Derrick Castle to Present Webinar on Bridge Specs

Derrick Castle of the Kentucky Transportation Cabinet and a member of the SSPC Board of Governors will present an SSPC/*JPCL* Webinar titled, "Writing a Good Specification for Bridge Painting," on Feb. 16 at 11:00 a.m. The Sherwin-Williams Company is sponsoring this free webinar.

This webinar is the first of 20 SSPC/*JPCL* webinars to be presented during 2011 to provide continuing education and technology updates to protective coating specialists and others interested in the technology.

In his webinar, Castle points out that a coatings specification can be a complex and sometimes confusing document. At the same time, he says, it is regarded as the rulebook for quality control and quality assurance personnel responsible for inspecting the work on a coatings installation project. The webinar will review essential items to consider when writing a quality specification for a typical coating system being applied to a bridge.

To register for this free webinar, go to www.paintsquare.com/education.

*Schedule Change: The SSPC/*JPCL *Webinar "Quality Control of Abrasive Blast Cleaning Operations," originally scheduled for Feb. 22 at 1:15–2:15 p.m., has been moved to Nov. 8 at 11:00 a.m.–noon. It switches slots with the "Advances in Polyurethane and Polyurea Technology" SSPC/*JPCL *Webinar, which will now be held on Feb. 22 at 1:15–2:15 p.m. Check www.paintsquare.com for more information.*

International Paint Makes Personnel Changes

International Paint, an AkzoNobel company and provider of high-performance protective coatings and linings, has recently made several personnel changes.

Martin Criado

Martin Criado has been hired as the marine and protective coatings manager for Latin America. He will be responsible for marketing, sales, and business development for the marine and protective coatings market segments in Latin America.

Criado has more than 25 years of experience in the coatings industry. He has a BS in chemistry and a master's degree in chemical engineering from the Universidad de la Plata in Argentina.

Karl Nollsch

Chris McMillan

Karl Nollsch has been appointed to dual positions as water and wastewater market manager, Americas, and protective coatings distributor program coordinator. He will be responsible for leading all marketing and new business development efforts for the Americas, as well as the new Protective Coatings Distributor Program, serving as liaison between the protective coatings and specialty business sales teams.

Nollsch has over 32 years of experience in the coatings industry, has an associative arts degree from Sacramento City College, and is a certified NACE Coatings Inspector.

Chris McMillan has been promoted to protective coatings senior market manager. He will lead all protective coatings market managers in the power, oil/gas, high-value infrastructure, commercial infrastructure, and water/wastewater market segments throughout the United States, Canada, Mexico, and Central America.

McMillan has over 10 years of experience in the coatings industry and has a bachelor's degree in marine science from Texas A&M University. He is a member of SSPC and a certified NACE Level 3 Coatings Inspector and member.

SSPC Board Seeks Nominees

SSPC is now seeking nominations for two seats on its Board of Governors in the categories of Coating Contractor and Coating Material Supplier.

The Coating Contractor category is defined in the bylaws as "individuals who own or are employed by industrial contracting firms specializing in the removal or application of coatings and linings, either in the field or shop."

The Coating Material Supplier category is defined in the bylaws as "individuals who own, are employed by, or represent firms that manufacture or distribute coatings, linings, or the raw materials used to manufacture these products."

All nominees must be SSPC members. To nominate a candidate, SSPC asks that individuals submit a brief statement detailing the nominee's qualifications by March 15, 2011, to SSPC, Attn. Bill Shoup, Executive Director, 40 24th St., 6th Floor, Pittsburgh, PA 15222-4656; fax: 412-281-9992; email: shoup@sspc.org.

Companies Plan to Expand in China

Bayer MaterialScience, AkzoNobel, and Harsco have recently announced expansions in China.

Bayer MaterialScience plans to expand its R&D and production of high-grade materials in China, investing more than $1.3 billion to accelerate production of polyurethane raw material MDI and high-performance polycarbonate by 2016.

The headquarters of the Polycarbonates Business Unit will be relocated from Leverkusen, Germany, to Shanghai, the company said.

