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The Voice of SSPC: The Society for Protective Coatings

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By Rob Portsmouth, Huntsman Pigments

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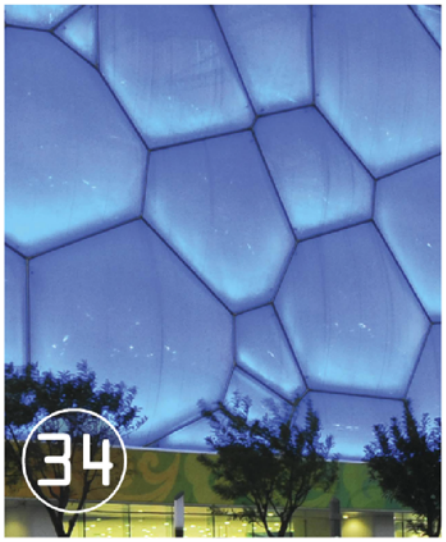

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Voting for the Board of Governors

This month, we sent an electronic ballot to the SSPC membership allowing each individual member the opportunity to have his or her voice heard on the issue of who will determine the strategic direction of the organization. I know that sometimes SSPC is seen as a heavily staff-run organization; we are when it comes to the day-to-day operations and the decisions that are made. But it is the Board of Governors that ultimately determines how we do business. Article IV, Section 6 of the SSPC Bylaws, entitled "Powers and Duties of the Board," states in part: "The Board of Governors shall supervise, control, and direct the affairs of SSPC; shall determine and interpret its policies within the limits of the Bylaws; shall actively prosecute its purposes; and shall have discretion in the disbursement of funds."

Although the paragraph continues, I quoted its essence. Unlike many organizations, SSPC is composed of different demographics, such as facility owners, painting contractors, equipment manufacturers, and other sectors of the industry. Our Board reflects these demographics. It has, for example, three owners, three painting contractors, two equipment suppliers, and representatives of our other demographics. (The members of the Board and their demographics were listed in the Annual Report in the March 2013 issue of *JPCL*.) With that system, when an issue is discussed, the governing body gets the perspective of the entire membership and how it may or may not affect a certain portion of the membership. We also have two international members on the Board, so we get the perspective of how things are done outside the United States, because what we do here is not always what others do overseas.

I ask you to take notice when announcements are made on our website or in *JPCL* when we are looking for members to serve on the Board. We are always looking for folks who want to give back to the industry and will bring a strategic focus to the organization. We need those who will put their own personal or business agendas aside for the good of the entire organization. As I say, we are looking for folks who are able, when they walk into the Board meetings, to have their SSPC hat on, not their company's or the one with their own name on it.

This month, and around this time every year, it is important that you take a couple of minutes to vote for the candidates who you feel will best fulfill those responsibilities that are laid out in the Bylaws that I have quoted. As in any election, that is how change is made and direction is determined.

Bill Shoup

Bill Shoup
Executive Director, SSPC

Free Webinar on Soluble Salt Testing, Extraction Offered

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Webinar Education Series

The 2013 SSPC/*JPCL* Education Webinar Series continues with another free webinar, "New Methods for Testing and Extraction of Soluble Salts," which will be presented on Wednesday, June 19, from 11:00 a.m. to 12:00 noon, EST.

This webinar describes the most commonly used field methods for the retrieval and analysis of soluble salts on steel and other nonporous substrates. Coatings applied on surfaces contaminated with soluble salts exceeding a certain concentration exhibit diminished performance. This presentation is intended to assist the user in selecting specific procedures for retrieval and analysis, and will explore the various methods used to determine the concentration of the soluble salts in the extracted solution.

Dr. Lisa Detter-Hoskin, Principal Research Scientist at Georgia Tech Research Institute, will present this webinar. Dr. Detter-Hoskin holds a Ph.D. in Inorganic Chemistry from Purdue University and a M.S. in Management of Technology from Southern Polytechnical State Institute. She has been the Director of GTRI's Materials Analysis Center for 16 years.

Dr. Lisa Detter-Hoskin

Dr. Detter-Hoskin has decades of theoretical and applied knowledge of materials testing, forensics, and failure analysis, and her corrosion research includes steel, stainless steel, galvanized steel, copper, brass, aluminum alloys, and titanium and tantalum coated alloys. She is particularly knowledgeable of aggressive inorganic acid-induced corrosion reactions, field and lab testing, corrosion remediation, and corrosion inhibitor systems, and she has developed procedures for greater extraction efficiency of soluble salts from corroded metals. This webinar is sponsored by Chlor*Rid International, Inc.

Registration, CEU Credits

This program is part of the SSPC/*JPCL* Webinar Education Series, which provides continuing education for SSPC re-certifications and technology updates on important topics.

SSPC is an accredited training provider for the Florida Board of Professional Engineers (FBPE), and Professional Engineers in Florida may submit SSPC Webinar Continuing Education Units to the board. To do so, applicants must download the FBPE CEU form and pass the Webinar Exam, which costs $25 but is free to SSPC members.

Register for this online presentation at www.paintsquare.com/webinars.

Corrosion Takes Center Stage at NATO

From April 23–26, officials from the U.S. Defense Department's Office of Corrosion Policy and Oversight, SSPC, and NACE met with representatives of the German, French, and UK ministries of defense at a Corrosion Prevention and Control Workshop at the NATO School in Oberammergau, Germany, to share strategies and technology for fighting material degradation on weapon systems and facilities.

Part of a worldwide effort to combat corrosion, this workshop was a first for the United States, according to Daniel J. Dunmire, Director of the DoD corrosion office. Speakers representing the German,

Free Videos Offer Film Thickness Demos

Kenneth A. Trimber

Hands-on demonstrations of two popular coating thickness gages are the latest free offerings in an original 30-part video tutorial series, presented by KTA-Tator, Inc. and produced by PaintSquare.

Narrated by KTA-Tator president Kenneth A. Trimber, "How to Measure Wet Film Thickness" and "How to Measure Dry Film Thickness" are the newest additions to Coating Inspection Instruments: A PaintSquare Video Education Series, available exclusively through PaintSquare.com throughout 2013. The series teaches viewers how to work with a variety of instruments to achieve the best project results.

The first title in the series, "How to Determine Blast Cleanliness - SSPC VIS 1 Guide and Reference Photographs," was released earlier this year.

The entire series will be hosted by Trimber, who has been with KTA since 1968 and has more than 40 years of experience in the industrial painting field. Trimber is a past president of SSPC and chairman of its Commercial Coatings Committee. He is also an SSPC Protective Coatings Specialist, an SSPC C-3 Supervisor/Competent Person for the Deleading of Industrial Structures, and a NACE-Certified Level 3 Coatings Inspector.

French, and UK ministries of defense discussed the importance of corrosion prevention and control to their agencies.

Corrosion Office Chief Engineer Dick Kinzie briefed attendees about DoD's ongoing cost of corrosion study of weapon systems and infrastructure, addressing how European defense ministries might tailor U.S. methodologies to suit their own needs.

Matt Koch, U.S. Marine Corps Corrosion Prevention and Control Program Manager, outlined the corps initiatives to reduce corrosion costs for ground and amphibious vehicles. Dunmire and Corrosion Office staff members also discussed how they provide direction to DoD and federal government agencies through policy guidance, inter-service collaboration, research and technology oversight, and the promulgation of maintenance practices that prevent corrosion.

Participating organizations that reviewed their institutional support of DoD's multifaceted educational objectives included SSPC, NACE International, and the National Center for Education and Research on Corrosion and Materials Performance (NCERCAMP) at The University of Akron, Aalen (Germany) University.

Susan Louscher, Executive Director of NCERCAMP, outlined its mission to support all federal and state agencies and industry through corrosion-related research and advocacy activities pursued by promising graduates of UA colleges and partner institutions worldwide.

Bill Shoup, SSPC's Executive Director, called the four-day workshop "very beneficial to our organization, allowing SSPC the opportunity to hear how defense organizations from the UK, France and Germany try to address their own corrosion-related challenges."

"Whereas we think we have unique obstacles in the United States Department of Defense, our counterparts in other defense ministries face similar challenges," Shoup said. "As SSPC works with the DoD Corrosion Office and our allies worldwide, I believe that good ideas will emerge to help each of us solve these problems." **JPCL**

Correction

Because of an editing error on p. 22 of the March 2013 *JPCL* article, "Lessons from Coating Water and Wastewater Treatment Structures," the measuring capacities of Type II and Type V gauges were incorrectly represented. Contrary to what was printed, not all Type II gauges are limited to 1,000 psi. Depending on the model, Type II gauges can have maximum adhesion limits ranging from 500 to approximately 3,000 psi. In general, Type V gauges can measure higher adhesion values than Type II gauges at the same position.

The captions to Figs. 5 and 6 reflected the editing error and should have appeared as follows.

Fig. 5: Example of a Type II gauge

Fig. 6: Example of a Type V gauge

Avoiding Blistering and Cratering in Polyurethanes

What causes blistering and crater formation in freshly applied polyurethane topcoats, and how can these problems be avoided?

From Stephen Bothello
Jotun Paints

Blistering is the formation of bubbles or raised protrusions, like pimples, whereas cratering is the formation of small depressions on the surface of the paint film that do not expose the underlying coat.

Blistering is most often caused by moisture contamination either in the hose/paint line or during mixing, particularly in high humidity conditions, or in cold conditions, e.g., at night when condensation occurs in the line/metal surface as temperatures cool. The hardener or isocyanate has a general preference to react with moisture. To minimize the risk of contamination or avoid it altogether, be sure to clean the hose/line by flushing it with fresh thinner. Also, make sure the relative humidity is below 85% and that there is no condensation on steel. The steel temperature should be 3 C (5 F) above the dew point at the beginning of painting.

A frequent applicator-related cause of blistering or bubble formation is solvent entrapment, when the film thickness of a coat is higher than the recommended paint thickness per coat. With this condition, the surface of the wet paint film dries rapidly, preventing solvent release from within the paint film. The solvent will, however, rise to the surface within the paint film, as a result of restriction from the already dried surface, to form bubbles or blisters at the surface.

In certain cases, the blisters or bubbles will burst, forming circular depressions (craters) that do not expose the underlying coats. This cause of cratering can be avoided by eliminating all moisture contamination and applying paint at the recommended thickness, being sure to first reduce the paint with the recommended thinner at the prescribed levels.

Cratering is also caused when air pockets are produced in especially fast-drying polyurethane topcoats. Fine particle contamination in the paint or excessive mixing just before application leads to the air pockets. To avoid this case, ensure that proper filtering and straining are performed, and avoid over-mixing.

Cratering can also be caused by silicone/oil contamination in the paint line or by more than the required level of flow and wetting additives in the paint itself. In this case, the manufacturer's technical representative will need to conduct a proper investigation of the paint.

From Jorge Lizarraga
International Paint

There are several causes for blistering and cratering in a freshly applied polyurethane coating, such as a high wet film thickness applied in one coat, high ambient humidity that reacts with the isocyanate leading to carbon dioxide (CO_2) bubbles, high surface temperature, or a very light solvent used in high ambient temperatures.

But the most common cause is the application of high wet film thickness in one coat. In this case, the evaporation of the solvent creates bubbles, which can do one of two things. When they reach the coating surface, or burst, a crater results. Alternatively, if the bubbles are trapped in the film, blisters form. The way to avoid this effect is to apply the coating in several light coats, in a moisture-controlled atmosphere, with a suitable solvent.

From Dipesh Vyas
Carboline

Here are a few points I've learned that may be helpful.

First, when a polyurethane is applied over a micaceous iron oxide-rich epoxy midcoat, one way to avoid blistering or cratering is to apply a mist coat and then apply the full coat.

Second, consider the possibility of contamination from the spray assembly—hose, pump, and other components—especially when you have finished applying the epoxy midcoat. The majority of epoxy thinners are not compatible with polyurethane. Contamination from the wrong thinner can be avoided by pre-cleaning the spray assembly with a polyurethane thinner before starting application. Do not use this thinner for polyurethane paint dilution.

Paint formulation can also cause cratering or blistering.

Problem Solving Forum questions and answers are published in *JPCL* and its sister daily electronic publication, *PaintSquare News.*

Q&A WITH DWIGHT WELDON

BY CHARLES LANGE, JPCL

Dwight Weldon is the founder and President of Weldon Laboratories, an independent paint testing laboratory located outside of Pittsburgh, PA, that focuses on routine testing and failure analysis of paints and coatings. Before starting his laboratory in 2001, Weldon spent 18 years at KTA-Tator, Inc., as Laboratory Director and eventually Vice President of R&D. He is the author of the book, "Failure Analysis of Paints and Coatings," published by John Wiley and Sons, as well as many other articles and published works relating to coatings testing and analysis. He is also a *JPCL* contributing editor.

JPCL: Were you always interested in coatings, or were you more interested in general sciences before getting into the industry?
DW: When I was getting my degrees in chemistry I really had no idea what field I wanted to get into, but I hoped it would somehow involve analytical chemistry. It was really more by chance that I wound up in the coatings industry. My first job after getting my masters degree in chemistry was as a formulator for a company that made automotive coatings. It was a good experience, because not only did we do formulations, but we made up our own test batches, sprayed them ourselves, and did the testing of them. From there, I moved on to KTA-Tator, Inc.

JPCL: What are some of your most trusted and helpful sources of information when it comes to coatings research and analysis?
DW: There are several good resources available when it comes to coatings testing and analysis. Obviously, the various ASTM test methods are invaluable, since many customers reference them. The ASTM Gardner Sward Paint Testing Manual is very useful, as is "An Infrared Spectroscopy Atlas for the Coatings Industry" (published by what used to be the Federation of Societies for Coatings Technology), and Clive Hare's book, "Protective Coatings" (published by SSPC). Also, the various professional contacts one makes in the course of a career can be very helpful.

JPCL: Can you briefly explain the process of putting together your book, from the planning and research stages through the editorial and publishing stages? Did you enjoy the process?

DW: The book was quite an experience—and quite a lot of work! I love to write, but I had never done anything this big before. The hardest part was figuring out how to organize it, since failure analysis is a very circular process. I finally decided that I had to start with some basic coatings chemistry, because if you don't understand how paint is supposed to work, it's not likely that you'll figure out why it is failing. I then decided to introduce the various analytical techniques, and what you can and can't learn from them. I decided that the last part of the book needed to be examples or case histories, to sort of pull everything together and make it feel real.

It took about a year of writing at night and on the weekends to come up with the initial manuscript. This was then sent to the publisher, who, of course, suggested several changes. Just making sure that all the figures were numbered correctly and had the correct captions was a chore! It probably took another year or so of back-and-forth changes to the manuscript to get it to the stage of actual publication, and of course you have to do extremely careful proofreading of the final manuscript. It was hard but very enjoyable work, and it gave me a great feeling of accomplishment.

JPCL: How do you go about explaining some of the more technical or complicated information about coatings to facility owners or other clients that may not be as well-versed in these issues as you are?

DW: That can be a challenge, but I start with the assumption that the people I'm dealing with are smart and capable. I often get annoyed reading technical papers, because it can seem like the goal of the author is to make himself incomprehensible, almost as a mark of his expertise. Chemistry and coatings science are, of course, complicated subjects, but I try to make them more understandable by using straightforward language, and by trying to give analogies whenever I can think of one! I actually consider communication as a big—and enjoyable—part of my job.

JPCL: What has been the most significant development in coatings science or technology over the course of your career?

DW: I've been in the coatings industry for over 30 years, and a lot has happened in that time. It's hard to say that one development has been more significant than another, because each was significant at the time that it happened. I think, in general, the most significant development is the increasing role of science in the development of coatings. There is a much better understanding of the fundamental science behind paint nowadays, whereas 30 years ago paint making was perhaps more of an art.

JPCL: What are some of the major future developments or trends in coatings that you foresee on the horizon?

DW: Obviously lower and lower VOC seems inescapable, what with increasing government regulations. This might result in some novel coating types being developed. I also think there is a lot of room for further development in polyurea and polysiloxane technologies.

JPCL: What has been the highlight or proudest moment of your career thus far?

DW: This one is easy to answer—my book. I grew up in a home where books and writing were important. My sister has literary credits to her name, and my father actually published short fiction during the Depression. So having a shiny hardcover book show up in the mailbox with my name on the front cover was awesome—especially when I knew all the work that went into it.

JPCL: Do you have any advice for a young person looking to get into the coatings field?

DW: I would tell them that there are a lot of opportunities in the coatings field for people of differing talents. It's not just about making paint, or testing paint. There is room for the scientist, but also for technical writing, advertising, marketing, and management, not to mention the field of commercial paint application. And whatever aspect of coatings they get into, I would advise them to take pride in their work, and to treat what they are doing as a profession and not as a job. A profession is something that is enjoyable and helps you to grow as a person. It's also important to always keep learning. Actually, I suppose that attitude is another thing that distinguishes a profession from a job.

JPCL: What are some of your interests outside of coatings? How do you like to spend your free time?

DW: You mean apart from eating? Spending time with my son is really high on my list. Anybody who is a parent knows how fast they grow up. I also really enjoy tennis, swimming, and reading. Give me a beach and a good book, and I'm content.

JPCL

Fig. 1: Blistered floor coating with a writing pen for scale.

The Case of...

The Contractor Who Almost Got Floored

By Raymond S. Tombaugh, PCS, KTA-Tator, Inc.
Richard A. Burgess, PCS, Series Editor

Most of the past Cases from the F-Files have focused primarily (although not exclusively) on coating failures on steel. However, coating failures can and do occur on other substrates such as aluminum, wood, and concrete, to name a few. In this case, a warehouse concrete floor coating was exhibiting blistering only a few months after installation.

A large existing warehouse building was being modified to house a light manufacturing facility. The floor was constructed of concrete slabs. It was reported that there was no moisture barrier underneath the slabs.

The floor coating project included removal of an original clear coating by portable centrifugal blast cleaning. The new system consisted of four coats that included an epoxy penetrating primer, an aggregate-filled epoxy base coat, an epoxy grout coat, and an epoxy finish coat. It was reported that moisture vapor transmission (MVT) testing was performed by the contractor prior to the new coating installation. The testing indicated a low MVT of less than 2 lbs./1,000 square feet/24 hours. Blisters began to appear in the coating within a few months of the floor coating installation (Fig. 1). In this case, aggregate in a concrete floor, in the presence of moisture, caused blistering of the coating system. It is a relatively uncommon problem that could have easily been blamed on the contractor as mis-application of the coating, void of a thorough scientific analysis of the problem (in the field and laboratory) as well as knowledge of concrete substrates. Let's take a closer look.

Field Investigation

A visual examination revealed that blisters were present in all areas of the floor and were present in two conditions—areas with blisters that were still sealed (intact), and areas where the blister caps were ruptured. An amber material was found on the surface where the blister caps had ruptured. The concentration (density) of the blisters varied from location to location.

The intact blisters varied in size, having diameters that ranged from ½" to 2". When evaluated in accordance with ASTM D714, the blisters were categorized as blister size No. 2 with a frequency between few and medium. When intact blister caps were removed, standing water was observed on the underlying surface (Fig. 2).

The plane of separation within the blisters appeared to occur between a gray cementitious coating layer and an opaque layer of material that covered a coarse profile in the surface of the concrete.

