, loose rust and loose millscale, but does not provide a good surface for painting. In addition, the debris (though minimal in volume) still must be collected and disposed of as hazardous waste.

e. Pressurized water jetting [41 MPa^2 (6000 psi) minimum]: Pressurized water jetting will remove loose paint, but not intact rust or millscale. Also, collecting, filtering and treating the water may be required (see discussion below).

f. Low pressure water jetting [3.5-10 MPa^2 (500-1500 psi)]: This pressure is able to remove loose surface debris (e.g., chalking, dirt, bird droppings). This technique is often specified in lieu of conventional solvent cleaning prior to performing spot hand or power tool cleaning. It may also be done after the mechanical cleaning, in which case it would also remove any loose material produced from that operation.

g. Other methods: These include sodium bicarbonate blasting, chemical stripping and sponge jetting and are available but have not yet been fully proven in production applications on bridges.

The industry has developed some standard techniques for preparing rusted or degraded areas adjacent to intact paint areas. These are described in the two sections of SSPC-PA 1 included below.

10.2.1 Only loose, cracked, brittle, or non-adherent paint shall be removed in cleaning unless it is otherwise specified. Cleaning shall be performed two inches beyond the damaged areas in all directions until tightly adhered paint is obtained. Where the remaining paint is thick, all exposed edges shall be feathered. Spot cleaning shall be conducted in a manner which will minimize damage to sound paint. Rust spots shall be thoroughly cleaned and the edges of all old paint shall be scraped back to sound material (see Section 15.11).

15.11 In maintenance painting it is not ordinarily intended that sound, adherent, old paint be removed unless it is excessively thick or brittle or is incompatible with the new paint. It is essential, however, that the removal of deteriorated paint be carried back around the edges of the spot or area until an area of completely intact and adherent paint film, with no rust or blisters underneath, is attained. Edges of tightly adherent paint remaining around the area to be recoated must be feathered so that the repainted surface can have a smooth appearance. The remaining old paint should have sufficient adhesion so that it cannot be lifted as a layer by inserting the blade of a dull putty knife under it.

- Example: CALTRANS

Surface preparation: Steam cleaning as per standard specification (includes biodegradable detergent followed by rinsing with fresh water). Areas containing rust or other foreign substances not removed by steam cleaning or interfering with bonding are removed using vacuum blast equipment.

4. Surface Preparation Sequences and Criteria

The two different types of surfaces, intact and degraded, typically receive different degrees of surface preparation. The degraded areas normally require mechanical cleaning by hand or power tools or abrasive blast cleaning. The intact areas are more typically cleaned with pressurized water, steam or solvents, but in some cases may receive no cleaning at all. The water cleaning may be done before or after the mechanical cleaning. Some agencies specify pressure washing prior to any cleaning (including blast cleaning) because the water is believed to be effective in removing chlorides and other soluble salts and preventing them from being impacted onto the substrate. Another approach is based on washing the surface after mechanical cleaning to remove dust and debris generated during the process. Some examples of DOT approaches are as follows:

a. Kentucky DOT

   Step 1: Pressure wash entire surface at105 kgf/cm^2 (1500 psi).

   Step 2: Hand or power tool clean loose material.

   Step 3: Remove dust.

b. Arkansas DOT

   Step 1: SP 6 rusted areas

   Step 2: SP 7 remaining area [feathering edges 8 cm (3 inches) into intact paint)

c. California DOT

   Step 1: Steam clean with detergent.

   Step 2: Rinse with water

   Step 3: Vacuum blast rusted or degraded areas.

d. Georgia DOT

   Step 1: Vacuum power tool rusted and disbonded areas.

   Step 2: Prime cleaned areas.

   Step 3: Pressure wash [175 kgf/cm^2 (2500 psi), 15 l/min (4 gallons/min) minimum.]

   Step 4: Apply full coats (after two day dry).

e. Mississippi/DOT

   (1) Water blast the entire surface, followed by hand tool cleaning to remove loose or flaking paint or rust.

   (2) Tight paint and rust need not be removed.

   (3) Areas with heavy oil, grease or soot not cleaned by water blasting. Use approved biodegradable solvent (Bioact ARE-0); brush or mop solvent wipe with rag, then rinse with water blasting.

f. Nebraska DOT

   (1) Pressure wash [35-56 kgf/cm^2 (500-800 psi)]

   (2) Test for chloride using Surface Contamination Analysis Kit (KTA-Tator); surfaces to be "completely free of contamination."

5. Containment

The amount of dust and debris produced during an overcoating project is normally much less than for total removal. It depends on the type of removal methods (e.g., hand tool cleaning generates the least dust and blast cleaning the most). There remains a need to contain the debris in accordance with RCRA which defines any lead containing debris (hazardous or nonhazardous) deposited in the environment as "illegal disposal." Vacuum shrouds around the tool (e.g., needle gun, rotary peening tool, or blast cleaning tool) can significantly reduce the dust, but none are 100% effective. Vacuums are less effective around connections, edges and corners. The operator must often use a variety of heads or tools, which can slow productivity; therefore inspection and monitoring are important. Where vacuum tools are not utilized or are not rigorously enforced, containments are strongly recommended. At the least, impermeable ground covers should be placed under the bridge at least 4 m (10 feet) out [more if working at elevations of 8 m (20 feet) or higher]. Side containment is also normally required. These can be suspended from the hand rails or outriggers in a manner similar to that for full containment. The containment tarps or screens are designed to catch the solid particles and keep the dust from dispersing outside the work area.

Containment of the water used for pressure washing is an important concern. The water may contain suspended lead particles and may itself need to be tested for leachable lead per TCLP prior to discharge. If small quantities of water are used, it may be acceptable to pond it until the testing can be conducted. Many decontamination trailers have water filtration systems for the shower and wash water. This system may also be suitable for the water used for surface cleaning.

Examples of DOT approaches for containment of overcoating are as follows:

a. California

   Containment: Drapes and tarps used to contain vacuum blasting must be approved in advance.

b. Mississippi DOT

   Pollution control: Debris is confined to immediate area of bridge. Screens and barriers are used during water blasting and painting.

6. Environmental Monitoring

The need for air, soil and water monitoring are also significantly reduced for overcoating compared to full coating removed by abrasive blast cleaning. None of the states responding to the survey required ambient air monitoring (e.g., using high volume samplers) for overcoating projects. However, it is advisable to include a prohibition or limitation on visible emissions outside the work area. (Refer to SSPC Guide 6.) This can be readily monitored by the inspector or supervisor and controlled by adjusting operations.

For work done over water, a containment water boom may be required if the waterway or the community is sensitive to the threat of contamination. It is more difficult to collect debris without employing a barge. For these reasons, when working over water it might be preferable to require stringent vacuum shrouds (e.g., with power tools) to minimize the debris that is released. Also, if extensive rigging over the water is required, it may be more appropriate to undertake full removal in the first place.

Soil monitoring is relatively easy and should be required before and after the project, similar to the procedure for a full removal project. This entails taking samples at various locations around the bridge using a square template (see SSPC Guide 6). This is to protect the DOT and the contractor against claims that the repaint operation contaminated the soil.

Examples from state agency:

a. California: Air and soil monitoring and protective clothing are the same for overcoating as for full removal.

7. Waste Handling, Treatment and Disposal

Overcoating generates considerably less waste than full removal. Normally, the area cleaned is no more than 15-20% of the surface, and only loose material is removed. The volume of waste is typically less than 1% of that produced from blast cleaning the total surface. However, even this small amount must be collected and handled as a hazardous waste. If the amount is less than 100 kg/month (220 lb/month), the DOT is classified as a conditionally exempt small generator. The generator can avoid some of the documentation requirements, but the waste must still be tested, labeled, and disposed of in accordance with RCRA.

8. Worker Protection

The OSHA Interim Final Rule on Lead in Construction (May 1993) identifies the level of protection and types of measures based on the expected or measured airborne lead dust generated. For hand tool cleaning or vacuum shrouded power tools, the contractor must assume a lead level (averaged over eight hrs) of between 50 $\mu g/m^3$ and 500 $\mu g/m^3$. The contractor must still perform exposure testing and not simply base the worker protection program on assumed levels. A half face respirator will provide a protection factor of 10 (i.e., reduce the worker exposure from 500 $\mu g/m^3$ to 50 $\mu g/m^3$), thereby meeting the permissible exposure level of 50 $\mu g/m^3$. For power tools without shrouding, the assumed lead dust level is up to 2500 $\mu g/m^3$. This would require a respirator with a protection factor of 50 (i.e., a full face air purifying respirator).
In addition, if the PEL is exceeded, all the other provisions of the lead standard become applicable, including medical monitoring, written compliance plans, hygiene and decontamination facilities (e.g., showers), and employee training on lead.

These provisions would not be applicable if the contractor can demonstrate that the eight hour average is below the action level of 30 $\mu g/m^3$. This condition may be achieved when the time spent on surface preparation is short (e.g., one or two hours), when vacuum systems are used very carefully, or where removal of existing paint is severely minimized. Although such a strategy can be compliant, most reputable contractors are already following the lead standard on a regular basis, so the cost savings for omitting some of the requirements would be minimal (showers may be an exception). The strategy entails some risk because it might open the door to uninformed or poorly trained contractors who would not maintain the stringent controls necessary to reduce the lead exposure below the action level.

There is some effort within the protective coatings industry to compile data from various lead removal activities and identify those which consistently produce low quantities of lead dust.

9. Coating Materials

a. Compatibility and Durability

For an overcoating project, the newly applied coating must be compatible with several types of substrates, including existing intact paint, tight rust, tight millscale and cleaned bare steel. The coating must be capable of protecting these non-ideal (non-blast cleaned) surfaces, which requires the following:

(1) Good wetting and spreading on the surface,

(2) Good adhesion to iron oxide and paint,

(3) Ability to cover irregularities (e.g., interfaces, edges, crevices), and

(4) Ability to protect against corrosion and weathering.

Selection of a coating system should, ideally, be based on a combination of lab testing, small field tests and data from other reliable sources (e.g., other DOTs). The tests and criteria are described in numerous technical publications. One test which is considered critical is a field patch test in which the candidate coating is applied over the expected substrates on the bridge. The patch should be at least 1 m^2 (11 ft^2), including edges, and left for exposure over a winter. This is needed to minimize the chance of an early delamination failure which may be caused by a combination of thick coating system and high stress induced by rapid temperature change.

- Example of Patch Test: Mississippi DOT

(1) Rust grade 5 to 10 (ASTM D610) clean by water blasting; rust grade 4 or lower requires hand tool cleaning in addition.

(2) Adhesion: Check adhesion of topcoat and primer with putty knife or dull knife. Also can use ASTM D3359 (2B to 5B is acceptable); adhesion also checked after water blasting.

(3) Thickness: If 508 µm (20 mils) or less, candidate for upgrading.

(4) Patches: If 635 µm (25 mils) or more or adhesion 1B or lower, apply test patch (ASTM D5064).

b. Types of Materials

A large number of different generic and trade products have been suggested and evaluated for overcoating. For most, there is not yet an adequate, long-term consistent track record to warrant unqualified recommendation. Several of the coatings most widely used by DOTs are described below:

(1) Oil-alkyd (inhibitive, lead free): This system is the most direct replacement for a lead containing oil alkyd (e.g., AASHTO M-229 or M 72), as it has the same resin base. Examples of materials include:

(a) SSPC Paint 25: Oil-alkyd with zinc oxide and iron oxide. This has been extensively used by DOTs for over 10 years. One drawback is the slow drying.

(b) Oil-alkyd with zinc hydroxy phosphite (Nalzin) or calcium borosilicate (Halox): These alternative pigments were introduced in the 1970s. Some formulations performed well in the SSPC PACE study (although some did not). Several DOTs have composition specifications based on these pigments in oil alkyd, including GA DOT, MA DOT, ME DOT.