Capacities for MDI will more than double to 1 million metric tons a year and 500,000 tons per year for high-performance polycarbonate. The construction of a 50,000-ton-per-year HDI production facility is also planned. With the expansion of its R&D center for polymers in Shanghai, Bayer plans to concentrate on areas in which China plays a leading global role, such as wind turbines and solar energy plants, the company says.

AkzoNobel is opening its sixth powder coatings facility in China in the Wuhan Economic and Technological Development Zone. The new factory will manufacture AkzoNobel Powder Coatings' Interpon range of products.

The Wuhan facility's current production capacity is 4,000 tons per year and can be further expanded.

Harsco Corp. and China's Taiyuan Iron & Steel (Group) Co. Ltd. have established a 25-year joint venture to address "the environmentally beneficial processing and metal recovery of TISCO's stainless and carbon steel slag production by-products across a range of potential commercial applications," the companies said.

The new company, TISCO Harsco Environmental Protection Enterprise, Co. Ltd., is the largest joint venture in either company's history. Harsco and TISCO will have a 60%–40% relationship in the partnership and have agreed to jointly commit capital at a ratio of about 1-to-1 to the projected revenues.

The parties still must sign off on definitive agreements regarding operations, technology licensing, and land leasing, and must obtain final Chinese government approval. When fully operational, the new venture is expected to process up to 1 million tons of stainless steel slag and up to 500,000 tons of carbon steel slag per year, the parties said.

The new company plans to market these materials for "zero waste" commercial re-use in such applications as road-making and construction materials, metallurgical additives, recyclable stainless steel scrap, and agricultural and turf fertilizer.

BASF Closes Cognis Deal

BASF has completed its $4.1 billion acquisition of German specialty chemicals company Cognis and says the deal will mean more, and greener, high-performance products for customers worldwide.

Cognis should be fully integrated into BASF by the end of 2011, the company said.

The deal will offer customers of the Performance Chemicals and Dispersions & Pigments divisions an expanded portfolio, BASF says. The acquisition will particularly expand BASF's portfolio with products based on renewable raw materials.

BASF acquired Cognis from GS Capital, the private equity arm of Goldman Sachs, Permira Funds, and SV Life Sciences. The acquisition received approval from the European Commission on Nov. 30, subject to BASF divesting several of Cognis' businesses.

BASF is a leading chemical company, with worldwide sales of more than ⇔50 billion (about $66 billion US) and about 105,000 employees at the end of 2009.

WEF Names New Executive Director

The Water Environment Federation (WEF) has named Kentucky sanitation executive Jeff Eger as executive director, effective Jan. 24.

Jeff Eger

WEF is a nonprofit technical and educational organization for water quality professionals. It has 36,000 individual members and 75 affiliated member associations worldwide.

Eger comes from Sanitation District 1 (SD1) in Fort Wright, KY, where he had served as executive director since 1994. He is a member and past chairman of The Ohio River Valley Water Sanitation Commission. He also chairs the Wet Weather Partnership, which focuses on environmentally responsible solutions to urban wet weather issues.

Senior Director Appointed for CPI

The American Chemistry Council (ACC) has appointed Lee Salamone as senior director of the Center for the Polyurethanes Industry (CPI), which took effect on Dec. 9.

CPI represents U.S. producers and distributors of chemicals and equipment used to make polyurethane, as well as manufacturers of polyurethane products.

Salamone formerly served as a director on ACC's public health and poly team. She also worked as a public affairs consultant with the Silicones Environmental, Health and Safety Council of North America and was most recently a senior consultant with AcuTech Consulting Group.

Salamone will be responsible for day-to-day management of CPI, working closely with the steering and management committees, other trade associations, and the customer community.

When Can You Coat New Concrete

How can I determine when concrete has cured sufficiently to be coated, besides waiting the 28 days typically specified?

From Avneet Bhargava
JK Meridian Coatings

Painting of concrete is very tricky. The curing doesn't just stop on the 28th day, so the ASTM plastic sheet method should be tried before application. However, an application of a clear mist coat is recommended to displace air and moisture in the concrete before building up the desired DFT.

From Chuck Pease
PCG

Typically, you would want to perform either the plastic sheet test method (ASTM D4263) or the calcium chloride test (ASTM F1869) to assure that the moisture content in the slab will support coatings without a failure.

