Our mission is to provide a world-class transportation experience that delights our customers and promotes a prosperous Missouri.
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Executive Summary

In an on-going effort by MoDOT to improve the care of the approximately 3,959 steel bridges on the state highway system, a review of the current processes used for controlling corrosion has been performed. The review was considered to be an engineering priority because corrosion left uncontrolled can lead to the premature decline in the conditions ratings and service life of these vital structures.

MoDOT’s tangible results of Innovative Transportation Solutions, Environmentally Responsible, and the Best Value for Every Dollar Spent provide the basis for which the coating program was evaluated. By evaluating current practices and recommending changes to the processes, the ability to slow the number of bridges becoming deficient due to corrosion will enable MoDOT to address more structures and reduce maintenance backlogs.

Currently, MoDOT has three basic coating programs consisting of a MoDOT internal overcoating program, a contract maintenance coating program, and a new construction coating program. The coating industry is continually working on promising new products to limit the amount of corrosion and extend the life of the coating system. However, until these systems are developed and fully proven to be an improvement over MoDOT’s current practices, MoDOT should continue the use of the current state-of-the-art systems now in use, as they provide the best value. For these current systems to properly function, MoDOT must focus on two primary areas: an in-place coating evaluation program and an inspection program during the application of the coatings.

Evaluation of the Existing Coating Condition on Each MoDOT Bridge

By utilizing the Central Office bridge maintenance forces, Regional bridge maintenance forces, and District materials forces, MoDOT can better determine the coatings needs of each individual bridge and then prioritize the work necessary to reduce the amount of corrosion that occurs on the steel superstructures and therefore extend the service life of the coatings as well as the structure. The Bridge Division and Central Office bridge maintenance section would then be able to develop a preventative maintenance program for the coatings for the remaining life of each structure.

On-Site Inspection During All Coatings-Related Application Operations

The inspection of the coatings during application affords MoDOT the opportunity to ensure that the coatings will perform as intended for the life of the system. In turn, this permits MoDOT the ability to do more work for all bridges without having to return to the bridge to repair prematurely failing protective coatings.
The implementation of the findings of this Task Force will ensure better quality coatings in the preservation of steel bridges on Missouri’s state highway system.

Introduction

The bridge design community has long recognized the capabilities of steel for economical bridge construction. While the physical properties of steel make it viable and desirable as a material of construction for bridges, steel is subject to corrosion if it is not properly coated.

For decades, moisture and residual chlorides were prevented from attacking steel by the use of lead-based coatings. When environmental and health issues associated with the use of lead-chromium and other heavy metals-based coatings came to the forefront, the coating industry responded by introduced new technologies. Presently, the primary method or “Gold Standard” for coating bare steel entails the use of an inorganic zinc-rich primer with topcoats to protect the primer and provide for aesthetic considerations.

When some old paint is intact, adherent, and performing satisfactorily, it is MoDOT’s policy to extend the service life of that coating by overcoating. Overcoating is the term used to describe the practice of applying paint over some or all of the old coating. This practice allows for the repair of the coating in some areas. Usually, a coating that contains calcium sulfonate is applied. Primarily, MoDOT uses the calcium sulfonate system for overcoating painted steel. These surfaces usually contain lead paint.

MoDOT’s structural steel coatings program can be categorized into three areas. The first category is MoDOT’s Internal Coatings Program. This program involves the use of MoDOT forces to coat the steel. The second category is classified as the Contract Maintenance coating program in which coatings contractors are retained. The third category is classified as the New Construction Coating Program. During this program, inspection in the shop is performed by the MoDOT inspectors. Inspection of the intermediate coat and topcoat in the field at the jobsite is performed by MoDOT construction inspectors or materials inspectors, depending on the District policy.

The Bridge Coatings Task Force is comprised of Coating Contractors, Fabricators, Bridge Engineers, Chemists, Consultants, Professionals from the Coating Industry, and Field Personnel. (See Appendix A for the list of Task Force Members.)
Background Information and Research

Using resources from the Bridge Division fabrication section, the team conducted a survey of the surrounding states and other participants from the North Central States Consortium (NCSC) to determine the methods of coating structural steel that they are currently using for new construction and recoating / overcoating. The NCSC is a group of 10 states in the north central area of the US. The member states include Illinois, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin. Additionally, surveys were sent to Arkansas, Kentucky, Maine, New York, Oklahoma, Pennsylvania, Tennessee, and Texas. The results of the survey are attached in Appendix B. Based on the responses from the survey, it appears that MoDOT is only one of a few states (Arkansas, Kentucky, and New York) that completely overcoat with calcium sulfonate on a frequent basis. There are several states that use calcium sulfonate for zone painting situations on structural steel, but they did not indicate this on their response to the survey. A majority of the state agencies are using the same systems for new construction as MoDOT currently specifies. However, maintenance coating operations by the respondees indicates a wide variety of systems in use.

In addition to the survey of the State DOT’s, the coating industry members of the team provided information regarding coating systems that may be of benefit to MoDOT. At this time, there is only one system that is beginning to be used that MoDOT has not previously used for recoating or new construction. In addition, one coating manufacturer has developed a new coating system that is still in need of further evaluation. MoDOT is considering an evaluation of the product in the field through FHWA Innovative Bridge Funds. MoDOT remains open to evaluating new coating technologies as they are developed. When a new and possibly better coating is identified, it should be inserted into the MoDOT coatings program, provided that the system is not a single-source product.

Current MoDOT practices for coatings and the systems used are as follows:

- **Internal Coating Program**
  - **Use:** Overcoating performed by MoDOT forces
  - **Surface Prep:**
    - No blast cleaning
    - No power washing / waterjetting
    - Limited hand tool or power tool cleaning
  - **Coating:** Calcium sulfonate

- **Contract Maintenance Program**
  - **Use:** All field operations where complete coating removal and replacement are required.
  - **Surface Prep:**
    - Blast cleaning to remove all old coating and mill scale
    - Some power washing / water jetting
Coating: Calcium sulfonate

MoDOT System ‘G’
Inorganic Zinc Primer
Epoxy intermediate coat
Polyurethane finish coat

MoDOT System ‘H’
Inorganic Zinc-rich primer
Waterborne Acrylic intermediate coat
Waterborne Acrylic finish coat

- New Construction Program
  Use: Mix of shop and field operations
  Surface Prep: Blast cleaning in the fabrication shop to remove all mill scale.
  Shop-applied application of Inorganic zinc-rich primer
  Coating: Field-applied System “G” or System “H” intermediate and finish coats. MoDOT also permits (as an option) the shop application of System “G” or “H” intermediate and finish coats.

(Each program will be discussed further in the report.)

Other Current Practices

MoDOT current specifications require the contractor to apply coatings in accordance with SSPC-PA 1, “Shop, Field, and Maintenance Painting.” There are no current requirements for contractor certification programs or requirements for fully trained coating inspectors.

MoDOT Mission

Develop a plan that protects our steel structures from the effects of corrosion by using any or all available surface preparation and / or coatings technology.

MoDOT Objectives

The Task Force discussed and evaluated the performance of the coating systems in place on MoDOT bridges, the methods and practices used by other states, and new technology. In addition, a review of current contract documents was undertaken. The results of the analysis are attached as Appendix C.
From these analyses, the following areas of concentration were developed:

1. Achieve the optimum success rate with our current paint systems.

2. Establish an evaluation and planning program used strictly and only for bridge coatings and corrosion control.

3. Become proactive in inspection of painting systems during application. Use procedures / training from nationally recognized standards. This will ensure consistent inspection and results for projects from District to District within MoDOT. This further enables MoDOT to achieve the expected life cycle from the paint systems on its structures. Careful and consistent inspection can be expected to avoid premature coatings failure and the ensuing corrosion damage to the steel.

4. Test and evaluate existing coating systems, and provide this information to bridge designers and regional bridge maintenance crews.

5. Implement new specifications and recommended new practices in order to increase coatings life cycle, thereby increasing savings and conserving and extending the effectiveness of existing funding.

Review of Current Programs

Internal Coatings Program

The Task Force started with the internal coatings program to take advantage of the input from former State Bridge Maintenance Engineer Carl Callahan. Mr. Callahan presented the group with a history of the bridge painting program, including the need to depart from any open nozzle abrasive blast cleaning. Some of the limitations discussed included: no open nozzle abrasive blast cleaning, and no low pressure water cleaning (less than 5,000 psi) for chloride mitigation due to environmental restrictions requiring water collection and disposal. Hand tool and mechanical surface preparation methods are allowed in conjunction with some solvent cleaning. Given these limitations, Mr. Callahan indicated that the low cost to overcoat with calcium sulfonate (CSA), the ease of application, minimal solvent-based waste, and forgiving nature given the absence of surface preparation makes CSA the only viable material for the internal coating program.

Currently, the internal coatings program entails hand tool and mechanical cleaning in general accordance with applicable SSPC Standards and application of CSA coating. During the biennial bridge inspections, the inspector visually evaluates the condition of the existing coating and determines the need for
coating repairs. Based on those evaluations and needs, the regional bridge crews schedule coating operations based on work priorities and available resources (manpower, funding, etc.).

The current evaluation process is based on the inspector's opinion. There is no objective visual evaluation or in-depth analysis of the existing coating to identify need and appropriate scope of work. Wholesale use of CSA overcoating is not as cost effective as when using overcoating only as dictated by existing coating condition.

**Contract Maintenance Coating Program**

The Contract Maintenance Coating Program utilizes CSA coatings for overcoating. In addition, either System G or System H is used when recoating bare steel. All structures selected for the Contract Maintenance Coating Program are either recoated or overcoated. The selection of structures for the Program is based on the visual inspection conducted by Central Office bridge maintenance personnel, District Office bridge personnel, or District Office resident engineers. The option to recoat or overcoat involves a careful engineering judgment that depends in part on the amount of corrosion present and / or the amount of steel section loss that has taken place.

At this time, District 6 is the only District that is conducting additional tests of the coating during the selection / screening process. District 6 personnel evaluate the thickness of the existing coating, its adhesion, and whether it contains lead prior to recommending prospective coating maintenance actions.

Ultimately, however, funding issues, rather than technical engineering-type coating condition parameters, will usually determine whether the bridge is overcoated or whether the coating system is completely removed and replaced.

**Overcoating Issues**

The *Missouri Standard Specifications for Highway Construction* address the methods used for surface preparation and coating application. One issue that exists with the overcoating process is that the removal of chlorides from the surface of the coating or the substrate is not addressed. The specifications allow, as an option, the contractor to use power washing to clean the steel surface prior to application of the new coating.

Note: According to definitions provided in SSPC-SP 12 “Surface Preparation and Cleaning of Metals by Water Jetting Prior to Recoating,” there are four levels of water cleaning / water jetting. They are:
1. Low pressure water cleaning - pressure less than 5,000 psi (LP WC)
2. High Pressure water cleaning - pressure between 5,000-10,000 psi (HP WC)
3. High pressure water jetting - pressure between 10,000-30,000 psi (HP WJ)
4. Ultrahigh-pressure water jetting - pressure above 30,000 psi (UHP WJ)

When MoDOT engineers are considering which is the appropriate level of cleaning, there are two issues that are problematic.

The first issue involves the collection and disposal of the wash water. Since many of the structures being overcoated contain lead-based paint, the contractor must collect and dispose of all of the water used for cleaning as hazardous material. If the structure does contain lead-based paint, the restrictions for disposal of the wash water are so costly that the contractors often do not elect the power wash option. Additionally, non-lead-based paint power washing operations required collection of the wash water and disposal off the bridge site.

The second issue (with the current specification) is the specified maximum pressure for the power washing operations. In order to achieve proper chloride removal, it is believed that the minimum pressure for the power washing operations needs to be significantly higher.

Recoating Issues

Recoating of structural steel requires the contactor to completely remove the entire existing coating, to blast clean the exposed structural steel, and apply an inorganic zinc-rich primer along with the intermediate and finish coats associated with either System G or H. The process requires containment of the blast media and coating residue. Again, the cost associated with disposing of this material and / or cleaning solutions for chloride removal, especially when lead-based paint is being removed, is a factor that overrides all others.

In certain instances, MoDOT has incorporated the strategy of mixing recoating with overcoating. The premise is to clean and recoat the areas exhibiting significant corrosion. These areas are often found beneath the joints in the structure with System G coatings (IOZ/E/U). The remaining structure is overcoated with calcium sulfonate.

While the current system utilizes most of the best technology available, there are areas for improvement that will reduce the life cycle costs. When these changes to the Specifications are made and implemented, MoDOT will realize tremendous benefits.

New Construction Coating Program

Current Process – The new construction program consists of a shop-applied inorganic zinc-rich primer and the field application of the System G (Inorganic
zinc / Epoxy / Urethane [Z/E/U]) or System H (Zinc / Acrylic / Acrylic [Z/A/A]) intermediate coats and topcoats. The primary system that is being using is System G (Z/E/U), which provides the better performance of the two systems. System H (Z/A/A) is used primarily on coating of weathering steel joints, since the dull finish more closely matches the patina of the weathering steel. The extent of the field coating is dependent upon the guidelines established in the Missouri Standard Specifications for Highway Construction Section 1081.

- For most grade crossings, the entire structure receives the intermediate field coat, and the outside faces of the exterior girders receive the finish field coatings.

- Stream and railroad crossings have the finish coatings (intermediate and topcoat) applied only to the outside faces of the exterior girders.

The Standard Specifications address the methods of surface preparation and application requirements with performance-based requirements. Since the initial coating is applied in the shop environment with consistent controls, a higher potential exists for the coatings to perform better for a longer duration.

Based on the information provided by the team members, MoDOT's current New Construction Coating Program offers very good performance for the initial cost. Some of the other systems that are available offer similar performance but at an increased cost. The use of these systems should be explored, since these coatings typically entail the application of only one field coat over the inorganic zinc primer versus the two coats applied over the inorganic zinc now specified

**Recommendations**

**Internal Coatings Program**

**Keep the Current System** – Calcium sulfonate (CSA) is currently the “best-fit” option for the internal coatings program given the surface preparation and application limitations established by MoDOT. However, MoDOT should continue to explore and evaluate new technologies that fit MoDOT capabilities.

**Environmental Issues** – The environmental requirements associated with wash water from power washing must be re-evaluated. MoDOT should work with DNR to determine if the possibility exists to release clean wash water back into the environment. Naturally, this wash water will be tested, and the release requirements would be developed and incorporated into the work practice utilized by MoDOT’s forces. If the ability to dispose of wash water at the bridge site
becomes available, MoDOT crews would be given the ability to remove chlorides prior to coating. This would greatly increase the coating performance, especially under joints.

**Evaluation Program** – In order to ensure that maintenance forces are optimizing their coatings program, a paint inventory and condition evaluation program needs to be developed and incorporated into the TMS database. Basic data would be collected annually during the NBIS inspections. The data would then be indexed and used to create a work prioritization program for work by MoDOT forces over a defined period of time. Alternately, the use of such an approach could result in the decision that the work be scheduled for contracted maintenance forces. The requirements are yet to be determined, the inspection staff trained, the data collected, and the TMS database populated. An example of an evaluation and prioritization program is the “Model Coating Condition Evaluation Program” developed by a Task Force member and included in Appendix G. Similarly, several coating suppliers have created evaluation programs that are available for use by MoDOT.

It is anticipated that some bridges are in a condition that touch-up or overcoating are considered viable. Prior to any painting, the condition of existing coatings should be evaluated based on the custom-tailored MoDOT program guidelines to determine if the coating is an appropriate overcoat candidate. This evaluation may be made by an internal bridge inspection team (such as the deck survey team), the Bridge Maintenance Superintendent, or by outside sources. The testing should include, as a minimum, a detailed visual condition, coating adhesion, qualitative lead evaluation, and a dry film thickness assessment (see Appendix G, “A Model Coating Condition Evaluation Program”).

**Contract Maintenance Coatings Program**

**Pre-Evaluation of Existing Coating System and Maintenance Painting Planning** – In reviewing the practices of the contract maintenance coating program, the team determined the need to establish an evaluation and planning program. Proper evaluation of the existing coatings to determine the condition of the coating prior to application of new coatings permits MoDOT to determine the best outcome considering the existing conditions. The program, identical to that used for the internal coatings program, should utilize a life cycle cost analysis during the coating selection process. Appendix G provides an example of a “Model Coatings Evaluation Program.”

**Environmental Issues** – One of the largest expenses incurred by MoDOT is the current specification regarding collection and disposal of wash water. These requirements should be reviewed in order to develop realistic achievable environmental requirements for the collection and disposal of wash water to make washing (or the higher pressure water jetting) viable for the contractors as a measure to remove chlorides prior to the application of the new coating. The
Kentucky Transportation Cabinet has conducted research on filtering technology for wash water. MoDOT needs to explore these filtering technologies by establishing pilot programs that are extensively monitored with random jobsite samples to ensure that they actually do what they claim concerning wash water collection, filtering, and disposal. Disposal of the wash water is controlled by regulations established by the Environmental Protection Agency (EPA) and the Missouri Department of Natural Resources (DNR). MoDOT should explore the formation of a joint task force with the EPA and DNR to explore and evaluate the options available concerning new ideas and technology for wash water collection, processing, and re-use / disposal.