In most cases, the backs of the blister caps had a piece of what appeared to be aggregate attached to it. There was a depression in the floor at the location that corresponded to the aggregate on the back of the blister cap, as shown in Fig. 3.

Adhesion was generally poor in most areas where sound blisters were present that were tested. The coating could be easily removed with a knife or chisel. Again, an opaque material was found on the surface of the concrete (Fig. 4).

Adhesion was also poor in areas where blisters were already ruptured. The amber-

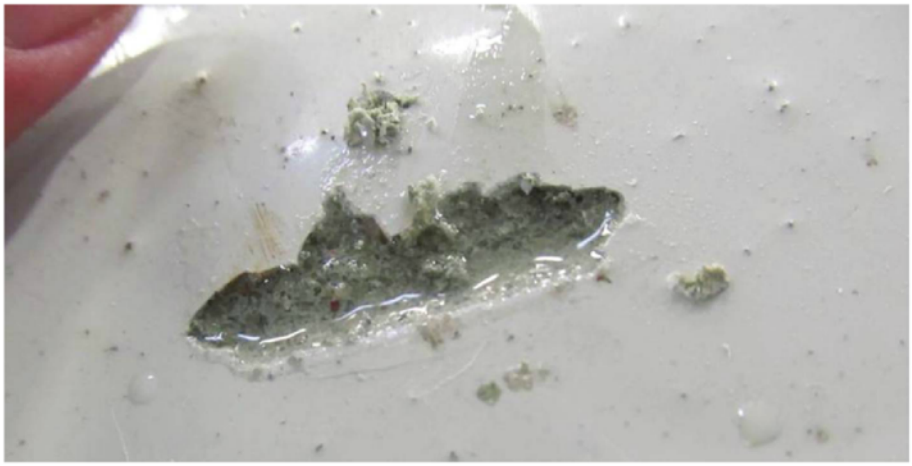

Fig. 2: Opened blister/bump in the floor coating surface revealed water.

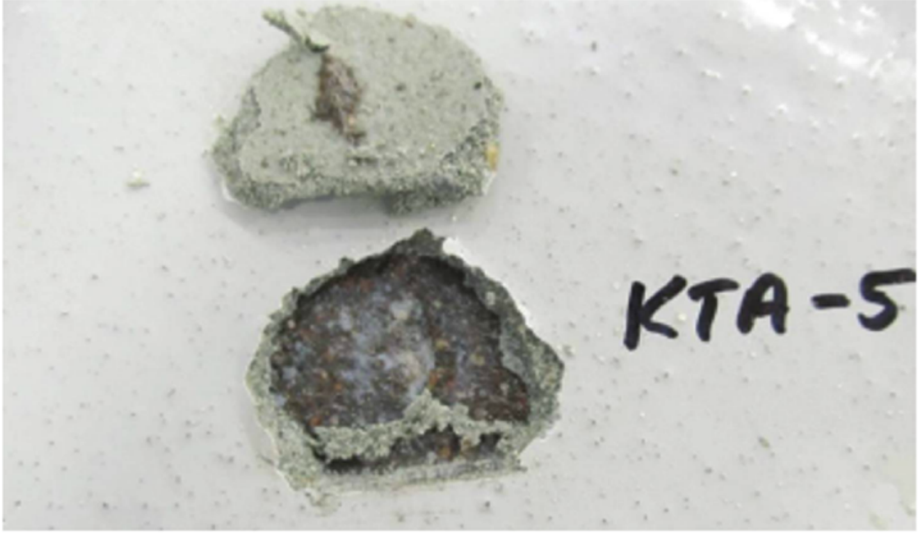

Fig. 3: An opened blister shows the plane of separation between base and cap.

Fig. 4: Running a chisel against an exposed edge caused cracking and delamination of the coating.

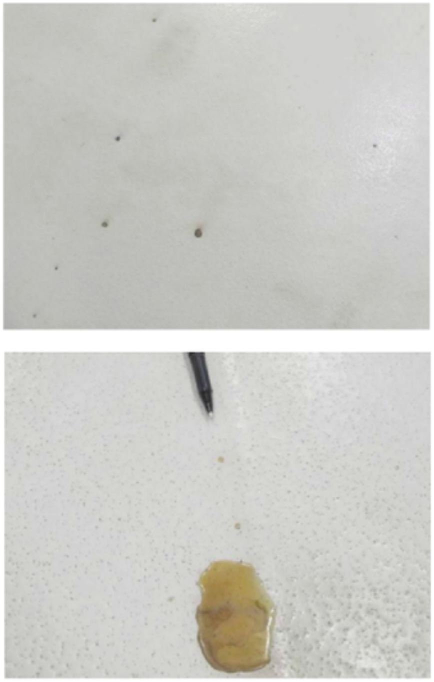

Fig. 5a (top) shows holes in the floor where the amber residue was wiped up and Fig. 5b (bottom) where the amber material was still present on the surface.

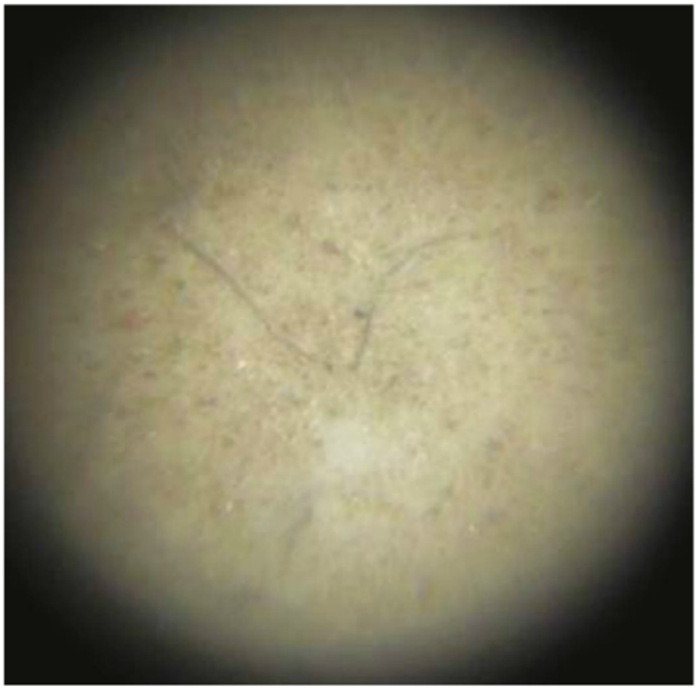

Fig. 6: Cracks in the film at the bottom of blisters were visible under magnification (30X).

colored material associated with the broken blisters appeared to have been wiped away from some areas, leaving staining. Other areas of broken blisters revealed deposits of the sticky amber material on the coating surface (Figs. 5a and 5b).

Cracks were visible when the amber material was removed and the surface of the coating at the bottom of the blisters was examined under magnification (Fig. 6).

When the intact blister caps were removed, again the underlying surface was wet, and an opaque layer was observed on the surface of the concrete. In some cases, there was a soft white liquid under the blister cap. Examples are provided in Fig. 7 and Fig. 8.

Fig. 7: Wet surface found below and intact blister.

Laboratory Investigation

Microscopic examination revealed that there was no primer coat attached to the back of the blister caps. The blister caps consisted of two layers—an aggregate-filled gray bottom coat ranging between 38 mils and 93 mils in thickness, and a light gray topcoat ranging between 2 mils and 11 mils in thickness.

Chemical analysis (Fourier transform infrared spectroscopy) of the coating layers determined that each was consistent in formulation with the specified epoxy coatings. Chemical analysis of the blister fluid identified it to be a silicate with hydrogen bonding (likely due to bound water). Similarly, the white deposits observed on the surface of the concrete contained silicates.

Chemical analysis of the amber deposit determined it to be consistent with carboxylate ions.

The latter two findings shed some significant insight into the cause of the problem. The first useful finding was determining that the opaque material present on the surface of the concrete and the blister fluid both contained silicates. The presence of silicates on the concrete surface underneath the blisters is a strong indication that an alkali-silicate reaction was occurring in the concrete. The field observation that aggregate was attached to the back of the blister cap supported this analysis. The aggregate pieces on the blister cap corresponded to depressions in the concrete.

The aggregate (chert/chalcedony, in this case) reacts with the alkalinity in the concrete in the presence of moisture to create a silicate gel. The silicate gel forms at a location where there is no space for it to form (between the concrete and the coating) increasing internal pressure. Blistering and poor coating adhesion occur as the gel pushes the coating off of the substrate to make space.

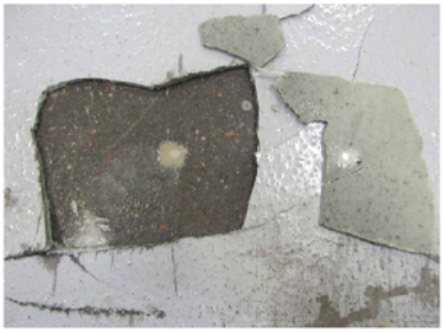

Fig. 8: Some intact blisters also had a white pasty material inside intact blisters.

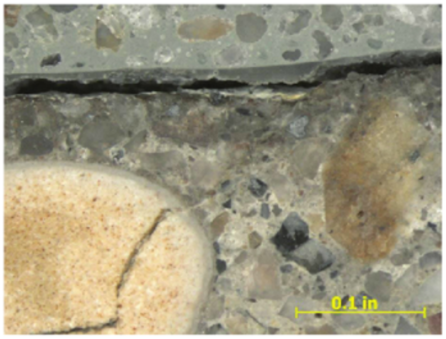

Fig. 9: A section view through concrete with reactive aggregate.

Associated with this reaction is spalling of the reactive aggregate. While there were strong indications that the aggregate had spalled underneath the blisters, petrography was required in order to confirm the presence of alkali-silica reactions (ASR) in the concrete (Fig. 9). As such, several concrete cores with intact blisters were removed from the slab for petrographic analysis.

The petrographic analysis determined that the coating was delaminating at locations where white alkali-silica gel deposits were observed on the bottom surface of the coating system and on the top surface of con-

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crete. The gel deposits could be traced to cracks radiating from chert/chalcedony coarse aggregate particles near the top surface of the concrete. Confirmation was obtained that ASR was present in the slab.

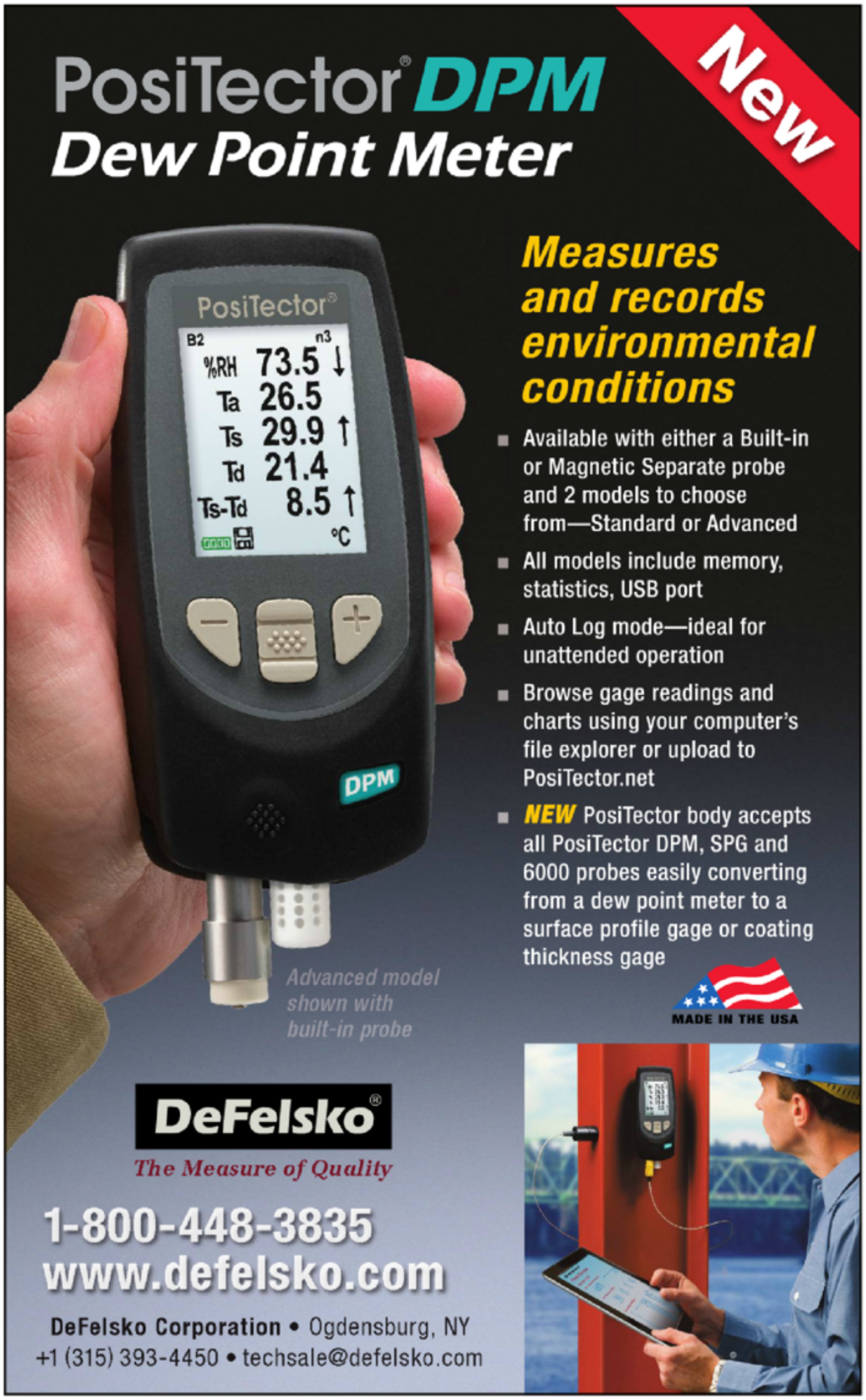
As indicated above, the ASR reaction requires moisture. Despite the fact that many MVT tests were reportedly performed across the floor of the facility (all resulting in acceptable levels), there was a significant amount of water found beneath the coating—more than enough to cause the reaction. Another laboratory finding indicated that the amber-colored liquid was composed of carboxylates. When carboxylates are found on coating systems, there is a strong indication that moisture was present in the slab when the coating was applied. This infers that either the MVT tests were performed incorrectly, or the water table changed between the time that the testing was performed and the coating was applied.

One final important finding indicated by the petrographic analysis was that evidence of ASR was observed only in the top 0.3 inches of the concrete. The body of the concrete did not exhibit distress, and the amount of reactive aggregate included in the concrete did not exceed the amount permitted by industry standards.

As a result, remediation of the floor coating would first include removal of the coating and the top 0.3 inches of concrete. Once the top layer was removed, it was recommended to allow the slab to dry out for approximately two weeks before another set of MVT tests was performed.

If the MVT tests exceeded acceptable levels for coating, then application of a moisture barrier was recommended to seal the concrete. Once the moisture barrier cured, it was recommended that the concrete be retested to verify that the MVT rate had been reduced to below acceptable levels. If the MVT rates were satisfactory, the originally specified coating system could be reapplied.

Ray Tombaugh is a Senior Coatings Consultant for KTA-Tator, Inc., providing coatings failure analysis, condition assessment, specification preparation, project management, and other coatings-related services. He holds a B.S. in chemical engineering from Lehigh University, is a member of SSPC, and is a NACE-Certified Coatings Inspector Level 3 (Peer Review). **JPCL**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PERFORMANCE OR PREFERENCE?

City of Anoka Water Tank Reconditioning Revisited

By Dan Zienty, Short Elliott Hendrickson Inc.

In 2003, the City of Anoka, MN, completed the reconditioning of its 400,000-gallon legged water storage tank. A two-year warranty inspection followed in 2005. The project was reported in the May 2007 issue of the *JPCL*.[1] The significance of the project, as highlighted in the May 2007 article, was that the tank provided the opportunity to test and compare the performance of three coating systems for reconditioning interior surfaces in immersion and above the high water line (the vapor area), an area that is always difficult to protect. Systems tested included two NSF-approved, AWWA standard multi-coat systems (AWWA ICS No. 1, a two-coat epoxy polyamide and AWWA ICS No. 5, a moisture-cured [MCU] zinc primer/epoxy polyamide/epoxy polyamide), and a single-coat (untopcoated) MCU zinc coating recently approved by NSF but not an AWWA standard system. The 2005 inspection, as reported in the May 2007 *JPCL*, showed that all three systems were performing well.

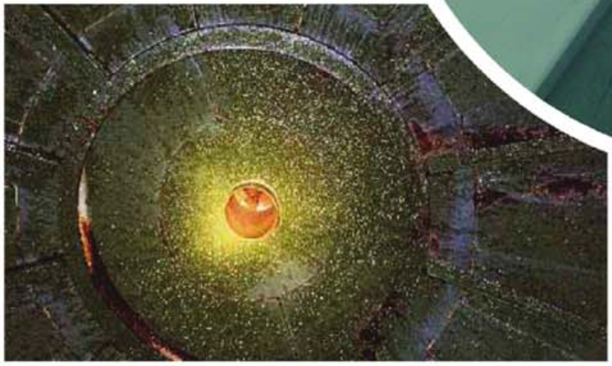

Fig. 1a (left): Condition of vapor area in interior of roof in 2001
Fig. 1b (above): Anoka Water Tank test site prepared in 2003 to compare systems in the vapor area
Photos courtesy of the author

In 2009, the City contracted again with an engineer for a periodic inspection of the tank, including the interior surfaces. The results of the evaluation led to planning between the City and its engineer for the completion of maintenance repairs scheduled for the summer of 2011. In the end, surfaces primed with the MCU organic zinc performed best. This article summarizes the original project and 2005 warranty inspection results, then focuses on subsequent inspection, repair, and performance of the interior linings tested above the high water line.

Background: Original Project, Coating Trials, and Subsequent Warranty Inspection

In 2001, the City of Anoka contracted with an engineer to completely evaluate one of its 400,000-gallon legged water storage tanks. The purpose, as is usual, was to assess the general condition of the facility, determine whether maintenance or complete reconditioning was required, and develop an estimated cost for the scope of work.

As noted in the 2007 *JPCL* article on the project, while water storage tanks may vary greatly in size, style, and design, all share a common need for maintenance or periodic reconditioning. Coating remediation in steel tanks is most common in areas with limited access for painting, such as interior surfaces above the water line, but also includes surfaces directly in immersion. Unsealed roof lap-plate seams and intermittently welded roof support systems require special attention during coating application because they cannot be protected in the same way as the rest of the tank. That is, in many parts of water storage tanks, cathodic protection (CP) in the form of an impressed current system (see AWWA D104) has been used as a backup method after coating application to improve the long-term serviceability of the applied system. However, as good as these CP systems are in providing protection where holidays may exist or abrasions may occur, or where tank design prohibits thorough surface preparation and painting, they cannot be used in the difficult-to-access areas above the water line (vapor area).

In the City of Anoka's case, the evaluation conducted by the engineer identified the need for a complete removal and replacement of aged alkyd systems on both the interior and exterior of the tank. (Although such alkyds are no longer used in water tanks because NSF found that they contain leachable heavy metals and other toxins, they were extremely effective as primers beneath topcoats. Thus, many of the old systems are still intact in interior dry spaces of water tanks and have not yet been abated.)