Then there is *in situ* relative humidity (RH) testing, touted to be much more accurate than the plastic sheet method or any of the calcium chloride tests. There is research on *in situ* RH testing confirming that it is more effective in showing what is going on with moisture in the slab at a deeper level than either the plastic sheet or calcium chloride testing.

Applying any coating to concrete slabs without testing is asking for trouble. Never rely on time frames alone based on days of cure. Always perform at least one of the above-mentioned tests at various locations throughout the slab.

Editor's Note: This question was posted on the daily electronic newsletter, PaintSquare News (PSN), October 25—31, on behalf of JPCL. Responses, including the ones here, were solicited through the PSN posting. The answers have been selected and edited to conform to JPCL's style and space limitations. To read more responses submitted for this Forum question and for others, click the JPCL Problem Solving Forum of any issue of PSN. If you would like to receive PSN, visit www.paintsquare.com.

From Tom Gibbon
Greenman Pedersen Inc.

I think that the question is a trick question in the sense that neither is dependent upon the other. Depending upon the type of coating applied, concrete does not have to be fully cured to coat it successfully. Furthermore, some coatings are used to insure full or better curing, i.e., curing compounds sprayed on the concrete to retard or prevent loss of moisture needed to cure concrete.

The closest answer must assume certain conditions that are not indicated in the question: the concrete has attained sufficient strength to support itself; has dried sufficiently so that the moisture in the concrete will not cause disbonding of the coating; and meets requirements for several other conditions such as environment.

If this is a question about moisture, then it needs a leader in that direction; if the question is truly about the cure of the concrete, then answers about the chemical and structural conditions are appropriate.

When can you coat the concrete? You can coat it when it is structurally sound enough (usually after stripping the forms or other supports), chemically stable, and sufficiently dry so as not to cause disbonding. Using the plastic sheet method to detect moisture and applying a sealer are correct to the extent that they address the items above.

But the real answer is to address all of the items that require stabilization of the concrete so you don't interfere with the bonding or chemical reaction of the coating.

From Tom Schwerdt
Texas Department of Transportation

There seems to be some real confusion on this topic. Yes, typically paints require concrete to have dropped to a particular moisture level before painting—but moisture level is only moderately related to the original question of when the concrete has cured. Concrete can pass a moisture test and still not be fully cured. Concrete can be fully cured, and still have enough moisture to interfere with the application of most paints.

Moisture level largely depends on the mix design (cement composition, water/cement ratio, fly ash or other replacements for cement, additives, aggregate type, etc.); curing method (if any); environmental conditions; and time. Retained moisture level is at best only indirectly correlated with cure.

You should also measure the pH of the concrete and ensure it has dropped enough that the coating will not be damaged.

The Case of the Coating Failures Waiting at the Train Station

By Cynthia L. O'Malley, Manager-Laboratory Services, KTA-Tator, Inc.
Richard A. Burgess, KTA-Tator, Inc., Series Editor

A single aesthetic coating problem can warrant a field investigation to determine the cause and corrective action. Often, however, an appearance issue leads to the discovery of other coating problems, sometimes related, often unrelated. This month's F-Files is a case in point. Porcelain enamel-coated decorative panels installed in commuter train stations were exhibiting rust stain and corrosion. The investigation of the appearance of the panels expanded to include several other coating problems.

Background

Five stations of a commuter rail transportation system were constructed of carbon steel and coated at approximately the same time. Column covers, wall and ceiling cladding, soffit, security screens, and structural support systems received protective coating systems. One system, a porcelain enamel, was specified for perforated and solid decorative panels. Uncoated stainless steel components were also used.

Approximately six years after construction, perforated carbon steel panels coated with the porcelain enamel had become rust stained. In addition, a more conventional coating system applied to carbon steel panels had begun to split and delaminate. All five stations exhibited coating problems, but the observations in this case are from the station with the most defects.