**Contractor Certification** – Quality of preparation and application of the surface coating system is critical to the life of the coating system. A method to ensure quality surface preparation and coating application would be to require, by specification, that coating contractors be certified by recognized Contractor Certification Programs by independent societies such as SSPC: The Society for Protective Coatings. Current MoDOT specifications do not define levels of quality during application of the coating, nor do they require contractor certification. Requiring contractors to be certified will increase the level of performance due to the need for the contractor to maintain its certification.

In addition, the team recommends requiring certification for painting contractors, individual blast cleaning personnel, coating application personnel, and inspectors. SSPC has created programs detailed below that will fulfill all of MoDOT’s needs.

**Painting Contractor Certification Programs (PCCP)**

The SSPC Painting Contractor Certification Programs are based on consensus standards developed by a diverse committee of industry professionals. It is a nationally recognized independent contractor evaluation program, as well as a pre-qualification tool developed by SSPC for facility owners and others who hire industrial painting contractors.

Each program reviews the industrial painting contractor’s primary ability to provide quality work in accordance with applicable safety, health, and environmental compliance standards. The program is divided into the following categories:

Qualification Procedure No. 1: “Field Application to Complex Industrial and Marine Structures” (QP 1) evaluates contractors who perform surface preparation and industrial coating application on steel structures in the field.

Qualification Procedure No. 2: “Field Removal of Hazardous Coatings” (QP 2) is a supplement to QP 1 that evaluates the contractor’s ability to perform industrial
hazardous paint removal in a field operation. Two QP 2 categories are available based on the type of equipment and containment:

- Category A - Negative Air Containment
- Category B - No Negative Air Containment

Qualification Procedure No. 3: “Shop Painting Certification Program” (QP 3) evaluates a contracting company's ability to perform surface preparation and protective coating application in a fixed shop facility. SSPC issues three categories of shop certification:

- Enclosed Shop
- Covered Shop
- Open Shop

Recommendation: Since many of the steel bridges in Missouri still contain lead-based paint, the team recommends that MoDOT require by specification that the minimum level of certification for the field coating contractors be SSPC QP 2, “Field Removal of Hazardous Coatings.”

**Training of Inspection Personnel** to evaluate the condition of the coatings on all MoDOT bridges and create a program to identify those bridges requiring coatings work. The program must enable MoDOT personnel to create a plan which will provide a schedule and budget for future coatings work on every structure. This is an undertaking which may require the creation of a new task force to focus on the development of this program.

The writers envision the creation of a five-phase evaluation program (including training of personnel).

**Phase One:** Visual inspection and evaluation (more in depth than the existing program). This inspection would occur most often during the NBIS inspection or by other personnel as needed. The visual-only inspection would be based on established criteria to assess the degree of rusting. All inspectors would be provided with visual reference standards to permit consistent evaluation statewide.

**Phase Two:** In-depth evaluation of in-situ coatings including (but not limited to) adhesion, thickness, lead, and chloride concentration. These evaluations would be conducted on the recommendation from the evaluation from Phase One. The evaluations would be conducted by either District personnel, Central Office bridge maintenance personnel, or by the Regional bridge maintenance personnel.
Phase Three: Maintenance of a statewide coating condition database. In order to make the appropriate decision for corrosion protection and mitigation for each bridge on an on-going basis, a database is a necessity. Only by being able to determine the condition of the coating over time will a plan for all bridges emerge. Training in the acquisition, management, and use of coating condition assessment data is crucial in an on-going program.

As an example, it may be that two bridges separated by only a short distance, which were painted at the same time, could age at dramatically different rates. The coating on one bridge might be in need of attention in ten years, while that on the other bridge may not need any attention for three decades. The difference in performance may be attributed to many causes. Planning for maintenance of the two will be very different. The coating on the bridge which has deteriorated at three times the rate of the other will require attention much sooner. When data on many bridges are combined, a plan for remediation of each structure in similar condition in any given District or area can be developed.

Phase Four: Training of blast cleaning and coating application personnel. There is also an “SSPC Coatings Application Certification Standard” as well as a certification program for blast cleaning personnel, the “SSPC Dry Abrasive Blaster Certification (C-7).” Both the blast cleaning and coating application personnel assigned to MoDOT projects should receive the training and demonstrate through “hands-on” training their ability to actually perform the tasks required correctly at the time of their certification. SSPC C-7 certification is required by the U.S. Navy on its projects referencing NAVSEA Standard Item 009-32. This phase would be considered optional as directed by the District or Division Engineer.

Phase Five: Inspection of the surface preparation and application of the coatings by the contractor. This training would permit MoDOT personnel to provide quality assurance inspection of the contractor’s surface preparation and coating application efforts as well as lead exposure safety awareness. Appropriate training would be provided to District construction and materials personnel, the Central Office fabrication personnel, and bridge maintenance personnel.

There are many ways that MoDOT can provide the necessary training for bridge coating inspectors. One method would be to have a professional consulting engineering firm specializing in coatings design present training for MoDOT inspection personnel. Another would be to utilize either or both professional organizations such as The Society for Protective Coatings (SSPC) and the National Association of Corrosion Engineers (NACE) to provide the training. (A description of what each organization would provide is appended – see Appendix D.)
**Chloride Mitigation** – The performance of paint and related products applied to steel can be significantly affected by the presence of water-soluble salt contaminants. Unless salts are removed from a steel surface prior to repainting, poor paint performance can be expected. Salts on the steel surface are hygroscopic and will absorb moisture from the air, causing osmotic blistering of the paint system and accelerating the rate of steel corrosion. Removal of salts is often difficult because they are embedded in pits in the steel surface. The salt contaminants can remain in the bottom of the pits, often beneath the corrosion product. In order to adequately remove the salts from the surface, it is often necessary not only to remove the corrosion product but also to flush the salt from the corrosion pits. Flushing of chlorides is most commonly done in accordance with high pressure water cleaning or high pressure water jetting of the structure.

Pressure washing and water jetting refers to cleaning performed at pressures as follows:

- Low pressure water cleaning - pressure less than 5,000 psi, (LP WC)
- High Pressure water cleaning - pressure between 5,000-10,000 psi (HP WC)
- High pressure water jetting - pressure between 10,000-30,000 psi, (HP WJ)
- Ultrahigh-pressure water jetting - pressure above 30,000 psi. (UHP WJ)

The performance of a paint system applied over a salt-contaminated surface depends on the service environment, the type and design of the paint system, the thickness of the paint, and the nature and amount of salt contaminant.

Testing for chloride contamination on the steel surfaces beneath joints must be performed before and after blast cleaning to ensure their removal before application of inorganic zinc primer. It is also recommended that chloride testing occur at other locations on the structure for both overcoating and recoating operations before and after cleaning operations.

According to FHWA-RD-91-011, acceptable levels that can remain should be at or less than 50 μg / cm² (fifty micrograms per square centimeter). A copy of FHWA-RD-91-011 is appended (see Appendix E).

**Surface Preparation** – In order for a coating system to function properly, the surfaces beneath (bare steel or existing coating) need to be prepared properly. The team reviewed the current process and recommends that MoDOT establish improved surface preparation criteria.

As discussed above, the presence of chloride contaminants on the surfaces can lead to premature coating failures. It is imperative that chlorides be removed from the structure prior to application of new coatings. With chloride removal in mind, it is recommended that high pressure water cleaning be required by
contract on all overcoating and recoating projects in the contract maintenance program. For the high pressure water cleaning to be effective, it is recommended that the current *maximum* pressure of 1,500 psi be increased to a maximum pressure of 10,000 psi.

**Training for MoDOT Personnel** – Additionally, in the overcoating process, the engineer is designated as the person who will ensure that the contractor is removing enough material (loose paint, corrosion, etc.) to enable the new coating to perform properly. Training for MoDOT personnel by one of the recommended training programs (described in Appendix D) will provide MoDOT engineers with the knowledge to ensure quality coating application.

**Pre-Bid and Annual Standards Meetings** – The team recommends that it would be beneficial to MoDOT and the contractor to hold pre-bid meetings on all coating projects in order to review the requirements and expectations for the project, and to discuss all facets of the project and any unusual concerns the contractor may have about the project.

While the team was reviewing the current processes in the contract maintenance coating program, one common theme that arose was that the contractors may not be aware of the expectations that MoDOT has for the painting program. As a result, the team explored the possibility of creating an annual standards meeting. This meeting would be held early in the calendar year (January, February, or March) prior to the start-up of coatings operations to review the expectations for field coating applications. At the meeting, field samples (or mock-ups) of properly prepared surfaces and applied coatings would be preserved and made available to both contractor and MoDOT inspectors for their mutual review. As a result, there would be uniform enforcement of the coating inspection process by MoDOT. All contractors statewide would know what is expected of them by MoDOT on any project on which they are working.

It is also recommended that there be mandatory Pre-Bid meetings which require attendance by all contractors and field coating contractors performing work on the project. If the contractor does not sign-in in person, their firm will be barred from bidding (either as a prime or subcontractor) on the contract. It is believed that by requiring their attendance at both an annual standards meeting and pre-bid meetings, MoDOT is ensuring that the contractors are familiar with and committed to working with MoDOT to provide the best product possible to the people of the State of Missouri.

**On-Site Reference Samples** – A concept that was developed by the team while reviewing the current coating processes was to have the contractor prepare on-site reference samples. The Task Force recommends adding to the specifications the requirement that the coating contractor produce and preserve a surface preparation and coating application sample area on a section of the steel on the bridge at the jobsite. Based on the application, MoDOT and the contractor
would then both examine and agree that the final product applied to the structure would match the sample area before final acceptance of all coated areas by MoDOT inspectors.

**Stripe Coats** – Based on the team’s review of the current processes, there are several proposed revisions and additions to the existing specifications.

Currently, the specifications require that the coatings be applied in accordance with SSPC PA 1 “Shop, Field, and Maintenance Painting of Steel.” This standard references the use of stripe coatings (see Section 6.6) during the application of coatings. A stripe coat is a coat of paint applied only to edges or to welds on steel structures before or after a full coat is applied to the entire surface. The stripe coat is intended to give those areas sufficient film thickness to resist corrosion. The specification states that “if stripe coating is required in the procurement documents, all corners, crevices, rivets, bolts, etc….should be stripe coated...” The team recommends that specific language be added to specifications requiring stripe coatings in accordance with SSPC-PA 1 (see Section 6.6).

**Other Recommend New Practices:** The following recommended new practices should be implemented into our program.

1.) “Zone Painting” of structures, where we only paint and / or spot prime those areas that are in need of corrosion protection rather than overcoat or recoat the entire structure.

2.) Explore the use of “mixed coating systems,” where the different systems are applied to the structure based on the need for corrosion protection. For example, the use of System G may be needed at the expansion joints and calcium sulfonate used on the remainder of the bridge.

3.) Utilize two-coat paint systems. Several such two-coat systems have been extensively studied by either North East Protective Coating Committee ([http://maine.gov/mdot/nepcoat/about.htm](http://maine.gov/mdot/nepcoat/about.htm)) or FHWA and found to perform as well as three-coat systems. The two-coat systems contain the same aggregate thickness as applied in the three-coat systems. There would be significant labor savings by not applying a third coat. A new system “I” (polysiloxane) is currently being worked into the specification (see the recommendations for the new construction coatings program). Additionally, the possibility of single coat and spot prime with finish coating systems exist and could be evaluated on a case-by-case basis.

4.) Explore the possibility of establishing a separately funded (possibly Federally) coatings program exclusive to coatings. This had been tried in the past by Central Office bridge maintenance but, due to scope creep and the desire for additional work on the structure, the coatings portion of the project was deferred.
In those cases, coatings, the first line of defense against corrosion, are simply not being applied. By dedicating a separate fund exclusively to coatings and not permitting scope creep to eliminate painting, steel structures can be coated properly to extend the life of the structures.

5.) STIP – Programming / Flexibility. Eliminate scope creep / permit parallel creep for coating work.

6.) Due to their faster cure time, utilize organic zinc primers for Systems G and H. This will result in labor savings and less impact on traffic. It is noted that while inorganic zinc-rich primers provide superior corrosion resistance, the slightly lowered corrosion resistance of organic zinc-rich primers is a good trade-off in order to speed up the work.

7.) It is recommended that MoDOT investigate and evaluate a potential contractor / material supplier warranty program (similar to that used in the MoDOT Safe and Sound Program). The possibility of establishing a warranty program was a contractor suggestion. By requiring warranties, it is believed that the contractor will be motivated to take additional precautions to ensure proper surface preparation and application and thus prevent early failure of the coatings and the resulting call-backs for repairs.

Shop / New Construction Coatings Program

Contractor Certification – There is a need to ensure the quality of the application of the coating product itself. Current specifications are “performance based,” which requires the testing of the final product. Many times, testing of the final product missed defects in the surface preparation and application of a coating. It is recommended that MoDOT require the applicator to be certified to ensure that they are knowledgeable in the application of the coating. By requiring certified contractors, the performance level will be increased due to the need for the contractor to maintain the certification.

The team recommends also requiring certification for blast cleaning, coating application, and inspection personnel. In order to assure that MoDOT bridges are blast cleaned, painted, and inspected by personnel with the best training and experience, it is recommended that these personnel be qualified in accordance with the SSPC Training and Certification Programs:

- Blast cleaning personnel must be certified under the SSPC C-7 program.
- Coating application personnel must be certified under the SSPC Coating Application Specialist (CAS) program as an SSPC Coating Application Specialist Level 2 Full Status.
- Inspectors must be trained and certified under the SSPC Bridge Coating Inspector (BCI) program.
Certification of Painting Contractor for the Contract Maintenance Coating Program – The Task Force has also recommended that contractor certification be required for the New Construction Coating Program.

(In order to maintain consistency, the minimum level of certification for the field coating contractors in the New Construction Coatings Program should be the SSPC QP 2. It is recommended that MoDOT use only shops which are certified as SSPC QP 3 Shops.)

New Construction (Shop Certifications) – The American Institute of Steel Construction (AISC) has a coating certification program designated as the Sophisticated Paint Endorsement (SPE) for shops applying complex coatings such as those used on bridges. SPE is an add-on endorsement for shops holding the AISC shop certification currently required.

(Note: AISC and SSPC are currently working together to create a joint certification program that would encompass the SSPC QP 3 and SPE certifications into one program. MoDOT should consider this program for shop-applied coatings when it is available (sometime in 2009). The consolidation of these two programs into programs that follow the same written standard should serve to strengthen both programs. Therefore, after the two programs are judged to be identical, shop certification in accordance with either SSPC-QP 3 or under the AISC SPE endorsement should be accepted.)

Mandatory Pre-Bid and Annual Standards Meetings – To ensure the quality of the application of the coatings for new construction, the team recommends mandatory pre-bid meetings to discuss MoDOT’s requirements and expectations for bridge coatings.

On-Site Reference Samples – In a manner similar to that discussed in the Contract Maintenance Coating Program, the use of on-site reference samples should be required in order to establish baseline acceptance criteria for both surface preparation and the finished coatings.

Training of Inspectors – This is a substantial undertaking, possibly requiring the formation of a task force to create this program.

The application of coatings in New Construction is very similar to the application of coatings under Contract Maintenance except for the surface preparation that is usually completed in the shop. The Task Force determined that MoDOT could create an internal training program for the shop or field inspection of coatings and coating application for New Construction. This program would be modeled after the SSPC Bridge Coating Inspector (BCI) program.
Using the knowledge gained from the training programs for inspection of the Contract Maintenance Coatings Program, a curriculum would be set up to exclusively train field inspectors in the areas of repairs to applied coatings, proper surface preparation, coatings application, and inspection techniques.

Training would be conducted in the off-season when coatings are not being applied. To keep the inspectors that are trained in the Contract Maintenance Coatings Program current with their knowledge, they would be required to assist in the training of the inspectors for the New Construction program. This could be added to the current certification program.

**Stripe Coats** – To maintain the high quality of coatings and to minimize early corrosion, the team recommends stripe coating be applied on new construction coatings as discussed previously in the Contract Maintenance coating process.

**Recommended New Practices / Materials** – The following recommended new practices should be introduced in the MoDOT New Construction Coatings Program:

1.) Organic Zinc Primers – As discussed above, MoDOT’s primary product for the zinc primer is inorganic zinc primer. It is recognized that there are advantages and disadvantages to every coating type. The inorganic zinc primers perform extremely well, especially when no intermediate or finish coats are applied over them. However, one disadvantage of inorganic zinc-rich primers is that they are very difficult to repair if they are damaged during shipping or erection. When inorganic zinc primer is applied over itself in a repair situation, the primer may not adhere well. MoDOT currently requires that repairs to inorganic zinc primers be conducted with an approved epoxy mastic primer. These epoxy mastic primers do not contain zinc and will therefore not provide the corrosion resistance of a zinc-rich primer. Also, the color tint of the epoxy mastic primer does not closely match the color of the zinc-rich primer. If the repaired area does not receive the intermediate and / or the finish coat, the appearance of the final product is a splotchy and visually unappealing to the traveling public.