(2) Oil-alkyd with calcium sulfonate: A formulation of this coating gave excellent results over hand tool cleaned steel in the SSPC PACE program. Several DOTs have evaluated these paints on full bridges (IN DOT, MO DOT).

(3) Moisture cured urethane primer: This is a one component aromatic or aliphatic polyurethane. It is often pigmented with aluminum or zinc and has been

used extensively on bridges in various locations in the United States. It is claimed to have the ability to applied on damp surfaces at temperatures as low as 0°C (32°F). States using this include WA and OR.

(4) Epoxy mastic primer: Epoxy mastics, often pigmented with aluminum flakes, have been available for over 20 years, primarily for application over previous paint or rust, and have long histories on a few bridges (MO DOT). FHWA studies have shown them to be susceptible to undercutting when applied over salt contamination. The compatibility test described above is particularly important with epoxy mastics. DOTs specifying epoxy mastics include PA DOT and SC DOT.

(5) Penetrating primer: These coatings are designed to penetrate old loose coatings, such as oil alkyds, and provide a good bond to subsequently applied coatings. Penetrating primers have low molecular weight and low viscosity. They are clear or lightly pigmented.

(a) Epoxy penetrating primer: These are two component 100% solids. One product was developed at least 10 years ago and has performed well on weathering steel and other badly rusted surfaces.

(b) Urethane penetrating primer: This is a one component moisture cured aromatic polyurethane. It has reportedly been used extensively in Germany, but has relatively little documented use in the U.S.

Examples of systems used by states are as follows:

i) CALTRANS

Painting: Spot blasted areas receive two coats of undercoat, then two coats of topcoat applied to entire structure.

ii) KY DOT

Spot prime (brush) cleaned areas with moisture cured urethane. Brush apply full two-component urethane intermediate and topcoat.

iii) LA DOTD

Alkyd system. Primer: pigment zinc hydroxyphosphite (a) or calcium borosilicate (b).

iv) ME DOT

Oil-alkyd zinc hydroxyphosphite formula specification. Two coats aluminum epoxy mastic (QPL), two component aliphatic polyurethane topcoat for fascias only (QPL).

v) NE DOT

Rust penetrating sealer (for joints with pack-out), calcium sulfonate alkyd primer [VOC 250 kg/l (2.1 lbs/gal)], calcium sulfonate alkyd top-coat [VOC 275 kg/l (2.3 lbs/gal)].

D. Contracting and Inspection Practices

1. Prequalification of Painting Contractors

Most state DOTs have a prequalification scheme for painting and other contractors, but typically the main requirement is to acquire a bond and sometimes insurance. Because of the risk and difficulty of lead paint removal, a number of states (CT, MD, NC, IN) have required contractors to meet the requirements of SSPC-QP 1 (Standard Procedure for Evaluating the Qualifications of Painting Contractors: Field Application to Complex Structures) or QP 2 (Standard Procedure for Evaluating the Qualifications of Painting Contractors to Remove Hazardous Paint). These programs evaluate a contractor's capability to manage projects, technical expertise, quality control, worker health and safety and environmental protection. In its proposed rule on Title X, EPA proposes that all contractors engaged in lead paint activities be certified by the state. This would entail following EPA standards for conducting deleading, and using only certified supervisors and workers.

2. Work Performed by General Contractors

In many instances the removal of lead paint (involving containment, ventilation, recyclable abrasives) is more costly than the repainting. Some firms, (e.g., general contractors) are specializing in paint removal, leaving the repainting to other contractors. (SSPC has developed a standard for prequalification of firms that remove the lead paint.) One factor affecting this trend is that many of the rehabilitation projects involve lead paint removal. The general contractors see the opportunity to perform a larger portion of the work rather than letting it out to painting contractors. A related occurrence is the competition among tradesmen and labor unions (e.g., laborers, ironworkers, painters, blasters) for this type of work. Traditionally, it had been done by painters, but much of the work is mechanical and does not involve surface preparation or painting.

3. Pre-Bid Conferences

Most paint specifiers and contractors agree on the benefits of attending a pre-bid conference. It allows the owner to explain the specific requirements and circumstances, what regulations are in effect, the extent of enforcement, the protocols for inspection, the presence of lead-based paint. In 1993 FHWA issued a memo requiring a mandatory pre-bid conference for all federally aided lead paint removal projects. Unfortunately, due to complaints from several agencies, this requirement was changed to a recommendation in 1994. This makes it more difficult for some states which had state laws restricting mandatory pre-bid conferences. It would be extremely difficult for a contractor to prepare a realistic plan and bid for a total removal project without examining the bridge site and hearing the state requirements explained.

4. Inspector Training and Responsibility on Lead Paint Issues

Most inspectors on DOT paint removal and repainting projects have not received training on the hazards of lead or the procedures for inspecting environmental or worker safety aspects. Although many states have utilized National Highway Institute and other paint specific training, these have not traditionally incorporated health and environmental subjects. This training is essential for two reasons: first, inspectors must be aware of the hazard to protect themselves and their family from adverse health effects and the employer, the DOT, from liability for such occurrence. Second, the paint removal specification often contains requirements for containment, environmental monitoring, and worker health. If the inspector is to enforce the specification, he or she must be familiar with these activities. The DOT must also explicitly identify the responsibilities of the inspector, as even with several days of training the inspector will not be an industrial hygienist or environmental specialist.

There are several organizations that have developed good training programs and modules for industrial lead paint inspectors. At least one state, North Carolina, has presented such a course for their in-house inspectors.

For third party inspectors, there is also a need for lead specific training. The DOT requirements for inspectors should include a minimum of two days training on industrial lead paint removal.

5. Insurance and Risk Considerations

Lead paint removal is a very risky business and there have been several noteworthy citations by OSHA, EPA and state environmental agencies. One contractor was cited for over $5 million because of inadequate worker protection from lead hazards. Ironically, most painting contractors are not insured for claims involving lead paint. This is because the policies almost all have a "pollution exclusion" clause. The insurers are not willing to take the risks in an area in which there are no limits on the liability or the costs for clean-up or remediation. Two common reasons for the difficulty in complying are the lack of precise directions in the specifications, and the erratic and inconsistent enforcement of the rules by the regulatory agencies.

Under hazardous waste regulations (RCRA and CERCLA), the facility owner (DOT) is responsible for the proper disposal of the hazardous debris. In some states the contractor may be designated co-generator, but the owner is never absolved of the responsibility. And contractors may go out of business while the DOT has the deeper pockets.

For worker health, the employer (e.g., the contractor) is responsible for the safety and health if the worker. As noted above, a number of states have issued very specific requirements for worker protection, in some cases exceeding the OSHA requirements. This may be an unnecessary risk. The state is, in essence, claiming that OSHA's requirements are not adequately protective. However, the state may not have a strong basis for this contention even when the contractor is at fault. As proven by recent citations in Ohio and Pennsylvania, the owner will still pay the price if the contractor is unable to complete the project. In addition, the adverse publicity is undesirable.

At least one state, Illinois DOT, indemnifies the contractor for liability. It does this by creating a fund, paid for by a percentage of the contract price. In essence, Illinois has established a state insurance fund for the contractors.

6. Basis of Payment

There are a variety of approaches regarding how to cost the project for payment. In the past many states have preferred to use a lump sum payment for a bridge painting project rather than unit pricing (e.g., by ton or square foot). For lead paint removal, however, the traditional cost factors are significantly altered. Often the cleaning and painting account for less than half of the total cost of the project. So to ensure that contractors devote enough effort to non-traditional aspects of the job, such as containment, waste disposal, environmental monitoring and worker protection, these are often listed as separate payment items. The procedure and cost for disposing of the waste can be highly unpredictable because it depends on whether the waste is hazardous by the TCLP test.

Some states have elected to pay for hazardous waste disposal as a separate item. Others have taken on the responsibility of disposing of the waste themselves.

Examples of DOT approaches are as follows:

- Example: NJ DOT

  Blast cleaning structural steel .... ton

  Blast cleaning misc. appurtances .... lump sum

  Blast cleaning and painting bearings .... unit

  Painting structural steel .... ton

  Lead health and safety plan .... lump sum

  Containment plan .... lump sum

  Waste disposal plan .... lump sum

  Additional monitoring and testing .... cost

- Example: CALTRANS for overcoating

  Spot blasting and undercoating (including containment, protective clothing and debris disposal). Based on square foot, finish coats (including steam cleaning). Lump sum. Air and soil monitoring separate.

E. Sources of Information

The technology and the regulations have been changing significantly over the last eight or ten years and this trend is expected to continue. There is a need for continual additional information in the form of guides, directories of services and product, industry standards, compilations and explanations of regulations, and evaluation of the practice and experimental techniques by DOTs and other agencies. The following sources have proven to be of value:

1. Information on Regulations

a. SSPC Online (http://www.sspc.org), SSPC tutorials, SSPC International Conference, SSPC Compliance in Industrial Painting Conference, special seminars, conference proceedings.

b. SSPC *Journal of Protective Coatings and Linings* (*JPCL*): Contains a monthly column on regulation news, periodic summaries of regulations. (Back issues now also available on CD-ROM.)

c. "Industrial Lead Paint Removal Handbook," Second Edition, SSPC 93-02, K. A. Trimber: Contains chapters on waste regulation, air, water and soil regulations, worker protection regulations, and appendix of relevant portions of the Code of Federal Regulations.

d. Periodicals (SSPC's *Compliance* [formerly *Pb*], *Deleading Magazine*, *Lead Alert*, PDCA's *Briefer*, *Lead Abatement Contractor*)

e. Federal Register: Daily compilation of all U.S. government regulations, proposals and commentaries.

f. Code of Federal Regulations: Annual compilation of federal regulations classified by title (e.g., Title 40 for environmental, Title 29 for labor).

g. Private service for regulatory update on daily or weekly basis in print or electronic versions (i.e., BNA).

h. EPA publications: On waste disposal, Clean Air Act, spills, guidance for small business (available from small business office).

i. PDCA compliance manual for OSHA Lead in Construction regulations.

j. Other training programs (e.g., NACE, universities).

2. Information on Techniques and Practices

a. SSPC tutorials, exhibits and seminars, International Conference and Compliance in Industrial Painting Conference, special seminars, conference proceedings.

b. Presentations at SSPC local chapter meetings.

c. SSPC *Journal of Protective Coatings and Linings* (*JPCL*) contains regular features on research, innovative technology, news from the field, annual buyers' guide on equipment and services, and periodic summaries of regulations (now also available on CD-ROM).

d. SSPC's *Pb*, a bimonthly newsletter containing short items on assessing techniques and costs. Recently renamed *Compliance* to indicate a broader concern with health, safety and environmental issues.

e. FHWA reports on five-year program, overcoating.

f. State DOT reports.

g. Other periodicals (*Materials Performance*, *Deleading Magazine*, *Lead Alert*)

h. FHWA RD-94-100 "Lead Containing Paint Removal, Containment and Disposal," L. M. Smith and G. L. Tinklenberg, February 1995.

i. NCHRP Synthesis No. 176, "Bridge Paint: Removal, Containment and Disposal," B. R. Appleman. Transportation Research Board, Washington, D.C., February 1992.

F. Determining Costs and Sources of Funds

Estimating costs for lead paint removal or overcoating projects is extremely precarious. There are enormous variations from state to state for nominally similar projects. Often the bids for a single project may differ by more than 50%. Among the major reasons for this variability are the following:

1. Lack of specificity or clarity in the specifications. For example, just requiring "containment of the debris" or "observing all federal, state and local regulations" is inadequate direction for a contractor to prepare a meaningful and competitive protection plan.

2. History of poor or sporadic enforcement of project specification by the DOTs and environmental and health standards by the regulators.

3. Contractor ignorance of the regulations or technology. Such contractors will bid unrealistically low and it may be difficult to exclude the bid unless the engineers are very knowledgeable about the costs and operations.