Fig. 1: Corrosion and metal loss at base of steel column
Photos courtesy of KTA-Tator

The project design specification described the coating requirements for the carbon steel panels. The required coating system on the metal face and backing sheets was to be porcelain enamel (primer and finish coats) of not less than 0.83 mm (32.7 mils). The porcelain coatings were to be, "...applied after forming the panels, including drilling, cutting holes, and welding attachments..." Promptly after the coatings were applied and cured (fired), they were to be protected until installation with a strippable film or adhesive cover. The design specification cited Porcelain Enamel Institute (PEI) standards that correlate to a coating service life of 20 to 30 years, with maintenance limited to routine cleaning.

The porcelain enamel coating requirements are partially reproduced below.

Comply with Porcelain Enamel Institute (PEI) standards and recommendations, including sheet preparation. Apply prime coat to both faces of sheet, and apply finish on exposed face. Fire both coatings at approximately 816 C for Type A acid resistance; apply at least one (1) additional separately fired coating to the face side of the units. Protect the back side of panels with additional separately fired porcelain enamel coating.

Coating thickness—Minimum 0.064 mm (3.9 mils) cover coat. Total thickness:

Continued

Table 1 – Summary of Components Examined, Specified Protection, and Field Observations

Item	Substrate	Coating Specified	Observation
Structural Columns	Carbon steel	Galvanized-clad	Corrosion and rust through at bases
Solid Wall Panels	Carbon steel	Porcelain enamel	Delamination and peeling
Grating/Screen Wall Panels	Carbon steel	Porcelain enamel	Corrosion, rust stain at edges of openings
			Porcelain coating stress cracks
Perforated & Louvered Panels	Carbon steel	Porcelain enamel	Corrosion, rust stain at edges of openings
Porcelain Panel Supports	Carbon steel	Zinc primer/unknown finish	Underfilm corrosion, undercutting
Tubular Window Frames	Carbon steel	Zinc primer/unknown finish	Breakthrough rust, undercutting corrosion
Pipe Light Supports	Carbon steel	Galvanized	Breakthrough corrosion
Panel Support Footings	Carbon steel	Unknown	Rust bleed
Uncoated Metal Panels	Stainless steel	None required	Rust color stains and scratches

Fig. 2: Split in primer on solid wall panels

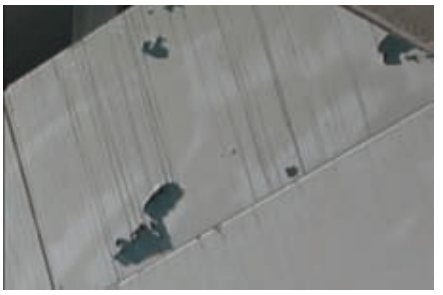

Fig. 3: Compromised coating adhesion on solid wall panels

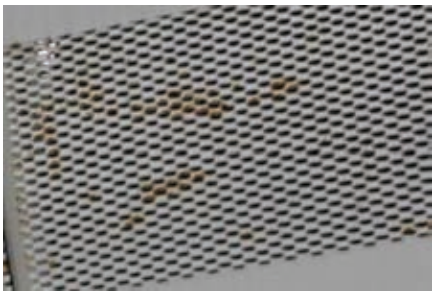

Fig. 5: Rusted grating/screen

0.100 mm to 0.500 mm. Do not exceed 0.500 mm (19.7 mils) total thickness.

The thickness of porcelain enamel can be greater, depending on the steel's thickness, according to Data Bulletin PEI 502 (porcelainenamel.com).

The project specifications required hot rolled steel components of the (structural) support system to be hot-dip galvanized with zinc, ASTM A123, 0.38 kg/m^2 (1.245 oz/ft^2), and then clad with coated covers or left uncoated.

Site Observations

Overall, most rust stain (and corrosion) on the decorative (porcelain-coated) wall panels appeared to have occurred around penetrations where the coating system was thin and the primer often visible. In addition, some of the onsite assembly work was not skillfully executed, especially on the stainless steel

Fig. 4: Magnified view of rusted grating/screen on some porcelain-enameled panels

panels and channels, as evidenced by scratched and rusting stainless steel surfaces. Other components exhibited corrosion and were examined as well (Table 1).

Steel Columns

Steel columns (Fig. 1) exhibited extensive corrosion and metal loss at the base. Corrosion originated inside the columns, apparently from rainwater entering openings in the top of the columns and collecting in the base.