Fig. 2: 2005 inspection—no significant failures in single-coat system or two traditional systems in the vapor area

The interior roof support system included angle construction with intermittent welds (Fig. 1a). Following presentation of the report to the City, the engineer approached the coating supplier and the City of Anoka with the concept of developing an interior specification that would follow standard surface preparation practices (SSPC SP-10, Near-White blast cleaning) for the entire tank interior. However, with City permission and with responsibility taken by the coating supplier (during the two-year warranty period), the interior coating system would include sectional application of two AWWA-approved systems, and application in a single area of an NSF-approved, immersion-grade, MCU organic zinc—not to be topcoated. The engineer received approval from the Minnesota Department of Health for this first-of-its-kind undertaking with the untopcoated zinc.

In the summer of 2003, the City of Anoka's tank was taken out of service for the reconditioning. The entire bowl area to within 1 foot of the overflow, the wet riser, and ⅓ of the roof and roof structural steelwork was painted with a two-coat polyamide epoxy (AWWA system ICS No. 1) following surface preparation as defined above. One-third of the roof and roof structure was prime coated with the MCU organic zinc and two coats of polyamide epoxy (AWWA system ICS No. 5), and the final ⅓ received a single coat of the moisture-cured organic zinc system (Fig. 1b). The epoxy polyamide was the same in ICS No. 1 and ICS No. 5. All systems were applied and inspected in accordance with the coating manufacturer's recommendations and SSPC guidelines (Table 1).

In accordance with the specification, the tank was evaluated in June of 2005 for the two- year warranty. Surfaces below the water line were inspected by an engineering company using the dive method. Surfaces above the water line and roof structural steelwork were investigated by the engineer, assisted by the coating supplier, using a disinfected inflatable rubber raft. Results of the warranty inspection identified no significant failures in the single-coat zinc system when compared to the two traditional systems (Fig. 2). The only notable failure was at the manway cover, the result of an application

Table 1: Systems Tested

System	Prep	First Coat	Intermediate	Topcoat
2-Coat Epoxy (Meets AWWA ICS No. 1)**	SSPC-SP 10, Near-White	High-solids epoxy (NSF 61-approved) @4-6 mils DFT	N/A	High-solids epoxy (NSF 61-approved) @4-6 mils DFT
1-Coat Organic Zinc 2-Coat Epoxy (Meets AWWA ICS No. 5)	SSPC-SP 10, Near-White	MCU organic zinc-rich coating (NSF 61-approved) @3-5 mils DFT	High-solids epoxy (NSF 61-approved) @4-6 mils DFT	High-solids epoxy (NSF 61-approved) @4-6 mils DFT
1-Coat Organic Zinc (Non-Standard system)	SSPC-SP 10, Near-White	MCU organic zinc-rich coating (NSF 61-approved) @3-5 mils DFT	N/A	N/A

**Note: remaining interior areas of tank, not part of the test study region, protected with this coating system.

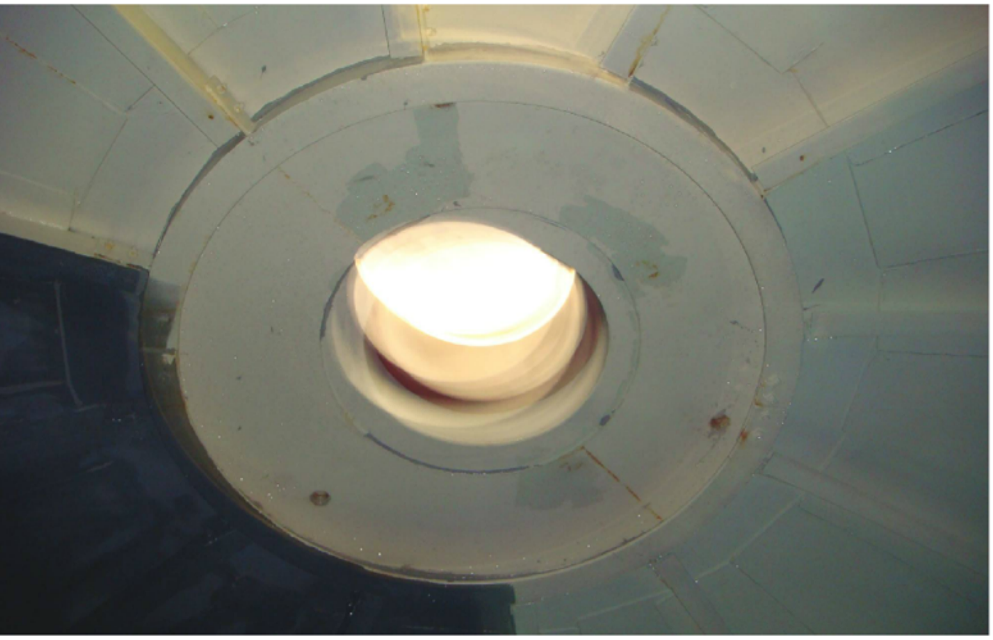

Fig. 3: 2009 inspection—minor failures typical to this type of tank

error.

Anoka Revisited

In November of 2009, the engineer was contracted again by the City of Anoka to complete a periodic inspection in accordance with AWWA M42, which recommends an inspection every three years, or as required by state regulatory agencies. Similar to the warranty inspection completed in 2005, the evaluation was accomplished using a disinfected inflatable raft and NACE-certified coating inspector. A dive inspection was not included as part of this investigation.

The result of this inspection identified a number of minor coating failures in areas typical to this style of tank, including along lap-plate seams, missed (coating) connection points, and missed (caulk) intermittent welds (Fig. 3). Most of the observed failures were in the areas coated with AWWA system ICS No. 1, two-coat polyamide epoxy (Fig. 4). The single-coat MCU organic zinc system exhibited spot failures at the previously documented manway area and near the horizontal transition area (water line or weir box) between the zinc and two-coat epoxy systems. Again, it is believed that the failures in the zinc area are the result of application error and not the system itself (Fig. 5).

Fig. 4: 2009 inspection—minor failures in two-coat polyamide epoxy

Fig. 5: 2009 inspection—spot failures of single-coat zinc, attributed to application error

Results of the inspection were reviewed both with the City and a representative of the coating manufacturer. Though both were satisfied with the overall results, a plan for maintenance repairs would need to be developed to minimize expansion of coating failure at the affected areas going forward. At the direction of the City, the engineer was requested to develop an approach in a Request for Quotation (RFQ) format that would incorporate the following:

- notice of invitation,
- project scope,
- time constraints,
- terms and conditions, and
- specifications.

An invitation to bid was sent to three contractors known in the area for the quality of their work and their experience on tank maintenance projects, providing the City with the opportunity to compare costs among three similarly qualified firms.

Although the focus of this case study is based on lining performance in the area above the water line, it should be noted that the general project scope specific to this facility (this was part of a two-tank maintenance project) included complete draining, removal of existing sediment, complete power washing of interior immersion surfaces, surface preparation of identified areas exhibiting rust and corrosion, prime and finish coating of affected areas as applicable, and disinfection of the tank in accordance with AWWA C652.

The project was set to begin in mid-August, with project completion by mid-September. This schedule provided for ample time (four weeks) to get the project completed, the probability of good weather, and a period when the City is just shy of peak water demand.

The specification was put together with the assistance of the coating manufacturer's representative to provide for accuracy and consistency with interpretation of the prod-

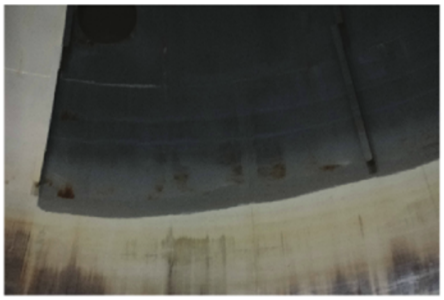

Fig. 6: 2011—Close-up of area for spot repairs of single-coat zinc

Fig. 7: 2011—Example of area for spot repair of two-coat epoxy system

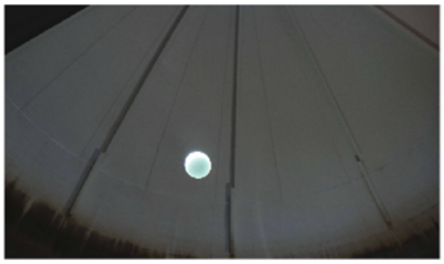

Fig. 8: 2011—Example of area for spot repair of three-coat zinc-epoxy-epoxy system (two-coat epoxy to be used for repair)

uct data sheets and the original specification. Maintenance repairs would involve all areas of the tank, including not only the bowl, but also each of the test areas (starting one foot below the overflow) that are the focus of this article.

Although abrasive blasting was recommended, there was concern with over-blasting, which could cause fracturing of any of the coating systems in the tank. This risk was discussed with the awarded contractor before starting the operation. Therefore, specified surface preparation allowed both SSPC-SP 10, Near-White Metal, and SP 11, Mechanical Cleaning to Bare Metal, to create a minimum one-mil profile, with the method to be determined by the contractor.

Specifications centered on surface preparation and coating application, accounting for means and methods based on conditions identified in the tank's evaluation and respective of the manufacturer's specific product recommendations. The coating application needed to be clearly defined and monitored to prevent system compatibility problems between the single-coat MCU organic zinc system and the polyamide epoxy in the other two systems tested above the water line, especially where the ICS No. 1 and the ICS No. 5 systems met the single-coat system. (Without special provisions in surface preparation, the MCU organic zinc might not be compatible over the epoxy polyamide, but there were no compatibility problems when simply applying the epoxy polyamide over repair areas for the MCU organic zinc of the ICS No. 5 system.) For repairs needed, the single-coat MCU zinc would be used on areas where the zinc itself had been tested originally; for repair of the other two systems tested in the vapor area, two coats of the epoxy polyamide would be used.

The Project

The City awarded the project in 2011. For the tank with the trial areas above the weir box, work began the third week in September. Sediment removal, power washing of the tank's interior surfaces, and rigging were completed first. Then, repair areas within the bowl itself could be readily identified. Repair areas below the weir box (areas in immersion) of the two-coat polyamide epoxy system were few. Spot failures appeared isolated to the rim angle where the bowl shell plate and roof plates met. Most of the repair work, though minimal, was above the water line as previously defined (Figs. 6–8).

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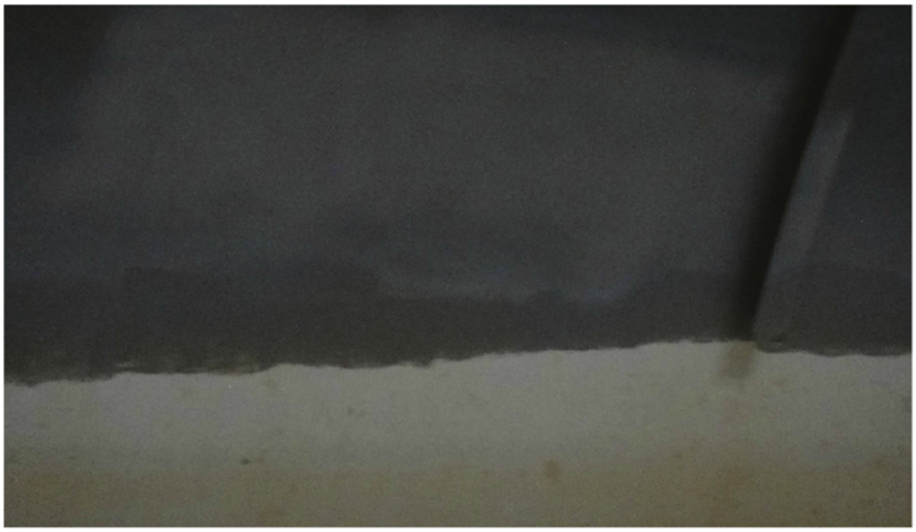

Fig. 9: 2011—Preparation of spot repair area of single-coat zinc

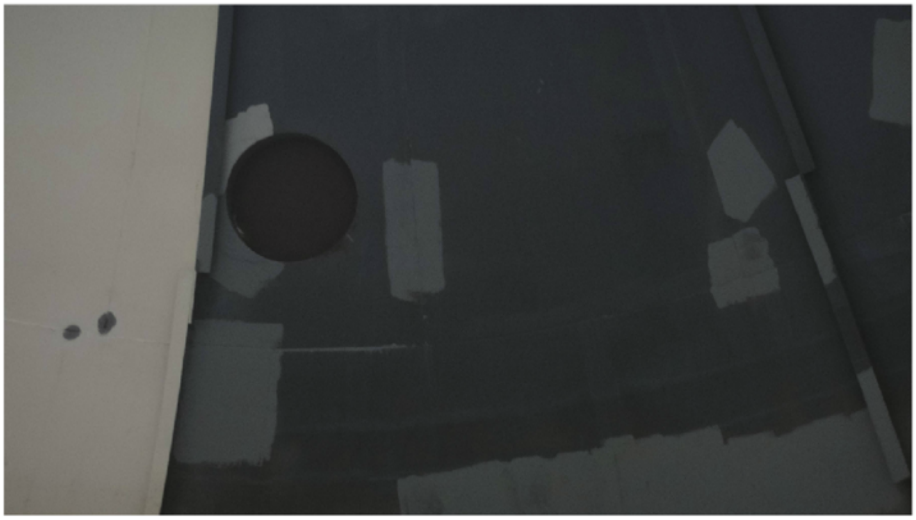

Fig. 10: 2011—Repaired areas of spot failure of single-coat zinc

The entire repair process took two days. Surface preparation and priming of all areas were completed on day one. The contractor elected to spot abrasive blast all areas; this was followed by prime coat application with the MCU organic zinc system in the single-coat zinc segment of the roof and roof support angles (Figs. 9–10). Spots disturbed by abrasive blasting in this designated test area were rolled and edges over-rolled to eliminate any possibility of holidays that could occur from fracturing of the system caused by blast cleaning. The spot repairs of the single-coat zinc accounted for approximately 30 square feet, or 3% of the original 2003 test area.

Next, the contractor prepared the epoxy system (primer) for spot application for both ICS No. 1 and No. 5 (Fig. 11, p. 30). The epoxy system was used for the repair of the original three-coat zinc-epoxy-epoxy (ICS No. 5) system because not only would the epoxy cover the areas disturbed by blasting, but also the areas would very likely be overlapped to ensure that no voids remained. The zinc coating was not used because the manufacturer's data sheets for the zinc indicated that it would not be compatible with the epoxy intermediate and finish coats, and would likely lead to delamination failures in

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the future. In total, the repair area for the tank was approximately 60 square feet, or less than 1%.

The next day, the epoxy finish coat (Fig. 12) was applied over ICS No. 1 and ICS No. 5, and coating cure time began. Five days later, the spot repairs were examined, and a rub test was performed. It showed that curing was complete. The tank was then cleaned (power washed), sealed, and disinfected in accordance with AWWA and as outlined in the specification.

System Value

The Anoka 400,000-gallon legged tank had been in continuous service for eight years before maintenance. The case study of the three interior coating systems—epoxy-epoxy (ICS No. 1), zinc-epoxy-epoxy (ICS No. 5), and the single-coat zinc—showed that each of the standard systems remains viable for consideration when specifying. However, aside from mishaps in the application process, zinc, as part of a complete system, appeared to enhance the service life of the tank's interior surface as compared to the epoxy system alone (above the weir box). Further, a case can be made for single-coat application of zinc in areas above the weir box. Results were surprising: The

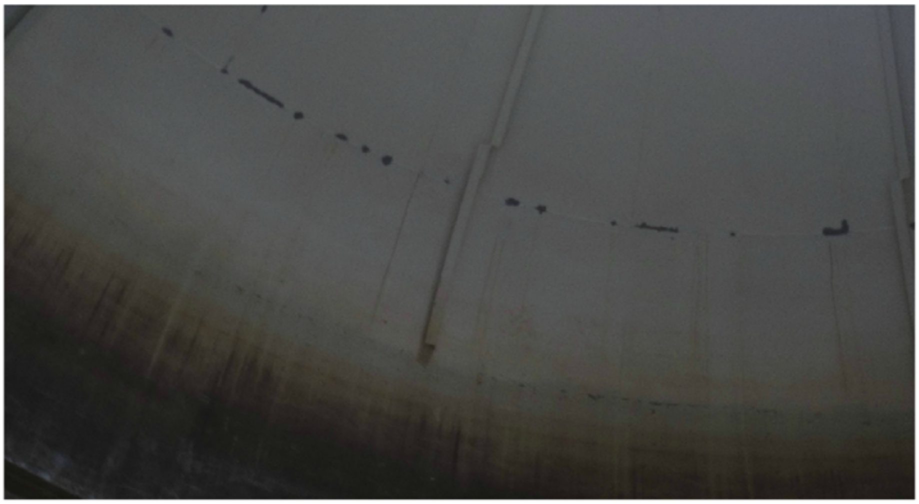


Fig. 11: 2011—Preparation of spot repair areas for two-coat epoxy

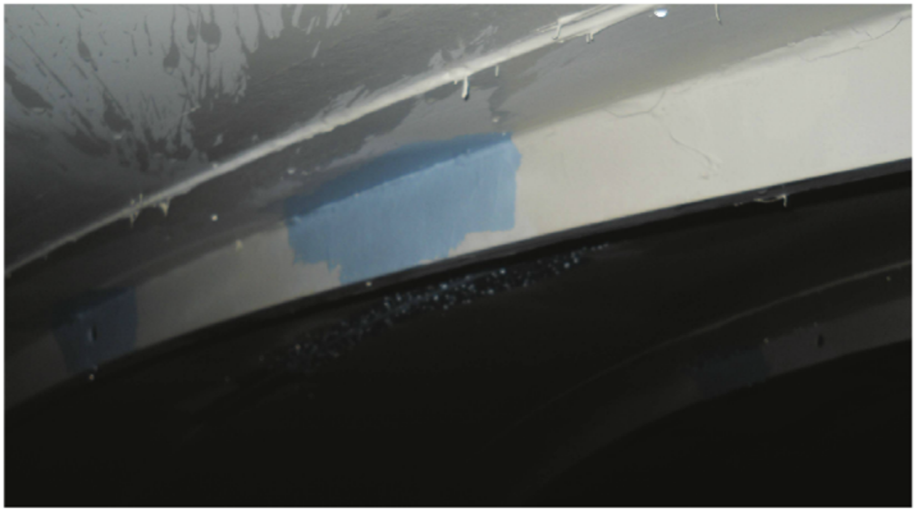
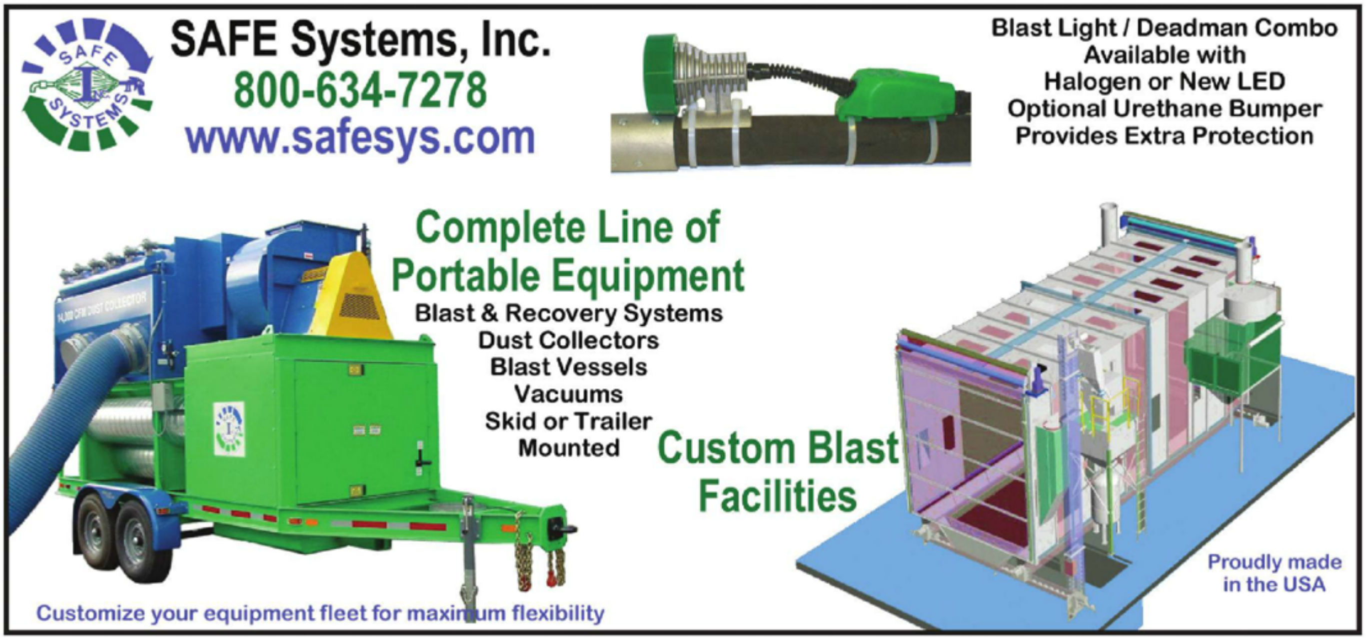


Fig. 12: 2011—Topcoated spot repair area with second coat of epoxy (used for repairs of two-coat epoxy and of three-coat zinc-epoxy-epoxy)



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zinc performed well on both plate and structural surfaces in areas that were both hard-to-coat and consistently in condensation. Though caulking was placed along the intermittent welds, few indications of rusting in this test segment were identified. As with any system, performance is not strictly a matter of formulation for the right service, but adherence to correct application and work practices to obtain the desired end result. For the City of Anoka, this translates into long-term service with minimal maintenance. The next periodic inspection is scheduled for 2016.