4. Unrealistic requirements for traffic control. The cost to keep one or more lanes open may be extremely high as contractors limited to a short working day must spend a large proportion of the time on mobilization and demobilization.

SSPC has compiled some data from a project in 1992 and 1993. Some sporadic data have been compiled for 1994. The costs for total removal and containment range from $43/m^2$ ($4/ft²) to $216/m^2$ ($20/ft²). Smith and Tinklenberg have also compiled some data (FHWA Report DTF#61-89-C-00192, 1995). An approximate breakdown is given as follows:

	Range		Average	
	$/m²	($/ft²)	$/m²	($/ft²)
Cleaning and Painting	22-43	(2-4)	27	(2.50)
Containment	11-54	(1-5)	22	(2.00)
Disposal	0-33	(0-3)	5	(0.50)
Environmental Monitoring	0-22	(0-2)	5	(0.50)
Worker Health	11-22	(1-2)	16	(1.50)
Overhead/Miscellaneous	0-22	(0-2)	5	(0.50)
Total	44-88	(4-18)	81	(7.50)

The report also discusses the effect on cost of blasting productivity for the various abrasive blasting techniques, the difference in costs between expendable and non-expendable abrasives, costs for alternative removal methods, some details on the cost of containment, costs of disposal for hazardous and non-hazardous waste, and costs for environmental monitoring, worker health and miscellaneous items.

SSPC has developed estimates for the distribution of costs for overcoating of bridges as follows:

	Range		Typical	
Cost Factor	$/m²	($/ft²)	$/m²	($/ft²)
Materials	3-6	(0.25-0.55)	4	(0.35)
Mechanical Surface Preparation	0.5-3	(0.05-0.25)	1	(0.10)
General Surface Preparation	0.5-4	(0.05-0.35)	1	(010)
Application	3-8	(0.30-0.70)	5	(0.50)
Containment/Disposal	5-22	(0.50-2.00)	5	(0.50)
Worker Health	5-22	(0.50-2.00)	9	(0.80)
Overhead	3-11	(0.25-1.00)	5	(0.50)
Total	21-74	(1.90-6.85)	31	(2.85)

Unfortunately, it seems that each year the regulations become a little more stringent. In 1993 the OSHA Lead in Construction Standard forced many contractors to enhance their worker protection programs. In the next few years, the impact of EPA Title X will be felt. This will require several days of training and certification of all workers and supervisors, and establish the new environmental standard for contracting firms. It will also place more burden and direct cost on the owner in the form of increased record keeping and training and certifying employees who are involved in lead paint identification or removal activities.

V. SUMMARY AND RECOMMENDATIONS

A. Follow-up of Workshop Recommendations

There are still many difficulties and uncertainties regarding the DOTs' ability to maintain the tens of thousands of steel bridges containing lead paint. A continuing coordinated effort by all ofthe agencies and companies involved is necessary. The types of actions needed include regulatory policy, DOT and legislative budgeting, prioritization, investments in equipment, and effective communication and implementation of the technology.

The workshop identified eight priority technology issues and eleven priority regulatory issues. For each issue summarized below are the following:

1. Description of need
2. Organization needed to support and carry out recommended actions
3. Estimated cost and time

B. Summary of Technology Issues

1. Technology Issue #1

a. Description: Develop a procedure for prioritizing bridge maintenance needs (e.g., to defer, to totally remove, to overcoat, or to replace steel).

b. Agency: This requires FHWA (preferably) or state DOT support. The work could be done by a research contractor or a DOT with sufficient staff resources.

c. Cost and time:

(1) Standard form: $30K, 6 months

(2) Compile cost data: $200K, 2 years

(3) Computerized model: $300K, 3 years

2. Technology Issue #2

a. Description: Evaluate the effectiveness of overcoating (the lifetime, the costs, the required environmental and worker protection).

b. Agency: FHWA coordination plus DOT implementation.

c. Cost and time:

(1) Assess practice: $100K, 18 months

(2) Inspection and monitoring procedures: $80K,12 months

(3) Compatibility test: $350K, 3 years

(4) Assessing condition: $700K, 4 years

(5) Evaluate surface preparation: $120K, 12 months

(6) Accelerated test: $500K, 4 years.

3. Technology Issue #3

a. Description: Evaluate life cycle costs.

b. Agency: FHWA or TRB for development; SSPC or ASTM for standard formats.

c. Cost and time:

(1) Compile costs: $150K, 18 months

(2) Standard formats: $200K, 2 years

(3) Develop model: $250K, 2 years

(4) Conversion kit: $50K, 6 months.

4. Technology Issue #4

a. Description: Performance criteria for containment structures and systems. (Describe the means to determine effectiveness of emissions control rather than requiring specific designs of containment.)

b. Agency: FHWA, TRB; SSPC or ASTM for standards; training organization.

c. Cost and time:

(1) Containment standards: $250K, 30 months

(2) Ventilation system standards: $500K, 4 years

(3) Dust collector requirements: $120K, 12 months

(4) Inspector training: $80K, 1 year

5. Technology Issue #5

a. Description: Evaluation of productivity and effectiveness of surface preparation methods. (Methods are needed which can produce less dust and debris yet provide a high production rate and roughened clean substrate for painting.)

b. Agency: Equipment suppliers, DOD, FHWA, EPA, research agencies.

c. Cost and time:

(1) Assess water methods $60K, 9 months

(2) Lead dust data: $150K,12 months

(3) Evaluate current methods: $300K, 3 years

(4) Guidelines: $75K, 9 months

6. Technology Issue #6

a. Description: Guidelines for renovation, demolition and other activities disturbing lead paint. [These activities are not intended to remove lead paint, but may disturb them (e.g., busting rivets).]

b. Agency: FHWA, TRB, state DOT, Associated General Contractor (AGC).

c. Cost and time:

(1) Regulatory and legal guidelines: $50K, 6 months

(2) Recommended procedure: $130K, 18 months

(3) Standard for steel disposal: $75K, 12 months.

7. Technology Issue #7

a. Description: Assuring adequate inspection of lead paint removal projects; that is, ensure that inspectors are knowledgeable and trained and can meet regulations.

b. Agency: NHI, FHWA, TRB, DOTs

c. Cost and time:

(1) Analysis of needs: $50K, 6 months

(2) Training curriculum: $70K, 9 months

8. Technology Issue #8 and Regulatory Issue #8

a. Description: Safety and health guidelines for lead paint removal. (These should include both EPA and OSHA requirements, but also be practical.)

b. Agency: FHWA, NIOSH, OSHA, TRB, DOTs, labor groups

c. Cost and time:

(1) Develop model guidelines: $60K, 6 months

C. Summary of Regulatory Issues

1. Regulatory Issue #1

a. Description: Uniformity and reciprocity of state training and certification requirements. (If contractors are required to take multiple courses and multiple certification exams, these costs will be passed on to owner.)

b. Agency: State Department of Health, EPA, FHWA, SSPC

c. Cost and time:

(1) Establish ad hoc group consisting of DOTs, FHWA, SSPC, industry, contractor, suppliers, consultants: intense campaign to work with state agencies: $18K from 4-5 agencies, 12-18 months.

2. Regulatory Issue #2

a. Description: Quality and content of lead paint abatement training courses. (Training should be relevant to structural steel, and consistent with OSHA requirements, but not excessive.)

b. Agency: FHWA, NHI, SSPC working with EPA, states.

c. Cost and time:

(1) Worker and supervisor course: $60-$80K, six to nine months.

3. Regulatory Issue #3

a. Description: Public exposure to lead debris for bridge maintenance. (DOTs are responsible for protecting the public and should protect themselves from liability.)

b. Agency: FHWA, TRB and State DOT

c. Cost and time: $30K, six months to develop guidelines.

4. Regulatory Issue #4

a. Description: Project design criteria based on risk assessment. (Risk assessment is essential if DOTs are to conserve funds yet adequately protect the public and workers.)

b. Agency: FHWA, TRB, state DOT with help from design and consulting firms.

c. Cost and time: $250K, two years.

5. Regulatory Issues #5 and #6

a. Description: Air monitoring protocols and applicability of regulations. (Guidelines are needed on the relevance of air quality rules and on cost-effective monitoring on bridge projects.)

b. Agency: SSPC with input from DOTs, state air quality authorities, EPA.

c. Cost and time: State DOT evaluation projects ($10-$15K), 12-18 months of committee work.

6. Regulatory Issue #7

a. Description: soil sampling. (Current guidelines on sampling, and clean-up are inadequate.)

b. Agency: EPA, FHWA, DOT

c. Cost and time: $50K and six months to analyze existing data, followed by interagency task force ($10K per agency, 12 months).

7. Regulatory Issue #9

a. Description: Medical surveillance. (Guidelines are needed on cost effective and protective means.)

b. Agency: FHWA, NIOSH to fund hygiene specialist, DOT to implement.

c. Cost and time: $90K, 12 months for guidelines; $30K, 12 months for follow-up.

8. Regulatory Issue #10

a. Description: Assigned protection factor for abrasive blast helmets. (Provide more realistic numbers to allow use of proven, effective respirators.)

b. Agency: NIOSH and OSHA with data from industry.

c. Cost and time: $60K, six months to analyze existing data; possibly need new data @ $200K for two years; NIOSH, OSHA review six additional months.

9. Regulatory Issue #11

a. Description: Uniform worker lead exposure sampling and assessment. (Procedures and formats needed to ensure that data are valid and can be utilized to assess protection.)

b. Agency: FHWA, TRB, DOTs, NIOSH with input from hygiene firms, contractors.

c. Cost and time:

(1) Procedures $60K, nine months

(2) DOT, contractor evaluation $100K, 12 months

(3) Analyze and assess data $175K, 18 months

D. Using What Is Currently Available

The above sections recommend actions for various key players including DOTs, regulators, associations and industry groups. Chapter IV of this report also contains considerable guidance on what can be done now to address the issue. The DOTs and highway agencies have a need to maintain and protect steel bridges while also conforming to environmental and worker health and safety regulations. Highway and bridge agencies must develop and carry out programs which take into account the complexity of issues regarding costs, risk, performance, public perception, extent of corrosion protection and bridge appearance. For most agencies, the elimination of the lead hazard will require 10 to 20 years or more. Therefore, any strategy must examine the long term picture. This includes future liability and risk, short term and long term costs for maintenance, prospects of bridge replacement or major rehabilitation and the reaction by the public and the political community and the press.

The following recommendations are presented for consideration by highway agencies:

1. **Recommendation 1**

State and other bridge and highway officials should formally establish a high level task group or program to look at this issue on an ongoing basis.

2. **Recommendation 2**

Agencies must recognize that there has been considerable effort expended by industry groups as well as highway groups. A strong body of technology has been developed and is widely disseminated. Agencies should become thoroughly familiar with what is being done by other highway agencies and other industries.

Commentary: There are several options available for remediating the lead paint on structures. These include full removal and repainting, partial removal, replacement of steel, deferral, and combinations of these.

For each of these options, there are numerous examples of procedures and practices presented in the report. Each of these approaches has specific advantages and disadvantages. These have also been analyzed in this report and in referenced literature.

There are no easy, cheap solutions to this problem. Some apparently easy solutions may entail significant risk of early failure or severe regulatory fines and citations. Other solutions appear technically and environmentally sound, but may be too expensive to implement as a general policy. The alternative to deferral or waiting for things to improve (because of improved, more cost effective technology or perhaps regulatory relief) is also fraught with risk, as these prospects are not very likely.

3. **Recommendation 3**

Highway agencies must take a stronger role in representing their position to regulatory agencies and how the regulations will impact bridge painting and maintenance and the ability of the bridges to serve the public needs.