Another product which should be considered for the repair of inorganic zinc-rich primers is organic zinc-rich primer. Organic zinc primers contain zinc powder which is suspended in an organic coating. The product will provide protection similar to inorganic zins, especially when the primer is coated with intermediate and top coats. Organic zinc-rich primer coatings generally do not require quite the same degree of meticulous surface preparation and will adhere well to the inorganic zinc primer. Finally, the tint of the epoxy zinc-rich primer product closely matches the inorganic zinc and provides a better visual appearance in the situations where no intermediate and / or no topcoat is / are applied.
MoDOT currently provides the option for the contractor to apply the intermediate and final coats in the shop or in the field. Comments that were received by the team indicate that there is an additional cost incurred due to lost time in the shop. The lost time is a result of the amount of time and extra handling of the steel while it must lay around the shop waiting for the required cure time for the inorganic zinc-rich primer. Organic zinc-rich primers cure at a much faster rate and therefore would provide a high quality, lesser cost alternative for shop-applied coatings.

(Appendix F highlights the differences and similarities of inorganic and organic zinc primers.)

2.) Rapid Deployment Coating Systems – MoDOT’s current coating systems have proven to be cost effective when applied properly. There are new technologies that are being developed by the industry that appear to offer the same benefits to MoDOT’s current coatings program. Many of these new technologies involve a so-called “rapid deployment approach” by requiring the use of a two-coat system versus a three-coat system. These systems will still require the use of the tried and proven inorganic or organic zinc-rich primer as the main means of corrosion prevention. However, the second coat will provide the same coating thickness and properties of the intermediate and/or topcoats with the application of only one coat. Currently, the material cost for this technology may be higher than the systems used by MoDOT, but a potential for cost savings in the field application exists due to the need for the contractor to apply one less coat of paint in the field. This reduces the manhours and the time on the structure. Some systems that MoDOT should explore are:

   a. Polysiloxane finish coats
   b. Polyaspartic finish coats
   c. Inorganic ethyl silicate finish coats
   d. Possibly others

MoDOT has conducted testing on the polysiloxane finish coats in the chemical laboratory with excellent results. Based on the laboratory testing, MoDOT will be creating a new System I (inorganic zinc primer/polysiloxane finish coat) that may be a coating option on future projects.

3.) Innovative Bridge Research Funds – As technology in the coating industry changes, MoDOT will be receptive to new technology and will apply the material to bridge steel actual field conditions. Sometimes, new technology, as it is being developed, is proprietary. This can limit MoDOT’s ability to test the material. The Federal Highway Administration offers Innovative Bridge Research Funding that MoDOT should utilize to experiment with and evaluate new technology.
Summary of Findings / Recommendations

Internal Operations

Given the internal constraints imposed on the Internal Program to meet environmental regulations (no cleaning which removes any paint or entails the use of water), the Task Force review of the current program revealed that there are no alternative materials or processes available that meet our needs.

Contracted Operations

Although the current coatings systems offer MoDOT very cost-effective corrosion prevention, the Task Force review determined that there were will likely be some new materials in the future.

There are some application-related issues that could be implemented that should increase the service life of the coatings applied under Contract Maintenance. These recommendations include:

Pre-Evaluation of Existing Coatings – Create a program for effective analysis of the existing coating to determine the type of coating operation that needs to occur and when the operation needs to occur (see Appendix G).

Environmental Issues – MoDOT should try to work with other regulatory agencies to determine the applicability of current regulations and possible solutions for disposal of wash water and paint chips generated when coating removal and chloride mitigation efforts are required. Additionally, it is believed that there is new equipment, which, if used, could improve the overall effectiveness of the operation and still protect the worker and the environment.

Contractor Certification – In order to provide the best quality application of coatings to increase service life of the coating, MoDOT should require the use of certified coating contractors in both the field and in the shop.

Chloride Mitigation – For overcoating and recoating, MoDOT should require that chlorides be removed from the structural steel prior to application of the new coating by conducting testing and removal with proper high pressure water cleaning (HPWC) techniques in accordance with SSPC-SP 12.

Trained Inspectors – With MoDOT requiring certified contractors, the State must also provide trained inspectors who are able to work with the contractors and thoroughly understand coatings operations. For maintenance coatings operations, the inspectors should be trained to one of the nationally recognized programs. For new construction, the training may be conducted internally.
Pre-Bid and Annual Standard Meetings – By establishing mandatory meetings, MoDOT will be able to communicate with the contractors the expectations required for each coating job. In turn, the contractors will experience consistency in enforcement of the contracts statewide.

Stripe Coating – Although MoDOT currently specifies SSPC-PA 1 “Shop, Field, and Maintenance Painting of Steel” for paint application, there is a need to specify the use of the stripe coating requirement in Section 6.6 “Stripe Coating” to ensure that coatings are being applied to the areas that have higher tendency to experience early failure and the resulting corrosion.

On-Site Reference Samples – To ensure that each contractor and inspector have an understanding of what is required for final acceptance, MoDOT should require that the contractor produce (and preserve) an on-site application area (mock-up) which will serve as the “job standard” for the project.

Organic Zinc Primers – While organic zinc primers approach the superior protection of the inorganic zinc primers, the use of these primers has potential to enhance MoDOT’s coating programs. MoDOT should use organic zinc primers for field touch-up of inorganic zinc in the field. Due to the faster curing time of organic zinc, MoDOT should explore the use of these fast-curing primers for “Rapid Deployment” projects where the entire structure must be cleaned and coated such that traffic impact is absolutely minimized.

“Rapid Deployment” Coatings – Some technology has been developed that MoDOT could possibly employ in the future. These technologies typically require two-coat systems versus the existing three-coat systems with the same or better performance. By using these two-coat systems, the contractor will spend both less labor manhours and time actually deployed on the structure, thereby ultimately providing savings to MoDOT.
Appendix A
Team Members
<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kent Nelson – Chair</td>
<td>MoDOT</td>
<td></td>
</tr>
<tr>
<td>Todd Bennett</td>
<td>MoDOT</td>
<td></td>
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<td>Carl Callahan</td>
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<td>Carboline</td>
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<td>Chuck Dolejsi</td>
<td>MoDOT</td>
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<td>Ken Foster</td>
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<td>Before retirement</td>
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<td>Dane McGraw</td>
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<td>Dee McNeill</td>
<td>Sherwin-Williams</td>
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<td>Mark Mitchell</td>
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<td>Randy Morris</td>
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<td>Bill Stroessner</td>
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<td>J.D. Wenzlick</td>
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<td></td>
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<td>Ken Chism</td>
<td>Hartman-Walsh Corp.</td>
<td>Responded that they wanted to attend, but did not.</td>
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<tr>
<td>Don Thomas</td>
<td>Thomas Industrial Coatings</td>
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Appendix B

Results of Survey of Adjoining and NCSC States
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<th>Arkansas</th>
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### New Fabrication

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<tr>
<th>Primer</th>
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<th>Inorganic zinc</th>
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<tr>
<td>Shop</td>
<td>X</td>
<td>X</td>
<td>X</td>
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</tr>
<tr>
<td></td>
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### Intermediate Coat

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### Top Coat

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### Existing Structures

#### Field Re-Coating

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<th>Powerwash</th>
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| Intermediate Coat | Epoxy | Urethane | Aluminum filled epoxy mastic | X | X | X | X | X | X | X | X | X | X | X | X |

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<td>X</td>
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### Comments

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### Problems

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### New Products

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<td></td>
<td></td>
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<td>Gaps</td>
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### Product Evaluation

| none |

### Field Application

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25
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<th>Wisconsin</th>
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<th>S. Dakota</th>
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<td>Jeff Weber</td>
<td>Brian Kibler</td>
<td>Craig Welch</td>
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<td>Faice Welch</td>
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<td>Denis Dubois</td>
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### New Fabrication

#### Primer
- Shop
  - Organic Zinc rich primer: Approved
  - Inorganic zinc: Approved
- Inorganic Zinc rich epoxy: Approved
  - Zinc: Approved

#### Intermediate Coat
- Epoxy: Approved
- Urethane: Approved
- High Build Polyesperthane: Approved
  - Shop Applied: Approved

#### Top Coat
- Epoxy: Approved
- Urethane: Approved
- Aliphatic polyesperthane: Approved
- Water Born Acrylic: Approved
- Acrylic: Approved
  - Shop Applied: Approved

### Existing Structures

#### Field Re-Coating
- Fluid surface prep: Approved
- Removal: Approved
- 3 layer: Approved
- 4 layer: Approved
- 5 layer: Approved

#### Primer
- Zinc: Approved
- Organic rich primer: Approved
- Inorganic zinc: Approved
- Aluminized: Approved
- Organic Rich epoxy: Approved
- Acrylic Primer: Approved

#### Intermediate Coat
- Epoxy: Approved
- Urethane: Approved
- Aluminized: Approved

#### Top Coat
- Aliphatic polyesperthane: Approved
- Polyurethane: Approved
- Urethane: Approved
- Water Born Acrylic: Approved
- Mixed top coat: Approved

### Comments
- Works well

### Problems
- Peeling: None
- See Attachment
- See Attach
- Lead paint: Peeling
- Peeling: Yes
- Peeling:

### New Products
- Polyesperthane: Approved
- Weathering Steel: Approved
- Zinc rich epoxy: Approved
- Aluminized: Approved
- Urethane: Approved

### Product Evaluation
- NRP: Approved

### Field Application
- Contract: Approved
- Contract: Approved
- Contract: Approved
- Contract: Approved
- Both: Approved
- Both: Approved
- 5 interior: Approved
See my answers in bold.

Jeff Weiler  
Transportation Engineer  
Structural Fabrication Group  
Phone: 517-322-1235  
Cell: 517-204-2106  
Fax: 517-322-5664  
weilerj@michigan.gov

>>> <Daniel.Davis@modot.mo.gov> 11/14/2007 1:25PM >>>

We are evaluating our current coatings program and systems used for our steel bridges, both new & existing structures. We are interested in learning what coatings program and systems your state uses for both new & existing steel bridges. How do you prioritize the structures for over-coating or recoating? MDOT has 8 separate regions and each region is responsible for prioritizing based on bridge inspection reports. How do you evaluate the steel bridge coatings used in your program? We will evaluate coating systems that have gone through NTPEP.

New structures:
1) What coating system(s) are used & how are they performing?
   We use a 3 coat system (zinc rich primer, epoxy intermediate and urethane top coat) which has performed well. MDOT requires all new structural steel to be shop painted. The only painting allowed in the field is touch up. This has helped the overall performance greatly.

2) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)
   Any coating system that goes through NTPEP could be reviewed but nothing specific at this point.

Existing structures:
3) Do you use over-coating systems or paint removal and recoating?
   MDOT only blasts and paints. No overcoating.

4) Do you use internal personnel or contract the work?
   All work that I'm aware of is contracted and inspected by an MDOT representative which may or may not be an MDOT employee.
5) What coating system(s) are used & how are they performing?
   **Same systems as used for new bridges.**

6) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)?
   **Same as new bridges.**

7) What problems have you experienced with the new or existing coatings?
   **The only problems that I am aware of have been from contractor errors (improper cleaning, atmospheric conditions etc.). The main problem that I've seen is extensive peeling that occurs within a year of the application which is a result of the errors listed above.**

Thanks, Jeff

   We thank you for your assistance and information. Have a good day!
We are evaluating our current coatings program and systems used for our steel bridges, both new & existing structures. We are interested in learning what coatings program and systems your state uses for both new & existing steel bridges. How do you prioritize the structures for over-coating or recoating? How do you evaluate the steel bridge coatings used in your program?

**New structures:**
1) What coating system(s) are used & how are they performing?
   
   For new structures inorganic zinc primer, water borne acrylic top coat

2) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)
   
   Looking into moisture cured polyurethane..

**Existing structures:**
3) Do you use over-coating systems or paint removal and recoating?
   
   Removal is used on all but RR crossing and then sometimes we encapsulate if it’s lead. Blast to SSPC-SP 6

4) Do you use internal personnel or contract the work?
   
   Contract

5) What coating system(s) are used & how are they performing?
   
   Organic zinc primer and water borne top coat

6) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)?
   
   We tried a SSPC-SP 7 (Brush Off Blast) with a Wasser Paint System. This is **not** recommended!

7) What problems have you experienced with the new or existing coatings?
   
   Getting experienced inspectors in the field is a challenge
   
   TCLP can get you in trouble if you do not tell the Contractor the results or do the test. 5 mg/l is the threshold for lead – no-lead
Daniel;

I am forwarding this to our paint specialist Bryon Beck.

Thank you;
Brion Klopf
Bridge Operations
(517) 204-6701

>>> <Daniel.Davis@modot.mo.gov> 11/14/2007 12:18 PM >>>
We are evaluating our current coatings program and systems used for our steel bridges, both new & existing structures. We are interested in learning what coatings program and systems your state uses for both new & existing steel bridges. How do you prioritize the structures for over-coating or recoating? How do you evaluate the steel bridge coatings used in your program?

New structures:
1) What coating system(s) are used & how are they performing?
2) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)

Existing structures:
3) Do you use over-coating systems or paint removal and recoating?
4) Do you use internal personnel or contract the work?
5) What coating system(s) are used & how are they performing?
6) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)?
7) What problems have you experienced with the new or existing coatings?

We thank you for your assistance and information. Have a good day!

Daniel L. Davis.
Fabrication Technician- Bridge
Missouri Department of Transportation
(573)751-3853 daniel.davis@modot.mo.gov
Re: Survey of your state's coatings program and systems for both new & existing steel bridges.

New structures:
1) What coating system(s) are used & how are they performing?  
**Organic Zinc primer, Epoxy or Urethane Intermediate and Urethane Topcoat**

2) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.) **None**

Existing structures:
3) Do you use over-coating systems or paint removal and recoating?

4) Do you use internal personnel or contract the work?

5) What coating system(s) are used & how are they performing?  
**Organic Zinc primer, Epoxy or Urethane Intermediate and Urethane Topcoat. Well**

6) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)? **None**

7) What problems have you experienced with the new or existing coatings? **None**
Re: Survey of your state’s coatings program and systems for both new & existing steel bridges.

See embedded answers below (underlined):

Todd L. Niemann, P.E.
Structural Metals and Bridge Inspection Engineer
AASHTO/AWS D1.5 Bridge Welding Code Chairman
Minnesota Department of Transportation
(651) 366 - 4567 work
(612) 741 - 1413 cellular

>>> <Daniel.Davis@modot.mo.gov> 11/14/2007 11:25 AM >>>
We are evaluating our current coatings program and systems used for our steel bridges, both new & existing structures. We are interested in learning what coatings program and systems your state uses for both new & existing steel bridges. How do you prioritize the structures for over-coating or recoating? How do you evaluate the steel bridge coatings used in your program?

New structures:
1) What coating system(s) are used & how are they performing?

Mn/DOT Answer: Three Coat Systems - Inorganic Zinc Rich Epoxy, Epoxy or urethane intermediate, Aliphatic Polyurethane

2) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)

Mn/DOT Answer: Expanded use of uncoated weathering steel

Existing structures:
3) Do you use over-coating systems or paint removal and recoating?

Mn/DOT Answer: Almost exclusively paint removal and recoating.

4) Do you use internal personnel or contract the work?

Mn/DOT Answer: Contract
5) What coating system(s) are used & how are they performing?

**Mn/DOT Answer:** Three Coat Systems - Organic Zinc Rich Epoxy, Epoxy or urethane intermediate, Aliphatic Polyurethane

6) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)?

**Mn/DOT Answer:** Two Coat System - Zinc Rich Epoxy - Polyaspartic Ester Urethane

7) What problems have you experienced with the new or existing coatings?

**Mn/DOT Answer:** Limited problems; mostly typical application issues

We thank you for your assistance and information. Have a good day!

Daniel L. Davis.
Fabrication Technician- Bridge
Missouri Department of Transportation
(573)751-3853 daniel.davis@modot.mo.gov
Daniel,

Here is our response as follows:

New Structures:

1) What coating system(s) are used and how are they performing?

For the most part, we use weathering steel and only paint at the abutments and joints. If we do paint, the coating is a zinc silicate primer and an acrylic topcoat.

2) What new technologies are you reviewing or trying(coatings, materials, inspection, etc.)?

We are always looking at different coatings that are available and the performance of those products. At this time, we are not aggressively reviewing any products that may change our current specifications.

Existing Structures:

3) Do you use over-coating systems or paint removal and recoating?

We do not use over-coating. We remove the paint and recoat. We have tried to get a bigger bang for our buck by zone painting. Many bridges, we can paint the exterior of the exterior girders, areas close to the abutments, and around the joints. These are the worst areas and the remaining paint is in usually pretty good shape.

4) Do you use internal personnel or contract the work?

We do not paint internally, everything is contracted out.

5) What coating system(s) are used and how are they performing?
We use an Epoxy Paint System. It is a three coat system which consists of a Zinc-rich Epoxy primer, a High-solids Aluminum Epoxy Mastic intermediate coat, and an Aliphatic Polyurethane to coat. This system has performed exceptional for us. We have had no failures and the product seems very durable.

6) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)?

As stated before, we are always reviewing and reading material about other products, but with such good performance with our current product, we are in no hurry to change.

7) What problems have you experienced with the new or existing coatings?

On new structures, the problems experienced is a bubbling of the top coat if it is applied before the primer is fully cured. On existing structures, the key is to get the steel blast properly. Once this occurs, the system works great.

If you have any questions, please contact me.

Dave Jensen
Mr. Daniel Davis,

Here are Jeff's answers.

Sincerely,

Scott Milliken, P.E.
Bridge Division
Phone: (402) 479-4801
Fax: (402) 479-3752
e-mail: smillike@dor.state.ne.us

My responses are imbedded in the questions, bold.

- Jeff
Gentlemen,

Could you provide me with an answer that I could respond to this with?

Thank you,

Scott

----- Forwarded by Scott Milliken/DOR/NEBRLN on 11/14/2007 12:05 PM -----
Daniel.Davis@modot.mo.gov

11/14/2007 11:20 AM

To smillike@dor.state.ne.us

Subject Survey of your state’s coatings program and systems for both new & existing steel bridges.

We are evaluating our current coatings program and systems used for our steel bridges, both new & existing structures. We are interested in learning what coatings program and systems your state uses for both new & existing steel bridges. How do you prioritize the structures for over-coating or recoating? How do you evaluate the steel bridge coatings used in your program?

**New structures:**
1) What coating system(s) are used & how are they performing?

   Most of our new steel bridges are weathering steel which we do not paint. When we paint non-weathering steel we use a 3-coat zinc/epoxy/urethane system. Excellent.

2) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)

   Weathering steel

**Existing structures:**
3) Do you use over-coating systems or paint removal and recoating?

   Full removal and replacement
4) Do you use internal personnel or contract the work?

   Let to contract

5) What coating system(s) are used & how are they performing?

   Zinc/epoxy/urethane. Excellent.

6) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)?

   None

7) What problems have you experienced with the new or existing coatings?

   Failure of calcium sulfonate coatings on an overcoating project.

   We thank you for your assistance and information. Have a good day!

Daniel L. Davis.
Fabrication Technician- Bridge
Missouri Department of Transportation
(573)751-3853 daniel.davis@modot.mo.gov
"Dubois, Denis" <Denis.Dubois@maine.gov>

12/14/2007 06:48 AM

To <Leonard.Foster@modot.mo.gov>
cc

Subject

RE: Survey of your state’s coatings program and systems for both new & existing steel bridges

Mr. Foster,

Following is my reply. Your original text/questions are black and the replies are in blue.

We are evaluating our current coatings program and systems used for our steel bridges, both new & existing structures. We are interested in learning what coatings program and systems your state uses for both new & existing steel bridges. How do you prioritize the structures for over-coating or recoating? How do you evaluate the steel bridge coatings used in your program? **We, in the State of Maine, try to get optimum effectiveness from our bridge paints. Bridges are inspected in accordance with federal guidelines every two years and the information from the inspection reports provides information about the paint condition. The inspection reports along with regional Bridge Maintenance crews that have responsibility to maintain them provide the information to prioritize painting.**

New Structures:

1) What coating system(s) are used & how are they performing? **We use NEPCOAT listed products for new structures. It is still early to judge, NEPCOAT lists are only about 10 years in existence; they are, however, performing well to date.**

2) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.) **We have ho dipped galvanized some bridges; one bridge had fascia beams Duplex coated (Top coated galvanizing).**

Existing Structures:

3) Do you use over-coating systems or paint removal and recoating? **We prefer to do complete removal then coat bare steel. In order to minimize traffic restrictions we often only paint critical areas at deck joints, normally approximately 6 to 10 feet at abutments. Over coating is normally done incidentally when original coating is damaged by local structural work.**

4) Do you use internal personnel or contract the work? **Protective coating is done by both, Bridge Maintenance and contract work.**
5) What coating system(s) are used & how are they performing? **We use 3 coat Moisture Cured products such as Wasser and Xymax. These products have been used for the past 10 to 12 years and are performing satisfactorily so far.**

6) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)? **None.**

7) What problems have you experienced with the new or existing coatings? **Coatings have a limited life and re-coating/maintenance is expensive. We have tried to use inorganic zinc rich systems in the field to get optimum life; however, we have found that they are not field friendly.**

Regards,

Denis Dubois, Fabrication Engineer

Maine DOT, Bridge Program

16 State House Station

Augusta, ME 04333-0016

Tel 207.624.3406, Fax 207.624.3491
"Wehrle, Craig"
<craig.wehrle@dot.state.wi.us>
11/14/2007 12:26 PM

To "Leonard.Foster@modot.mo.gov"
cc

Subject
RE: Survey of your state's coatings program and systems for both new & existing steel bridges.

For new structures we use zinc, epoxy, urethane and are reviewing polysiloxane. For existing we use mainly total removal/recoat and some overcoating. We contract the work. We like our present system. Problems occur when shops circumvent SSPC rules. Getting the primer coat right is key. The blasting needs to be done with non uniform shot. Mixing a little Black Beauty helps though it is tough on the machinery.

-----Original Message-----
From: Leonard.Foster@modot.mo.gov [mailto:Leonard.Foster@modot.mo.gov]
Sent: Wednesday, November 14, 2007 11:15 AM
To: craig.wehrle@dot.state.wi.us
Subject: Survey of your state's coatings program and systems for both new & existing steel bridges.

We are evaluating our current coatings program and systems used for our steel bridges, both new & existing structures. We are interested in learning what coatings program and systems your state uses for both new & existing steel bridges. How do you prioritize the structures for over-coating or recoating? How do you evaluate the steel bridge coatings used in your program?

New structures:
1) What coating system(s) are used & how are they performing?
2) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)

Existing structures:
3) Do you use over-coating systems or paint removal and recoating?
4) Do you use internal personnel or contract the work?
5) What coating system(s) are used & how are they performing?
6) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)?
7) What problems have you experienced with the new or existing coatings?

We thank you for your assistance and information. Have a good day!

Leonard Foster
Fabrication Technician- Bridge Division
Phone: 573-751-3853
Fax: 573-526-5488
To <Leonard.Foster@modot.mo.gov>
cc
Subject Survey of your state's coatings program and systems for both new & existing steel bridges.

1.) Inorganic Zinc with polyurethane topcoat. Appears to be working well.
2.) Nothing new.
3.) Both overcoats and full removal.
4.) Contract to paint - normally NDDOT inspects.
5.) overcoat- 3 layer moisture cure urethane. Full removal - repaint with organic zinc primer, epoxy, and polyurethane topcoat. Some delamination on overcoats.
6.) Nothing new.
7.) Some repair problems with shop coating steel - some delamination of overcoats.

Steven R Henrichs PE
Transportation Engineer
North Dakota Department of Transportation
300 Airport Road
Bismarck, ND 58504-6005
phone: 701-328-6910
fax: 701-328-6913
We really have no set procedure for prioritizing our painting projects. We try to coordinate re-painting with other rehabilitation work being done to a particular structure or we re-paint when we start to see enough loss in the coatings where section loss is starting to occur. We also have no evaluation system in place for our coatings. We have hired KTA-Tator in the past and plan on hiring them again to evaluate our coating systems.

1) For new structures we use a two coat system of inorganic zinc primer with a high build polyurethane finish that is all shop applied. Field repairs are done with an aluminum filled epoxy mastic primer and high build aliphatic polyurethane finish coat.

2) Currently we are trying to get KTA-Tator hired to review our systems and recommend any new systems, technologies or inspection.

3) We typically do full paint removal and recoating unless it is just touch up or minor repair work.

4) All of our painting is done by contract work.

5) For existing structures we use an Alkyd primer with an Alkyd top coat. Other than some fading and chalking, we haven't had a lot of problems with any of our re-paints.

6) Other than reviewing the new over-coat systems, we have not looked into any other new technologies for coatings, material, or inspections yet. We have decided not to use the over-coating based on discussions with Eric Kline at KTA-Tator. We felt that the potential for problems if not done just right and the shorter life expectancy than a complete blast and re-coat were not worth the risk.

7) We have only had two major problems with new paint systems and one of them was field applied and it is peeling off in large sheets. We think we had moisture problems in the field with this one and therefore we shop apply everything now. The other pre-mature failure we had was on a shop applied product that we think was just improperly applied. Other than these two and some steel railing paint failures, we have not seen a lot of problems with our paints either new or re-paints on existing structures. However, you have to realize that we are in a fairly arid environment throughout most of our state and we do not use a lot of deicing salts either so we don't see a lot of corrosion on our steel structures.
Subject: Survey of your state’s coatings program and systems for both new & existing steel bridges.

We are evaluating our current coatings program and systems used for our steel bridges, both new & existing structures. We are interested in learning what coatings program and systems your state uses for both new & existing steel bridges. How do you prioritize the structures for over-coating or recoating? How do you evaluate the steel bridge coatings used in your program?

New structures:
1) What coating system(s) are used & how are they performing?
2) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)

Existing structures:
3) Do you use over-coating systems or paint removal and recoating?
4) Do you use internal personnel or contract the work?
5) What coating system(s) are used & how are they performing?
6) What new technologies are you reviewing or trying (coatings, materials, inspection, etc.)?
7) What problems have you experienced with the new or existing coatings?

We thank you for your assistance and information. Have a good day!

Leonard Foster
Fabrication Technician- Bridge Division
Phone: 573-751-3853
Fax: 573-526-5488
From: Wayne Seger [mailto:Wayne.Seger@state.tn.us]
Sent: Friday, October 03, 2008 3:48 PM
To: powerspm@watsoncoatings.com
Subject: Re: MoDOT Coatings Program / Systems Evaluation Survey

>>> "Paul M. Powers" <powerspm@watsoncoatings.com> 10/3/2008 10:49 AM >>>
Dear Wayne,

I have been asked, as a Team member of the Missouri Department of Transportation Task Force on Coatings Evaluation, to forward you a short survey regarding your states use of protective coatings for steel bridges (new and existing structures). We are interested in how you prioritize the structures for over-coating or recoating, how you evaluate the performance of the systems and what current technology (types of coatings) you are using. We would greatly appreciate you input on these topics.

Sincerely,

Paul M. Powers
National Sales Manager / Structural Steel Div.
Watson Coatings, Inc.
N.A.C.E. Certified Coatings Inspector #5643
Task Force Team Member – MoDOT

New Structures:

1) What coating system(s) are used and how are they performing?  
   Most of our new steel bridges are weathering steel and only the ends anchored in concrete are painted. Of those steel structures that do require painting, we use a 3 -step process of inorganic zinc, tie coat, and a urethane top coat.

2) What new technologies are you reviewing or testing (coatings, materials, inspection, etc)?
   None currently

Existing structures:

3) Do you use over-coating systems or paint removal and recoating?  99% of our repaints on existing bridges are a blast to bare steel and 3 coat process.
4) Do you use internal personnel or contract the work?  All of our repainting operations are done by contract. Some spot painting is done with in-house forces.
5) What coating system(s) are you using and how are they performing? As mentioned before, the inorganic zinc, tie coat, urethane top coat. So far so good.
6) What new technology are you reviewing or testing (coatings, materials, inspection, etc)?
   None at this time

7) What problems have you experienced with the new or existing coatings?  Lack of proper application is the primary issue. This should be corrected with closer inspection and using highly qualified inspectors.

Other Comments:

Thank you in advance for your assistance and information!
See Below.

From: Paul M. Powers [mailto:powerspm@watsoncoatings.com]
Sent: Friday, October 03, 2008 11:53 AM
To: Castle, Derrick (KYTC-WSC)
Cc: Kent.Nelson@modot.mo.gov
Subject: MoDOT Coatings Program / Systems Evaluation Survey

Dear Derrick,

I have been asked, as a Team member of the Missouri Department of Transportation Task Force on Coatings Evaluation, to forward you a short survey regarding your states use of protective coatings for steel bridges (new and existing structures). We are interested in how you prioritize the structures for over-coating or recoating, how you evaluate the performance of the systems and what current technology (types of coatings) you are using. We would greatly appreciate you input on these topics.

Sincerely,

Paul M. Powers
National Sales Manager / Structural Steel Div.
Watson Coatings, Inc.
N.A.C.E. Certified Coatings Inspector #5643
Task Force Team Member – MoDOT

New Structures:

1) What coating system(s) are used and how are they performing?
   *New Steel: Typically IOZ/Epoxy/Urethane with IOZ applied in the shop. Performing well.*

2) What new technologies are you reviewing or testing (coatings, materials, inspection, etc)?
   *None*

Existing structures:

3) Do you use over-coating systems or paint removal and recoating?
   *Typically we are specifying full removal (SSPC SP-6) and recoat.*

4) Do you use internal personnel or contract the work?
   *We are 100% Contractor and are rapidly moving toward 100% Consultant inspection.*

5) What coating system(s) are you using and how are they performing?
   *Typically Epoxy Zinc/Urethane or MCU Zinc/Urethane, several recently completed projects used 1-coat Calcium Sulfonate, upcoming projects are expected use 3-coat systems of either Epoxy Zinc/Epoxy/Urethane or MCU Zinc/Epoxy/Urethane.*

6) What new technology are you reviewing or testing (coatings, materials, inspection, etc)?
   *Performance of coating systems applied over varying levels of soluble salt contamination and coatings utilizing optically active pigmentation (OAP).*

7) What problems have you experienced with the new or existing coatings?
Numerous areas on structures recently abrasive blasted to SSPC SP-6 and coated with 1-coat calcium sulfonate are showing premature failure in areas prone to soluble salt exposures. This failure prompted the study noted above.
New Structures
1) A prime coat that is an inorganic zinc-rich paint meeting AASHTO M300 for Type I or Type II. The finish coat is a epoxy tie coat recommended by manufacturer of prime coat and a coat of urethane paint which is a high build aliphatic polyurethane paint compatible with previous coat. Working fine.
2) None

Existing Structures
3) Both
4) Internal for over-coating and contract for paint removal and repainting.
5) Over-coating system is a pressure wash and coat with calcium sulfonate. Usually lasts between 5 and 10 years. See number 1 for removal and repainting.
6) None
7) Sometimes our over-coating system may not last more than a couple of years. Very dependant on material we are over-coating and condition (humidity, cleaning, etc.) at time of placement. If there is good inspection on paint removal and repainting then we get a good product.
I have been asked, as a Team member of the Missouri Department of Transportation Task Force on Coatings Evaluation, to forward you a short survey regarding your state's use of protective coatings for steel bridges (new and existing structures). We are interested in how you prioritize the structures for over-coating or recoating, how you evaluate the performance of the systems and what current technology (types of coatings) you are using. We would greatly appreciate your input on these topics.

Sincerely,

Paul M. Powers
National Sales Manager / Structural Steel Div.
Watson Coatings, Inc.
N.A.C.E. Certified Coatings Inspector #5643
Task Force Team Member - MoDOT

New Structures:

1) What coating system(s) are used and how are they performing?
2) What new technologies are you reviewing or testing (coatings, materials, inspection, etc)?

Existing structures:

3) Do you use over-coating systems or paint removal and recoating?
4) Do you use internal personnel or contract the work?
5) What coating system(s) are you using and how are they performing?
6) What new technology are you reviewing or testing (coatings, materials, inspection, etc)?
7) What problems have you experienced with the new or existing coatings?

Other Comments:

Thank you in advance for your assistance and information!
Sorry for the tardiness. I’d be interested in the summary. Enjoy.

Peter Weykamp, PE  
Bridge Maintenance Program Engineer  
NYS DOT  
50 Wolf Rd Pod 5-1  
Albany, NY 12232  

(p) 518 457-8485  
(f) 518 457-4203  
(c) 518-935-7470  

>>> "Paul M. Powers" <powerspm@watsoncoatings.com> 10/3/2008 12:00 PM >>>  

Dear Peter,  

I have been asked, as a Team member of the Missouri Department of Transportation Task Force on Coatings Evaluation, to forward you a short survey regarding your state’s use of protective coatings for steel bridges (new and existing structures). We are interested in how you prioritize the structures for over-coating or recoating, how you evaluate the performance of the systems and what current technology (types of coatings) you are using. We would greatly appreciate you input on these topics.

Sincerely,  

Paul M. Powers  
National Sales Manager / Structural Steel Div.  
Watson Coatings, Inc.  
N.A.C.E. Certified Coatings Inspector #5643  
Task Force Team Member – MoDOT  

New Structures:  

1) What coating system(s) are used and how are they performing?  
2) What new technologies are you reviewing or testing (coatings, materials, inspection, etc)?

Existing structures:  

3) Do you use over-coating systems or paint removal and recoating?  
4) Do you use internal personnel or contract the work?  
5) What coating system(s) are you using and how are they performing?  
6) What new technology are you reviewing or testing (coatings, materials, inspection, etc)?
7) What problems have you experienced with the new or existing coatings?

Other Comments:

Thank you in advance for your assistance and information!