Reference

1. Dan Zienty, Lee Dornbusch, and Tony Ippoliti, "Performance or Preference? A Look at Selected Systems for Water Tank Interiors," *JPCL*, May 2007, pp. 23–29.

Editor's Note: This article is based on a paper the author presented at SSPC 2013, the annual conference of SSPC: The Society for Protective Coatings (sspc.org). The paper is published in the conference *Proceedings*.

Dan Zienty has served as a Protective Coatings Specialist at SEH for more than 15 years. He has a Bachelor's degree in Construction Technology from Purdue University and holds several certifications, including NACE International (NACE) Coatings Inspector, SSPC Protective Coatings Specialist, and Supervisor for Deleading Industrial Structures. He has received numerous Engineering Excellence Awards from the Consulting Engineers Council of Minnesota for his work on water tower restorations, and has authored and presented related articles on protective coatings maintenance. Zienty is an active member of SSPC and the treasurer of the North Central Region Chapter of SSPC.

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Developments in Zinc Primers for Corrosion Protection

By Pascal Verbiest, dr.sc., Umicore Zinc Chemicals

Fine zinc powder was recommended for use in paints as long ago as 1840. But it is only in the past 50 years, with the development of zinc-rich paints based on synthetic and inorganic paint resins, that zinc powder has become commonly used, specifically in paints for heavy-duty corrosion protection. The main applications for coatings containing zinc are the long-term corrosion protection of industrial and marine constructions (such as steel infrastructure, pipelines, bridges, windmills, and offshore drilling platforms) and the temporary protection of steel sheets (shop primers) during newbuilding of ships. Zinc coatings are specified in standards such as ISO 12944, Norsok M-501, SSPC-Paint 20, and the new IMO Performance Standard for Protective Coatings (PSPC).

Zinc primers are considered to be the most effective anti-corrosion paint systems in use and have proven their excellent performance over many decades. The thickness of the zinc primers can vary between 10 and 120 microns; the higher the thickness and the higher the zinc powder content are in the paint, the longer the corrosion protection of the steel will last.

Well-known examples of steel structures protected by zinc dust primers are the Beijing National Aquatics Center (the Olympic "water cube") and the Øresund bridge, which connects Sweden and Denmark (Figs. 1 and 2).

Editor's Note: This article is the fourth in *JPCL*'s 2013 series on generic coating types.

Fig. 1: The Beijing National Aquatics Center. The steel construction is protected against corrosion by zinc-rich primers.
Courtesy of the author.

Fig. 2: The Øresund bridge, connecting Sweden and Denmark. The coating system (using a zinc-rich primer) has been designed to protect the bridge against corrosion for a period of at least 100 years.

This article reviews types of zinc powder and how they are made, types and composition of zinc primers, the corrosion protection mechanisms of zinc primers, suitable uses of the primers, and tips on application.

Zinc Powder: The Main Constituent of Zinc Primers

Zinc powders are the main constituent of zinc-rich paints.

There are two groups of processes used to produce metallic zinc powders: the distillation and the atomization processes. The choice of the process and the type of feed (pure zinc or zinc residues) affects the particle size distribution of the zinc powder and its chemical purity.

Powders produced by the atomization and the distillation technology processes have different morphologies. While the atomization process produces spheroidical powders, the distillation process always leads to spherical pow-

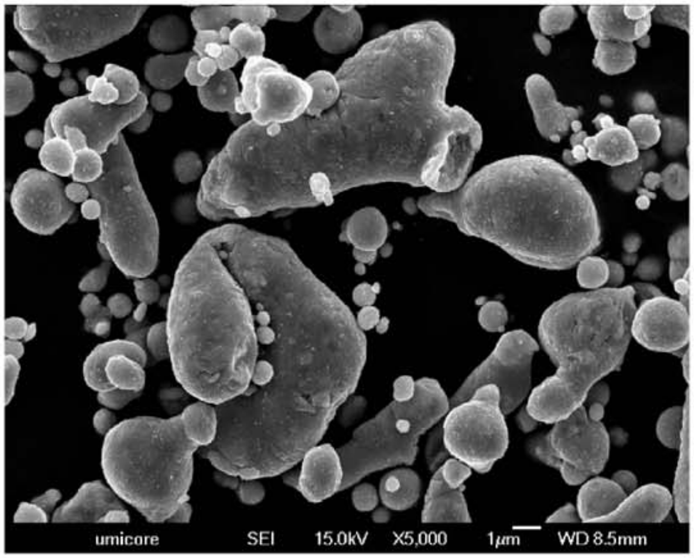

Fig. 3: Spheriodical morphology of an atomized zinc powder

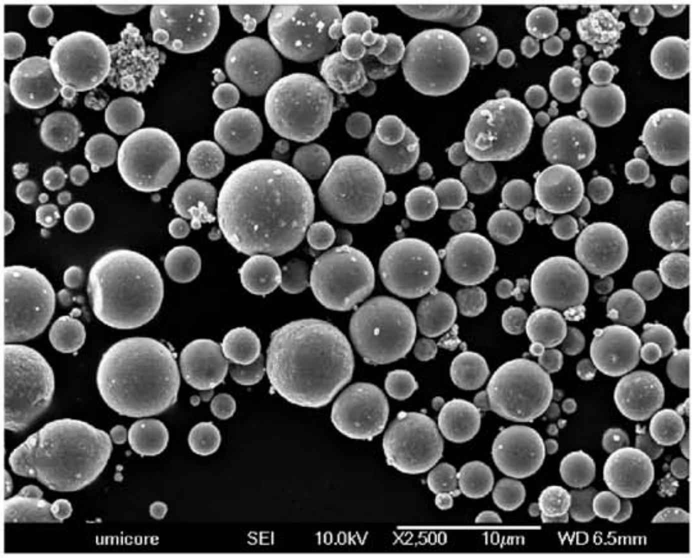

Fig. 4: Spherical morphology of a distilled zinc powder

Table 1: Types of Zinc Powders According to ASTM D520 and ISO 3549

Type of Powder	Type I	Type II	Type III
Total zinc (wt%) min	97.5	98	99
Metallic zinc (wt%) min	94	94	96
Lead (wt%) max	-	0.01	0.002
Iron (wt%) max	-	0.02	0.002
Cadmium (wt%) max	-	0.01	0.001
Zinc oxide (wt %) max	6	Remainder	Remainder
Coarse particles on a 150-micron sieve	None	0.1%	0.1%
Coarse particles on a 75-micron sieve	-	0.8%	0.8%
Coarse particles on a 45-micron sieve	4.0%	3.0%	3.0%

ders. Both morphologies are illustrated in Figs. 3 and 4.

The average particle size of paint-grade zinc powders ranges from 3 to 15 microns. The manufacturer chooses the size based on factors such as the thickness of the paint, paint composition, and paint properties. According to the ASTM D520 and ISO 3549, zinc powders for coatings are divided into three different types (Table 1), depending on their purity and their zinc metal content.

Zinc Primers: Types and Composition

Based on the zinc content, zinc paints can be divided into two categories: zinc-rich primers and zinc primers.

Zinc-rich paints are paints in which zinc powder is the only active pigment, and it is present in levels above 80 wt% in the dry paint film. Because of these high levels of zinc powder, the paint has the qualities of a metallic zinc film, which allows the paint to protect the steel by an additional mechanism—cathodic protection. Zinc-rich paints provide excellent corrosion protection in heavy-duty and marine environments.

Zinc primers with lower zinc content (25%–70%) are used to protect steel in less aggressive environments and to provide temporary corrosion protection. Although they have a lower proportion of zinc, they also provide an excellent barrier coating and hinder the spread of rust from an edge or scratch. Well-known zinc primers are the shop primers—very thin zinc primers (with a thickness of on average 10–15 microns) are used for temporary protection of steel sheets (six months to one year) stored for the newbuilding of ships.

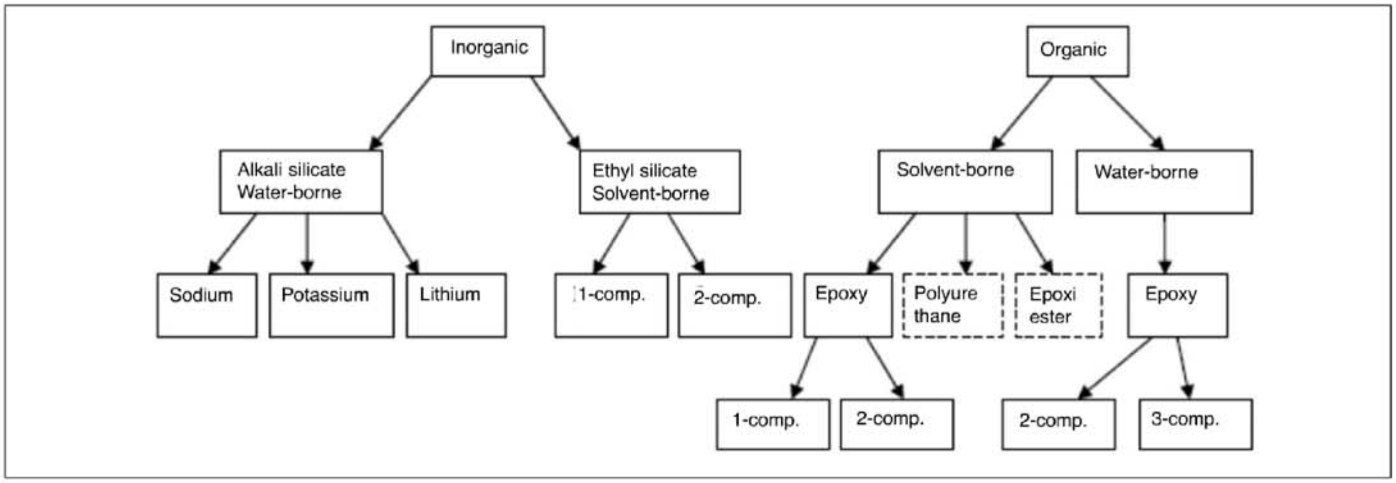

Fig. 5: Division of zinc paints generally used by the paint industry

Zinc powder paints also contain additives for different purposes. Coloring, anti-settling, curing as well as anti-gassing, and thixotropic agents are added.

A more common division of zinc powder paints is based on the binder and the solvent. The main groups used by the industry today are shown in Fig. 5 and described below.

Solvent-borne ethyl silicates are the most commonly used inorganic primers, while zinc epoxies are the most commonly used organic zinc primers.

The solvent-borne epoxies are generally two-component systems. Curing agents consist of polyamides and amine adducts. The waterborne epoxies used to be three-component systems (with zinc dust being one of the components) because a combination of zinc and water will react and create hydrogen gas. New technology has resulted in two-component waterborne epoxies that are stable.

The waterborne silicates can be made with zero VOC and are more environmentally friendly compared to even waterborne epoxies that need co-solvents to ensure good film formation.

Both inorganic and organic zinc primers have many benefits, but some properties are more optimum for a single type of primer. Table 2 compares the different properties of alkali silicate, ethyl silicate, solvent-borne, and waterborne epoxy zinc primers.

Because of the properties shown in Table 2, the areas of use are different for inorganic and organic zinc primers.

Typical applications for inorganic zinc silicates are on barge decks (because of the extremely good abrasion resistance); pipelines; power plants; power transmission lines; bridges; ships; tankers (interior and exterior surfaces, including storage tanks, oil rigs, and offshore drilling platforms); water tanks; and steel to be primed in the shop.

Typical applications for organic zinc epoxies are as high-performance coatings with good flexibility applied to steel substrates that are impossible or hard to blast to Sa 2½ because of cost or accessibility, such as on poorly pre-treated steel; in maintenance projects; and for touch-up of zinc silicate shop-primed steel.

Shop primers already mentioned are a specific type of zinc primer used for the temporary protection of steel sheets.

The high performance shop primers used today are based on zinc ethyl silicate. These shop primers are excellent for welding and cutting

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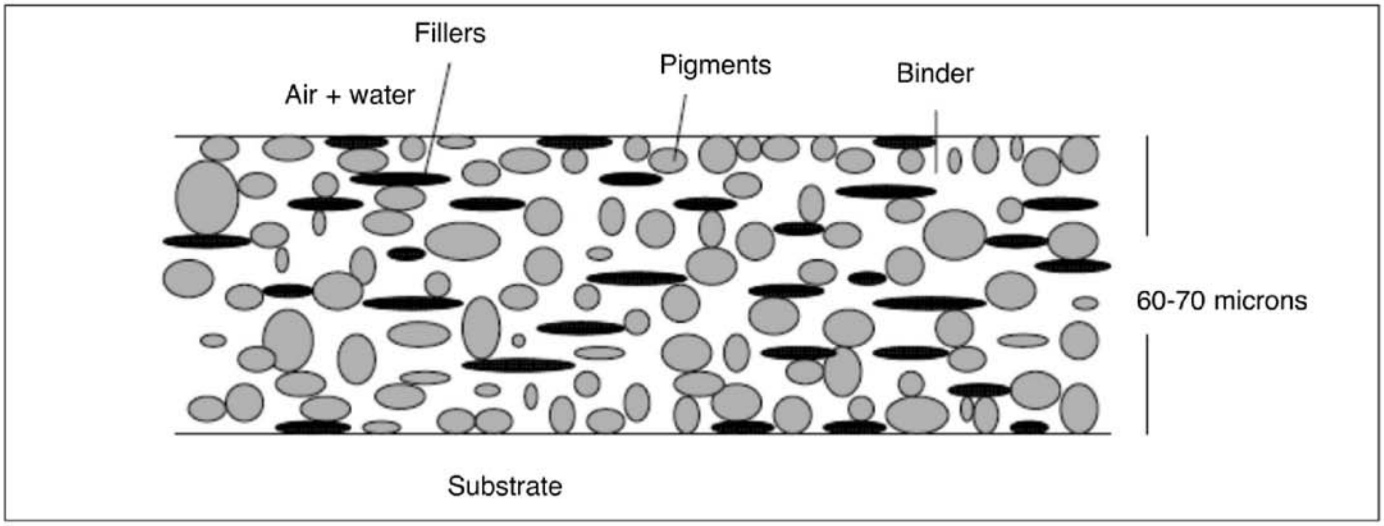

Fig. 6: Barrier effect provided by a zinc primer on a steel substrate

Table 2: Typical Properties of Common Zinc Primers

Property	Alkali Silicate	Ethyl Silicate	Solvent Epoxy	Water Epoxy
Corrosion Protection	Excellent	Excellent	Very Good	Very Good
Topcoating	Fair	Good	Very Good	Very Good
Adhesion	Very Good	Very Good	Good	Good
Cohesion	Fair	Fair	Good	Good
Surface Tolerant	Fair	Good	Very Good	Good
Mud Cracking	Good	Not Good	Very Good	Very Good
Welding	Excellent	Excellent	Fair	Bad
Cutting	Excellent	Excellent	Fair	Bad
Abrasion	Excellent	Excellent	Very Good	Very Good
Flexibility	Limited	Limited	Good	Fair
Shelf Life, Months	9	6	12	12
Curing	5 Days	12 Hours	7 Days	7 Days
Pot Life, Hours	5	8-12	24-48	6
Flash Point	>100°C	<23°C	25-35°C	>100°C
Overcoating interval 23°C/10°C	2h/8h	12h/24h	1.5h/2h	2h/3h
Chemical Resistance	Excellent within pH 6-10	Excellent within pH 6-10	Not Used	Not Used
Heat Resistance	400°C	400°C	120°C	120°C
VOC g/L	0	470	420	140
Vol% Solid	75	60	60	55
Tolerance of High Humidity	Very Good	Excellent	Fair	Very Good
Water Resistance	Very Good	Very Good	Excellent	Very Good
Sovent Resistance	Excellent	Excellent	Very Good	Very Good
Use Friendly	Fair. Need special equipment, and water must be removed for drying.	Good. Needs humidity to cure.	Very Good	Good. Water must be removed for drying.

processes because they do not contain any organic materials when cured. (Any organic material still present in the paint film will contribute to gas formation and to pore formation.) The shop primers are unbeatable on back burning, pore formation, and welding fumes as soon as cured. Uncured ethyl silicate has poor welding and cutting properties because it still contains some organic material. The lower the zinc content is, the quicker the welding of the shop primer is.

Zinc epoxy was used in the shop primer market for some years, but the consumption has decreased considerably. The reasons are the high zinc content and the organic vehicle that creates pores in the welding seams.

Zinc Primers: Corrosion Protection Mechanisms

Zinc primers offer four-fold protection.