Commentary: There are varying degrees of "purity" an agency can adapt with regard to environmental and health advocacy and protection. Some groups will urge the agencies to adopt the most protective and restrictive procedures, which are normally also the most expensive and are often impractical. There are other forces, sometimes proprietary interests or groups within the bridge agency, that advocate higher risk (of environmental contamination and performance) to stretch agency budgets. There is no single correct approach to establish the correct level of environmental responsibility for an agency.

4. **Recommendation 4**

Networking among bridge agency representatives and participation in training programs and conferences is an excellent investment.

Commentary: These activities will help the agency determine what is being done by other DOTs and by the industry, how effective these are and how the risk, performance and cost aspects influence choices. It is also important that any knowledge or insight be utilized and made available to higher levels of management for subsequent decision making.

5. Recommendation 5

Agencies should work more closely with AASHTO and FHWA to identify areas for proactive leadership by these organizations.

Commentary: Industry associations and others can also assist in efforts to develop new solutions. Too many agencies attempt to solve the problem on their own, which results in duplication of effort. This means that many small programs are conducted, all of which lack the "critical mass" to make a real breakthrough.

VI. APPENDICES

A. List of Workshop Attendees

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B. Categorizing and Ranking the Issues

TABLE 1
RANKING OF FHWA WORKSHOP TOPICS
SSPC Lead Paint Removal Conference
March 15, 1994

Topic	D	I	D	D	F	D	D	I	F	D	S	E	I	I	D	S	I	Avg.	Rank
CONTAINMENT PRACTICES & SPECS	1	1	5	2	2	1	5	5	1	1	2	1	2	6	2	1	2	2.4	1
Ventilation & Dust Collection	2	1	1	1	1	1	1	2	1	2	2	1	2	1	2	2	1	1.4	1
Paint Removal & Collection	1	1	3	2	2	1	1	1	2	2	1	2	3	2	3	1	2	1.6	2
Abrasives & Recycling	3	2	1	1	1	1	1	3	1	2	3	3	1	2	1	3	1	1.8	3
ENV & HEALTH PRACTICES & SPECS	2	2	4	3	4	2	1	2	3	2	3	4	1	1	3	2	3	2.4	2
Ambient Air Monitoring	2	1	1	1	2	1	1	2	1	1	3	2	1	1	2	1	1	1.4	1
Worker Hygiene	1	1	3	1	1	1	3	1	1	3	1	4	4	1	1	1	1	1.7	2
Soil Monitoring	3	2	4	1	2	1	2	2	1	2	3	1	3	2	1	2	2	2.0	3
Waste Disposal	4	1	6	2	1	1	1	2	2	2	2	1	2	2	2	2	3	2.1	4
Wipe Sampling	5	2	2	2	2	4	3	3	2	2	3	4	5	2	2	3	2	2.8	5
FIELD PRACTICE & DATA	5	3	2	5	1	4	2	3	2	4	4	2	3	5	5	5	5	3.5	3
Overcoating	1	1	1	1	1	2	1	1	1	1	2	1	1	1	3	2	2	1.4	1
Zone Painting	3	1	2	2	1	2	1	1	1	1	2	2	3	1	2	2	2	1.7	2
Lead Exposures	4	2	[illegible]	1	1	1	3	2	1	3	1	3	2	1	1	1	1	1.8	3
Steel Replacement	2	2	3	3	3	2	2	3	3	1	3	3	4	2	3	3	2	2.6	4
IMPACT OF REGULATIONS	3	5	3	1	5	6	4	6	5	5	1	6	4	2	1	3	1	3.6	4
Enforcing OSHA Lead Standard	2	2	1	1	1	2	1	1	1	2	2	1	1	1	1	1	1	1.3	1
Title X - EPA/States	1	2	2	1	1	1	1	1	1	2	1	2	2	1	1	1	1	1.3	1
Other EPA (Solid Waste)	4	2	3	1	3	3	3	2	2	2	2	2	1	2	2	1	2	2.2	2
Other OSHA	3	2	4	1	3	4	3	2	3	2	3	4	4	2	2	2	2	2.7	3
COST & PERFORMANCE	4	4	6	4	4	3	3	1	4	6	5	5	5	3	6	4	4	4.2	5
Cost Breakdown	2	2	2	1	1	1	1	1	1	2	1	1	2	1	1	1	1	1.3	1
Case Histories	1	2	1	1	2	1	1	2	2	2	1	2	1	1	2	1	1	1.4	2
MATERIAL SPECIFICATIONS	6	6	1	6	6	5	6	4	6	3	6	3	6	4	4	6	6	4.9	6
Field Test Methods	1	1	1	2	1	1	3	1	1	1	1	1	1	2	1	1	2	1.3	1
Accelerated Testing	2	1	2	1	3	3	3	1	2	1	3	2	2	1	3	2	2	2.0	2
AASHTO/NEPCO	3	2	3	3	3	2	1	2	3	1	3	2	3	2	2	2	3	2.4	3

D = DOT Rep
I = Industry
F = FHWA
S = State Reg
E = EPA

C. Written Presentation Materials

1. *Overview of Workshop*, Bernard R. Appleman, SSPC

FHWA Workshop:
Developing Guidelines for Lead Paint Compliance
Dr. B. R. Appleman
Steel Structures Painting Council

FHWA Workshop:

Developing Guidelines for Lead Paint Compliance

July 10-12, 1994
Charlotte, North Carolina

Objective

To develop guidelines for cost-effective compliance with lead paint removal regulations

Approach

- Assemble experts
- Identify issues (General Session)
- Identify current practice (Breakout 1)
- Key problems and needs (Breakout 1)
- Determine end products (Breakout 2)
- Develop consensus (Breakout 2)
- Summarize and discuss (General Session)
- Initiate follow-up (coordinators)

Coordinators

- **Regulations Group**
  - Dan Adley, KTA Environmental (Leader)
  - Dean Bullis, MD Dept. of Environment
  - Chris Lovelace, NC DEHNR
  - Cathy Ganley, ATC Environmental
- **Technology Group**
  - Lloyd Smith, CCC & L (Leader)
  - Bill Medford, NC DOT
  - Eileen Phifer, MI DOT
  - Brian Castler, CT DOT
  - Dave Copenbarger, IL DOT

Key Topics

1. Containment Practices and Specifications
2. Environmental and Health Practices and Specifications
3. Field Practices and Data
4. Impact of Regulations
5. Cost and Performance
6. Material Specifications

Containment Practices and Specifications

- Ventilation and Dust Control
- Abrasives and Recycling
- Paint Removal and Collection

1. *Overview of Workshop*, Bernard R. Appleman, SSPC (continued)

FHWA Workshop:
Developing Guidelines for Lead Paint Compliance
Dr. B. R. Appleman
Steel Structures Painting Council

Environmental and Health Practices and Specifications

- Ambient Air Monitoring
- Worker Hygiene
- Waste Disposal
- Soil Monitoring
- Wipe Sampling

Field Practice and Data

- Overcoating
- Zone Painting
- Steel Replacement
- Lead Exposures

Impact of Regulations

- Enforcing OSHA Lead Standard
- Title X - EPA/States
- Other EPA (Solid Waste)
- Other OSHA

Cost and Performance

- Case Histories
- Cost Breakdown

Material Specifications

- Field Test Methods
- Accelerated Testing
- AASHTO/NEPCO

Workshop End Product

- Assessment of technology
- Sample specifications
- Environmental monitoring procedures
- Training and certification guidelines
- Review of DOT practices
- Compendium of regulations
- Ongoing information update
- Recommendations for research

2. ***Containment and Ventilation*, Lloyd M. Smith, Corrosion Control Consultants and Labs, Inc.**

FHWA Workshop:
Developing Guidelines for Lead Paint Compliance
Dr. Lloyd M. Smith
Corrosion Control Consultants and Labs, Inc.

Containment

SSPC Guide 6I

- Materials
  - Permeability
  - Durability
  - Responsibility
- Large vs. Small
- Evaluation Methods

Ventilation

- Air Flow
  - Minimum Required
  - Worker Exposure
- Dust Collectors
  - Filtration
  - Cartridges

Negative Pressure

- 0.03" WC is sufficient

Air Movement

- Anenometer measurements 20% to 50% lower than pitot tube measurements
- Air make-up 4 to 8 times the size of exit ducts
- High-volume, low-speed fan works best
- High-volume, high-speed fan causes turbulence

2. *Containment and Ventilation*, Lloyd M. Smith, Corrosion Control Consultants and Labs, Inc. (continued)

CONTAINMENT MATERIALS TESTS FOR DURABILITY AND PERMEABILITY

Materials	Time to Perforation (Seconds) 1.2 m (4 ft)	1.5 m (5 ft)	Lead Permeability (μg/m³)
Screens	3	10	2000-3000
Reinforced Polyethylene	5	16	BDL[1]
Reinforced Vinyl	11	98	BDL[1]
Reinforced Rubber	>150	NT[2]	BDL[1]
Coated Woven Polypropylene	4	13	New: BDL[1] Used: 325
Uncoated Woven Polypropylene	4	11	825

[1] Below Detectable Limits of 75 μg/m³

[2] Not Tested

2. *Containment and Ventilation*, Lloyd M. Smith, Corrosion Control Consultants and Labs, Inc. (continued)

PERMEABILITY OF SEAMING METHODS

Seam Type	Lead Permeability (μg/m³)
Rolled and Clamped	BDL[1]
Double-Laced and Taped	100
Caulked and Taped	91
51-mm- (2-in) wide Velcro	1417
25-mm- (1-in) wide Tear	280

[1] Below Detectable Limits

2. ***Containment and Ventilation*, Lloyd M. Smith, Corrosion Control Consultants and Labs, Inc. (continued)**

WORKER EXPOSURE vs. CONTAINMENT DESIGN

Containment Design	Containment Height m (ft)	Worker Exposure (μgPb/m³)	Average Airflow m/min (ft/min)
Parallel with beams	2.2 (7)	4250 - 15 500	61 (200)
Parallel with beams	4.3 (14)	8500 - 19 500	23 (75)
Perpendicular to beams	2.2 (7)	3500 - 15 250	91 (300)
Perpendicular to beams	4.3 (14)	6000	52 (170)

3. *Non-Blast Removal Methods*, Bernard R. Appleman, SSPC

Non-Blast Paint Removal

Common Techniques

- Wire brush
- Needle gun (with vacuum)
- Rotary peen (with vacuum)
- Abrasive disks
- Chemical stripping
- Water washing/jetting

Key Issues

- Field productivity
- Surface quality
- Lead exposures/debris
- Worker protection requirements
- Containment/disposal requirements
- Confirmation/inspection
- Enforcement/inspection

Water Washing Issues

- Worth doing?
- Before or after mechanical?
- Collection/filtering/disposal
- Optimum pressure equipment

4. ***Illinois DOT Lead Paint Removal Program Overview*, David Copenbarger, Illinois Department of Transportation**

Lead Paint Removal Special Provisions

System	Description
1. Cleaning and painting new steel and adjacent areas of existing steel structures.	Cleaning and painting small areas of new steel and the existing surfaces next to the new steel.
2. Cleaning and painting existing steel structures, partial removal (modified SSPC SP 3) surface preparation.	Spot cleaning by power tools and spot painting designated areas of structure.
3. Cleaning and painting existing steel structures, partial removal (modified SSPC SP 6) surface preparation.	Spot cleaning by abrasive blasting in containment. Spot prime and intermediate coat. Full coat of final coat on all bridges.
4. Cleaning and painting existing steel structures, complete removal (modified SSPC SP 10) surface preparation.	Full cleaning by abrasive blasting in containment of total structure. Full coats of paint on all structure.
5. Containment and disposal of lead paint residues from power tool cleaning.	Must be included with systems 1 and 2.
6. Containment and disposal of lead paint blasting residues.	Must be included with systems 3 and 4.