Painting Survey.doc

New Structures:

1) What coating system(s) are used and how are they performing?

NYSDOT had been using a three coat system using moisture-cure urethanes, for both recoating and over-coating. The system did not reach expected service life. Recently, we revised the primer coat to a zinc primer and two coats of urethane. Time will tell.

2) What new technologies are you reviewing or testing (coatings, materials, inspection, etc)?

Unknown

Existing structures:

3) Do you use over-coating systems or paint removal and recoating?

Both

4) Do you use internal personnel or contract the work?

Projects involving open blasting are contracted. State maintenance forces efforts amount to a very small percentage of the work.

5) What coating system(s) are you using and how are they performing?

See above.

6) What new technology are you reviewing or testing (coatings, materials, inspection, etc)?

NYSDOT is moving from complete painting of the superstructure to zone painting – typically including the girder ends and fascia beams. State maintenance forces are now applying Calcium sulfonate on SP-3 surfaces and will continue to investigate other materials.

7) What problems have you experienced with the new or existing coatings?

Too early to comment. At this time the move to zinc primer seems to be successful.

Other Comments:

The industry must develop/educate/advocate for a coatings program that includes the maintenance of the coating system. They should work with the owners – or regional groups - to develop guidelines, materials, procedures, and evaluate coatings that can be applied without blasting by owners and provide an effective intervention treatment between contracted coatings projects.
Appendix C

Results of Review of Existing Programs
Internal Coatings Program

Current System: Calcium Sulfonate

Materials:

Current Benefits:

1.) Simple
   a.) Surface Preparation is minimal – Hand Tool / Power Tool
   b.) Application
   c.) Clean-up
2.) VOC Compliant
3.) Low Stress
4.) Easy Repair
5.) High Film Tolerant (> 10 mil Dry Film Thickness)
6.) Rust Inhibitor
7.) Low Cost
8.) Salt Tolerant
9.) Overcoat again with CaSu

Current Deficiencies:

1.) Abrasion resistance
2.) Undercutting due to damage from debris (coating system under the CaSu) (need to quantify)
3.) Future removal to bare substrate
   a.) Contaminated abrasive
   b.) Impregnate steel with CaSu
   c.) Higher removal cost - Up from $2.00 / square foot to as much as $15.00 / square foot
4.) Overcoat only with CaSu

Process:

Current Benefits:

1.) Cheap versus other systems (price comparison not quality)
2.) Ease of application – Do more for money and staff
3.) Doesn’t rely on a plan of action
Current Deficiencies:

1.) No evaluation of existing system prior to overcoating  
2.) No set evaluation program  
   a.) Overcoating  
   b.) Removal  
3.) No evaluation of failure mechanism  
4.) Programming of Bridge Maintenance schedule  
5.) Is it really cheap? Premature failures requiring rework before scheduled time to recoat.

Constraints of the Program:

Does calcium sulfonate mask cracks that would be seen with other coating systems?

Money – Limited resources – Do more with less.

Planning for the effective use of the money.

Effective / appropriate surface preparation

Prioritized maintenance

Manpower / training / equipment

Inability to dispose of power wash water – If power washing were to be used.

Define / Evaluate Options:

Establish a planning program

Maximize product potential (use product at the right place at the right time)

 Attempt to receive more money for the program.

Optimize the money available.

Re-evaluate environmental requirements for wastewater from power washing

Recommend New Practices:

Optimize local maintenance crews from the reorganization. Establish a pilot program for coatings to plan and prioritize coating operations and analyze new technology
Create an evaluation program and provide training to personnel. Prevent repeating the process over and over.

Create a work prioritization program. Determine what needs to be done first – what can wait.

Establish effective surface preparation criteria

1.) Dechlorify the structure
2.) Removal of enough material for coating to work properly
3.) Consider power washing the structure with a high pressure (10,000 to 15,000 psi)

Utilize zone painting

Consider the use of sacrificial anodes in addition to the overcoating
<p>| Program: Internal System: Calcium Sulfonate |
|------------------------------------------|---------------------------------------------|---------------------------------|---------------------------------|---------------------------------|
| <strong>Deficiency / Issue</strong>                  | <strong>Recommendation</strong>                         | <strong>Impact</strong>                      | <strong>Implementation</strong>              | <strong>Cost Benefit</strong>                |
| Abrasion Resistance                     | None at this time material wise. Process wise – Look at evaluation criteria | 5                              | Maintain existing               | None                            |
| Undercutting over existing coating      | None                                       | 5                              | Maintain existing               | None                            |
| Future Removal                          | Explore ultra high pressure water blast – this is time dependent | 5                              | May not be as bad as thought since CaSu hardens overtime | Will be higher depending upon removal process. |
| Evaluation Program                      | Sites need to be analyzed for applicability | 1                              | Create separate task force to create program | As program develops, may have increased lifecycle of coating |
| Existing coatings need to have adhesion checked |                                   |                                | Utilize industry in development of the program |                                  |
| Uniform analysis of % rusting (from SSPC) |                               |                                |                                  |                                  |
| Special crew to do evaluation based on annual inspections |                           |                                |                                  |                                  |
| Trained inspectors                      |                                             |                                |                                  |                                  |
| Needs to be standardized                |                                             |                                |                                  |                                  |
| Chloride Mitigation                     | Powerwash                                  | 2                              | Requires MoDOT to purchase      | $$                              |
|                                          |                                             |                                | Collection of wastewater / EPA issues | $$$                             |
|                                          | Chlor-rid                                  | 5                              | Requires powerwash before and after application or blast cleaning after application | $$$                             |</p>
<table>
<thead>
<tr>
<th>Deficiency / Issue</th>
<th>Recommendation</th>
<th>Impact</th>
<th>Impact</th>
<th>Implementation</th>
<th>Cost Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride Mitigation</td>
<td>Rust / Epoxy Penetrating Sealers</td>
<td>4/5</td>
<td>Doesn’t fully address chloride removal</td>
<td>$$</td>
<td>$$$</td>
</tr>
<tr>
<td>Zone paint</td>
<td>Paint needed areas only</td>
<td>5</td>
<td>Already doing</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Mixed Systems</td>
<td>Not feasible with existing crews – requires blast cleaning</td>
<td>5</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Sacrificial Anodes</td>
<td>Question Effectiveness – Explore the opportunity to try on a test bridge. BASF has test program</td>
<td>3</td>
<td>Need research on the effectiveness under joints where no constant moisture present</td>
<td></td>
<td>Zinc Pucks approx. $20 per puck.</td>
</tr>
<tr>
<td>Programming Bridge Maintenance Statewide</td>
<td>Effective coating with environmental constraints</td>
<td>3</td>
<td>Establish proper procedures for coating in cold weather, heat and moisture</td>
<td></td>
<td>$ - Proper work up front increases future performance.</td>
</tr>
</tbody>
</table>
**Contract Maintenance Coatings Program**

Current System: Calcium Sulfonate – Overcoating  
System G or H – Recoating

Current Benefits:

1.) Some bridges done correctly – Surface prep – reblast to bare steel and build backup  
   Flexibility for:  
   a.) Surface Preparation  
   b.) Systems Used  
   c.) Scheduling (night work, etc.)  
   d.) Chloride mitigation

2.) Use of multiple systems – System G & H in combination with Calcium Sulfonate  

3.) Production (not sure what was meant here)  
   Scope  
   Schedule  
   Staff

4.) Safety Equipment available (technology)

5.) More projects can be done with improved lifecycle cost and Federal funding available

6.) Expertise of coating contractors  

7.) Potential for increased QC/QA

8.) Specification driven – if spec’d properly

Current Deficiencies:

1.) Initial Cost  
2.) Process / Scope of work changes due to site conditions at start of job  
3.) Lack of Paint Inspection Program / Evaluation (beyond basic program in place)  
4.) Not doing all of potential strengths  
5.) Time lost between identifying need and acting on the need  
6.) Defining scope to fit budget and inability to change scope once in STIP and combating scope creep.  
7.) Contractor does absolute minimum to get paid.  
8.) Effective use of money / budge for program  
9.) Enough inspection and guidelines for inspection  
10.) Weak specifications  
11.) No Warranty (not even 1 year industry standard  
12.) Lack of accurate budgeting using feedback from inspection and evaluation program
13.) No contractor certification programs in place.
   a.) For blaster
   b.) For applicators
   c.) For inspectors.

14.) Lack of safety emphasis – keeping bridge safe by controlling corrosion

Constraints of the Program:

“The way we’ve always done it” mentality and the resistance to change the specifications

Environmental issues permitting specifications from doing what actually needs to be done

STIP – Programming / Flexibility

Money to do everything that needs to be done

Prioritized maintenance

Manpower / training / equipment

Inability to dispose of power wash water – If power washing were to be used.

Traffic Control (vehicle, rail, boats)

Location of structure (surrounding environment) controlling options

Weather / time of season

Accelerated Schedules

Lack of perceived value of coatings systems on life of structure

Define / Evaluate Options:

Establish a evaluation and planning program

Realistic Environmental requirements

Specifications – new specifications and revised existing specifications

Evaluate a potential contractor / material supplier warranty program (similar to Safe and Sound)
Utilize a contractor certification program

Qualification programs for blasters, coaters and inspectors

Life cycle cost analysis

Best practices (of above) Define one or two of best and eliminate multiple options

New technologies:
   a.) Materials
   b.) Inspection
   c.) Equipment
   d.) Surface Preparation

Recommend New Practices:

Explore the possibility of establishing a Federally funded coatings program exclusive to coatings only.

Create a two-phase evaluation program and provide training to personnel.

Phase One: Visual inspection and evaluation (more in depth than existing program)

Phase Two: In-depth evaluation to including (but not limited to) adhesion, thickness, chloride concentration, etc.

Look and crack indicating coatings

Contractor Ownership Programs (similar to Safe and Sound Program)

Utilize one or two coat systems with increased surface preparation – significant labor savings

Emphasize safety by controlling corrosion

Eliminate scope creep / permit parallel creep for not coating work.

Utilize organic zinc primers for system G and H due to fast cure time – labor savings and less impact on traffic.

Utilize wet on wet or wet on near wet applications

Calcium Sulfonate over bare steel

Be open to accepting/trying new technology (research projects / IBR funds)
Training for persons selecting process after field evaluation is complete

Dedicated budget for coatings (no creep)

Develop a best practice for chloride mitigation
## Program: Contract Maintenance  
System: Ca Sulfonate, System G or H

<table>
<thead>
<tr>
<th>Deficiency / Issue</th>
<th>Recommendation</th>
<th>Impact</th>
<th>Implementation</th>
<th>Cost Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation Program</td>
<td>Preliminary visual inspection &amp; evaluation</td>
<td>1</td>
<td>Utilize industry in development of the program</td>
<td>Initial cost to train.</td>
</tr>
<tr>
<td></td>
<td>Existing coatings need to have adhesion checked, chloride levels</td>
<td></td>
<td>Utilize NACE, SSPC or Consultant training programs</td>
<td>Long term cost would save money</td>
</tr>
<tr>
<td></td>
<td>Uniform analysis of % rusting (from SSPC)</td>
<td></td>
<td>Internal program for visual inspection / evaluation</td>
<td>Able to plan scope of project closer to contract cost</td>
</tr>
<tr>
<td></td>
<td>Special crew to do evaluation based on annual inspections</td>
<td></td>
<td>Internal training program for test methods.</td>
<td>$</td>
</tr>
<tr>
<td></td>
<td>Trained inspectors</td>
<td></td>
<td>Use NACE or other trained inspectors for references</td>
<td>$$</td>
</tr>
<tr>
<td></td>
<td>Needs to be standardized statewide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Eliminate project planning scope creep</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloride Mitigation</td>
<td>Pressure wash</td>
<td>2</td>
<td>Collection of rinse water / EPA issues</td>
<td>$$ - Long-term performance is increased</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Appropriate pressure levels and flow rates</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Define appropriate end result for chloride levels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chlor-rid</td>
<td>5</td>
<td>Requires pressure wash before and after application or blast cleaning after application. Long</td>
<td>$$$ - Cost to performance ?</td>
</tr>
<tr>
<td>Deficiency / Issue</td>
<td>Recommendation</td>
<td>Impact</td>
<td>Implementation</td>
<td>Cost Benefit</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------------------------------------</td>
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<td>---------------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Chloride Mitigation (cont.)</td>
<td>Rust / Epoxy Penetrating Sealers</td>
<td>4/5</td>
<td>Doesn’t fully address chloride removal</td>
<td>$$$$</td>
</tr>
<tr>
<td>Specification Revisions</td>
<td>Pre-paint season meetings</td>
<td>2</td>
<td>Reacquaint contractor to job requirements and new specifications</td>
<td>$</td>
</tr>
<tr>
<td></td>
<td>Mandatory Pre-bid Meetings</td>
<td>1</td>
<td>Air job specific issues prior to bid</td>
<td>$</td>
</tr>
<tr>
<td></td>
<td>Job site samples / standards</td>
<td>2</td>
<td>Defines pre-job acceptance criteria</td>
<td>$</td>
</tr>
<tr>
<td></td>
<td>Contractor Certification</td>
<td>2</td>
<td>SSPC QP1 &amp; QP2 – must enforce equally</td>
<td>$</td>
</tr>
<tr>
<td></td>
<td>Worker Certification</td>
<td>2</td>
<td>Several programs available</td>
<td>$$</td>
</tr>
<tr>
<td></td>
<td>Blasters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Painter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inspectors – Contractor &amp; MoDOT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stripe Coat</td>
<td></td>
<td>2</td>
<td>Add to Sec 1081 Contrasting Color</td>
<td>$ Minimal cost, excellent benefit</td>
</tr>
<tr>
<td>Contractor / Supplier material warranties</td>
<td></td>
<td>2</td>
<td>Minimum of one year and specific well defined conditions</td>
<td>$$</td>
</tr>
<tr>
<td>Environmental Regulations</td>
<td></td>
<td>2</td>
<td>Rinse water collection and disposal / EPA &amp; DNR</td>
<td>$$</td>
</tr>
<tr>
<td><strong>Program:</strong></td>
<td><strong>Contract Maintenance</strong></td>
<td><strong>System:</strong></td>
<td><strong>Ca Sulfonate, System G or H</strong></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
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<td>---------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Deficiency / Issue</strong></td>
<td><strong>Recommendation</strong></td>
<td><strong>Impact</strong></td>
<td><strong>Implementation</strong></td>
<td><strong>Cost Benefit</strong></td>
</tr>
<tr>
<td>Contractor Ownership Programs</td>
<td>Paint and maintain – similar to Safe &amp; Sound</td>
<td>4</td>
<td></td>
<td>$$$ - Long term benefit</td>
</tr>
<tr>
<td>Dedicated Budget for Coating Program</td>
<td>Annual program dedicated to coatings utilizing improvements from the program</td>
<td>1</td>
<td>Proactive reengineering of the program to make it self sustaining and long service life</td>
<td>$</td>
</tr>
<tr>
<td>Zone paint</td>
<td>Paint needed areas only</td>
<td>5</td>
<td>Looking into implementation</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Mixed Systems – Calcium Sulfonate in conjunction with G or H</td>
<td>5</td>
<td>Case by Case basis done during the evaluation program</td>
<td>None</td>
</tr>
<tr>
<td>Sacrificial Anodes</td>
<td>Explore the opportunity to try on a test bridge. BASF has test program</td>
<td>3</td>
<td>Need research on the effectiveness under joints where no constant moisture present. Explore test bridge</td>
<td>Zinc Pucks approx. $20 per puck.</td>
</tr>
<tr>
<td>New Materials</td>
<td>Crack indicating coatings</td>
<td>5</td>
<td>Experimental product that can indicate cracks in steel substrate</td>
<td>Doesn’t address corrosion mitigation</td>
</tr>
<tr>
<td></td>
<td>One coat systems w/ more surface prep</td>
<td>3</td>
<td>New systems are in the works</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Organic Zincs</td>
<td>2</td>
<td>Faster cure times to overcoat</td>
<td>$ Less time needed</td>
</tr>
<tr>
<td></td>
<td>Ca Sulfonate over bare steel</td>
<td>3</td>
<td>No sacrificial benefit of zinc but has been used in certain application</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Optically Active Pigmentation</td>
<td>2</td>
<td>Provides better feedback on application thicknesses</td>
<td>$ More uniform coating thickness</td>
</tr>
<tr>
<td></td>
<td>Polysiloxanes</td>
<td>1</td>
<td>System I in the works</td>
<td>$</td>
</tr>
<tr>
<td></td>
<td>Wet on almost wet application</td>
<td>2</td>
<td>Faster recoating times – organic zincs with epoxies</td>
<td>$ Less time needed by contractor</td>
</tr>
</tbody>
</table>
New Construction Coatings Program

Current System: System G – Inorganic Zinc Primer/Epoxy Int./Urethane Top
System H – Inorganic Zinc Primer/Waterborne Acrylic Int. & Top

Current Benefits:

1.) Long Field History – Proven Performance
2.) Surface Profile Exists – Allows for easier repairs and future recoats
3.) Maintaining Primer and top coats; not the substrate
   Better lifecycle costs
   No mill scale
   Better surface prep
   Uses zinc
4.) Shop applied primers have a better starting point for the field coats
5.) Use of inorganic zinc primer only
   Low initial cost
   Should be enough
   Less aesthetically pleasing to traveling public
6.) Year round coating in the shops with climate controls
7.) Recoat (field coats) window for inorganic zinc is open
8.) Inorganic zinc is faying surface is okay
9.) Total system shop coating has potential for better quality
10.) Proven record – contactors area familiar with product.