- Barrier mechanism, type 1 (Fig. 6)

Zinc primers seal the underlying metal from contact with its corrosive environment by creating a barrier against water and oxygen. The corrosion rate of steel is roughly proportional to the concentration of dissolved oxygen. The barrier restricts the oxygen supply and, as such, is a mode of corrosion prevention.

The barrier protection is a mechanism provided by any type of coating and is not specific to a zinc primer.

- Cathodic protection mechanism (Fig. 7)

Zinc-rich primers provide galvanic (also called cathodic or sacrificial) protection. The zinc will "sacrifice" itself to protect the steel.

Iron is under cathodic protection when its corrosion potential has been lowered beneath the value of -850 millivolts versus SCE (standard calomel electrode). Below this value, iron bears such an excess of negative charges that it is impossible, from a thermodynamic point of view, for ferrous ions to leave the metallic lattice. Iron is said to be in a state of immunity. This very efficient protection can be obtained by a galvanic coupling between iron and zinc. The zinc plays the role of an anode that corrodes sacrificially to protect iron, the cathode, where only reduction reactions can occur.

Zinc-rich primers formulated to protect iron cathodically contain a very high concentration of zinc particles. Indeed, for this mechanism of protection to take place, the zinc particles must be in electrical contact with each other and, in turn, with the iron substrate.

To provide cathodic protection, the paint has to be formulated at PVC = CPVC (pigment volume concentration = critical pigment volume concentration) or at PVC > CPVC. In essence, this means that the zinc loading of the zinc primer has to exceed 80% in the dry film: Only a zinc-rich primer is able to provide cathodic protection.

- Barrier mechanism, type 2

The zinc corrosion products (zinc hydroxides, zinc hydroxycarbonates) formed during the lifetime of a zinc primer block porous regions and thus create a second barrier against corrosion. They also seal damaged regions.

- Alkalinization

It is well known that the corrosion rate of steel is lower in alkaline solutions than in neutral ones. The alkalinization of the electrolyte contained in a zinc-rich primer will occur because the corrosion of the zinc powder gives basic zinc corrosion products (zinc hydroxides, zinc

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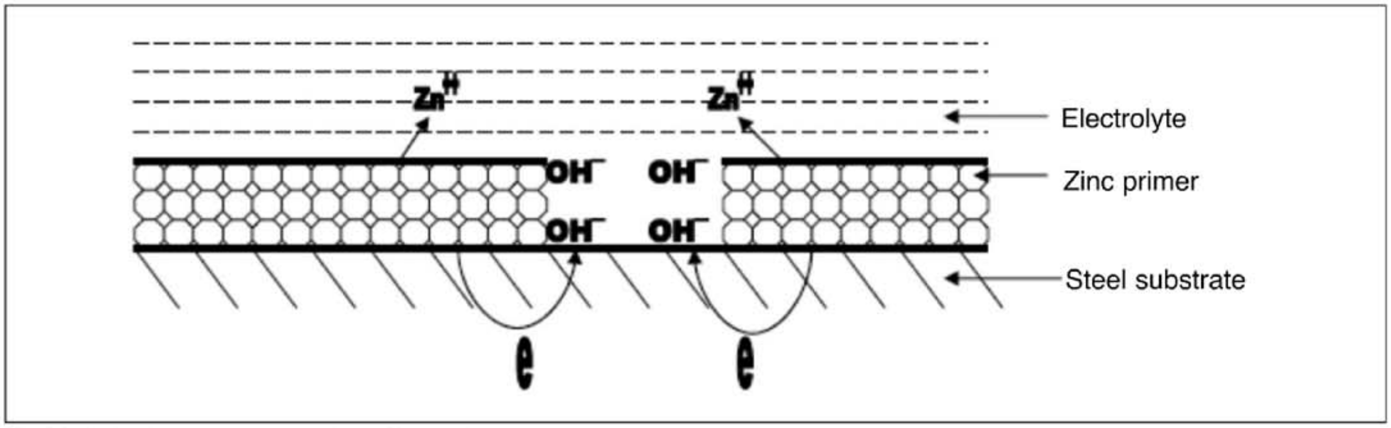

Fig. 7: Cathodic protection mechanism of zinc-rich primers

hydroxyl carbonates, etc.) and because of the formation of hydroxyl ions on the steel surface during the cathodic protection. This alkalinity certainly contributes to the protection of the steel once the cathodic protection is exhausted.

Application of Zinc Primers

To protect the steel adequately, correct surface preparation is required. Zinc ethyl silicate paints do not show either good adhesion or adequate wetting properties because of the nature of the binder. Therefore, the surface of the steel should be prepared by abrasive blasting to an Sa 2 ½ finish, or, for severe environmental conditions and for waterborne silicate primers, an Sa 3 is recommended. In addition, it is generally recommended that the "roughness" of the abrasive blasted surface be in the range 25–45 microns, preferably even at the higher end of this range.

Zinc primers can be applied by conventional or by airless spray techniques.

Zinc primers must be topcoated when exposed to highly aggressive media in order to control the reaction among zinc and water vapor, oxygen, and carbon dioxide coming from the environment.

The most common problem resulting from topcoating is bubble and pinhole formation, a phenomenon attributed almost entirely to zinc silicates. (It rarely occurs with zinc epoxies.) The dry film of most self-curing inorganic silicate paints is very porous. When certain reasonably fast-drying organic topcoats are sprayed over a dry self-curing inorganic zinc coating, the pores in the inorganic zinc film are sealed off, trapping air. Pinholes and bubbles are the result of entrapped air trying to leave the dried paint film. Care needs to be taken during application of topcoats by using a mist coat technique or by using a tie-coat.

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After finishing his master's studies in inorganic chemistry at the University of Ghent (Belgium), Pascal Verbiest obtained a Ph.D. in Inorganic Chemistry, focused at Reactions of Organotin-halides, in 1991. His career started at the Belgian steel company Sidmar (now ArcelorMittal) as a researcher in the field of enamelling steels.

In 1994 he joined Umicore as a Research Manager in Overpelt, Belgium (at the Business Unit Industrial Products), and then moved to Umicore Research in Olen, Belgium, in 1997 as Senior Project Manager. Since 2000, he has been part of the BU Zinc Chemicals, focusing on development projects related to zinc oxide and zinc powder in a variety of applications (paints, rubber, cosmetics). In 2009 he became Head of Product Development at the Business Unit Zinc Chemicals. **JPCL**


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IS LEAD DEAD?

A LOOK BACK and a LOOK FORWARD at 20 YEARS OF BRIDGE PAINTING UNDER THE OSHA LEAD IN CONSTRUCTION INTERIM FINAL RULE AND OTHER RELATED STANDARDS

By Alison B. Kaelin, CQA, ABKaelin, LLC

On May 4, 2013, OSHA's standard for protecting construction workers from lead exposure (29 CFR 1926.62) celebrated its 20th anniversary. Initially titled, "Lead Standard: Interim Final Rule on Lead Exposure in Construction," and now simply titled "Lead," 1926.62 was issued because of what was known at the time about the health risks of overexposure to lead—risks such as neurological disorders and reproductive problems. Despite 20 years of training and education for 1926.62 as well as enforcement of it, Occupational Safety and Health Administration (OSHA) statistical data from October 2011 through September 2012 for citations for the SIC code most commonly used for bridge painters, 1721, Painting/Paper Hanging, indicates that citations under 1926.62 remain the top regulatory finding for painting. Moreover, that finding mirrors the regulatory findings over the past 10 years.

This article will report statistics on violations of 1926.62 among painting and other construction trades; summarize findings on blood lead levels and current knowledge about the health risks lead exposure poses; review 1926.62 and related regulations affecting lead exposure; and offer observations, recommendations, and questions for owners and others involved with lead paint removal on bridges and other structures.

OSHA Enforcement of 29 CFR 1926.62

Table 1 presents data from OSHA on lead violations from October 2011 through September 2012 in a variety of trades, including painting, based on their SIC codes. (SIC codes 15, 16, and 17 address building and general construction, heavy construction, and special trades.) The data in Table 1 shows that for every inspection of the trades identified, an average of 2 to 12 citations per inspection are issued under 1926.62, with the main code for painters, 1721, showing an average of 4.4 citations per inspection. The sidebar on past and current enforcement of 1926.62 on bridge painting jobs also demonstrates that in some cases, OSHA is still finding egregious violations of 1926.62.

Blood Lead Levels

Blood lead level (BLL) data is no more encouraging than enforcement data for 1926.62. The lead standard for construction requires provision of medical exams and more frequent testing when BLLs are greater than or equal to (≥) 40 micrograms per deciliter (µg/dL), and it establishes a temporary removal threshold due to elevated blood lead level when testing performed at least two weeks apart results in BLLs ≥ 50 µg/dL.

The state-based Adult Blood Lead Epidemiology and Surveillance (ABLES) program, which has tracked laboratory-reported BLLs in U.S. adults since 1994, reported that in 2010, 31,081 adults had BLLs ≥10 µg/dL; among these, 1,388 had BLLs ≥40 µg/dL.

The ABLES database for the construction sectors most associated with bridge painting and construction demonstrates that despite the 50% decrease in the national prevalence rates of BLL ≥25 µg/dL levels over the past 17 years, levels remain relatively high in the construction sectors (Table 2).

While Table 2 indicates a consistent decrease in Group 17: Construction Special Trade Contractors from 2002–2008, it also demonstrates that incidences of BLLs above 25 µg/dL are 5 to 10 times those of other construction SIC codes. Table 2 also shows that BLLs for the other SIC codes for construction (Group 15 and Group 16) declined in

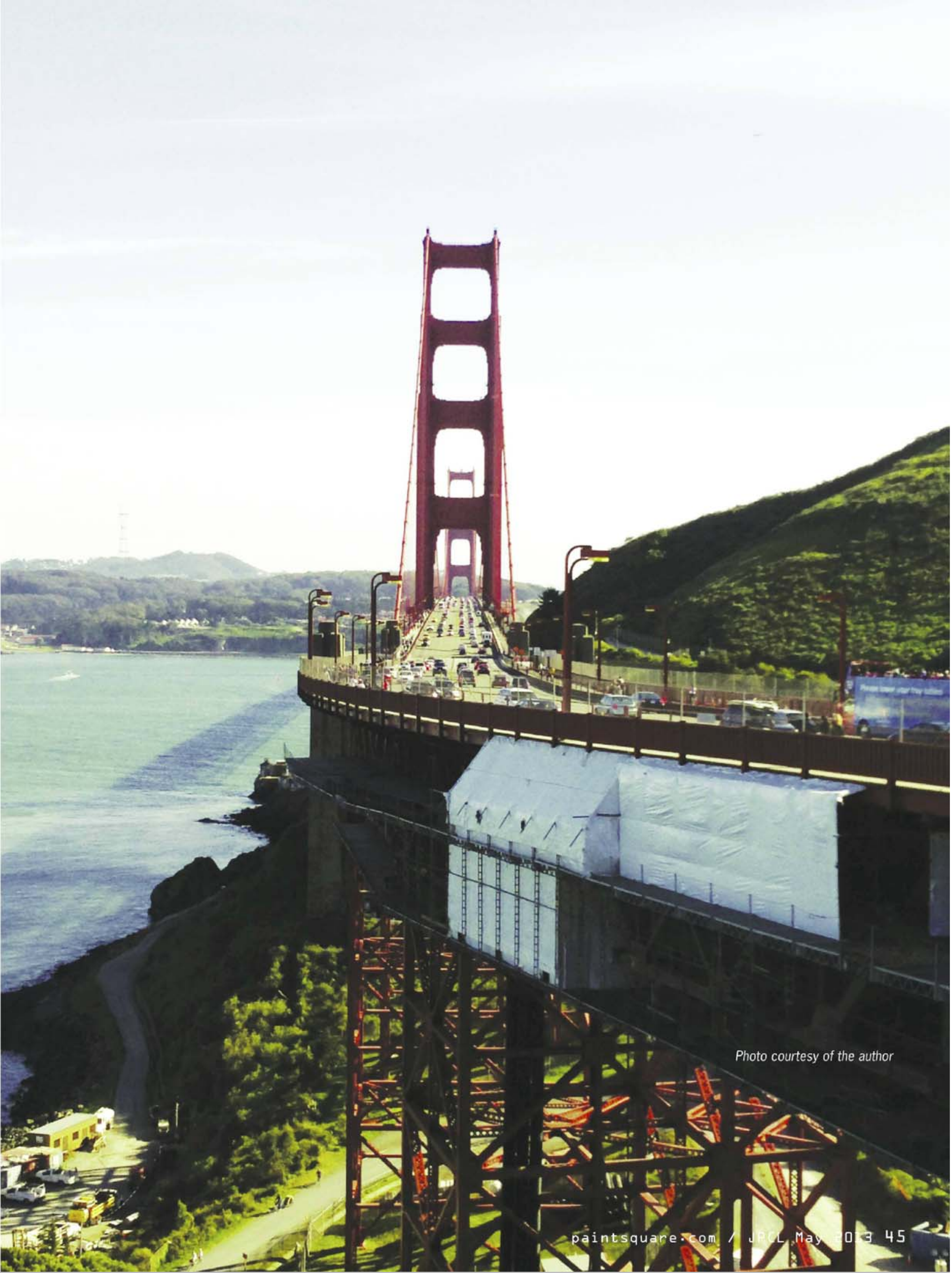

Photo courtesy of the author

Table 1: Violations of 29 CFR 1926.62, Oct. 2011–2012, by 4-Digit SIC Industry Group

Number of Citations	Number of Inspections	Penalty Amounts ($)	Industry Classification
31	7	34,035	1721/Painting and Paper Hanging
27	10	32,451	1795/Wrecking and Demolition Work
18	8	6,688	1799/Special Trade Contractors, Not Elsewhere Classified
12	1	19,175	1791/Structural Steel Erection
8	2	3,600	1542/General Contractors-Nonresidential Buildings, Other than Industrial Buildings and Warehouses
6	2	3,375	1794/Excavation Work
5	2	3,210	1741/Masonry, Stone Setting, and Other Stone Work
4	2	4,788	1541/General Contractors-Industrial Buildings and Warehouses
4	2	7,000	1629/Heavy Construction, Not Elsewhere Classified

Table 2: Number of Adults with BLL ≥ 25 µg/dL by Industry Subsector in the Construction Sector

CONSTRUCTION SUBSECTOR	SIC CODE	2002	2003	2004	2005	2006	2007	2008
Building Construction General Contractors and Operative Builders	15	105	61	24	42	25	84	85
Heavy Construction other than Building Construction Contractors	16	175	212	98	90	111	57	145
Construction Special Trade Contractors	17	967	913	852	760	699	616	574

the early 2000s but appear to have increased in the later 2000s.

ABLES has concluded that because BLLs are often not available for many lead-exposed workers (either not tested or not reported), ABLES data should be considered a low estimate of the true magnitude of elevated adult lead exposures in the United States.

Moreover, recent research on health effects of lead (discussed further in the next section) has led to increased concerns about the toxicity of lead at low doses. Therefore, in 2009, the ABLES program updated its case definition for an elevated BLL to a blood lead concentration ≥10 µg/dL.

In 2010, using the new elevated BLL case definition, the ABLES program reported a rate of 26.4 adults with BLLs ≥10 µg/dL per 100,000 employed. ABLES estimates that 95% of adult BLLs above 25 µg/dL are work-related, with the data indicating that lead remains a national occupational health problem and that continued efforts are needed to reduce lead exposures.

New Studies and Health Effect Data

On June 13, 2012, the National Toxicology Program (NTP, U.S. Department of Health and Human Services) issued, "Monograph on Health Effects of Low-Level Lead." It was based on NTP researchers' evaluations of over 28,900 publications on health effects and exposure to lead. The publications were peer-reviewed literature related to the adverse health effects occurring at BLL of <5 and 10 µg/dL in adults and children. Researchers categorized conclusions drawn from the evaluation as having data that was sufficient, limited, or inadequate. They concluded that the health effects at the BLLs identified in Table 3 have sufficient or limited supporting data.

Unlike OSHA, the EPA is required to periodically evaluate new scientific evidence and draw conclusions and causal judgments (cause-and-effect relationships) regarding air pollution-related health and environmental effects of lead. In November 2012, the EPA issued its Third Draft Integrated Science Assessment (ISA) for Lead (Related to NAAQS-Lead). Some highlights of the third ISA include the following:

- supports existence of a causal relationship for the health effects of lead for children and adults that were expressed in the NTP report;
- identifies historical and newly deposited lead in soils (which is re-entrained and distributed nearly continuously) as a significant exposure pathway for lead;
- identifies a likely causal relationship between lead and cancer;

Table 3: Summary of Health Effects Categorized as Limited and Sufficient

Health Area	Population or Exposure Window		NTP Conclusion	Principal Health Effects	Blood Lead Level Evidence
Neurological	Prenatal		Limited	Decrease in measures of cognitive function	Yes, <5 µg/dL
			Limited	Decreased IQ, increased incidence of attention-related and problem behaviors, decreased hearing	Yes, <10 µg/dL
	Children		Sufficient	Decreased academic achievement, IQ, and specific cognitive measures; increased incidence of attention-related and problem behaviors	Yes, <5 µg/dL
			Sufficient	Decreased hearing	Yes, <10 µg/dL
	Adults		Sufficient	Increased incidence of essential tremor	Yes, <10 µg/dL
			Limited	Psychiatric effects, decreased hearing, decreased cognitive function, increased incidence of ALS	Yes, <10 µg/dL
			Limited	Increased incidence of essential tremor	Yes, <5 µg/dL
Immune	Children		Limited	Increased hypersensitivity/allergy by skin prick test to common allergen and IgE (not a health outcome)	Yes, <10 µg/dL
Cardiovascular	Adults		Sufficient	Increased blood pressure and increased risk of hypertension	Yes, <10 µg/dL
			Limited	Increased cardiovascular-related mortality and ECG abnormalities	Yes, <10 µg/dL
Renal	Adults		Sufficient	Decreased glomerular filtration rate	Yes, <5 µg/dL
	Prenatal		Limited	Reduced postnatal growth	Yes, <10 µg/dL
	Children		Sufficient	Delayed puberty, reduced postnatal growth	Yes, <10 µg/dL
			Limited	Delayed puberty	Yes, <5 µg/dL
Reproductive and Developmental	Adults	Women	Sufficient	Reduced fetal growth	Yes, <5 µg/dL
			Limited	Increase in spontaneous abortion and preterm birth	Yes, <10 µg/dL
		Men	Sufficient	Adverse changes in sperm parameters and increased time to pregnancy	Yes, ≥15-20 µg/dL
			Limited	Decreased fertility	Yes, ≥10 µg/dL

- confirms causal health effects on plants, and on vertebrae and invertebrates; and
- states that evidence strongly suggests that cumulative exposure plays a role in adult renal and cardiovascular effects.

Each of the ISAs have shown that progressively lower BLL and airborne exposures are associated with cognitive deficits and behavioral impairments in children and adults.

A December 2012 National Research Council of the National Academies publication, "Potential Health Risks to DOD Firing-Range Personnel from Recurrent Lead Exposure," affirms that the current OSHA standard is inadequate for the protection of DOD and other worker populations, and the publication suggests that reductions in BLL and airborne concentrations are necessary.