System	Used When:
SP 3	Paint **is not** considered salvageable or structure life is less than 10 years.
SP 6	Paint **is** considered salvageable and structure life is greater than 10 years.
SP 10	Paint **is not** considered salvageable and structure life is greater than 10 years.

Combination of methods on one structure may be used (Example: SP 3 on underside and SP 6 on fascia beams). Funding will limit the use of SP 10 on most bridges.

4. *Illinois DOT Lead Paint Removal Program Overview*, David Copenbarger, Illinois Department of Transportation (continued)

FHWA Workshop:
Developing Guidelines for Lead Paint Compliance
David Copenbarger
Illinois DOT

CAPPS

- Coating
- Assessment
- Painting
- Priority
- System

Rate Components

- Bearings
- Expansion
- Underside
- Fascia (2)
- Splash Zone (truss)
- Overhead (truss)

Five Rust Category Ratings

Category 1:	0-1%
Category 2:	1-10%
Category 3:	10-100%
Category 4:	Section loss < 1/6"
Category 5:	Section loss > 1/6"

Physical Tests

Tools	Purpose
Dry film thickness gage with calibration shims	Paint thickness
Stanley knife, 5mm cross cut guide and permacel tape	Paint adhesion
30X microscope	View steel substrate
Tooke gage	View layers of paint

Bid Results

SP 3	$2.50 Sq Ft
SP 6	$6.50 Sq Ft
SP 10	$10.50 Sq Ft

Problems

- Adhesion was poor on 90% of tests performed.
- SP 3 did not clean adequately at highly corroded expansion joints.
- SP 10 on complete bridges was cost prohibitive.

4. *Illinois DOT Lead Paint Removal Program Overview*, David Copenbarger, Illinois Department of Transportation (continued)

FHWA Workshop:
Developing Guidelines for Lead Paint Compliance
David Copenbarger
Illinois DOT

Modifications to CAPPS

- Framing plan not required
- Percentage rust for entire structure now required
- Physical tests under review

Painting Costs for Planning Purposes

Expansion area:	$20.00/sq ft
Spot clean and spot paint:	$2.50/sq ft
Spot clean and spot prime:	$1.50/sq ft
Full coat over spot prime:	$1.00/sq ft

25 Year Life Cycle Costs

Example: Rehabilitate 3 span continuous bridge

Total surface area:	10,000 sq ft
Expansion area:	200 sq ft
Percentage rust:	1,000 sq ft
Expansion:	200 sq ft x $20.00/sq ft = $4,000
Spot clean/prime:	1,000 sq ft x $1.50/sq ft = $1,500
Top coat:	9,800 sq ft x $1.00/sq ft = $9,800
	Total: $15,300

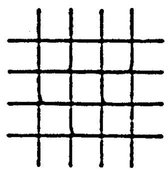
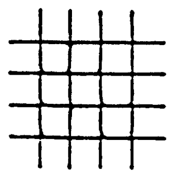
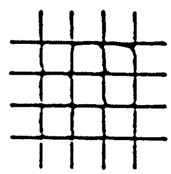
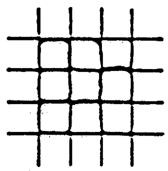
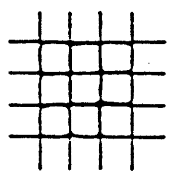
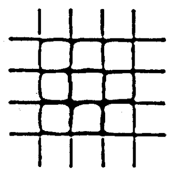
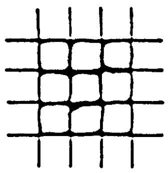
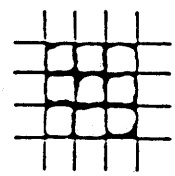
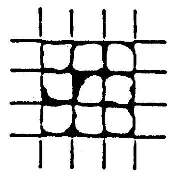
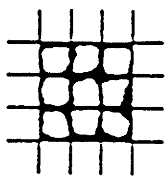
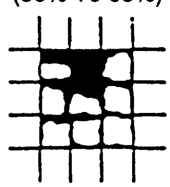
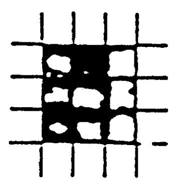
2 cycles required in 25 years = $30,000

Bid Results

- SP 6 at expansion joints
- SP 3 on the remainder of the bridge
- Full topcoat of finish paint
- Results $2.00 - $3.50/sq ft

4. *Illinois DOT Lead Paint Removal Program Overview*, David Copenbarger, Illinois Department of Transportation (continued)

Figure 1
Adhesion Classification Table

Classification	Surface Of Cross-Cut Area From Which Flaking Has Ocurred		
5B	None		
4B		(1% To 5%) 	
3B		(6% To 15%) 	
2B		(16% To 35%) 	
1B		(36% To 65%) 	
0B	Greater Than 65%		

4. *Illinois DOT Lead Paint Removal Program Overview*, David Copenbarger, Illinois Department of Transportation (continued)

TABLE 2
RISK OF SALVAGING EXISTING COATING BASED ON PHYSICAL CHARACTERISTICS

Adhesion Classification (Amount Removed)	Thickness and Substrate Condition					
	≤12 Mils			>12 Mils		
	MS	Rust	None	MS	Rust	None
5B (None)	Low	Low	Low	Low	Low	Low
4B (1% to 5%)	Low	Low	Low	Low	Low	Low
3B (6% to 15%)	Low-Mod	Low-Mod	Low	Mod	Mod	Low-Mod
2B (16% to 35%)	Mod	Mod	Mod	Mod	Mod	Mod
1B (36% to 65%)	Mod-Hi	Mod-Hi	Mod	Mod-Hi	Mod-Hi	Mod
0B (>65%)	Hi	Hi	Hi	Hi	Hi	Hi

Low = **Low Risk**—Coating strength capable of bearing additional coats.

Mod = **Moderate Risk**—Coating strength should be capable of bearing additional coats, but minor, localized lifting may occur.

Hi = **High Risk**—Coating integrity suspect; additional coats could cause disbonding and lifting.

4. ***Illinois DOT Lead Paint Removal Program Overview*, David Copenbarger, Illinois Department of Transportation (continued)**

Rehabilitation Projects

(existing steel to remain in place)

1. Structures Highly Visible to Motoring Public (grade separations, interstate, urban areas, etc.)

Area Cleaned	Method of Cleaning	Paint Type: Prime	Paint Type: Finish
5 feet either side of transverse deck joints	Completely blast clean—SP 6	Two full coats SSPC Paint 25 Alkyd	One full coat SSPC Paint 21 Alkyd
All other areas	Spot power tool clean—SP 3	Two spot coats SSPC Paint 25 Alkyd	One full coat SSPC Paint 21 Alkyd

2. Structures Not Visible to Motoring Public (stream crossings, rural areas, etc.)

Area Cleaned	Method of Cleaning	Paint Type: Prime	Paint Type: Finish
5 feet either side of transverse deck joints	Completely blast clean—SP 6	Two full coats SSPC Paint 25 Alkyd	One full coat SSPC Paint 21 Alkyd
All other areas	Spot power tool clean—SP 3	Two spot coats SSPC Paint 25 Alkyd	Spot coat SSPC Paint 21 Alkyd

Form CAPP A Field Data Summary Form		Bridge Number 1					Environment Rural							
		Inspector DAC							Date 7-28-92		Sheet 2 of 5			
Span		Rust Categories						Physical						Comments
		CAT 1	CAT 2	CAT 3	CAT 4	CAT 5	AVG	CAT	ADH	DFT	MS	RUST	RISK	
ENTIRE STRUCTURE	Bearings		33	50	17		2.8	3	OB	5	No	Yes	HI	
	Exp. Jts.		33	50	17		2.8	3	OB	5	No	Yes	HI	
	Underside		75	25			2.3	2	OB	5	No	Yes	HI	
	Fascia (N)		50	50			2.5	2	OB	5	No	Yes	HI	
	Fascia (S)		50	50			2.5	2	OB	5	No	Yes	HI	

Note: Total Surface Area of Bridge - 10,000 sq. ft.

4. *Illinois DOT Lead Paint Removal Program Overview*, David Copenbarger, Illinois Department of Transportation (continued)

ANALYSIS OF BRIDGE 1

Description — Three span overpass structure. Deck will be replaced. No fracture critical members or seismic deficiencies.

Paint System Decision

SP 3 — This system could be used since the coatings system is unsalvageable (Hi risk factor).

SP 6 — This system should not be considered since the coating system has a Hi risk factor.
This means there is a Hi risk that if the existing paint is overcoated it will delaminate from the steel.

SP 10 — This system could be used since the bridge is receiving a new deck and therefore the structure life is greater than 25 years.

Surface Area

Bridge Total — 10,000 sq. ft. This must be provided by the District.

Area Requiring Spot Surface Preparation and Spot Painting — This percentage should be provided as a square footage number by the District. Framing plan outlining areas should be included.

Estimate by determining the average rust category for the whole bridge. This average is then converted to a percentage of rust by Table 1. The areas of the bridge are grouped as outlined in CAPPS in Section J.

Bearings and Expansion Joints	= 2.8 + 2.8	= 5.6/2	= 2.8		
Underside			= 2.3		
Fascia (N) and Fascia (S)	= 2.5 + 2.5	= 5.0/2	= 2.5		
			7.6/3	=	2.5

From Table 1 2.5 = 5% Rust.

SO 5% of 10,000 = 500 sq. ft.

Life Cycle Costs

The life expectancy of a deck replacement is 30 years, so the paint systems should be evaluated for this time frame.

SP 3 — Life expectancy 5 years. 500 sq. ft. is spot clean and so:

Cycle (5 years)	Sq. Ft.	Cost $ Sq. Ft.	Total ($)
1	500	4.50	$ 5,000*
2	550	4.50	5,000*
3	605	4.50	5,000*
4	665	4.50	5,000*
5	732	4.50	5,000*
6	805	4.50	5,000*
			$30,000*

*Minimum cost should be $5,000. Use this cost if total SP 3 cost @ $4.50/sq. ft. is below $5,000.

4. *Illinois DOT Lead Paint Removal Program Overview*, David Copenbarger, Illinois Department of Transportation (continued)

SP 6 — Not an option.

SP 10 — Life expectancy is 25 years.

10,000 sq. ft. x $12.00/sq. ft.	=	120,000	(25 years)
*SP 3—500 sq. ft. @ $5,000	=	5,000	(5 years)
		125,000	(30 years)

*Add SP 3 for touch up after initial 25 year period.

Conclusion

SP 3 is the paint system choice for this bridge. The cost of steel repairs plus paint should be evaluated against total new steel replacement.

Form CAPP A
Field Data Summary Form

Bridge Number 2 Environment Rural
Inspector DAC Date 7-29-92 Sheet 2 of 5

Span		Rust Categories						Physical						Comments
		CAT 1	CAT 2	CAT 3	CAT 4	CAT 5	AVG	CAT	ADH	DFT	MS	RUST	RISK	
ENTIRE STRUCTURE	Bearings				100		4	4	OB	7	Yes	No	HI	
	Exp. Jts.				100		4	4	OB	8	Yes	No	HI	
	Underside			100			3	3	OB	8	Yes	No	HI	
	Fascia (N)				100		4	4	OB	7	Yes	No	HI	
	Fascia (S)				100		4	4	OB	7	Yes	No	HI	

Note: Total Surface Area of Bridge - 10,000 sq. ft.

4. ***Illinois DOT Lead Paint Removal Program Overview*, David Copenbarger, Illinois Department of Transportation (continued)**

ANALYSIS OF BRIDGE 2

Description — Three span overpass structure. Deck will be replaced. No fracture critical or seismic deficiencies.

Paint System Decision

SP 3 — This system could be used since the coatings system is unsalvageable (Hi risk).

SP 6 — This system should not be considered since there is a Hi risk.

SP 10 — This system coul be used since the bridge is receiving a new deck and the expected bridge life exceeds 25 years.