Current Constraints/Deficiencies:

1.) Expensive Initial Cost
   4% - 12% of cost of fabricated structural steel
2.) Adequately trained inspectors
3.) Touch up repairs are difficult with inorganic zinc – Specifications
   require the use of epoxy mastics which do not match well and offer
   no sacrificial anode.
4.) Aesthetic issues with primers only/touch-ups
5.) Specific product – the contractor and owner have to know what they
   are doing for the system to last
6.) Temperature and humidity issues with the recoat (finish) coat
   window.
7.) No use of organic zinscs.
8.) Touch-up repairs of top coats and primer due to construction or
   future collision damage
9.) Not permitted to use organic zinscs when shop costing the three coat
   system. Fabricator has to wait for inorganic zinc to cure out before
   applied other coats. Time and Money.
10.) Masking in the shop (crisp lines) for shop applied top coats.
11.) High traffic area field application issues
    a. containment issues
    b. time on site
12.) Cleaning between coats – time dependent
13.) Customized colors
14.) Effective enforcement and sufficient inspection/inspectors

Define / Evaluate Options:

Less expensive topcoats – Good product/ good price

Use of organic zinzs for touch-up and when whole systems are applied in the fabrication shop

Establish an inspection program / training

Consistent enforcement of the specifications / no variation from District to District or Project Office to Project Office - Coating Contractor is then on an even playing field and bid prices will reflect that

Utilize a contractor certification program

Revise or create new and better specifications

Use stripe coats as required in SSPC-PA1 (PA1 is already defined in the specifications as the governing requirement for application)

Utilize mandatory pre-bid meetings to discuss coating requirements. Contractor cannot bid unless they attend.

Utilize mandatory annual coating standards meetings to show contractors what the requirements are and what the expectations for the finished product.

More expensive top coats with a better lifecycle cost benefit.

Require pre-job samples preparation by the contractor and then use the sample as the reference standard for the job.

New technologies:
    a.) Materials –
    b.) Inspection
    c.) Equipment
    d.) Surface Preparation
Recommend New Practices:

Explore the use of new materials
   i. Two-coat systems
   ii. Polysiloxanes
   iii. Polyaspartics
   iv. Organic zincs
   v. Other touch-up primers

Create a mandatory training program
   vi. Contractor training program
   vii. MoDOT inspector training program

Require the use of SSPC certified contractors

Require attendance to mandatory pre-bid / annual standards meetings

Explore the use of metallizing (expensive and unattractive but one of the best protective coatings)

Use Hot Dip Galvanizing

Sacrificial anodes at high salt/moisture locations

Look and crack indicating coatings

Contractor Ownership Programs (similar to Safe and Sound Program)

Utilize wet on wet or wet on near wet applications

Be open to accepting/trying new technology (research projects / IBR funds)
<table>
<thead>
<tr>
<th>Deficiency / Issue</th>
<th>Recommendation</th>
<th>Impact</th>
<th>Implementation</th>
<th>Cost Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expensive Initial Cost</td>
<td>Explore use of more zinc only on the interior and intermediate and top coats on fascia only in all locations</td>
<td></td>
<td>1</td>
<td>Minimal for smaller structures due to mobilization costs.</td>
</tr>
<tr>
<td>Cost to blast clean and coat in shop</td>
<td>None – still must be done unless using weathering steel</td>
<td></td>
<td>1</td>
<td>None – nature of doing business unless something radically new comes along.</td>
</tr>
<tr>
<td>Adequately trained inspectors</td>
<td>Train to SSPC,SPE, NACE standards – Prefer SSPC BCI standards</td>
<td>2</td>
<td>Recommend certification for both the contractor and the owner</td>
<td>$ - Cost to obtain and maintain certification will incur slight initial cost but outweighed by lifecycle cost of quality of applied coating.</td>
</tr>
<tr>
<td>Touch-up repairs of zinc primer</td>
<td>Explore using organic zincs for repairs instead of epoxy mastics when primer only applications or extensive field damage.</td>
<td>2</td>
<td>Change specifications to permit use of organic zincs for repairs on primer only coatings. Change specifications to require contractor to reprofile and coat with organic for damages greater than a specified area at the contractor’s cost</td>
<td>$ - Provides opportunity for better blending on primer only structures and provides corrosion resistance on large repairs.</td>
</tr>
<tr>
<td>Organic Zincs</td>
<td>Use of organic zinc primers in shop when intermediate and topcoats are shop applied</td>
<td>3</td>
<td>Permits faster time to recoat between primer and intermediate saving time and money in shop.</td>
<td></td>
</tr>
<tr>
<td>Deficiency / Issue</td>
<td>Recommendation</td>
<td>Impact</td>
<td>Implementation</td>
<td>Cost Benefit</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>--------</td>
<td>--------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Masking areas</td>
<td>None</td>
<td>5</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>High traffic area field application</td>
<td>Define expectations of finish of coating to permit contractor to adequately choose method of application to meet minimum criteria</td>
<td>3</td>
<td>Specification revision to define standards</td>
<td>Allows the contractor to prepare the bid to reflect the location of the structure and method of application (spray vs. rolled)</td>
</tr>
<tr>
<td>Cleaning between coats – time dependent</td>
<td>Dust or salt contamination needs to be removed prior to application of field coats</td>
<td>2</td>
<td>Require performance-based requirements (allow contractor to choose method) to remove contaminants. For chloride removal, specify minimum level of acceptable contamination.</td>
<td>Prevents premature failure of coating system extends lifecycle of coatings.</td>
</tr>
<tr>
<td>Trained applicators</td>
<td>Train to SSPC (field) and SPE (shop)</td>
<td>2</td>
<td>Change specifications to require certification prior to bidding</td>
<td>$ - Cost to obtain and maintain certification will incur slight additional cost but outweighed by lifecycle cost of quality of applied coating</td>
</tr>
<tr>
<td>Program: New Construction System: Inorganic Zn, System G or H</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Deficiency / Issue</td>
<td>Recommendation</td>
<td>Impact</td>
<td>Implementation</td>
<td>Cost Benefit</td>
</tr>
<tr>
<td>Consistent enforcement of specifications – Office to office and District to District.</td>
<td>Mandatory Pre-bid meetings</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mandatory annual coating standards meetings</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Require submittal of pre-job samples to establish standards</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revise or create better specifications</td>
<td>New specs on certification</td>
<td>2</td>
<td>Require contractor to submit names of certified personnel who will be performing the work prior to starting work.</td>
<td></td>
</tr>
<tr>
<td>Stripe Coats</td>
<td>Required in SSPC-PA1 and PA1 is defined in current specs. Require enforcement and possibly use of different tinting to verify</td>
<td>1</td>
<td>Add specific language to specifications about stripe coating referring to PA1. Include option of tinting or prestriping.</td>
<td>Minimal cost for material and additional labor.</td>
</tr>
<tr>
<td>New Materials</td>
<td>Two-coat systems</td>
<td>4</td>
<td>Industry working on these</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Polysiloxanes</td>
<td>3</td>
<td>In the works.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crack indicating coatings</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Galvanizing – in high moisture areas</td>
<td>4</td>
<td>Must be analyzed in the design phase</td>
<td>Expensive and limited to size of component that can be dipped</td>
</tr>
<tr>
<td></td>
<td>Metallizing – in high moisture areas</td>
<td>4</td>
<td>Must be analyzed in the design phase</td>
<td>Very expensive</td>
</tr>
<tr>
<td></td>
<td>Optically Active Pigmentation</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deficiency / Issue</td>
<td>Recommendation</td>
<td>Impact</td>
<td>Implementation</td>
<td>Cost Benefit</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
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<td>--------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Wet on wet or near wet application</td>
<td>Utilize rapid recoat systems in specs. Materials already approved</td>
<td>3</td>
<td>Revise specs to remove any required drying times and change to manufacturer recommendations</td>
<td>Less time required by contractor – cost savings for deployment and labor</td>
</tr>
<tr>
<td>Less expensive topcoats</td>
<td>None – difference in cost of materials versus long-term performance lends to use of better quality product.</td>
<td>5</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Holiday Testing</td>
<td>Requiring simple test for critical areas and special structures (get in, get out, stay out) to ensure coating properly applied</td>
<td>2</td>
<td>Add to contract document (not necessarily standard specifications) for the special cases</td>
<td>Insures long term performance of properly applied coatings with little cost for special projects where we do not want to go back in the future to fix problems</td>
</tr>
</tbody>
</table>
Appendix D

Details of Inspector Training Programs
KTA-TATOR Inspection Class

Basic Course: Coatings Inspection

KTA’s basic inspection course offers three days of intensive, interactive training for inspectors, contractors, engineers, facility owners, and all those responsible for quality control or quality assurance during industrial surface preparation and coating application operations. This training provides an excellent mix of hands-on experiments, problem-solving workshops, lectures, and discussions on inspection issues that range from surface preparation to coating failures.

Hands-on workshops comprise approximately one-third of the course, and include: abrasive blast cleaning, power tool cleaning, airless and conventional coating application, coating inspection instrument use, and a mock coatings inspection. This course fulfills the training requirements for the American Institute of Steel Construction’s (AISC’s) Sophisticated Paint Endorsement (SPE) and the Society for Protective Coatings’ (SSPC’s) QP1 and QP3 painting contractor certification programs.

KTA-Tator is an approved provider of CEUs according to IACET/ANSI Guidelines. To successfully complete KTA’s Basic Coatings Inspection Training and receive 2.4 CEUs under these guidelines, a participant must attend all instructor-led sessions, participate fully in all activities, complete all assignments, and complete a written evaluation of the course. Participants must also score 75% or better on the final written examination and 75% or better on the timed, practical examination on the use of coatings instrumentation. Participants meeting all other requirements, but scoring lower than 75% on one or both of the final examinations, will receive a certificate of attendance but will not be awarded CEUs.
SSPC – The Society for Protective Coatings

Protective Coatings Inspector Program (PCI)

5 Days/40 Hours plus 1 Day Certification Exam
Credits: 4.5 CEU's

PCI Basic Inspector: Course, Course Exam (5 days)
(There are no prerequisites for this level.)
SSPC Member $895 / Non-Member $1095

PCI Certified Inspector: Course, Course Exam and Certification Exam (6 days)
(Pre requisites required)
SSPC Member $1045/Non-Member $1445

The objective of this course is to thoroughly train individuals in the proper methods of inspecting surface preparation and installation of industrial and marine protective coatings and lining systems on an array of industrial structures and facilities.

The course provides participants five days of intensive training and includes multiple workshops and problem solving exercises so that participants may immediately apply the learning in a classroom setting, without the pressures of production and project schedules. In order to enhance the learning environment and illustrate the importance of teamwork, the workshops and exercises will be done in small teams.

This course is completed with a comprehensive written examination and a practical (instrument use) examination. Students passing both components of the basic course exam at 70% or higher and meeting the prerequisites for certification can take the written and hands-on certification exams on day 6. A passing grade of 80% or higher on the written and hands-on certification exam is required to become an SSPC Certified Coating Inspector.

Bridge Coating Inspector Program (BCI)

4 Days/32 Hours plus 1 Day Course Exam & 1 Day Certification Exam
Credits: 4.5 CEU's
Class Times: Monday–Thursday, 8:00-5:00

Level 1: Course, Course Exam (5 days)
SSPC Member $895 / Non-Member $1,095
Level 2: Course, Course Exam and Certification Exam (6 days)
SSPC Member $1045/Non-Member $1445

Course Exam Only (1 day): (Includes exam and student manual)
SSPC Member $250/Non-Member $450

Certification Exam Only (1 day)
(Includes certification exam and student manual)
SSPC Member $250/Non-Member $450

The BCI course covers the fundamentals of how to inspect surface preparation and application of protective coatings on bridge steel. These fundamentals are applicable to those who inspect coating work both in the shop and in the field. The course covers unique situations that will affect inspection in the field (e.g. containment, field safety hazards, changing weather conditions), as well as the fundamental inspection skills required to inspect new bridge steel painted in the shop or in the field or maintenance systems applied in the field.

The first four days of the program are devoted to classroom lecture about bridge coatings inspection planning, substrate repair prior to surface preparation, surface preparation itself, coating surveys, specifications, and documentation requirements with ample time allotted to hands-on exercises and instrument practice. Lectures are supplemented by quizzes, group exercises, and hands-on workshops.

On Day Five, the Level 1 Course Exam is given. Students have 2 hours to complete the 100-question multiple-choice test and hands-on practical exam. On day six, students passing the course exam at 80% or higher can take the written and hands-on certification exams if they meet all of the prerequisites listed.

To become a BCI Level 2 Inspector and receive your CEU’s, you must attend all 32 hours of the course and pass the certification exam. See www.sspc.org/training/bridge.html for details.
NACE INTERNATIONAL

Coating Inspector Program

CIP Level 1
6-Day Classroom Course

1st day 10:00 a.m. to 7:30 p.m.
2nd - 5th days 8:00 a.m. to 7:30 p.m.
6th day 8:00 a.m. to 5:00 p.m. (unless otherwise noted)

Description
The CIP Level 1 Course is an intensive presentation of the basic technology of coating application and inspection over a full 60 hours of personal instruction and practice. This course provides both the technical and practical fundamentals for coating inspection work on structural steel projects.

CIP Level 2
6-Day Classroom Course
1st day 10:00 a.m. to 7:30 p.m.
2nd - 5th days 8:00 a.m. to 7:30 p.m.
6th day 8:00 a.m. to 5:00 p.m. (unless otherwise noted)

Description
The CIP Level 2 Course focuses on advanced inspection techniques and specialized application for both steel and non-steel substrates. The course includes in-depth coverage of surface preparation, coating types, inspection criteria, and failure modes for various coatings including specialized coatings and linings.

CIP Level 3 Peer Review
2-Hour Oral Examination

Description
The CIP Peer Review is a detailed oral examination in front of a three member-review board that lasts approximately 2 hours and is graded on a pass/fail basis. The Peer Review includes a series of questions to test the candidate's practical and theoretical knowledge of coatings and coating inspection. Candidates are questioned from a random draw of topics ranging from standards, procedures, ethics, coatings use, inspection instruments, role-playing, and specific case questions. Successful completion of the CIP Peer Review is required to achieve recognition as a NACE Certified Coating Inspector - Level 3 individual.
Effect of Surface Contaminants on Coating Life
4. Preliminary Guidance Levels for Salt Contamination on Bridges

Based on the above, a table has been constructed with tentative threshold levels for salt contamination on bridges (table 19). The recommended levels for the atmospheric zone are based on the data from the cyclic salt spray results, the 1-year atmospheric accelerated test, and the data by Morcillo.(17) The results from the FHWA weathering steel study are NOT incorporated into this table, as explained in a footnote to the table, where steel (particularly weathering steel) is heavily pitted after blast cleaning, the present methods for detecting soluble salts may not provide a true indication of the corrosion potential of those surfaces.

For the "immersion-like" zone on a bridge, the threshold levels were derived from the pressure immersion studies as well as those by Soltz, the BSRA, Weldon, and Dekker.(11, 22, 24, 25)

The table has some gaps, (i.e., for some of the coatings there is not sufficient data to estimate a threshold limit in a particular environment). In some cases (e.g., for oil-alkyd or water-borne acrylic in Zone 2) though no data have been developed in this study these systems are not recommended for this environment.

The accelerated exterior exposure and the natural exterior exposure are planned to be continued even though the project will be terminated. Thus, in another year or two, additional or more definitive data on the threshold limits of these coatings in the industrial atmosphere will be available.

The proposed guidance levels for the two bridge conditions are given in table 19. For the industrial atmosphere, the inorganic zinc/epoxy/urethane can safely be applied to 30 µg/cm² of chloride or sulfate. The epoxy zinc-rich system is considered safe at 20 µg/cm². At levels of 40 µg/cm² or higher, this system may give some reduction in lifetime. Slightly less forgiving are the topcoated epoxy mastic system and the water-borne alkali silicate zinc with an acrylic topcoat. The least tolerant systems are the alkyd system, and the complete water-borne acrylic system, and a conventional epoxy-polyamide system. Several of these levels are based on the results from the cyclic salt spray and should be used with caution until more definitive field results are available.

For the severe ("immersion-like") exposure zone, the inorganic zinc system exhibits extremely high tolerance (up to 50 µg/cm²). The only other system recommended for this type of condition is a two- or three-coat epoxy-polyamide system which is intended for intermittent or continuous immersion service.