It seems that despite 20 years of OSHA regulation and enforcement, we continue to fall short of regulatory compliance with the Lead Standard. At the same time, multiple scientific studies have proven that there are more health effects (including potential cancer risks) at far lower levels than OSHA or the bridge and painting industry ever considered. In light of both trends, the next section of this article reviews the regulations that were put in place around the time of 1926.62, notes the limitations of those regulations, and evaluates what changes (if any) have been made or are currently being considered.

Regulations: Background (Then And Now)

Definitions of Lead in Paint

Consumer Product Safety Act

The 1978 Consumer Product Safety Act (CPSA), applicable to the manufacturing of coatings for consumer use, banned paint and similar surface coatings that contained lead or lead compounds and had lead content (calculated as lead metal) in excess of 0.06 percent of the weight of the

Table 4: Current vs. Revised Labels and Signs, Based on the 2012 HCS

CURRENT LABEL TEXT	**REVISED LABEL TEXT**
CAUTION: CLOTHING CONTAMINATED WITH LEAD. DO NOT REMOVE DUST BY BLOWING OR SHAKING. DISPOSE OF LEAD CONTAMINATED WASH WATER IN ACCORDANCE WITH APPLICABLE LOCAL, STATE, OR FEDERAL REGULATIONS	DANGER: CLOTHING AND EQUIPMENT CONTAMINATED WITH LEAD. MAY DAMAGE FERTILITY OR THE UNBORN CHILD. CAUSES DAMAGE TO THE CENTRAL NERVOUS SYSTEM. DO NOT EAT, DRINK OR SMOKE WHEN HANDLING. DO NOT REMOVE DUST BY BLOWING OR SHAKING. DISPOSE OF LEAD CONTAMINATED WASH WATER IN ACCORDANCE WITH APPLICABLE LOCAL, STATE, OR FEDERAL REGULATIONS
CURRENT SIGN TEXT	**REVISED SIGN TEXT**
WARNING: LEAD WORK AREA POISON NO SMOKING OR EATING	DANGER: LEAD MAY DAMAGE FERTILITY OR THE UNBORN CHILD. CAUSES DAMAGE TO THE CENTRAL NERVOUS SYSTEM. DO NOT EAT, DRINK OR SMOKE IN THIS AREA

dried paint (or 600 parts per million, ppm). CPSA also declared such products as hazardous. This definition and Act explicitly applied to manufacturing of interior and exterior house paints intended for consumer use where risk of childhood lead poisoning exists. The definition and Act has never applied to coatings designed for industrial use.

The Consumer Product Safety Improvement Act of 2008 lowered the allowable concentration of lead in residential paint from 0.06 percent (600 ppm) to 0.009 percent (90 ppm).

HUD Guidelines

The Lead-Based Paint: Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing (referred to as the HUD Guidelines) were introduced in 1986 to address when abatement of lead-based paints would be required in residential housing. HUD established a level of 5,000 ppm to trigger the removal of lead-based paints. HUD based the level on the detection capabilities of X-ray fluorescent analyzers (XRF) of 1.0 mg/cm^2, equivalent to 0.5% (5,000 ppm). The level of 5,000 ppm was technology-driven and has no direct correlation between the lead-related health effects. The HUD Guidelines were updated in 1987, 1988, 1990, 1995, 1997, and 2012. The HUD definition of lead paint of 0.5% (5,000 ppm) was adopted in the Lead-Based Paint Hazard Reduction Act (Title X) of 1992 and 40 CFR 745, Lead; Identification of Dangerous Lead Levels—Final Rule of 2001.

In HUD's July 2012 update of its Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, it did not lower the lead level in its definition of lead in paint (0.5%); however, HUD stated that "HUD and EPA are collaboratively considering whether to lower the threshold level of lead-based paint; they are also looking into whether to lower the lead dust hazard standards... HUD, consistent with EPA, CDC and OSHA, notes that paint with lead that is deteriorated or disturbed, even if its lead content is below the current EPA and HUD standards, may still pose a human health hazard..."

Fig. 1: Hazards That Must Be Addressed for Inorganic Arsenic, Hexavalent Chromium, and Lead (based on HCS)

Inorganic Arsenic	Hexavalent Chromium	Lead
Cancer	Cancer	Reproductive/developmental toxicity
Liver effects	Lung effects	Central nervous system effects
Skin effects	Kidney effects	Kidney effects
Respiratory irritation	Acute toxicity effects	Blood effects
Nervous system effects		Acute toxicity effects
Acute toxicity effects		

The Children's Health Protection Advisory Committee (CHPAC) has petitioned EPA and HUD to reduce paint and dust thresholds.

The 1993 OSHA lead standard for construction concluded that in the absence of any health-based values, the initial protection portions of the standard would apply if any concentration of lead is present in the coating. This requirement remains in effect today. Thus, in 1926.62, OSHA did not define or establish a threshold level for lead in paint.

Worker Protection (OSHA)

The Residential Lead-Based Paint Hazard Reduction Act, also known as Title X, was enacted to protect families from exposure to lead from paint, dust, and soil. In one part of Title X, Congress directed OSHA to issue a rule to protect workers from exposure to lead in construction (1926.62). The standard was to be as protective as the 1990 HUD Guidelines in place at the time, which were based on the general industry lead standard (1910.1025) published in 1978; however, OSHA had previously said that 1910.1025 would not work in the construction industry. Thus, from the day it was published, 1926.62 was insufficient to truly protect the health of the industrial blasters, painters, or workers in other construction trades.

To issue a standard as soon as possible, OSHA was allowed to bypass normal rule-making procedures, which require issuing a notice of proposed rule subject to public comment before publishing a final rule. As a result, the current standard was not subject to any public or industry input, and was published as an

Table 5: A Summary of Lead-Related Limits and Standards in Place from the Late 1980s to Current

	1980s - 1990s (Then)	1990s – 2000s	> 2010s (Now)
Lead in Paint			
HUD Guidelines (Lead in Paint)	1985 5,000 ppm (0.5 %)	1995/1997 5,000 ppm (0.5 %)	2012 Reductions to paint level being considered
CPSA Lead in Residential Paints	1978 600 ppm (0.06 %)	2008 90 ppm (0.09%)	Same
OSHA	1993 Any	Same	Same
Lead in Dust			
HUD Guidelines (Lead Dust in Housing)	1986-1990 Window troughs - 800 µg/ft^2 Window sills - 600 µg/ft^2 Floors - 200 µg/ft^2	1995/1997 Window troughs - 400 µg/ft^2 Window sills - 200 µg/ft^2 Floors - 40 µg/ft^2	2012 Guidelines Updated. Reductions to dust levels being considered
Lead in Blood			
CDC (Children BLLs)	1985 25 µg/dL to 30 µg/dL	1991 10 µg/dL	2012 5 µg/dL
ABLES (Reporting Adult BLLs)	N/A	>25 µg/dL	>10 µg/dL
US DHHS Recommendation (Adult BLLs)	N/A	N/A	<10 µg/dL
OSHA Lead Standard BLLs	N/A	50 µg/dL (Medical Removal)	Same
Lead in Air			
OSHA Lead (Worker Airborne Exposures)	1992 Action Level - 30 µg/m^3 8-hr TWA PEL - 50 µg/m^3 8-hr TWA	Same	Same
NAAQS for Lead (Ambient Air)	1976 1.5 µg/m^3 over 90 day average	2008 0.15 µg/m^3 over 3 month rolling average	Same
Lead in Soil			
Lead in Soil 40 CFR 745 (Title X) Residential	None	2001 400 ppm play areas 1,200 ppm yard	Reductions to soil levels being considered
Lead in Waste			
RCRA Lead Hazardous Waste	1976 5 mg/L	1984 (Land Ban) 5 mg/L Stabilization to 0.75 mg/L	Same

"interim" final rule. This rule became partially enforceable June 3, 1993, and fully enforceable in October of 1993.

On December 13, 1993, OSHA issued a compliance directive for 1926.62. The compliance directive (OSHA Instruction CPL 2-2.58) established OSHA's interpretation of how the requirements of the standard would be enforced by compliance officers during site surveys.

In 1996, OSHA established a Special Emphasis Program: Lead in Construction (OSHA Instruction CPL 2.105). In it, OSHA offices nationwide were directed to rigorously enforce 1926.62 and the previous compliance directive, with specific emphasis on lead paint removal projects, including bridges.

In July of 2001, OSHA issued a National Emphasis Program (NEP) for Lead (CPL 02-00-130). OSHA reissued the NEP for lead (CPL 03-00-009) in August of 2008.

In 2008, as part of the OSHA NEP for Lead, OSHA started using ABLES data to initiate investigations and promote prevention in industries with BLLs above 25 µg/dL. This NEP remains in effect today and specifically targets the construction subsector SIC codes of 15, 16, and 17.

There have been no changes to 1926.62 (other than those related to the changes in other standards) since 1993.

California Department of Health/Occupational Lead Poisoning Prevention Program

In April 2011, the California Department of Health/Occupational Lead Poisoning Prevention Program (OLPPP) began providing information to support revisions to the 30-year-old Cal/OSHA Lead in Construction Standard, with recommendations based on more recent health-based scientific evidence. OLPPP suggests the following changes are necessary.

- Provide medical surveillance, including blood lead level (BLL) testing, to all employees likely to be exposed to lead, including annual blood pressure measurements and questionnaires regarding lead-related medical conditions.
- Require all employees subject to medical surveillance to have a BLL test at least every month for the first three months or upon change in task to a higher exposure, and then every six months thereafter. Test employees with a BLL at or above 10 µg/dL at least every three months, and test those with a BLL at or above 20 µg/dL at least every four weeks. Once three consecutive BLLs, taken at least four weeks apart, indicate a BLL below 10 µg/dL, the testing reverts to at least every six months.
- Remove workers from lead exposure if a single blood lead concentration is at or above 30 µg/dL or if two successive blood lead concentrations measured over a four-week interval are at or above 20 µg/dL.
- For employees who have been medically removed from work, return them to work when two blood lead tests taken four weeks apart are below 15 µg/dL.
- Reduce the Permissible Exposure Limit (PEL) and Action Level (AL) to achieve lower BLLs to reflect new medical/toxicological information on chronic and low-level health effects.
- Require regular testing of surfaces in eating areas and change areas and more frequent cleaning if lead is found. Establish a quantitative limit for lead on surfaces and specify sample collection and analysis methods.
- Conduct employee training quarterly. Maximize the use of participatory and hands-on methods during training.
- Post warning signs in areas where lead is present.
- Establish and require minimum engineering and work practice controls unless the employer can demonstrate that such controls are not feasible. Ban high-risk work practices.

Examples of Past and Current OSHA Enforcement of 1926.62 on Bridge Projects

Then

The first major enforcement action under 1926.62 was initiated in December 1993 to E. Smalis Painting Co. (Smalis) and resulted in the issuance of a proposed total penalty of $5,008,500. The penalty was ultimately reduced to $1,092,750. Some of the citations were categorized as serious and willful, in part because Smalis had been cited on the same project under general OSHA standards in 1992 (prior to the Lead Standard).

The citations included allegations of lead overexposure (monitoring showed worker exposures inside containment to range from 12,604 µg/m^3 and 33,458 µg/m^3, failure to have a lead compliance program, failure to maintain employee injury and illness records, failure to provide OSHA with access to employee medical records, failure to implement proper engineering and work practice controls, and failure to monitor for overexposure. In addition, OSHA cited Smalis for failing to provide its employees with training, adequate respiratory protection, hygiene facilities/practices, medical surveillance, medical removal protection and benefits, and notification of blood lead levels (BLLs) and removal benefits.

Another major enforcement action under 1926.62 was initiated in 1994 against Manganas Painting Co, Inc. The citations resulted in proposed penalty amounts of $2,452,500, ultimately reduced to $239,650. The citations included allegations of lead overexposure and failures to monitor all employee exposures, require employees exposed above the PEL to shower, implement medical surveillance, and provide notification of BLLs and removal benefits.

Now

In January 2013, OSHA issued substantial citations against a bridge painting contractor that included 38 alleged willful and repeat violations for allegedly endangering employees while performing abrasive blasting and repainting of bridges at three different job sites in 2011 and 2012. Alleged citations related to 1926.62 include the following.

- Failure to provide a HEPA vacuum for decontamination from lead (This citation was also issued under the Cadmium Standard.)
- Employee exposures above the PEL not controlled by engineering and work practices
- Failure to ensure that employees exposed above the PEL showered
- Failure to conduct initial airborne exposure monitoring, biological monitoring, training; failure to provide appropriate respiratory protection and personal protective equipment for power tool operators, containment movers, and employees performing blow-down and clean-up
- Failure to provide notification of biological monitoring and airborne exposure monitoring
- Failure to make initial and periodic biological monitoring available to affected employees
- Failure of written compliance program to contain all required information
- Failure to prevent presence of consumption of food, beverages, and cigarettes when exposures exceed the PEL
- Failure to clean protective clothing or properly store protective clothing after use
- Failure to use signs

While these citations may be considered to be indicative of rogue painting companies, they demonstrate that after 20 years of enforcement, we are still likely to see gross violations of 29 CFR 1926.62.

While none of the above has become law, OLPPP also has a series of posters for occupational adult workers. The posters inform workers about suggested blood lead levels of less than 10 µg/dL, recommend hygiene and housekeeping practices, and outline potential health effects of lead for adults.

Hazard Communications Standard

The 2012 revisions to the Hazard Communication Standard, or HCS (See *JPCL*, May 2012) modify the language used on signs and labels related to 1926.62 to include the words "Danger" or "Warning" and to include specific references to key health effects. Over the next few years, labels and signs for lead will change, as shown in Table 4.

The HCS also requires chemical manufacturers and importers to evaluate and classify each of their chemicals based on new performance-based criteria, to determine the physical and health hazard classes based on 16 physical hazards, 10 health hazards and one environmental hazard and to "identify and consider the full range of available scientific literature and other evidence concerning the potential hazards." The HCS specifically requires classifications of hazards for lead, arsenic, and hexavalent chromium (Fig. 1, p. 50).

Evaluations and classifications that the HCS requires are already being seen in revisions to safety data sheets for abrasives, coatings, solvents, and other materials used in the bridge painting industry. The identification of the presence of lead and hazardous metals in materials and abrasives may result in 1926.62 and other comprehensive health standards being applicable new construction projects involving abrasive blast cleaning (even when no old coatings are involved).

Worker Certification and Training (HUD/EPA)

Title X also directed EPA to add lead to the Toxic Substance Control Act (TSCA) and to establish a model training curriculum, accredit training providers, and certify lead professionals and workers.

EPA published the final rule for housing and child-occupied facilities (40 CFR 745) in 1996. EPA specifically determined that these regulations were not applicable to industrial operations and removed any industrial requirements before issuing the final rule.

The SSPC C-3 Course, Competent Person/Supervisor Course for Deleading of Industrial Structures, was developed to try to meet the expected EPA training requirements for industrial painting; without the course, coatings professionals would have little or no industry-specific training.

In July 2012, HUD updated its Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing for the first time since 1997.

EPA has proposed new regulations under 40 CFR 745 for Lead; Renovation, Repair, and Painting Program for Public and Commercial Buildings. The proposed regulations are similar to the 2001 regulations for residential housing lead abatement but would apply to public, commercial, and institutional buildings. EPA is currently accepting comments on these regulations.

EPA

National Ambient Air Quality Standards for Lead

Ambient lead emissions were addressed in 40 CFR 50.12, "National Primary and Secondary Ambient Air Quality Standards for Lead" (NAAQS for Lead). The criterion for the NAAQS for Lead was established in the 1970s as 1.5 µg/m^3, expressed as a maximum arithmetic mean averaged over a calendar quarter. NAAQS for Lead was used extensively from

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1986 onward as a means of evaluating the effectiveness of containments and to "verify" that the public was not negatively affected by industrial painting operations.

In 2008, the NAAQS for Lead was reduced to 0.15 $\mu g/m^3$ expressed as a three-month rolling average. The value is now fully in effect. Several areas of the country are not in attainment with this value. It is uncertain whether monitoring performed at or near industrial painting projects can meet this level due to a variety of factors, including the duration of monitoring, laboratory detection limits when flame atomic absorption spectroscopy is used, and the effectiveness (or lack thereof) of the containment and ventilation systems employed.

Clean Water Act (CWA)

The Clean Water Act does not permit lead debris to enter bodies of water or storm sewers, or to be located in areas where wind or rainwater could transport it into bodies of water. Storm water management regulations under the Clean Water Act also prohibit the release or storage of lead and other hazardous materials on the ground where it can be carried into waterways and storm water management systems.

There are several petitions requesting the EPA to reduce the drinking water standards for lead and chromium.

Waste Handling and Disposal

The Code of Federal Regulations addresses waste handling, storage and disposal issues, particularly in terms of hazardous waste, under sections 40 CFR Parts 260-265 and 268. These sections are often referred to as the Resource Conservation and Recovery Act (RCRA). Waste determined to be hazardous through analysis using the Toxicity Characteristic Leaching Procedure (TCLP) must be handled, stored, transported, and disposed of in compliance with RCRA. The hazardous concentration for lead is 5.0 mg/L.

The Hazardous and Solid Waste Amendments (better known as Land Ban), issued in 1984 and phased in over the next 10 years, banned the addition of iron filings to lead-containing debris (as illegal treatment), prohibited land disposal of many hazardous wastes, and required that lead hazardous waste be stabilized to 0.75 mg/L before disposal.

The ban on adding iron filings to lead-containing debris and subsequent studies shed light upon the fact that during TCLP testing, small particulates of iron (and steel) in the lead debris will plate the lead and make it non-detectable during analysis, giving the appearance of passing the TCLP.

The EPA issued various memoranda and interpretations stating that the addition of iron (steel) to lead debris is not effective for long-term stability and is only a temporary stabilizer and that further stabilization is necessary. The EPA also stated that waste generators who do not stabilize lead-containing waste resulting from blast cleaning with iron/steel abrasives may be held liable under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) if the lead is eventually released into the environment.

Soils

In the early 1990s, no regulations specifically addressed lead in soils relative to industrial situations.

However, another EPA interpretation under the Land Ban states that discharges of lead onto soils without a permit (for hazardous waste disposal) can be treated as illegal disposal of hazardous waste or operation of an unlicensed treatment, storage, and disposal facility.

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For residential and child-occupied facilities, 40 CFR 745, Lead; Identification of Dangerous Lead Levels–Final Rule (in 2001), established soil clearance levels of 500 ppm lead in play areas and an average of 1,200 ppm in the balance of the yard.

California is currently using a residential soil level of 90 ppm.

In the years immediately after OSHA issued 1926.62, members of the coatings industry developed and took courses to learn about the hazards of lead and other metals. FHWA, SSPC, NIOSH, and other groups initiated conferences, studies, and reports on technology and regulations. OSHA initiated other comprehensive health standards for cadmium, arsenic, and hexavalent chromium. SSPC initiated or updated new programs and documents to identify regulatory requirements and provide strategies to protect the workers, the public, and the environment, such SSPC-QP 2, C-3 and C-5 training, Guide 6 (Containment), Guide 7 (Hazardous Waste), Guide 16 (Dust Collection), and TU-7 (Environmental Monitoring). At the same time, the industry developed or improved equipment, technologies, and surface preparation and paint removal methods to address requirements for containment and engineering controls.