Surface Area

Bridge Total — 10,000 sq. ft. Provied by the District.

Area Requiring Spot Surface Preparation and Painting — Average should be provided by the District on Framing Plan. Can be estimated as follows:

Bearings and Expansion Joints	=	4		
Underside	=	3		
Fascia (N) and Fascia (S)	=	4		
		11/3	=	3.7

3.7 = 70% Rust

Life Cycle Costs

The life expectancy of a deck replacement is 30 years, so the paint systems should be evaluated for this time frame.

SP 3 —

Cycle (5 years)	Sq. Ft.	Cost $ Sq. Ft.	Total ($)
1	7000	4.50	$ 31,500*
2	7700	4.50	34,650*
3	8470	4.50	38,115*
4	9317	4.50	41,927*
5	10,000	4.50	45,000*
6	10,000	4.50	45,000*
			$30,000*

SP 10 —

$12/sq. ft. x 10,000 sq. ft.	=	120,000 (25 years)
$4.50/sq. ft. @ $5,000	=	5,000 (5 years)
		125,000 (30 years)

Conclusion

SP 10 is the paint sytem choice for this bridge. The cost of paint plus steel reqpirs shoul be evaluated against total new steel replacement.

5. *Full Removal of Lea-Based Coatings from Michigan Bridges*, Eileen M. Phifer, Michigan Department of Transportation

Full Removal of Lead-Based Coatings from Michigan Bridges

Eileen M. Phifer
Michigan Department of Transportation

I was asked to talk to you about the importance of full removal of lead-based coatings from structures. At the Michigan Department of Transportation (MDOT), we strive to:

1. successfully remove,
2. aggressively eliminate, and
3. continually change

to ensure a complete lead paint removal program.

Our policy instructs the contractor to successfully remove the coating on the bridge to a near-white cleanliness. This extends to all bridges regardless of coating system or steel type. The coating system applied to this cleaned surface is an organic zinc-rich primer with an epoxy intermediate and an urethane top coat.

It is important to us to aggressively eliminate as many lead paint issues now instead of a "wait-and-see" policy. Mill scale and excess thickness of the old paint system is a problem if we just overcoat the lead paint and remove it at a later date.

Part of our complete program has allowed the contractor to continually change and improve the containment systems used. For more than seven years, we hav been working at this complete program through the MDOT Bridge Committee, which is composed of personnel from the Materials and Technology Division, Construction Division, Maintenance Division, Design Division, Local Services Division, and FHWA. Granted, earlier versions of complete containment were not perfect, but these trials resulted in a gradual improvement.

We had many growing pains and some of the problems included:

1. Allowing wet abrasive blasting--We discontinued this method due to releases of contaminated water to the sewer system.
2. Releases of dust--We solved this by requiring contractors to improve new types of enclosures.
3. Other releases and environment violations--We provided more training and informationto the project managers to minimize the risk of fines.

Some new problem in the last year include:

1. More difficult containments.
2. Unique structures--Talented and innovative contractor needed to work on special containments.
3. Tighter regulations--We issued a new special provision.

In addition, there are other factors that come into play. For instance, contractors have not had much time to adjust to new regulations an requirements. Secondly, by thoroughly informing our new inspectors, they have been increasingly nervous about the worker exposure. Finally, keeping the Department o Natural Resources and other regulatory agencies informed of our work has resulted in a committee to review and approve all special provisions.

6. *Extracts from Massachusetts Highway Specification on Overcoating, Critical Aspects of Overcoating*, Michael Fitzgerald, Massachusetts Highway Department

Extracts from Massachusetts Highway Specification on Overcoating
Critical Aspects of Overcoating

Michael Fitzgerald
Massachusetts Highway Department

SUBMITTALS

The Contractor shall provide written programs for each of the following items within thirty (30) days of award of the contract:

1. **Paint Removal, Containment and Ventilation Plan** The Contractor shall provide a written plan for the method employed for surface preparation, containment and ventilation. This submittal shall include drawings, load-bearing capacity calculations, and wind load calculations. The plan shall meet the criteria for containment systems and shall include the following:

    1. A construction plan and drawings detailing proposed coating removal operations, as well as removal and transport of waste to a secure storage site.

    2. A plan and drawings detailing the proposed containment enclosure, including details of the following:

        A. Rigid, solid floor of platform. Trucks may be used for a working platform with prior approval by the Engineer.

        B. Containment walls with rigid and flexible materials.

        C. Rigid supports and bracing for the floor and wall panels, rigid or flexible supports and bracing for flexible walls.

        D. Calculations including localized overstress conditions, member stresses, H, Type 3, and Type 3S2 load rating and maximum dead and live load imposed on the bridge by the containment enclosures, only if the containment system is a suspended platform.

        E. Maximum allowable load for the floor/platform.

SUBMITTALS Cont.

F. Wind load and wind stresses imposed on the bridge by the containment enclosures shall be calculated and submitted, only if the containment system is a suspended platform.

G. Connections to the bridge, i.e., clamps, rollers. (Note: Welding and bolting is not allowed.)

H. Auxiliary stationary source lighting.

I. Location of equipment and impact on traffic.

J. Elevation view of the containment enclosure with indications of any encroachments on the surroundings. The bridge vertical clearance shall be maintained above the active travel lanes.

NOTE: The structure loading for containment design and load rating shall be in accordance with AASHTO using H, Type 3 and Type 3S2 loads. The allowable overstress for all conditions shall not exceed 20%.

The Contractor shall have the drawings approved and stamped by a Professional Structural or Civil Engineer registered in the Commonwealth of Massachusetts. For projects over water and railroad the Contractor shall also comply with additional regulatory requirements which call for him to identify the type and placement of water booms, methods for anchoring the booms, procedures for removing debris, procedures for downstream boat and reserve person or team, and all railroad coordination procedures.

2. **Programs for the Protection of Ambient Air, Soil and Water**
The Contractor shall submit testing and evaluation programs that will be used to confirm that work does not violate Federal, State and Local regulations. The Contractor shall also submit a written program for monitoring ambient air quality for particulate and air borne lead emissions to confirm that fugitive dust emissions does not exceed the criteria for controls over environmental emission at the project site previously outlined under this item. The monitoring shall be done with PM 10 monitors in accordance

SUBMITTALS Cont.

with 40 CFR 50 and written approval by the Contractor's CIH. The monitoring plan shall detail who will perform the measurements, the planned number of measurements, the type and number of monitors to be used and provisions for background monitoring, and analytical methodology.

3. **Worker Health and Safety Program** The Contractor shall provide and submit a Health and Safety Program which meets or exceeds 29 CFR 1926. and 454 CMR 11.00. It shall include the following:

   A) **Compliance Program.** A written program to describe the engineering, administrative, housekeeping and protective equipment that will be used to reduce the exposure of the employees to a level less than the PEL (50 $\mu g/m^3$).

   B) **Respiratory Protection Program.** A copy of the respiratory protection program as required by 454 CMR 11.00, 29 CFR 1926.62 and 29 CFR 1910.134. Copies of the pulmonary capacity test results shall also be submitted.

   C) **Personal Hygiene.** A written description of the hygiene facilities and practices to be used, and protective clothing controls shall be submitted. Protective clothing shall be provided as required by 29 CFR 1926.62.

   D) **Medical Surveillance Program.** A written medical surveillance program shall be submitted, including a mechanism for submitted blood lead level testing results directly from the laboratory to MBLR and the Engineer. The program shall include the frequency of testing, the company policy at various action levels, the company policy regarding employee removal, and medical exams. For this special provision, the frequency of blood lead (Pb) testing shall be every four weeks, and the removal requirement is 40 $\mu g/dl$ as previously outlined.

   E) **Employee Training.** A copy of the employee training

SUBMITTALS Cont.

program in accordance with 29 CFR 1926.62 shall be submitted, as well as copies of employee certificates of completion of the course. In addition, the training program must also include the Hazard Communication training (29 CFR 1926.59) and include training for proper hazardous waste handling and management procedures in accordance with 310 CMR 30.00.

F) **Employee Access to Records.** Submit a statement that the employee has been informed of the hazards on the project and of their rights of access to exposure and medical records as required by 29 CFR 1910.20.

G) **Signs.** Submit a statement confirming the wording and placement of signs that will be posted in and around the work area in accordance with 29 CFR 1926.62 and 29 CFR 1910.145.

4. **Handling, Disposal and Analysis of Debris** The Contractor shall submit the following:

A) A written plan that addresses the collection, handling, sampling, testing and site storage of lead (Pb) paint and related debris including the testing of soil quality. The Contractor shall detail how he will comply with the Hazardous Waste Management rules, including testing, labelling, storage and accumulation requirements of 310 CMR 30.00. See also CRITERIA FOR HANDLING OF HAZARDOUS WASTE AND REPORTING RELEASE.

B) The Contractor shall submit the name and address of the certified testing laboratory to perform the sampling and analysis for TCLP.

C) The Contractor shall submit the name, address and EPA identification number of the DEP licensed hauler who will remove hazardous waste.

D) The Contractor shall submit the name, address and EPA identification number of the Treatment/Storage/Disposal facility who will receive the hazardous waste.

6. *Extracts from Massachusetts Highway Specification on Overcoating, Critical Aspects of Overcoating*, Michael Fitzgerald, Massachusetts Highway Department (continued)

SUBMITTALS Cont.

E) The Contractor shall submit a copy of the on-site contingency plan which outlines steps to take in the event of a hazardous waste spill or release including procedures for notification to DEP in the event of a reportable quantity release in accordance with 310 CMR 30.00 and 310 CMR 40.00.

F) The Contractor shall submit a plan of protection including paint overspray containment, for each individual site, to the Engineer 20 days prior to commencing any painting operation. At a minimum, the overspray containment enclosure shall be in accordance with SSPC Guide 6(I) Class 4. Tarpaulin material shall be fire retardant and impermeable to air and water. The joints shall be fully sealed except at the entryway. All mists of dust shall be filtered with collection equipment. For truss bridges a ceiling shall also be included.

7. *Abrasives and Recycling*, H. William Hitzrot, Chesapeake Specialty Products, Inc.

Key Issues for Abrasives

Waste Minimization

- Abrasive must be recyclable
- A minimum of 50 to 100 cycles

Proucitivity

- Must achieve a satisfactory cleaning rate (100 ft^2/8 hour day)
- Permit use of high (120-150 psi) nozzle pressure at 140 psi doubles productivity of 100 psi
- High density metallic abrasives more particle mass, more work on impact

Environmental

- Recycling minimizes generated waste
- Low breakdown of abrasive minimizes dust
- Abrasive must lend itself to recycling high density abrasives--easier to separate waste
- Steel abrasives lend themselves to magnetic separation
- SSPC-AB 2 Specification for Cleanliness of Recycled Ferrous Metallic Abrasives

Containment

- Designed to promote recycling
- Designed to create an air flow
- Ease of movement

Health and Safety

- Excessively high cost--needed to control and reduce costs
- Integrate containment ventilation and abrasive cleanliness requirements to assure a safe work environment
- Automation--take worker out of blast environment

Overcoating as an Alternative to Abrasive Blast

- Potential short-term saving can be very costly
- When coatings fail, it is symptomatic of a basic problem--loss of adhesion, band strength, etc.--red lead over mill scale
- Often more than one coating system involved (read causes of failure from KTA letter).

7. ***Abrasives and Recycling*, H. William Hitzrot, Chesapeake Specialty Products, Inc. (continued)**

Key Issues for Abrasives
(Definitions)

Recyclability: To reduce waste generation, an abrasive should be recyclable a minimum o 50 to 100 times.

High Density Metallic Abrasives: High density lends itself to cleaning and separation of waste products from abrasive particles.

Containment: Designed to create an internal air flow.

Nozzle Pressure: Higher nozzle pressures yield more work @ 140 psi, approximately doubles the work done at 100 psi.