H. DEVELOPMENT OF HIGHWAY USERS GUIDE

In order to make these results available for implementation by highway departments, a users guide has been drafted (appendix F). The guide is organized into the following sections:

General significance and sources of contaminants.
Table 19. Guidance levels for soluble salts on bridges.\(^a\)

<table>
<thead>
<tr>
<th>COATING SYSTEM</th>
<th>DFT (mils)</th>
<th>SAFE LEVEL(^b)</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONDITION A(^c)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Ethyl silicate zinc/epoxy or epoxy/urethane</td>
<td>6 to 8</td>
<td>5C</td>
<td>Based on pressure immersion testing, which is a more aggressive exposure (table 17), see comment below.</td>
</tr>
<tr>
<td>2 Ethyl silicate zinc/vinyl</td>
<td>5 to 6</td>
<td>3C</td>
<td>Based on exterior exposure by Morcillo (table 94) No failure at 33μg/cm² after 2 to 4 years. In industrial exposure.</td>
</tr>
<tr>
<td>3 Epoxy zinc/epoxy or epoxy/urethane</td>
<td>6 to 8</td>
<td>3C</td>
<td>Based on cyclic salt spray (table 18) for 5000 hours.</td>
</tr>
<tr>
<td>4 High solids, high-build epoxy (matte) / epoxy or urethane</td>
<td>6 to 8</td>
<td>3C</td>
<td>Based on cyclic salt spray (table 18) for 5000 hours.</td>
</tr>
<tr>
<td>5 Alkali silicate zinc/waterborne acrylic</td>
<td>5 to 7</td>
<td>1B</td>
<td>Based on exterior exposures (2 to 4 years) by Morcillo (table 94).</td>
</tr>
<tr>
<td>6 Oil alkyd (2-coat/alkyd or silicone alkyd)</td>
<td>5 to 7</td>
<td>7</td>
<td>Based on cyclic salt spray (table 18) 5000 hours.</td>
</tr>
<tr>
<td>7 Acrylic waterborne (3 coats)</td>
<td>6 to 8</td>
<td>7</td>
<td>Based on cyclic salt spray (table 18) 5000 hours.</td>
</tr>
<tr>
<td><strong>CONDITION B(^d)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Ethyl silicate zinc/epoxy or epoxy/urethane</td>
<td>6 to 8</td>
<td>5C</td>
<td>Based on pressure immersion testing for 2000 hours (table 17). No degradation observed at 50 μg/cm², which was highest level tested.</td>
</tr>
<tr>
<td>2 Epoxy polyamide (2 coats)/urethane (optional)</td>
<td>6 to 8</td>
<td>1C</td>
<td>Immersion; grade epoxy (e.g., MIL-P-24441) Based on pressure immersion for 1000 to 2000 hours (Soltz, table 96).</td>
</tr>
</tbody>
</table>

\(^a\) These levels are preliminary levels, based on accelerated laboratory testing and limited exterior exposure testing. Additional information and revisions of these levels will be available in the future from SSPC and FHWA.

\(^b\) Levels given in μg/cm² based on chloride. If sulfates are determined to be the major contamination species, these levels should be multiplied by 2.

\(^c\) Aggressive atmosphere: moderate to high industrial fallout (acid rain), intermittent exposure to deicing salts, no accumulation.

\(^d\) Immersion-like: heavy deicing salt usage, frequent splash, high time of wetness, pending (e.g., top flange near leaking joints), intermittent immersion.
Appendix F
Properties of Zinc Primers
November 30, 1995

Federal Highway Administration
Bridge Coatings Technical Note

From: Special Projects and Engineering Division,
Office of Engineering Research and Development

Topic: Zinc-Rich Bridge Coatings

Description: Zinc-rich coatings for steel bridges fall into two general categories: inorganic zinc and organic zinc. Both types of coatings are usually used as direct-to-metal primer coats in a multicoat paint system. Inorganic zinc coatings consist of zinc metal powder mixed into an inorganic silicate paint binder. This binder can be either solventborne (ethyl silicate) or waterborne (alkali silicate). The concentration of zinc powder in the mixed coating is >80% by weight for the best performing inorganic zinc paints. Organic zinc coatings contain zinc metal pigment mixed into an organic paint resin such as epoxy or urethane. The high zinc metal concentration in these coatings creates high electrical conductivity which allows the primer to provide sacrificial protection to any areas of exposed underlying steel. This sacrificial protection is the most desirable feature of these coatings; therefore, formulation of the coating to maintain conductivity after application and long-term exposure is critical. Zinc-rich coatings for steel are covered by AASHTO M300.

Cost Impact: Information from paint manufacturers indicates an average material cost of approximately $0.33 per square foot of painted steel for a coating system with a zinc-rich primer, an epoxy intermediate, and a polyurethane topcoat. This represents an increase in paint material costs of approximately 30% over a typical epoxy mastic/ polyurethane type barrier coat system (at approximately $0.25 per square foot). However, since current typical bridge repainting jobs with full removal of the existing system by blasting now cost between $5 and $12 per square foot, the increase in paint material cost by specifying the more durable zinc-rich system represents an impact to the cost of the job of less than 2%.

Performance Experience: Recent and ongoing FHWA-sponsored test programs have found that coating systems employing zinc-rich primers have performed very well as a generic class, even in harsh marine and salt-rich environments when applied over blast-cleaned steel (SSPC SP-10 or SP-5). Three-coat systems such as solvent borne inorganic zinc or organic zinc primer/ epoxy intermediate/ urethane topcoat, have shown performance far superior to all other conventional coatings (without zinc-rich primers) tested in parallel to-date under harsh exposure conditions. The primary performance difference between zinc-rich coating systems and systems based on barrier or inhibitive protection is the resistance to disbondment and underfilm corrosion at holidays or defects in paint films and at corners and edges of structural steel members. Performance of inorganic zinc-rich coating systems has been particularly good in various test programs. Organic zinc-rich systems have also performed well over blast-cleaned surfaces, as long as the zinc pigment concentration in the formulation has been sufficient to ensure conductivity of the primer. Many formulations are marketed as organic "zinc-rich" with low levels of zinc pigment. These formulations would not be expected to perform better than a similar barrier coating system without the zinc pigment.

Waterborne inorganic zinc coatings have gained popularity in recent years. These coatings can perform very well when properly applied and cured. These coatings also contain zero VOC - an attractive feature for fabrication shops with tight point-source emission regulation. Recent experience with these coatings has been mixed. Various laboratory and field exposures have shown excellent performance, whereas other laboratory, shop, and field applications have produced very early rust-bloom and topcoat disbondment problems. These failures are related to the complex curing mechanism and application techniques for waterborne inorganic zinics and are currently under investigation by researchers at FHWA.

Summary of Supporting Data: In marine atmospheric exposure testing, inorganic zinc or organic zinc/ epoxy/ urethane type coating systems showed excellent performance after 7 years over near-white blast cleaned (SSPC SP10) steel.
On a steel bridge in Central New Jersey used for testing 47 various coating systems, 10 of the 14 systems tested with zinc-rich primers scored 8 or better, and 13 of 14 scored 7 or better after eight years of service. (ASTM D610 "8" = 0.1% rust; "7" = 0.3% rust)

In the FHWA-sponsored “PACE” study, the coatings with zinc-rich primers performed best compared to other generic types of coatings evaluated under similar conditions. This study showed the benefits of zinc-rich primer coating systems in various environments (marine, industrial).

Recommendation: The test results and field experiences detailed above demonstrate the merits of coatings systems employing zinc-rich primers for steel bridges, particularly in salt-rich environments. These coatings have gained popularity and are currently widely used in new construction due to their excellent long-term corrosion control performance. In harsh environments research to-date has shown no suitable substitute for the corrosion protection provided by zinc-rich primers at the site of coating defects or structure edges. In the past, zinc-rich coatings (particularly inorganic zinc) were formulated at high VOC levels and have the reputation of being difficult to apply properly. While proper application of zinc-rich coatings is nominally more difficult than the very forgiving alkyd paints of the past, these coatings provide significant performance advantages in harsh exposures. Coating systems employing zinc-rich primers are widely available in formulations which meet all forthcoming environmental regulations, provide excellent long-term corrosion control performance, and can be easily applied with the proper equipment and know-how.

The use of waterborne inorganic zins should be continued only with proper equipment and under appropriate environmental conditions. Conditions of low air flow and high humidity during application and cure must be avoided. This is particularly true of field applications where environmental conditions during curing are uncontrollable. In shop environments where these coatings have been successfully applied on a regular basis, this coating can be used to provide excellent performance with greatly reduced VOC emission levels.

References:

Zinc-rich coatings and primers have the unique ability to provide galvanic protection to the steel surfaces to which they are applied. These coatings have a large amount of metallic zinc dust combined with the binder. There are two main types of zinc-rich coatings, which differ in type of binder. Inorganic zinc-rich coatings generally have a zinc silicate binder while the organic variety uses an organic resin such as an epoxy, butyl, or urethane. After proper application of a zinc-rich coating to a steel substrate the binder holds the zinc particles in contact with each other and the steel surface. This contact between two dissimilar metals, when in the presence of an electrolyte, will form a galvanic cell. The zinc particles become the anode in the galvanic cell and the steel substrate serves as the cathode. Galvanic action causes the zinc to be preferentially corroded while the steel is protected from attack. Zinc-rich coatings are unique in that they provide protection to the steel surface even at voids, scratches, pinholes and other small defects in the coating system.

**Organic Zinc-Rich Coatings**

Organic zinc-rich coatings are generally formulated from epoxy polyamide, vinyl, urethane, and chlorinated rubber binders. The type of binder used ultimately determines the drying and curing of the organic zinc-rich coating. These coatings use zinc dust as a pigment in high concentrations to achieve a dry film pigments volume of 75 percent or higher. When zinc particles are formulated into organic vehicles, the binder more thoroughly encapsulates the zinc particles than with inorganic vehicles. This encapsulation somewhat reduces the sacrificial capabilities of the applied coating. However, this characteristic of the binder also allows the coatings to more readily wet and seal the prepared surfaces. In this way, organic zinc-rich coatings are more tolerant of incomplete surface preparation. Topcoating with the same generic type of organic topcoat is more easily accomplished than with inorganic zinc-rich coatings because of a less porous surface. Organic zinc-rich coatings are often used to touch up and repair inorganic zinc-rich coatings because the organic binder provides better adhesion and wetting characteristics than another coat of inorganic zinc-rich coating. Organic zinc-rich coatings don’t provide the same heat and abrasion resistance of the inorganic zinc-rich coatings. Organic-zinc rich coatings are generally considered easier to apply and topcoat than their inorganic counterparts, however, they do not provide the same long-term corrosion protection as the inorganic zinc-rich coatings.

**Inorganic Zinc-Rich Coatings**

Inorganic zinc-rich coatings require an extremely clean surface for application. SSPC-SP 10, SSPC-SP 5, or application to a clean, pickled surface is generally required. Inorganic zinc-rich coatings have good mechanical properties and resist scuffing, scratching, and impact. These coatings also have good heat resistance, up to 750F. Some formulations of these coatings are suitable for immersion in salt water while other formulations are not intended for such use. Immersion in salt water increases the dissolution rate of the zinc particles in the binder and as such, the protective life of coatings in these environments will generally be less than that of fresh water immersion or atmospheric exposure. Topcoating with inorganic zinc-rich coatings tends to be more difficult than with other coatings because of the porous nature of the inorganic zinc primer. When applied the binder partially wets and binds the zinc particles together and to the substrate but it does not completely cover and seal the surface. As a result, topcoats applied over this porous surface can cause pinholes, voids, or bubbles within the topcoat.
FINAL REPORT

STEEL BRIDGE PROTECTION POLICY

VOLUME II

EVALUATION OF BRIDGE COATING SYSTEMS
FOR INDOT STEEL BRIDGES

FHWA/IN/JTRP-98/21

by

Luh-Maan Chang
Principal Investigator

and

Seunghyun Chung
Research Assistant

Purdue University
School of Civil Engineering

Joint Transportation Research Program
Project No.: C-36-26J
File No.: 4-4-10

Prepared in Cooperation with the
Indiana Department of Transportation and
The U.S. Department of Transportation
Federal Highway Administration

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views of the Federal Highway Administration and the Indiana Department of Transportation. This report does not constitute a standard, a specification, or a regulation.

Purdue University
West Lafayette, Indiana 47907

May 14, 1999
There are numerous advantages of inorganic zinc primers. Some of these are:

1. Inorganic zinc is unaffected by weather, sunlight, ultraviolet radiation, rain, dew, bacteria, fungus or temperature. The coating does not chalk or change with time. The inorganic zinc film remains intact with essentially the same thickness, even after many years of exposure.  

2. The chemical bond formed by the reaction of inorganic binder and the underlying steel surface prevents the undercutting of coating by corrosion.  

3. The chemical bond formed between the inorganic binder and the underlying steel surface does not allow underfilm corrosion.  

4. Inorganic zinc does not shrink while drying or curing.  

5. Inorganic zinc coated steel may be welded without any reduction in strength of the steel joint, because the zinc silicate matrix reacts with the welding flux and prevents zinc occlusions in the weld.  

6. The very strong film and chemical adhesion of inorganic zinc coatings form a base with outstanding friction characteristics therefore providing high coefficient of friction.  

7. Surface formed by inorganic zinc coatings is very hard, metallic and abrasion resistant.  

8. Chemical resistance of inorganic zinc coatings is excellent.  

Some limitations of inorganic zinc primers are also realized:

1. Inorganic zinc primer requires high degree of surface cleanness and extensive surface preparation.  

2. Inorganic zinc primer will not tolerate application over organic material and will immediately check, crack and chip off organic surfaces.  

3. Inorganic zinc coatings should never be applied over old paint.  

4. Inorganic zinc is not effective in freezing conditions.  

5. Inorganic zinc is not effective in high humidity.  

6. Inorganic zinc requires reactions with the atmosphere. If overcoated too quickly, a premature failure may occur due to the gases trapped underneath.
7. Inorganic zinc have a rapid drying time and time-to-water insolubility. 

8. Inorganic zinc needs direct metal-to-metal contact (zinc to steel) at the coating / substrate interface therefore a good surface preparation is a must.

9. The high-pigment (zinc dust) loading of inorganic zinc coatings gives them poor binder-to-substrate adhesion when compared to organic resin-based systems.

10. Inorganic zinc dries fairly quickly, usually within 15 minutes. After this initial drying stage, the coating is porous and will not provide a “barrier” sufficient to control corrosion.

11. Improper application over inorganic zinc will result in pinholes and blistering of the topcoat.

**ORGANIC ZINC PRIMER**

When the organic zinc primer to the inorganic zinc primer, a simple nature of the organic zinc primer is discovered. Organic zinc primers involve very little chemistry in formulation. These products are simple mixtures of zinc dust or metallic zinc pigment into the organic vehicle. Zinc is the primary pigment in these organic zinc-rich coatings, with very little addition of other pigmentation.

There are two requirements essential for effective operation of organic zinc-rich coating:

1. Zinc in the vehicle, in order to provide the cathodic protection required by zinc-rich coatings, must be in particle-to-particle contact or contain conductive filler, such as iron phosphide, to make an electrically conductive path through the organic matrix. Without this particle-to-particle contact, zinc in the coating essentially would be inert and surrounded by the organic vehicle, which would not allow the zinc to go into solution and provide the cathodic protection.
2. The second important consideration in organic zinc primers is that the vehicle or carrier of zinc pigment be alkali resistant. This is important since zinc, particularly under chloride environment, reacts to form a strong alkali that would adversely effect any alkali-sensitive resin or binder. The primary organic resins used to make organic zinc-rich primers are chlorinated rubbers, phenoxy resins, or catalyzed epoxy resins. While there are a number of other materials that can be used, these are the principal ones applied to steel structures.¹

Similar to the inorganic zinc primers, the organic zines also use a high-film loading of metallic zinc powder. This high-film loading allows the organic primers to be conductive. The goal is to create a conductive polymer coating that has the sacrificial corrosion protecting properties of the inorganic zinc with the enhanced barrier properties and applicability of the organic zinc.³

The most popular organic zinc coatings are the epoxy zinc-rich and the polyurethane zinc-rich coatings. The epoxy zinc-rich is based on the zinc-filled epoxy resin to which the curing agent is mixed. The polyurethane zinc-rich coatings are available in both single and two-component systems. The main difference between the single and the two-component system is in the packaging. For the two-component system the zinc dust and the vehicle is packaged in separate container. In order for reaction to take place, the zinc dust and the vehicle must be mixed prior to application. For the single component system, this is already mixed from the factory ready for use. Therefore, the single component system is packaged in only one container. According to Todd Tracy, "the main disadvantage of the single component system is that it has a short pot life, usually less than 6 months. Whereas the two-component system can have a pot life of around 18 months. Single component system also requires inhibitors to keep it from
reacting. These inhibitors may have an effect on the curing of the paint. Single component system requires more idealistic application condition, in regards to temperature and humidity. The only advantage of a single component system is that it may be more convenient to use since it requires no mix of components. The two-component system is preferred due to greater stability in terms of storage. The performance between the two is comparable.\textsuperscript{4}

Many attributes of organic zinc primer are realized:

1. Organic zinc-rich primer proved to be successful in arresting the pit-based corrosion characteristics of chloride-contaminated weathering steel. This system added the extra benefit of a high gloss, low chalking topcoat that is resistant to dirt pickup and aesthetically pleasing to the traveling public.\textsuperscript{8}

2. Organic zinc primers are less subject to critical surface preparation than inorganic zinc materials.\textsuperscript{1}

3. Organic zinc primers are more compatible with oleoresinous topcoats than inorganic zinc coatings.\textsuperscript{1}

4. Organic zinc has an excellent adhesion and undercutting resistance.\textsuperscript{9}

5. Organic zines are easier to apply than the inorganic zinc.\textsuperscript{10}

6. “Organic zinc-rich epoxy primers are hard, tough, and solvent-resistant as well as highly adherent. Tolerance for less-than-ideal surface preparation is better than for inorganic zinc-rich primers. The zinc provides a mechanism which sacrifices itself, delaying the corrosion of the base steel.”\textsuperscript{8}

7. The recoatability of organic zinc primer is better than inorganic zinc primers.\textsuperscript{8}

8. Humidity conditions are less critical for organic coatings which depend on moisture to cure.\textsuperscript{8}

9. Normally, no gassing or pinholes occur in the intermediate coat or in the polyurethane topcoat due to less porous nature of the organic primer coat, a common problem with inorganic primers.\textsuperscript{8}
10. Because curing time is predetermined by temperature, dry spray of the primer will not be a problem as it is with inorganic coatings sprayed in very warm temperature.  