But what have we as an industry done lately?

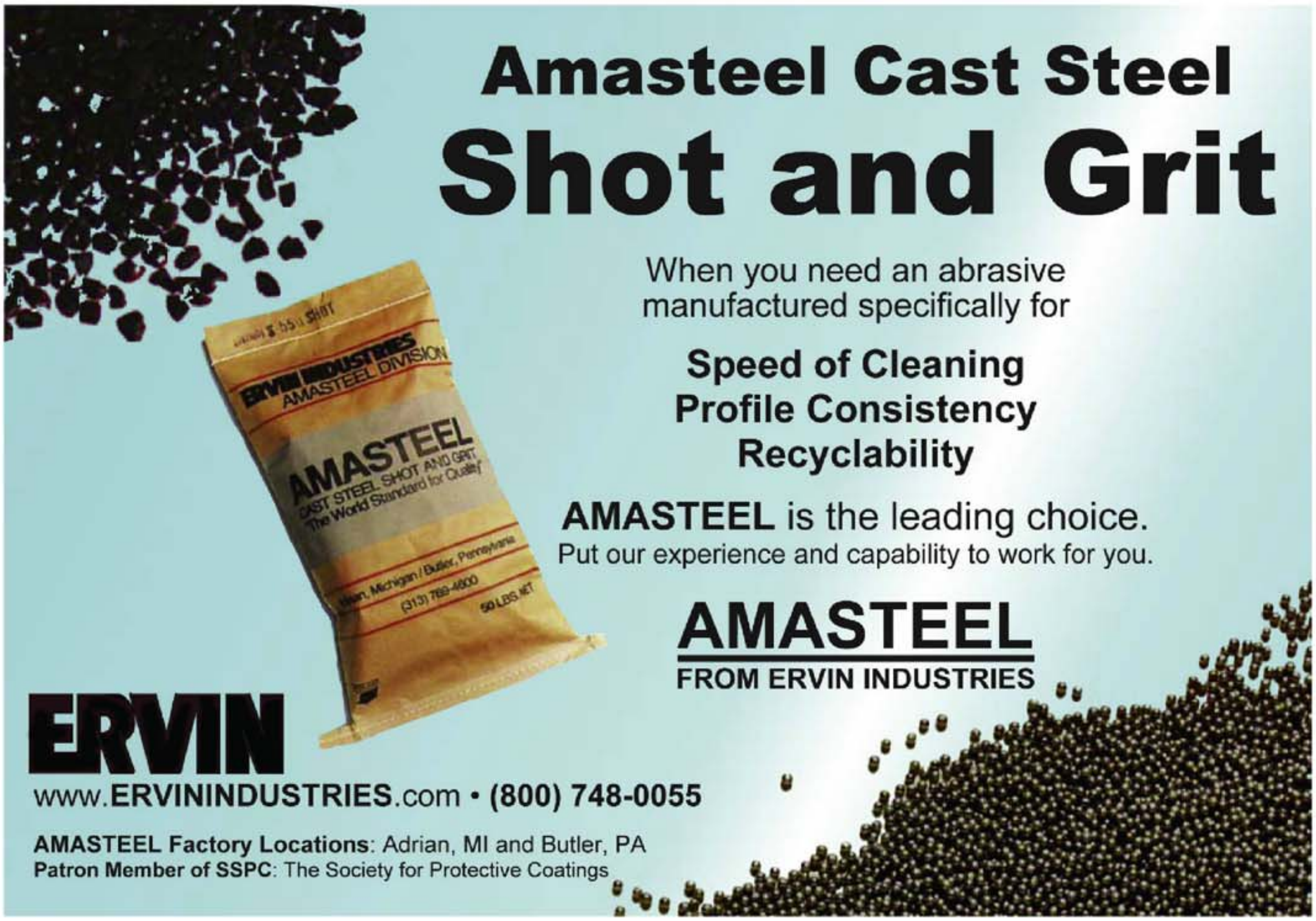
In the past few years, I have heard more than once that "lead is dead," and I have participated in or been made aware of projects in which the owners, consultants, and contractors appeared to not understand, to minimize, or to not enforce critical aspects of the OSHA and EPA standards related to protecting the workers, the public, and the environment from lead exposure and other hazards, and to managing hazardous wastes.

Based on the information presented in this article, I offer three thoughts on dealing with lead in 2013 and going forward.

Health Effects and Lower Exposure Levels

The scientific evidence reviewed or provided by our Federal health experts demonstrates repeatedly that overexposure to lead causes significant health effects in adults and children at BLLs as low as 5–10 µg/dL. In addition to the health effects outlined in 1926.62, there is sufficient evidence linking lead exposure to additional adverse health effects in the form of essential tremors, blood pressure, and hypertension, and identifying a likely causal relationship between lead exposure and cancer.

OSHA's 1926.62 was never based on construction risks or health effect data and, as such, is not sufficient to protect workers in



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bridge and other painting work (or any type of construction work). Most other lead thresholds and regulatory values for lead have been reduced significantly in the past 20 years and may be reduced further.

In 1926.62, the established OSHA thresholds for BLL exposures are significantly higher than the levels at which health effects may occur. Each employer with employees with potential exposures to lead should consider whether or not to implement intervention or voluntary medical removal at lower BLLs levels than required by OSHA.

Currently, 1926.62 requires implementing ongoing blood lead testing and engineering, worker, and hygiene control practices only when airborne exposure monitoring exceeds the action level and permissible exposure limits. This requirement is ineffective if monitoring is not performed or when wet methods of removal are used, and it does not account for incidental hand-mouth contact or ingestion, which can occur regardless of airborne levels. Should we re-evaluate what protections are necessary based on not only the paint but also the abrasives? Should we implement work practice, hygiene, and engineering controls when lead or other hazardous metals are present instead of implementing such controls based on airborne exposures?

New Sources of Lead and Exposure Pathways

Under the HCS revisions (based on amounts and how hazards are classified), amounts or levels of lead previously considered "incidental" or below reportable thresholds might now be reported on safety data sheets (SDSs). I have already seen lead and other hazardous metals (such as cadmium, beryllium, chromium, and arsenic) identified on SDSs for abrasives and other materials. My review of the lead and other comprehensive health standards for arsenic, hexavalent chromium, and cadmium appears to indicate that use of the abrasives or other materials containing hazardous metals may require implementation of initial protection and exposure determinations when these materials are used.

The EPA ISA data now identifies soil as a pathway for continuously re-entraining lead into the air and the rest of the environment. We know that the lead levels in soil near roadways and bridges have generally higher lead levels due to leaded gasoline and to breakdowns of previous coatings systems. Is this "historic" lead in the soil contributing to our worker and ambient exposures? Should we implement more pre- and post-soil sampling to identify these potential pathways?

Challenges with Compliance

Despite 20 years of OSHA's 19226.62 (and the annual training required by it), targeted enforce-

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ment by OSHA, and many training courses, articles, and guidance documents, the trades associated with bridge painting and construction continue to remain at the top of OSHA's list for violations of 1926.62. Are we complacent in our training, implementation, and innovation?

Some transportation agencies have taken a step back from 1926.62, as well as from EPA issues related to lead, and the agencies seem to have reduced their specifications and requirements related to lead over the last several years, rather than tightening them.

I wonder if this trend is due in part to a loss of organizational knowledge about lead as DOT staffing is reduced through retirement, layoffs, outsourcing, shrinking painting budgets, and a shift in focus to other issues. If so, have we thus handicapped the next generation in terms of our understanding and compliance with 1926.62 and other standards? Are the requirements for competitive-bid (low-bid) contracting and intense competition for limited work encouraging contractors to look for ways to reduce costs through reduced compliance?

If you work for a transportation agency (or other owner), I ask you five questions.

1. Who is your expert on lead and other hazardous metals?
2. Do your consultants have expertise in health and safety issues, risks, and controls for lead exposures?
3. When was your last lead training?
4. Do you understand why the requirements for worker and environmental monitoring and for containment are important in your specifications?
5. Are you appropriately managing your coating removal waste resulting from blast cleaning with steel abrasive?

If you are a general or painting contractor, I ask you three questions.

1. Are you adequately protecting your workers based on the health risks of lead or the regulatory requirements?
2. Can you risk a real or perceived overexposure to lead by a worker, worker's child or family member, or the public, especially given the health risks now known to be related BLLs lower than BLLs previously identified?
3. Are you using currently-available technology, work practices, and recommendations to access and control worker and public exposures?

All evidence suggests that the health and environmental effects of lead are present through more sources and at lower airborne and BLLs than we previously thought; therefore, current regulatory levels established by OSHA may not be low enough to protect our health.

I close with two questions for all of us in the coatings industry.

1. Do the lead projects today reflect the best

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available technology, engineering controls, and work practices necessary to reduce worker and environmental exposures?

2. Is it time for a reawakening about the hazards of lead exposures?

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Kaelin also provides SSPC C3, C5, and OSHA training, program review and development services, and contractor certification support services.

Kaelin is a certified quality auditor and NACE-certified coating inspector. She was a 2012 *JPCL* Top Thinker, a 2012 *JPCL* Editor's Award Winner, and an SSPC Technical Achievement Award winner in 2005. **JPCL**

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Exploring Marine Applications for Heat-Reflective Coatings

Editor's Note: A version of this article was published in the Oct.–Dec. 2012 Protective Coatings Europe.

By Rob Portsmouth, Huntsman Pigments

The sun's energy, when absorbed by exterior surfaces, can transfer through to the interior of a building, vessel, or vehicle, raising the internal temperature. This increased temperature can make the interior more uncomfortable and place heavy loads on air conditioning or cooling systems. These effects, in turn, can lead to a rise in associated energy consumption, as well as in carbon dioxide and greenhouse gas emissions. Solar reflective coatings are an economical, easy-to-use, and increasingly popular way of helping to prevent all of these effects.

This article describes the background to this technology and then discusses the potential advantages to be gained by using this in the marine coatings sector.

Emerging Standards for Solar Reflectance

The U.S. began using solar reflective coatings in the 1990s. They were used in cool roofs to carry out research on energy saving. This started the Cool Roof Rating Council program, which saw the solar reflectance (SR) standard set at 25 percent. Legislators and influencers globally have used this platform to formulate a series of policies, standards, and user recommendations, including the following.

- The European Cool Roof Council (ECRC) has been formed to make an important contribution to mitigating climate change through increasing the energy efficiency of buildings. The ECRC is promoting the certification of cool roof products and their use across Europe.
- In France, AFNOR, the French national association for standardization, is reviewing its current standards on solar reflectance to include a total solar reflectance value.
- Japan has issued the JIS K 5 675 Standards for roof coatings with high solar reflectance. JIS issues standards for industrial activities in Japan.
- In Australia, the City of Melbourne Council has suggested that if the roofs in its commercial building district were painted white, they could theoretically reduce the city's energy consumption by 1.25 million kWhr (4.5 million MJ) per year, equivalent to reducing emissions by 1.5 million kilograms of CO_2.[1]

It is not difficult to envisage how the benefits of cool roofs could be replicated in other industrial sectors. For example, in the marine sector, ocean-going vessels—and freight containers on deck—offer vast surface areas exposed to the heating effects of the sun.

Maritime Requirements for Energy Efficiency

In 2011, the International Maritime Organization (IMO) introduced a new chapter, making mandatory the Energy Efficiency Design Index (EEDI) for new ships. The regulations are non-prescriptive: Ship designers and builders are free to use the most cost-effective solution(s) for each particular vessel, as long as the required energy efficiency level is attained.

The new regulations make mandatory a Ship Energy Efficiency Management Plan (SEEMP) for all ships. The plan must set out how energy efficiency will be achieved on an individual ship. The best measures for each ship will vary depending on ship type, cargo, route, and other factors.

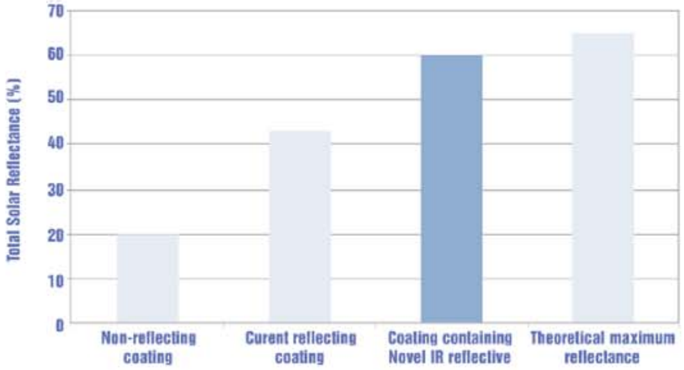
These maritime regulations and requirements would appear to offer an opportunity for coating and polymer manufacturers to develop innovative solar-reflective coatings for the marine market—in colors to suit customer requirements.

Some navies across the world have also specified requirements for the solar reflectance of their gray-colored fleet coatings (a traditionally difficult color or shade to obtain high solar reflectance), because increased solar reflective coatings can reduce the air conditioning loads internally, helping to save precious fuel.

Infrared Reflecting Pigments Help Deliver Choice

The industry recognizes that to obtain the highest solar reflectance, surfaces exposed to the sun should be white. This recognition is not new. It has long been known that painting houses white in hot and tropical areas can reduce the houses' internal temperatures. You only have to go to the Caribbean region to see this. However, we have come a long way since the days when Henry Ford famously prescribed a single color 'choice' for his company's automobiles ("any color…as long as it's black.") In the modern world, not all people want their roofs—or their ships or ocean containers—to be white.

Fig. 1: Comparison of Four Coatings for Total Solar Reflectance



A novel infrared reflecting pigment helps deliver energy-saving benefits in a wide choice of colors. The pigment is engineered to reflect infrared radiation from the sun and, when mixed with colored pigments, can yield high solar reflectance in an unprecedented range of colors.

For example, in the case of gray marine coatings, the use of the novel pigment can increase the solar reflectance close to the theoretical maximum for the color. Figure 1 demonstrates the effectiveness of this pigment by comparing the total solar reflectance measurements for four

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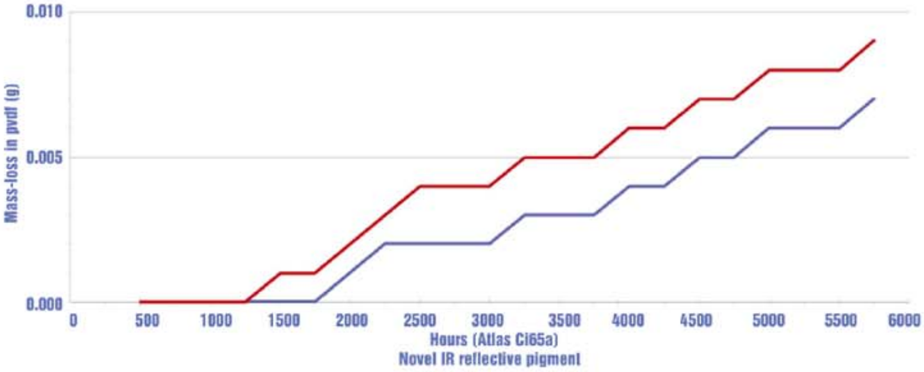
Fig. 2: Comparison of Coatings with Photocatalytic Pigments



paints that have been color matched to within ΔE <2, applied over a black substrate at approximately 75 microns' film thickness.

In this example, a coating containing the novel pigment and widely available colored pigments outperforms a coating optimized for solar reflectance by 17 points. Such an increase could reduce the surface temperature of the coating by 6–9 C (12–16 F).[2]

A reduction in temperature depends on the intensity of the sun's radiation at a particular latitude. Product testing has been carried out at known exposure sites, but it is interesting to speculate what the benefits might be if such a coating were applied to cargo vessels operating near the equator for a considerable time.

Reduced Thermal Cycling

Increasing the solar reflectance of a structure's surface has significant implications for not only energy efficiency, but also product durability. Reduced thermal cycling stress and coating temperature can lower the probability of delamination or peeling of the coating. This lower likelihood of peeling can result in extended product life and reduced product replacement cycles.

High-IR reflective pigments can be produced by crystal size modification of rutile titanium dioxide, and to enhance the photocatalytic stability of this novel pigment, a specially engineered coating has been applied to the pigment surface for durability. The coating acts like a protective shell around the pigment particles, helping prevent any electron holes that may have formed from reaching the particle surface and coming into contact with the resin.

The increased photocatalytic stability of the pigment was demonstrated using a durable alkyd-melamine formaldehyde paint system that is particularly suitable for testing durability, especially of the photocatalytic property of pigments. The results are shown in Fig. 2.