Overcoating: Major problems, patch tests not always valid (often more than one coating system used). Is risk of failure worth the short-term savings?

Excessively High Cost of Health and Safety Requirements: How to control these costs--integrate containment, ventilation an abrasive cleanliness requirements to assure a safe working environment.

8. ***Developing Environmntal Monitoring Protocols for Steel Structure Deleading Operations*****, Catherine Ganley, ATC Environmental, Inc.**

DEVELOPING ENVIRONMENTAL MONITORING PROTOCOLS FOR STEEL STRUCTURE DELEADING OPERATIONS

Introduction

There is currently a need to develop standard guidelines for conducting air monitoring in order to determine the environmental and public impact, if any, of steel structure surface preparation operations involving the disturbance and/or removal of lead-based paint (LBP).

Background

Childhood lead poisoning is expanding due to increased screening of blood lead levels; lower toxicity levels; public awareness and litigation. The main source of lead expoure occurring among children is residential.

Surface preparation involving LBP is under scrutiny due to the activity generating visible lead dust. The hazards are real as well as perceived. Agencies and contractors addressing these deleading operations are perceived to have "deep pockets" and may be looked upon as a source for retribution. In addition, public scrutiny is also due to a history of contamination events based upon surface preparation activities. The Williamsburg Bridge in Brooklyn, New York is an example of this.

Purpose and Need for Guidance

The actual hazards associated with surface preparation and deleading activities has not been quantified. In order to properly conduct deleading activities, defensible and cost-effective environmental monitoring protocols need to be developed. A number of generic monitoring specifications exist that lack uniformity and accountability for site-specific conditions.

The critical need at this time is to establish a standard guideline for conducting air monitoring as well as assessing the need to conduct soil, sediment and water sampling.

Collection of air monitoring data is crucial in order to adequately assess the efficiency of 1) the engineering controls and containment used for the deleading operations and 2) impact to the public and surrounding environment.

Recommendations

The establishment of uniform guidelines will document the impact of surface preparation operations as well as provide cost savings to the agencies and contractors performing these tasks and ultimately to the public.

8. ***Developing Environmental Monitoring Protocols for Steel Structure Deleading Operations*, Catherine Ganley, ATC Environmental, Inc. (continued)**

The following have been identified as key components necessary to provide a defensible air monitoring protocol:

- Specification of sampling equipment (PM 10 and TSP)
- Specific parameters to be tested
- Assessment of visible emissions
- Meteorological data
- Background/baseline protocol
- Duration of monitoring program (number of days)
- Duration of sample collection (hours)
- Specification criteria for site-specific monitoring (including review of work practices, sensitive receptors, site topography and structural dimensions)
- Selection/approval of monitoring firms based upon expertise and training
- Quality control/quality assurance
- Certified laboratory requirements

Conclusions

These guidelines will also result in positive public relations, reduce the risk of litigation, reduce project delays due to environmental concerns, and provide a database for rational decision making and cost savings by defining appropriate containments and environmental monitoring methods.

8. *Developing Environmental Monitoring Protocols for Steel Structure Deleading Operations*, **Catherine Ganley, ATC Environmental, Inc. (continued)**

1. PROBLEMS WITH SURFACE PREPARATION

- **NYC'S CHILDHOOD LEAD POISONING IS MUSHROOMING**
  - — CAUSE: RESIDENTIAL LEAD-BASED PAINT
  - — INCREASED SCREENING; LOWER TOXICITY LEVEL; PUBLIC AWARENESS AND LITIGATION
- **SURFACE PREPARATION INVOLVING LBP UNDER SCRUTINY**
  - — HIGHLY VISIBLE SOURCES OF LEAD DUST:
    - » REAL AND PERCEIVED HAZARDS
  - — PERCEPTION OF "DEEP POCKETS" (AGENCIES AND CONTRACTORS)
  - — PAST CONTAMINATION EVENTS CAUSE PUBLIC DISTRUST AND GREATER SCRUTINY

8. *Developing Environmental Monitoring Protocols for Steel Structure Deleading Operations*, **Catherine Ganley, ATC Environmental, Inc. (continued)**

1. PROBLEMS WITH SURFACE PREPARATION (cont'd)

- **AGENCY MUST DOCUMENT PROTECTION**
- **CONTRACTORS HIRE AIR MONITORING FIRMS**
- **GENERIC MONITORING SPECIFICATIONS DO NOT ACCOUNT FOR SITE-SPECIFIC CONDITIONS**

  — "BACKGROUND" LOCATIONS IN HIGH IMPACT AREA

  — "SENSITIVE RECEPTORS" MISSED

  — SOIL SAMPLING IN TIDAL ZONE
- **DATA AND SITE "EXPERIENCE" ARE LOST**

  — NO BASIS FOR UPGRADING WORK SPECS

  — AGENCIES SUBJECT TO SUSPICION/LITIGATION

8. *Developing Environmental Monitoring Protocols for Steel Structure Deleading Operations*, **Catherine Ganley, ATC Environmental, Inc. (continued)**

2. AGENCY NEEDS

CRITICAL NEED: INFORMATION TO PROVIDE LEAST-COST, SAFE METHODS FOR SURFACE PREPARATION

- **AGENCIES REQUIRE A MEANS OF ACCUMULATING AND ANALYZING DATA ON:**
  - — COSTS FOR ALTERNATIVE SURFACE PREPARATION METHODS, INCLUDING ENVIRONMENTAL COSTS
  - — CONTRACTOR PERFORMANCE
  - — LEAST-COST WORKSITE CONTAINMENT METHODS
  - — LEAST-COST ENVIRONMENTAL MONITORING METHODS
- **AGENCIES MUST INTERPRET AND APPLY RESULTS OF ANALYSES TO THEIR DECISION MAKING PROCESS**

3. DEVELOPING GUIDANCE FOR ENVIRONMENTAL MONITORING OF SURFACE PREPARATION OPERATIONS

SSPC STRATEGY

- **SPECIFY CRITERIA FOR SITE-SPECIFIC MONITORING**
  - — SENSITIVE RECEPTORS
  - — SITE TOPOGRAPHY AND STRUCTURE DIMENSIONS
  - — METEOROLOGY AND PREDICTIVE MODELING OF AIR AND SOIL IMPACTS
- **SPECIFY FIELD MONITORING PROCEDURES**
  - — DETAILED DATA COLLECTION PROTOCOLS ON SITE ACTIVITIES AND CONDITIONS
    - » CHECKLISTS AND FORMS FOR COMPUTER INPUT
    - » RECORD CONTAINMENTS AND WORK PRACTICES METEOROLOGICAL CONDITIONS, VISUAL EMISSIONS, LOCATIONS OF MONITORS AND SOIL SAMPLES, ETC.

8. ***Developing Environmental Monitoring Protocols for Steel Structure Deleading Operations*****, Catherine Ganley, ATC Environmental, Inc. (continued)**

- **CLOSELY MONITOR PRE-, DURING, AND POST-SURFACE PREPARATION OPERATIONS**
- **CREATE DATA FILES:**
  - — SITE CONDITIONS (METEOROLOGICAL DATA, TOPOGRAPHY, ETC.)
  - — WORK PRACTICES AND SURFACE PREPARATION METHODS
  - — ENVIRONMENTAL CONTROLS AND IMPACTS
  - — CONTRACTORS ACTIVITIES AND OTHER SITE VARIABLES

8. *Developing Environmental Monitoring Protocols for Steel Structure Deleading Operations*, **Catherine Ganley, ATC Environmental, Inc. (continued)**

5. AGENCY BENEFITS

- PUBLIC RELATIONS
- REDUCED RISK OF LITIGATION
- REDUCE PROJECT DELAYS DUE TO ENVIRONMENTAL CONCERNS
- DATA BASE FOR RATIONAL DECISION MAKING
- COST SAVINGS BY DEFINING APPROPRIATE CONTAINMENTS AND ENVIRONMENTAL MONITORING METHODS

9. *Waste Treatment and Disposal Issues*, **Bernard R. Appleman, SSPC**

Waste Treatment and Disposal Issues

1. **Minimizing quantity of waste**
2. **Disposing of steel grit waste**
3. **On-site treatment of waste**
   - Non-hazardous
   - Hazardous
4. **Use of pre-blast additives**
5. **Hiring haulers, disposal firms**
6. **Monitoring paint removal contractor**
7. **Need for hazardous waste training**
8. **Recovery/reuse of lead**
9. **Handling of scrap steel**

10. ***Overview of Lead in Construction Interim Final Rule*****, Daniel P. Adley, KTA/SET Environmental, Inc.**

FHWA Workshop:
Developing Guidelines for Lead Paint Compliance
Daniel P. Adley
KTA/SET Environmental, Inc.

Overview

29 CFR 1926.62
Lead Exposure in Construction
Interim Final Rule

29 CFR 1926.62 Lead in Construction

(a) Scope
(b) Definitions
(c) Permissible Exposure Limit
(d) Exposure Assessment
(e) Methods of Compliance
(f) Respiratory Protection
(g) Protective Clothing
(h) Housekeeping

29 CFR 1926.62 Lead in Construction

(i) Hygiene Practices
(j) Medical Surveillance
(k) Medical Removal Protection
(l) Employee Training
(m) Signs
(n) Record Keeping
(o) Observation of Monitoring
(p) Effective Dates

29 CFR 1926.62 Lead in Construction

Appendices

A. Substance Data Sheet
B. Employee Standard Summary
C. Medical Guidelines
D. Respiratory Fit Tests

Lead Exposure Levels for Selected Construction Activities

Hand Tool Cleaning	6 to 167 μ/m^3
Power Tool Cleaning	1 to 20,600 μ/m^3
Abrasive Blasting	1,352 to 58,700 μ/m^3
Equipment Operation	8 to 2,900 μ/m^3
Containment Movement	13 to 2,100 μ/m^3
Welding, Torch Cutting	1 to 28,000 μ/m^3

Protection During Assessments

Level 1 Hand scraping, drywall demolition, heat gun applications, and vacuum-shrouded hand tools.

Level 2 Rivet busting, power tool cleaning, abrasive cleanup, and containment movement,

Level 3 Abrasive blasting, welding, burning, and torch cutting

10. ***Overview of Lead in Construction Interim Final Rule*, Daniel P. Adley, KTA/SET Environmental, Inc. (continued)**

FHWA Workshop:
Developing Guidelines for Lead Paint Compliance
Daniel P. Adley
KTA/SET Environmental, Inc.

29 CFR 1926.62 (f)
Respiratory Protection

- Availability
- Selection
- Respirator Use and Fit
- Written Respiratory Protection Program

Respirator Selection:
Degree of Protection Provided

A "Protection Factor" is a measure of the degree of protection provided by a respirator for the wearer.

Assigned Protection Factor (APF)

APF x PEL = Maximum Use Concentration

Respirator Selection
Maximum Use Concentrations

$\leq$ 500 μ/m^3......... Half-mask, air-purifying (AP)
$\leq$ 1,250 μ/m^3...... Supplied-air (SAR) helmet
$\leq$ 2,500 μ/m^3...... Full-face AP; PAPR; or continuous-flow (SAR) hood
$\leq$ 50,000 μ/m^3.... Half-mask pressure-demand SAR
$\leq$ 100,000 μ/m^3.. Full-face, pressure-demand SAR

11. ***Title X Training and Certification: Notes and Comments*****, Dean Bullis, Maryland Department of Environment**

TITLE X
Residential Lead-Based Paint Hazard Reduction Act of 1992

Goal/Purpose: Lead hazard reduction (to prevent poisonings)

A. Takes a prioritized approach

B. Allows "interim controls"

C. Shift to "primary prevention"

How: Mobilize resources on a broad scale

A. Develop new framework/strategy
   1. Evaluation
      a. risk assessment
      b. inspection
   2. Reduction
      a. interim controls
      b. abatement

B. Impose specific requirements/deadlines (make the federal government the responsible landlord)

C. Provide federal leadership (long overdue)
   1. Time tables
   2. Clear standards
      a. worker protection
      b. training programs
      c. labs

What is the impact on SSPC?