11. Organic zinc primers may be used for spot repair to provide a zinc-based coating directly over bare steel and yet provide a tie between the old and new organic coating.  

Some disadvantages of organic zinc primers are as follows:

1. Organic zinc-rich primers are subject to the difficulties of any organic material applied directly over steel surfaces. This means they are subject to undercutting, blistering and similar adhesion problems not normally encountered with the inorganic zinc-rich primers.  

2. A light rust coloration on the steel surface may be more easily tolerated by an inorganic zinc coating than by an organic based material due to the possibility of the inorganic thoroughly wetting the oxide and reacting with it.  

3. Organic zinc primer provides less overall protection when compared to inorganic applied with ideal surface preparation.  

4. Organic zinc primers shrink while drying or curing, therefore not good for overcoating rough, pitted, corroded surfaces or rough welds.  

5. A majority of organic coating failure under severe corrosion conditions is by underfilm corrosion, starting at small breaks in the coating.
<table>
<thead>
<tr>
<th>Surface preparation</th>
<th>Inorganic Zinc Primer</th>
<th>Organic Zinc Primer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Less subject to critical surface preparation than inorganic zinc materials</td>
<td></td>
</tr>
<tr>
<td>Application</td>
<td>Inorganic films show better protection than most organics</td>
<td></td>
</tr>
<tr>
<td>Overall Protection</td>
<td>Easier to apply than inorganic</td>
<td></td>
</tr>
<tr>
<td>Aging</td>
<td>The matrix of the inorganic primer film is not subject to age-related deterioration as are organic primers. Weathering may actually improve its physical properties.</td>
<td></td>
</tr>
<tr>
<td>Adhesion</td>
<td>Organic zinc primers are subject to the difficulties of any organic material applied directly over steel surfaces. This means they are subject to undercutting, blistering and similar adhesion problems not normally encountered with the inorganic zinc primers.</td>
<td></td>
</tr>
<tr>
<td>Recoatibility</td>
<td>Recoatability of organic zinc is better than inorganic.</td>
<td></td>
</tr>
<tr>
<td>Compatibility</td>
<td>Organic zinc primers are more compatible with oleoresinous topcoats than inorganic zinc coatings. Recoatability of organic zinc primer is better than inorganics.</td>
<td></td>
</tr>
<tr>
<td>Underfilm Corrosion</td>
<td>Chemical bond formed between the inorganic binder and the underlying steel surface does not allow underfilm corrosion whereas the majority of organic coating failure occur by underfilm corrosion, starting at small breaks in the coating</td>
<td></td>
</tr>
<tr>
<td>Gassing or pinholes</td>
<td>Normally, no gassing or pinholes occur in the intermediate coat or in the polyurethane topcoat due to less porous nature of the organic primer coat, a common problem with inorganic primers.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix G
“Model” Coating Condition Evaluation Program
Using this or a similar system, the amount of visible coating deterioration and/or corrosion on each bridge is first assessed visually, optimally by an NBIS Survey team.

In order to enable them to quickly do so, a rating scale and system of data recording and data management are described. In this case, as an aid to making judgments regarding the percentages of corrosion encountered, a unique A, B, C and F rating scale which uses custom-tailored photos can be specifically developed.

*It is acknowledged and assumed that the MODOT system will, as necessary, be different somewhat from that discussed below. It will be specifically custom-tailored for Missouri bridges and further customized to fit the MODOT approach to maintenance painting planning. The system described below is an example of what can be accomplished with some dedicated effort and with some training.*

**Phase 1 – Initial Visual Assessment of Deterioration**

As shown below, an “A” condition indicates that the coating is in good condition with essentially no rework required. A “B” condition indicates that the coating shows some distress but is in a touch-up condition. A “C” condition indicates that substantial coatings repairs are required, with a “C” condition indicating that the extent of deterioration is so widespread that total system removal and replacement will likely be required. Note that this does not make coating system removal and replacement mandatory. However, it does indicate that the amount of deterioration is so widespread that substantial repairs, if not complete removal and replacement, will be required. An “F” condition indicates that complete coating removal and replacement is the only practical option and, in some cases, replacement of the entire component may be warranted.

The A, B, and C grading format assigned to each, together with the F, provides for four categories of coating deterioration as shown below:

- **Category A - Good Condition with No Rework Required**
  - A  Perfect or less than 0.03% corrosion and/or defects

- **Category B - Coating in Touch-Up Condition**
  - B  Slight touch-up condition with 0.3-10% corrosion and/or defects
Category C - Substantial Coating Repair or Replacement Required

C Touch-up/overcoat condition with 10-50% corrosion and/or defects

Category F - Complete Coating Removal and Replacement Required

F Very poor condition with greater than 50% corrosion and/or defects

Other Ratings

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NV</td>
<td>Item not visible for evaluation</td>
</tr>
<tr>
<td>NP</td>
<td>Item not painted</td>
</tr>
<tr>
<td>NG</td>
<td>Item not graded</td>
</tr>
</tbody>
</table>

(Note that the system follows the SSPC-Vis 2 (ASTM D 610) categories of deterioration, which provides a scale of 10 categories. These 10 have been aggregated into 3: A, B, and C.)

A system such as that proposed can likely cover almost all of the different variations encountered (painted ends of girders, fully coated – good in the middle, bad beneath the joints, etc.).

**Existing Coating Type**

The existing coating systems are determined as best as possible through previous historical data and through visual appearance of the systems. Certain assumptions may be made or, alternately, laboratory analysis can be utilized to determine coating type. After confirmatory testing, the results can be entered into the MODOT database at any time.

**Substrate Type and Condition**

The substrate is examined during the visual assessment to determine the type and condition of the substrate (i.e., the method and/or degree of surface preparation). The existing coating is removed for substrate examination in random locations. Based on those results, assumptions are made regarding the substrate condition on similar components.

**Substrate Defects**

Substrate defects (such as pitting) are documented during the visual survey, if possible. This can include pit depth, section loss, the presence of rust scale, pack rust, spalling or cracked concrete, and other similar defects.
Service Environment

A general classification of the service environment of each component is also noted during the visual assessment. The service environment plays a role in the amount of deterioration that occurs each year. Five basic service environments are given, but more can be added as appropriate.

1. Mild - rural or residential with no industrial fumes or fall out.
2. Moderate - industrial plants present but no heavy contamination from industrial fumes or fall out.
3. Harsh - heavy industrial and chemical plant area with high levels of fumes and fall out.
4. Sweating Surface - assumed to be subjected to condensation during times of coating application.
5. Water Immersion or Splash - surface completely covered by water during normal operating conditions or conditions occurring during the winter after a snow event and the application of deicing materials.

Accessibility Factors

The level of effort to access each component, as well as the complexity of the component itself, for surface preparation and painting (i.e., easy, average, or difficult) are observed and documented during the visual assessment. The level of effort to access a component directly affects the cost of painting the component. Three levels of accessibility which are associated with adjustable multipliers that are assigned (by a computer program or if a manual system is employed, based on experience) to the cost of painting a component or section of the structure. The multipliers shown below are based on generalized experience and can be modified based on local bidding patterns. General levels of accessibility are defined as follows:

<table>
<thead>
<tr>
<th>Level of Accessibility</th>
<th>Definition</th>
<th>Cost Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy</td>
<td>Simple Structures (no rigging required)</td>
<td>85%- 120%</td>
</tr>
<tr>
<td>Average</td>
<td>Simple Structures (rigging required) or Complex Structures (no rigging required)</td>
<td>120%-150%</td>
</tr>
<tr>
<td>Difficult</td>
<td>Complex Structures (rigging required) or Limited Access Areas</td>
<td>150%-300%</td>
</tr>
</tbody>
</table>
**Hazardous Metals**

The presence of lead or other toxic metals in paint can significantly increase the cost of repairing an existing coating if special provisions for containment and worker protection are required. A cost multiplier of 2 is typically used when lead or other hazardous metals are present, although this multiplier can be adjusted. The presence of hazardous metals in the paint is established based on discussions or research about the structure history, through use of field Lead Check swabs, and/or through paint chip sampling and laboratory analysis.

**Phase 2 – Physical Tests of Coating Integrity**

Physical tests of coating thickness and adhesion are generally made on structures which are in the B or better condition. On these structures, overcoating may be an option. These tests are necessary in order to determine whether the existing coating is of sufficient integrity to be overcoated (i.e., whether it can support additional coats). While this testing can be done anytime, on large projects, it is better to delay it until the specific areas that will be overcoated are identified. In this way, the amount of destructive testing is limited to those surfaces where it is applicable, and the testing is current. For example, adhesion tests today on coatings that will not be overcoated for two years are not relevant. To be accurate, the testing should be repeated at that time. Further, MODOT may wish to overcoat certain surfaces for aesthetics only, rather than to arrest corrosion. If those items exhibited only a limited amount of visible corrosion during the initial survey, testing would not have been triggered.

When the testing is performed, coating thickness is measured using non-destructive, magnetic dry film thickness gages calibrated on National Institute of Standards and Technology (NIST) calibration plates. Typically, a PosiTector® 6000 is used. This assessment provides the thickness of all coats combined.

Adhesion tests are conducted at random locations in accordance with Method A of ASTM D3359, “Measuring Adhesion by Tape Test.” Method A requires scribing an “X” through the coating with a sharp knife followed by the application and removal of a pressure sensitive tape. The amount of coating removed in the test area is evaluated using an ASTM rating scale. Ratings of 0A and 1A typically represent poor adhesion, 2A and 3A moderate adhesion, and 4A and 5A good adhesion.

**Risk of Overcoating**

The physical test results from the field investigation are factored into the decision considerations to determine the risk of applying additional coats to the existing system. The risks can be calculated and defined as follows:
RISK OF OVERCOATING

<table>
<thead>
<tr>
<th>ADHESION</th>
<th>DFT &lt; 10 mils</th>
<th>DFT 10-20 mils</th>
<th>DFT &gt;20 mils</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>4</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>3</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>2</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>1</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>0</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

Adhesion - Test results in accordance with Method A of ASTM D3359, "Measuring Adhesion by Tape Test"

DFT - Total Dry Film Thickness of the coating

High Risk - The integrity of the existing coating is poor and the coating will likely become detached if overcoated.

Moderate Risk - The integrity of the existing coating is marginal, but may be capable of supporting an additional coat.

Low Risk - The integrity of the existing coating is good and can be expected to support additional coats.
DATA EVALUATION – THE DECISION-MAKING PROCESS

(OONE WAY OF LOOKING AT THE DATA)

Coating Deterioration Curves - Projections of Coating Service Life

Managing all of the data is an issue. When data from hundreds or thousands of bridges are generated, the issue becomes one of resource management. Optimally, most people want to spend their money and time painting the top priority bridges first. In order to determine which structure that is, coating deterioration curves must be developed, even if they must be estimated initially. These deterioration factors or graphs are really the heart of a highly effective system. The curves depict the projected deterioration of coatings based on three variables:

1. Generic coating type (zinc, epoxy, alkyd, etc.)
2. Substrate condition (blast cleaned steel, over mill scale, etc.)
3. Service environment (mild, moderate, etc.)

The Y axis of each curve represents the percentage of visible deterioration. The X axis represents time. For the Y axis, this particular system converts the A, B, C, and F letter grades assigned to each component to a numerical value that is typically associated with a given type of repair:

<table>
<thead>
<tr>
<th>Rating</th>
<th>Score</th>
<th>Repair Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>No coating work recommended.</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>No coating work recommended.</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>No coating work recommended.</td>
</tr>
<tr>
<td>B</td>
<td>30</td>
<td>No coating work recommended.</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>Spot touch up (TU) repair recommended.</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>Extensive spot touch up (TU+) repair required in a few years</td>
</tr>
<tr>
<td>C</td>
<td>60</td>
<td>Spot touch up repair and overcoating (TU+) recommended.</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>Total coating removal and replacement (RR) recommended.</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>Total coating removal and replacement (RR) recommended.</td>
</tr>
<tr>
<td>F</td>
<td>90</td>
<td>Total coating removal/replacement (RR) or consider replacing the component.</td>
</tr>
</tbody>
</table>

As can be seen in the sample deterioration curve which follows, the score of the component automatically increases each year based on the slope of the curve.
The importance of the deterioration curve in decision-making is as follows. Assume a given component is in good condition today with an “A” rating (score of 0). The System automatically predicts the amount of deterioration of the coating on that component each year based on the specific curve that has been assigned to that component. Using the sample curve above, the System would project that a spot touch up repair (TU) of that component should be considered in Year 16 (i.e., at the time the score crosses the preset, but adjustable, TU line).

As additional years of data are collected within the System, the deterioration curves are adjusted to better predict the actual deterioration occurring on each component within the group of bridges. For example, it might be discovered that the coatings on a specific component are deteriorating more rapidly than previously predicted. The deterioration curve for that component can be adjusted to a more aggressive deterioration rate. Note that adjustments to the deterioration curves will likely alter the current projections for the amount of future work that will be needed.

As indicated previously, the recommended maintenance strategy is triggered when the coating is projected to deteriorate from one category to the next. For example, coatings that are currently in a “no work recommended” condition are scheduled for spot touch up (TU) when they move into the “TU” condition. Likewise, coatings that are currently in a “TU” condition are scheduled for spot touchup plus overcoat (TU+) at the point where the projected deterioration moves them into a “TU+” condition. Depending upon budgetary considerations (i.e., if additional funding is available), the coatings on certain components can also be scheduled for repair earlier in their deterioration cycle by adjusting the repair lines (i.e., by shifting the position of the TU, TU+, and RR lines).
Cost Calculations

Cost estimates for painting work are calculated by the System based on the period in time that the System schedules a specific repair. For example, if the System predicts that a component will move into the touch up condition in two years, the recommended repair strategy (i.e., TU), and the future cost of that repair are displayed. The estimated costs are based on unit costs for the various activities needed to do the work (washing, power tool cleaning, three coats, etc.), and the total surface area involved. Adjustments to the base costs are made if lead paint is present and to account for accessibility or complexity issues (e.g., a project requiring scaffolding for access is more costly to perform than one that can be accomplished working from the ground). The net present value for painting each component is also displayed in the software.

Ultimately, the painting forecast and costs should be based on the application of spot touch-up coats whenever feasible (e.g., when the failing coating is limited to well-defined areas) before the deterioration spreads to the point that full overcoating is required. This helps to prevent the application of too much coating, which can lead to premature spontaneous disbonding of the film. By minimizing the amount of coating being applied during a given maintenance cycle, the total number of maintenance cycles before total coating removal is required, increases. While this approach will successfully control corrosion, the disadvantage involves aesthetics as the repair areas may be readily visible. When aesthetics dictate that spot touch-up is an unacceptable approach, or the amount and distribution of failure is too widespread for spot repair, a full overcoat is required. The System computer-generated recommendations for spot touch up can be overridden and overcoating required instead. When this is done, the cost estimates are automatically recalculated. Similarly, the recommended painting years for individual components or entire areas can be overridden and the costs automatically recalculated.

Naturally, at the end of the day, human judgment must always be used to assess the reasonableness of the strategy suggested merely by the data itself.

A Maintenance Painting Plan for Every Bridge

When managing all steel bridges on a district or even statewide basis, the systematic application of selection criteria will enable a “plan” for the maintenance painting of every structure for the next 20 or even 30 or more years. These plans are adjustable based on the actual condition of the bridge and can be “tempered” by the availability of maintenance painting funds. For example, if coating repairs are deferred by a year, the cost of that deferral will be quantifiable in that certain bridges will slip from one rating category to the next at the attendant higher cost. When these changes are summed across all of the bridges in the district or State, the cost of not taking action is able to be calculated.