The crystal structure can be engineered to give optimal near infrared and visible reflectance ratios, with exceptionally low tint strength (approximately 25 percent of pigmentary titanium dioxide[2]) to enable dark (L*<40) and vibrant colors to be produced with high solar reflectance. To demonstrate the effect with a black coating, which is often the most difficult color to improve in terms of solar reflectance performance, two different formulations were color-matched close to RAL 9004 black. One formulation contained an infrared reflecting black pigment with titanium dioxide[2]; the other contained the infrared reflecting black pigment and the new infrared reflecting pigment. These paints were applied over black and white charts at

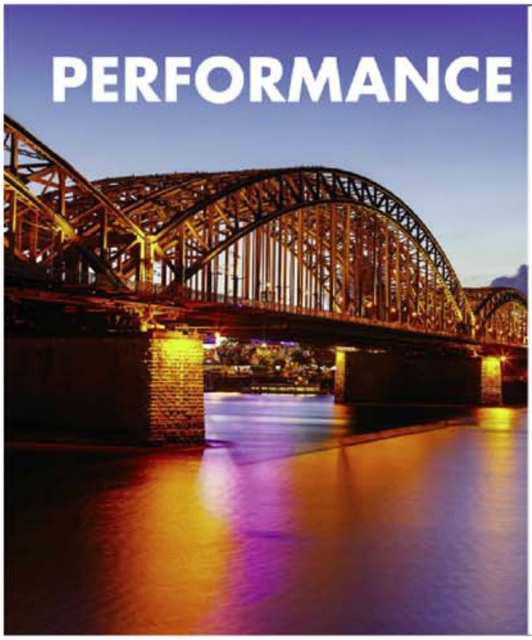

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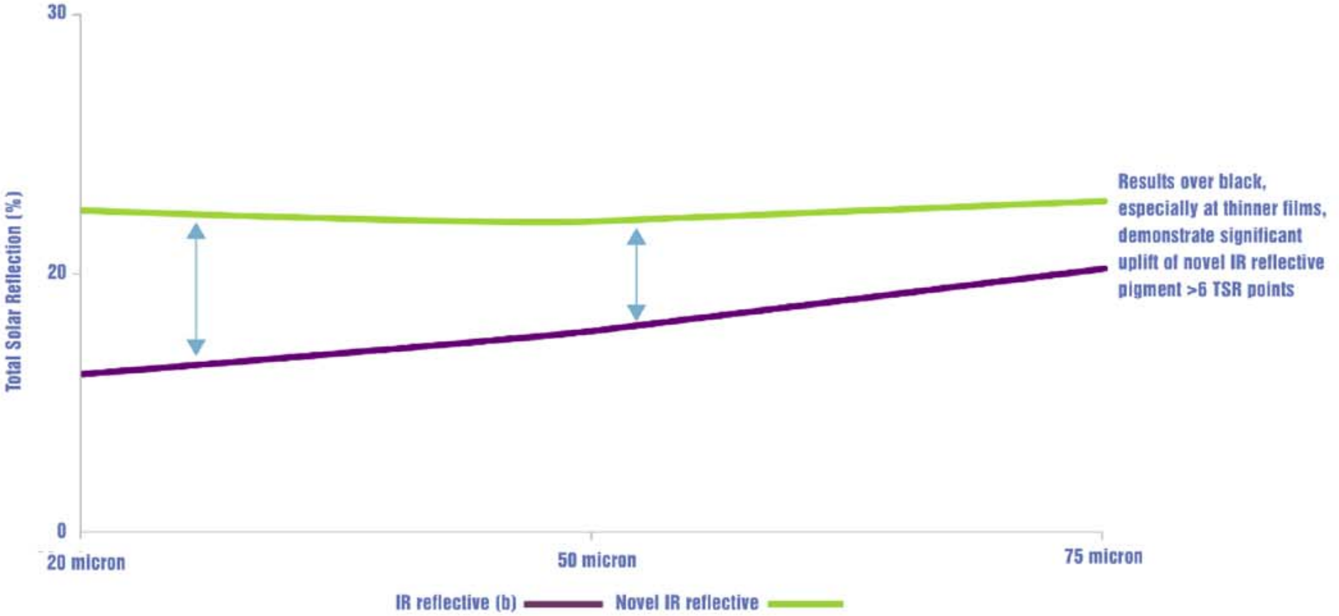
Fig. 3: Comparison of Solar Reflectance of Coatings Based on IR Reflective Pigments

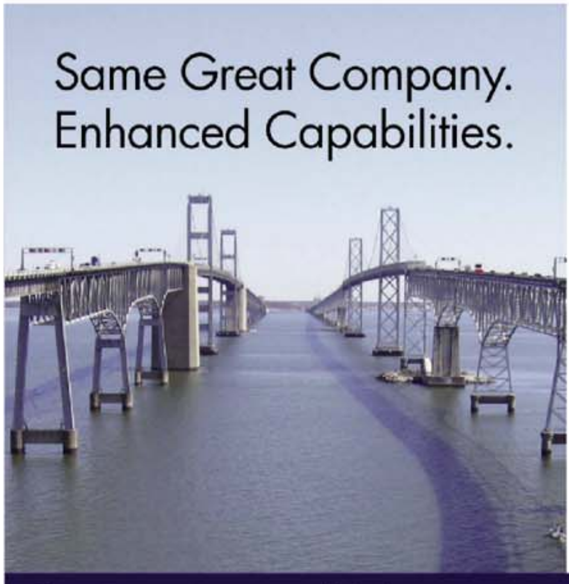


different thicknesses. The results in Fig. 3 show that the use of the new infrared reflecting pigment increased solar reflectance over a standard pigmentary TiO_2.

Potential Benefits in the Marine Sector

Increasing the solar reflectance levels of ocean-going vessels could open the door to potential savings. Less fuel may be needed to power air conditioning, important for cruise liners, or cooling/refrigeration systems, important for the carriage of many cargoes in the hold. Cooler ships also might help deliver more flexibility in design, shipping routes, and cargo types; and more revenue-generating 'free space' might be created on board by a reduced fuel requirement.

The concept of using heat-reflective coatings on ships' decks is not new. In 2002, four sister ultra-large crude carriers (ULCCs) were launched in Japan. The decks and upper hulls were painted white to reflect the sun's energy. There were two thoughts behind this: the coatings in the ballast tanks would be subjected to lower temperatures, thus delaying breakdown of the coating because of thermal cycling; and the temperature of the cargo would be lower, thus minimizing evaporative hydrocarbon emissions, a potential loss of profits, and increasing safety. White is not the most suitable color for decks (for aesthetic reasons); moreover, many operators want to have decks painted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in their corporate colors.

There might be other benefits. For example, could more extensive use of heat-reflective coatings have a role to play in the cost-effective protection and preservation of containerized cargo, both onboard and at the dockside? Studies have been carried out to determine the temperature and humidity cycles inside ocean containers. One study found that the most extreme temperature differences were observed on land while the containers were waiting for onward land transportation, and that the highest temperature, 57 C, was recorded in July at the dockside in Memphis, Tennessee.[3]

Conclusions

Coatings and polymers containing the novel IR reflective pigment could have an exciting role to play in delivering advantages—and end user benefits—in a range of marine applications. Potential cost and energy savings, as well as reductions in carbon footprints, are at the top of the benefits list. Greater freedom to venture beyond white as a color of choice is another bonus. The novel pigment offers more design flexibility while delivering improved thermal performance. For instance, it provides the opportunity to incorporate corporate branding colors, or to use color more extensively for ease of product identification.

A lower surface temperature also means increased comfort where people are in contact with surfaces. Perhaps this benefit suggests an opportunity for the application of coatings containing the pigment in the super yacht and small pleasure craft market. Extended product life for freight containers—and potential benefits for the goods inside—is also an opportunity that merits further investigation.

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2. Formulations containing a proprietary novel IR pigment have been compared to formulations containing a proprietary IR reflecting black pigment with titanium dioxide.
3. Summary of Prior Experiments Regarding Temperature in Sea Containers, R. Weiskircher, CSIRO Mathematical and Information Sciences, August 2008.

Dr. Rob Portsmouth is the Business Development Director at Huntsman Pigments, a division of Huntsman International LLC. **JPCL**

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Why Surface Preparation Is Important

Coatings experts often say that surface preparation of a steel surface is the most important part of a coating system. By this they mean that surface preparation affects the performance of the coating more than any other variable. Given that the proper coating system has been selected, if the surface preparation is poor, coating performance will often be compromised, even when the application is perfect. If surface preparation is good, then the coating applied over it is likely to perform well. For you, the applicator, it is useful to know why surface preparation is so important, because knowing why can help you do a better job. The following discussion focuses on the preparation of steel, but the concepts apply to other substrates as well.

Surface Preparation Is a Foundation

First, we can express the reason for the importance of surface preparation in a broad, general way, with the help of an analogy or comparison.

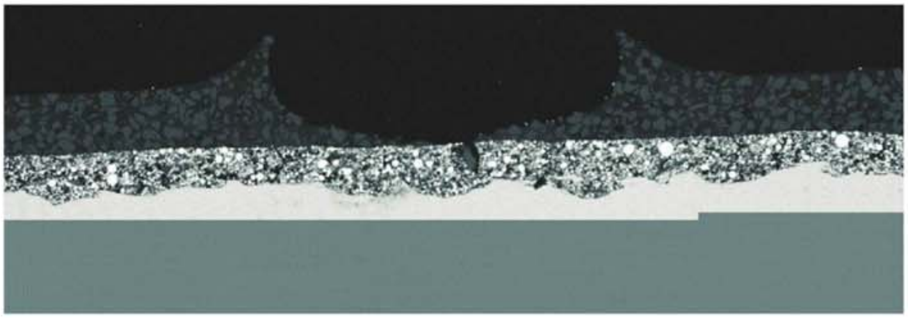

Fig. 1: Scanning electron microscope photo of a steel cross-section. The steel substrate is the shiny, smooth part toward the bottom—the granular, crystalline lighter gray layer is inorganic zinc. The darker gray top layer is a high-solids epoxy, complete with a large burst bubble in the middle.
Photo courtesy of International Paint Co./John Cozine

Surface preparation is to a coating system what a foundation is to a building. If a building has a poor foundation, it can list or lean, as the famous Leaning Tower of Pisa does, or it can collapse altogether. If a coating system has a poor foundation (surface preparation), it will fail sooner than expected (say, after five years rather than ten years), or it can fail catastrophically, within the first year of application. In both instances, reduced service life and catastrophic failure can result in great financial losses to a facility owner. The contractor may be held responsible for these losses if the surface preparation work is found to be faulty. As a professional painter, you have a responsibility to your employer to make certain that the surface preparation work you provide complies with the specification requirements—to provide the solid foundation necessary for the proper performance of the coating system.

When speaking about the function of surface preparation, it is important to go beyond the general concept of a foundation, and look to specific attributes. Surface preparation creates a foundation in two important ways: a mechanical way, by providing an anchor for the coating; and a chemical way, by allowing intimate contact of coating molecules with the steel surface. These elements of foundation are best understood by their opposites—the negative or detrimental conditions of slipperiness and debris on the surface.

Overcoming the Negative of Slipperiness

When a surface is very smooth, coatings have a difficult time adhering strongly.

This article was first published in October 1988, as part of the original Applicator Training Bulletin series, and in January 2005, when the series was revisited. The authors of the original article are Robert Barnhart (now deceased), then of Devoe Coatings (now International Paint); Debbie Mericle (no longer in the coatings business), then of Sline Industrial Painters (now part of K2 Industrial Services, which has partnered with the Halifax Group); Chuck Mobley, Mobley Industrial Painters (now Mobley Industrial Services, Inc.); Tom Hocking, Sullair of Houston; Jeff Bogran, then with Bob Schmidt, Inc. (now Axxiom), and now working for Energy Clean; and Ernestine McDaniel, then with Stan-Blast (now U.S. Minerals) and now working for GMA Garnet.

Free Webinar

Selection of Coatings over Galvanizing

Presented by Kevin Irving of AZZ Galvanizing Services, this webinar will explain selection of coatings for use over galvanized steel by following several steps. ■

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Imagine a coating on glass, for instance, and the ease with which it can be removed by a scraper or even a fingernail. Imagine, on the other hand, a rough surface like sandpaper on the same piece of glass, and how difficult it would be to remove a coating film from it. Steel, when it is abrasive blasted, has a surface that is rough like sandpaper, with a series of tiny peaks and valleys called surface profile (Fig. 1).

Coatings anchor themselves to the valleys of the profile, and the peaks are like teeth. This is why surface profile created by blasting is sometimes called an "anchor pattern" or "mechanical tooth."

Overcoming the Negative of Debris

Debris on a steel surface can be comprised of many different materials. They include dirt, dust, grease, oil, rust, moisture, and in some cases, millscale. When materials such as these are painted over, they interfere with both mechanical and chemical adhesion of the coating to the substrate and make it likely that the coating will fail prematurely. On the other hand, when all debris is removed, the coating can achieve complete and continuous contact with the steel substrate, thus assuring the best possible adhesion. When a coating adheres well, it will create a more effective barrier, minimizing the moisture that reaches the steel substrate and that helps corrosion.

Non-Visible Contaminants

Other forms of debris, not visible to the naked eye, are chemical contaminants. The most dangerous forms of chemical contaminants are soluble salts such as chlorides and sulfates. When such contaminants are painted over, they have the power to draw the moisture through the coating to cause blistering, detachment, and accelerated corrosion of the underlying steel.

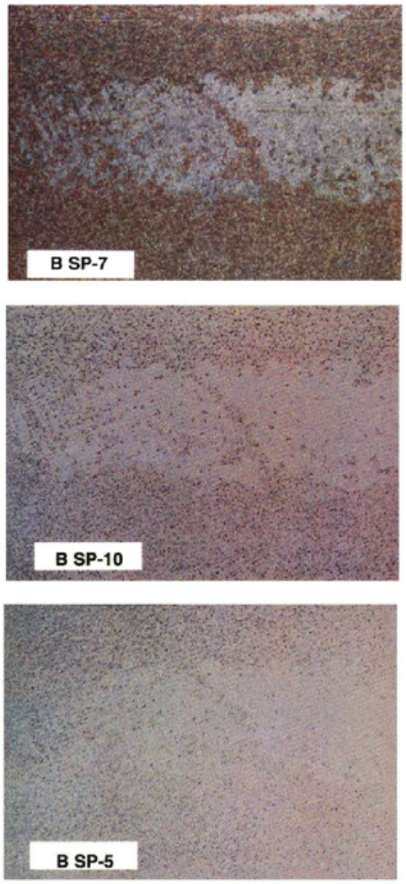

Fig. 2: Samples of degrees of blast cleaning on steel covered with rust and millscale, from SSPC's VIS-1, Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning. Courtesy of SSPC. Not to be used in place of the actual visual standard.

When structural steel is going to be repainted, areas that were previously rusted and pitted may contain soluble salt contamination, especially in the bases of the pits. Dry abrasive blasting typically does not remove these salts, so it is wise to check for their presence with specially-designed field test kits before painting, and then to take additional cleaning steps to remove the salts, if they are present in detrimental amounts. Testing for and removal of soluble salts will be discussed in detail in a later lesson.

Degrees of Separation

In any job specification, the degree of cleaning (Fig. 2) required for a given steel substrate before painting depends on a number of factors. The service environment of the coating system is perhaps the most important and, normally, is the first consideration when determining the degree of surface preparation. Generally, the more severe the environment, the better the surface preparation required. Severe service environments include immersion in liquids, exposure to aggressive chemicals or environments, high temperatures, or combinations of these conditions.

A second consideration is the generic kind of coating used. Some coatings, such as oils and alkyds, because they flow out and wet the surface well, can tolerate application over minimally-prepared or hand-cleaned surfaces. In addition, some epoxy mastics and other “surface-tolerant” coatings are formulated to be applied over hand- and power tool-cleaned surfaces. Coatings such as inorganic zincs, however, are at the other end of the spectrum. They require a higher degree of cleaning than many other types.

Cost is another factor in selecting the degree of surface preparation. Blast cleaning to SSPC-SP 5 (White Metal) is about 4–5 times more costly than to SSPC-SP 7 (Brush-Off) or SSPC-SP 3 (Power Tool). In some severe environments and with some coating types, rigorous cleaning is necessary, but in other instances, the cost and cost-benefit of higher grades of cleaning relative to increased coating lifetime will become an important factor in selecting the degree of surface preparation.

Finally, regulations may have an impact on the degree and method of surface preparation. In residential or congested urban environments, open blasting may be prohibited; in addition, where lead- or chromate-based paints are being removed, environmental and hazardous waste regulations may require containment and use of special surface preparation methods.

Determining the degree of surface preparation, as described above, is the job of a specifier or engineer. The task of doing the work is the contractor’s. No matter what

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degree of surface preparation is required, it must be done thoroughly. If hand-tool cleaning is required, then all of the surface area specified must be hand-tool cleaned, after it has been first cleaned by water or solvent according to SSPC-SP 1 to remove dirt, oil, or grease. If SSPC-SP 5 is specified, then conformance with the written description of SP 5 must be achieved on all designated surfaces.

In cleaning steel, it is also important to follow the proper sequence (Fig. 3). First, you must remove dirt and other debris. It is a lot easier to sweep mounds of dirt and other loose material off a surface with a broom (or by vacuuming in the case of lead-contaminated debris) than to try to remove it with surface preparation tools. The next step is removing visible oil and grease by solvent cleaning. Then you must conduct the operation of hand tool, power tool, or blast cleaning.

If you reverse these steps, particularly with blast cleaning, the force of the blasting abrasive may drive the debris into the roughened steel surface or profile, or spread it around as is the case with grease and oil. Then it is not easy to remove, and it may interfere with coating adhesion.

STEP 1:
Remove loose dirt and debris.

STEP 2:
Remove oil and grease by solvent cleaning in accordance with SSPC-SP1.

STEP 3:
Conduct cleaning operation (blasting, power tool cleaning, or hand tool cleaning).

Fig. 3: Observe the proper sequence when cleaning steel.

In addition, it is important to achieve the surface profile required by specifications. When the profile is too rough, the coating may not cover the peaks of the profile, and the result will be pinpoint rusting. When the profile is not rough enough, the coating may not anchor well to the surface, and the result will be loss of adhesion.

To make sure that a coating system will perform well as a barrier to prevent corrosion, you must roughen the steel surface for mechanical adhesion and make sure that all debris is removed so that the coating contacts the entire surface of the steel. In achieving these two conditions of cleanliness and profile, you will have assured that a proper foundation has been created for application of a coating system. This good foundation should help to provide many years of service life for the coating. **JPCL**

Upcoming ATBs

The following are among the upcoming Applicator Training Bulletins.

Application

- Product and Application Data Sheets
- Mixing and Thinning Paint

Quality Control

- The Effects of Weather on Cleaning and Coating Work
- Conforming with Job Requirements

Safety and Health

- Safety Considerations for Abrasive Blasting
- Anticipating Job Hazards

Free Webinar

New Methods for Testing and Extraction of Soluble Salts

Presented by Dr. Lisa Detter Hoskin of the Georgia Tech Research Institute, this presentation describes the most commonly used field methods for the retrieval and analysis of soluble salts on steel and other nonporous substrates.

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SSPC Publishes AB 1 Revisions

SSPC has announced changes to the standard SSPC-AB 1, Mineral and Slag Abrasives. The standard was developed for facility owners and specifiers, abrasive manufacturers and suppliers, surface preparation and coating contractors, and inspectors to establish quality benchmarks for non-metallic abrasives and to provide a classification scheme that would allow users to select the appropriate size distribution (work mix) for a given project. The standard was last revised and printed for reference in 1991.

The scope of AB 1 has been expanded to include manufactured non-metallic abrasives that meet the requirements of the standard, such as silicone carbide and other abrasives that are neither naturally-occurring minerals nor slag byproducts.

The responsibilities for testing to determine initial qualification to the standard, conformance testing for continued compliance, and testing for field quality control have been clarified in the revision. According to the revised AB 1, the supplier is responsible for third-party testing to determine initial qualification. The supplier is also responsible for conformance testing of material continued compliance when such testing is required by the purchaser. The contractor is responsible for field testing for oil and soluble salt contamination of delivered new media prior to initial use, and if the use of recycled work mix is permitted by project specification, the contractor is responsible for testing the work mix prior to field use. This testing shall be done once every work shift or 8-hour period, whichever is shorter.

The requirements for documentation of initial qualification testing include requirements for the credentials of the laboratory performing the qualification testing of the abrasive.

An appendix has also been added that contains additional requirements for non-metallic abrasives used by the U.S. Navy. This appendix is non-mandatory, unless specified by the purchaser, and includes additional requirements for friability, radioactivity, and inspection that are currently required by MIL-A-22262(SH).

Read the complete revised standard at www.sspc.org/standards.

SSPC 2014 featuring GREENCOAT

Abstracts Accepted for SSPC 2014

SSPC has issued a call for presentations for SSPC 2014 featuring GreenCOAT, which will take place from February 10–13, 2014, at the Coronado Springs Resort in Lake Buena Vista, FL. Presentation abstracts must be submitted to SSPC by June 1, 2013.

Authors of accepted papers will be notified by July 1, 2013. The first drafts of the papers will be due September 1, 2013, and the final papers will be due December 1, 2013. Final Powerpoint presentations for the show must be submitted by January 3, 2014.

Abstracts will be evaluated by SSPC's Education Program Advisory Committee based on originality, quality of the abstract (clearly defines outcomes, flows smoothly), relevance and significance to the industry, and objectives.

To submit abstracts or for more information, contact Sara Badami at badami@sspc.org, or call toll-free at 877-281-7772, ext. 2208.