What are the applicable requirements?

A. OSHA final rule--done!

B. Section 1021 Contractor Training and Certification

C. Amends TSCA by adding Title IV (Lead Exposure Reduction Act)

D. TSCA Section 402

Lead-based paint activities training and certification

A. EPA shall issue regulations on standards for performing lead-based paint activities.
Deadline: April 1994.

States are waiting!...or are they? Let's look at Maryland:

A. Knew what the "basics" were

B. Enabling legislation was passed

C. Knew no money (grants, HUD) without regulations

11. ***Title X Training and Certification: Notes and Comments*****, Dean Bullis, Maryland Department of Environment (continued)**

We wrote the Lead Paint Abatement Services Regulations, which include Section .12 Structural Steel

A. Worker training requirements
   1. Initial course: 3 days (21 hours)
      a. containment
      b. OSHA
      c. equipment
   2. Review course: 1 day (7 hours)

B. Contractor/supervisor requirements
   1. Initial courses and exams 4 days (28 hours) plus 2 years experience
   2. Photo ID (1 year)
   3. On-site regulation compliance responsibility
   4. Review course (1 day)

C. Performance standards
   1. Notification > 24 hours, < 10 days
   2. Comply with OSHA, etc.
   3. Containment
   4. Wastes (storage and disposal)

12. ***Costs to Repaint in Connecticut*****, L. Brian Castler, Connecticut Department of Transportation**

Cost to Paint in Connecticut

1970	$0.12/ft^2$
1987-88	$1.65/ft^2$
1990*	$6.02/ft^2$
1992*	$12.07/ft^2$
1993*	$12.39/ft^2$
1994* (first half)	$11.46/ft^2$

*See breakdown

12. ***Costs to Repaint in Connecticut*, L. Brian Castler, Connecticut Department of Transportation (continued)**

Cost to Paint in Connecticut

1990	75% Containment	$0.98
	Blast/Paint	$3.84
	Disposal	$1.20
		$6.02/ft^2
1992	100% Containment	$6.44
	Blast/Paint	$5.28
	Disposal	$0.35
		$12.07/ft^2
1993	Full Containment	$4.36
	Blast/Paint	$5.75
	Disposal	$0.14
		$10.25/ft^2
	Lead Health & Safety	$2.14
		$12.39/ft^2
1994 (first half)	Full Containment	$5.29
	Blast/Paint	$3.18
	Disposal	$0.05
		$8.52/ft^2
	Lead Health & Safety	$2.94
		$11.46/ft^2

12. *Costs to Repaint in Connecticut*, **L. Brian Castler, Connecticut Department of Transportation (continued)**

Cost to Paint in Connecticut 1993

Full Containment

Location	< 10,000 ft^2	> 10,000 ft^2
Bridge over Local Road	$9.21/$ft^2$* 22 bridges	$10.22/$ft^2$* 24 bridges
Bridge over Railroad	N/A 0 bridges	$8.91/$ft^2$* 10 bridges
Bridge over Water	$13.21/$ft^2$* 4 bridges	$11.06/$ft^2$* 14 bridges
Bridge over Expressway	$10.82/$ft^2$* 1 bridges	$8.32/$ft^2$* 13 bridges

* plus Lead Health & Safety @ $2.14/$ft^2$*

12. *Costs to Repaint in Connecticut*, L. Brian Castler, Connecticut Department of Transportation (continued)

Cost to Paint in Connecticut 1994

Full Containment

Location	< 10,000 ft²	> 10,000 ft²
Bridge over Local Road	$8.45/ft²* 5 bridges	$9.30/ft²* 8 bridges
Bridge over Railroad	N/A 0 bridges	$8.34/ft²* 4 bridges
Bridge over Water	$12.54/ft²* 2 bridges	$8.47/ft²* 8 bridges
Bridge over Expressway	N/A 0 bridges	$9.56/ft²* 25 bridges

* plus Lead Health & Safety @ $2.94/ft²*

12. ***Costs to Repaint in Connecticut*****, L. Brian Castler, Connecticut Department of Transportation (continued)**

Cost of Painting Plus Lead Health & Safety

Site	Bridge #	Ft²	$ Paint/Ft²	$ Lead Health & Safety/Ft²	$ Total/Ft²	Remarks
Granby	1565	3,359	$7.82	$2.43	$10.25	Over Brook
	1564	1,799	$14.61	$2.43	$17.04	Over Brook
	1563	2,133	$14.08	$2.43	$16.51	Over Brook
Branford	197	17,700	$6.43	$2.03	$8.46	Over I-95
	272	29,000	$6.33	$1.38	$7.71	Over I-395
Stonington	3906	10,000	$124.54	$5.60	$130.14	Over RR
Norwich	1415	20,000	$18.12	$4.26	$22.38	Over Brook
Old Saybrook	233	1,400	$25.00	$53.18	$78.18	Spot Paint Over I-95
Bridgeport	3547	8,200	$11.64	$30.48	$42.12	Spot Paint Over Local Street

13. ***Developing Guidelines for Lead Paint Compliance*, Pete Clogston, FHWA, North Carolina Division**

FEDERAL FUNDS AVAILABLE FOR BRIDGE PAINTING
INTERMODAL SURFACE TRANSPORTATION EFFICIENCY ACT OF 1991

- Highway Bridge Replacement and Rehabilitation Program (HBRRP)
  $2.5 Billion Annual Program
- Surface Transportation Program (STP)
- National Highway System (NHS)
- Interstate Maintenance

13. ***Developing Guidelines for Lead Paint Compliance*****, Pete Clogston, FHWA, North Carolina Division (continued)**

HIGHWAY BRIDGE REPLACEMENT AND REHABILITATION PROGRAM
ELIGIBILITY CRITERIA

- Deficient highway bridges on all public roads may be eligible for replacement or rehabilitation.
- Agencies participate by conducting biennial inspections and submitting inspection data to FHWA for the National Bridge Inventory.
- A sufficiency rating is assigned to each bridge based on inspection data input to the approved AASHTO sufficiency rating formula.
- A bridge must be both deficient and have a sufficiency rating of 80 or less to be eligible for rehabilitation.
- A sufficiency rating of less than 50 is necessary in order to be eligible for replacement.
- The "10-year rule" prevents a bridge from being classified as deficient for 10 years after construction or major reconstruction.
- For bridges that don't make the HBRRP selection list, Surface Transportation Program funds are available to address bridge painting on public roads of all functional classifications.

13. ***Developing Guidelines for Lead Paint Compliance*, Pete Clogston, FHWA, North Carolina Division (continued)**

HBRRP FUNDING FOR PAINTING OF ELIGIBLE BRIDGES

- Bridge painting may be undertaken as the sole work item or combined with other eligible work.
- Painting projects may include complete cleaning and repainting of entire structure, or spot cleaning and priming of corroded or failed areas, followed by one or two full topcoats.
- Random spot painting as would normally be accomplished through routine or periodic maintenance is not eligible.
- Examples of special cases where painting a portion of a bridge may be eligible:

  —Cleaning and painting of an entire truss but not the floor system

  —Cleaning and painting selected spans of a multi-span structure

  These types of projects need to be assessed on a case-by-case basis.
- Painting of any extent accomplished as part of a rehabilitation project would, as in the past, be eligible.
- Using HBRRP funds to paint a bridge as the sole work item would not make the bridge subject to the "10-year rule."

13. ***Developing Guidelines for Lead Paint Compliance*, Pete Clogston, FHWA, North Carolina Division (continued)**

FEDERAL FUNDS AVAILABLE FOR BRIDGE PAINTING
FHWA WORKSHOP

FHWA supports the use of pre-bid conferences for lead-based paint abatement projects.

FHWA Region 4 States:

- Alabama
- Florida
- Kentucky
- Mississippi
- North Carolina
- South Carolina
- Tennessee

Total number of state-owned bridges in the Region with lead-based paint = 12,000.

Total number of state-owned bridges in North Carolina with lead-based paint = 6,000.

FHWA Region 10 States:

- Alaska
- Idaho
- Oregon
- Washington

Approximately 1,000 state-owned bridges in Region 10 are coated with lead-based paint.

The new regulations have caused maintenance painting costs in this Region to rise from \$11-\$33 /m^2 (\$1-\$3/ft^2) to \$97-\$151/ m^2 (\$9-\$14/ft^2).

Recommendations from Region 10 review:

- Perform a comprehensive evaluation of the existing coatings
- Optimize the maintenance painting strategy
- Conduct pre-bid meetings
- Insure through hazardous waste procedures
- Invest in good inspection
- Test and evaluate new technologies

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSION TO SI UNITS

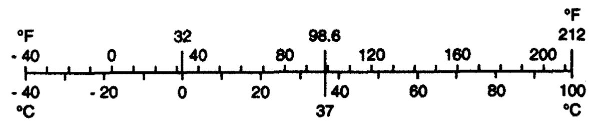
Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimetres	mm
ft	feet	0.0305	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
		AREA		
in^2	square inches	645.2	millimetres squared	mm^2
ft^2	square feet	0.093	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometres squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.028	metres cubed	m^3
yd^3	cubic yards	0.765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

Symbol	When You Know	Multiply By	To Find	Symbol
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9	Celsius temperature	°C

APPROXIMATE CONVERSION FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
		AREA		
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
ha	hectares	2.47	acres	ac
km^2	kilometres squared	0.386	square miles	mi^2
		VOLUME		
mL	millilitres	0.034	fluid ounces	mL
L	litres	0.264	gallons	L
m^3	metres cubed	35.315	cubic feet	m^3
m^3	metres cubed	1.308	cubic yards	m^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius temperature	1.8C + 32	Fahrenheit temperature	°F



* SI is the symbol for the International System of Measurement

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15. Supplementary Notes

FHWA Contracting Officer's Technical Representative: Terry Halkyard HTA-22
Workshop Breakout Group Leaders: Daniel P. Adley, KTA/SET Environmental and Lloyd Smith, Corrosion Control Consultants and Labs

16. Abstract

FHWA sponsored a workshop to identify critical issues and to develop guidelines for removing lead paint from highway bridges. About 45 representatives of highway and regulatory agencies and private industry identified, analyzed and gave recommendations for critical issues relating to Technology and Regulations as follows:

Technology Issues: Procedure for Prioritizing Bridge Maintenance Painting Needs; Evaluating the Effectiveness of Overcoating; Evaluating Life Cycle Costs for Bridge Coatings; performance Croteria for Containment Structures and Systems; Evlauting Productivity and Effectiveness of Surface Preparation Methods; Guidelines for Renovation, Demolition and Other Activities Disturbing Lead Painted Steel; Assuring Adequate Inspection of Lead Paint Removal Projects; Safety and Health Guidlines for Lead Paint Removal.

Regulatory Issues: Uniformity and Reciprocity of State Training Requirements; Quality and Content of Lead Paint Abatement Training Courses; Public Exposure to Lead Debris from Bridge Maintenance; Project Design Criteria Based on Risk Assessment; Air Montioring Protocols; Applicability of Federal Air Regulations; Soil Sampling; Specifications for Worker Protection; Medical Surveillance; Assigned Protection Factor for Abrasive Blast Helmets; Uniform Worker Lead Exposure Sampling and Assessment.

Guidelines were developed to assist highway and bridge agencies in planning and managing program to remove lead paint and to maintain bridges both cost-effectively and in compliance with environmental and health regulations. The guidelines include the following sections: Developing Strategy and Specification Requirements; Specifying Full Removal and Repainting; Specifying Spot Repair and Overcoating; Contracting and Inspection Practices; Sources of Information; Costs and Funding.

17. Key Words	18. Distribution Statement
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