Solid Wall Panels

Solid steel wall panels, for which a porcelain enamel had been specified, exhibited peeling coating. The finish coat had cracked and delaminated from a split in the primer coat (Fig. 2). A layer of primer remained on the panels; and another layer of primer was attached to the underside of the peeled finish coat. The exposed primer on some panels was an aqua hue, while a gray primer was exposed on others. Overspray on surfaces at the periphery of installed solid panels[2] indicated that the finish coat had been applied on site. The coating on these panels was not porcelain (or at least not fired porcelain) because it would not be possible to fire the

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Fig. 6: Corrosion around small holes of perforated panels

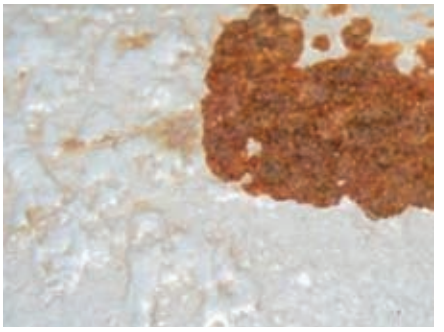

Fig. 7: Severe undercutting corrosion on structural steel support

Fig. 8: Active corrosion on galvanized pipe support for overhead lighting fixtures

ceramic base coating.

The aqua-primed panels had a total coating thickness of 5.5 to 6.5 mils, with approximately 3.5 mils of primer remaining where the finish coat had peeled. Adhesion problems were only on the grouping of solid wall panels.

Similar adhesion problems were not observed on other types of wall panels (e.g., perforated or louvered panels). Visible signs of compromised coating adhesion—irregular shaped patches of lighter color—were observed on the outside faces of solid panels (Fig. 3). The pattern suggested the surfaces received a touch-up coat.

The color of the finish coat on the solid panels differed slightly from nearby grated/screen panels. Furthermore, overspray at the periphery of the grouping of solid panels indicated that the solid panels received a non-porcelain finish coat after installation.

Porcelain Enameled Panels

Some porcelain-coated steel wall panels were formed with an open, grate-like screening. They were on the perimeter of the station and permitted air and light to enter the area. Many of these panels exhibited corrosion and rust bleed of the grate-like screen configuration. Close examination of corrosion sites under magnification revealed the light-colored finish coat was applied so thinly along the edges that the gray primer was visible. In addition, rust emanated from stress cracks in the coating system (Figs. 4 and 5). Total coating thickness within the grating/screen on some panels generally ranged from 4.5 to 5.5 mils. Coating thickness on the same panels, but away from the open grating/screen, was generally thicker and ranged from 5 to 7 mils. However, an open grate panel that exhibited no rusting had an overall thicker coating of 6 to 8 mils in the grating/screen area. Rusting was generally worse on wall panels exposed to the prevailing winds from the east.

Overlapping pieces of the tubular steel frame around the edges of the same grated/screened panels were insufficiently coated and were rusting. A zinc-rich primer and unknown topcoat had been specified for the tubular frame.

Corrosion was also found on perfo-

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Fig. 9: Scratches and abrasion on stainless steel door

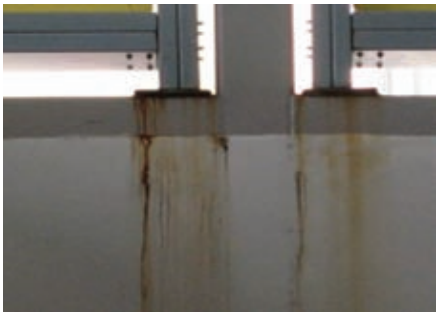

Fig. 10: Extensive rust bleeding on steel footings supporting wall panels

rated wall panels inside the train stations. These wall panels, even when they contained differently shaped architectural grating or holes and were different in color, exhibited the same deficiency: corrosion where the coating was thin around the periphery of individual architectural holes or grating configurations. Dark gray primer and corrosion was visible around ¾-inch diameter holes in yellow wall panels (Fig. 6). The total coating thickness was 7.5 to 10.5 mils in areas away from the exposed primer. Other yellow wall panels of different shapes had the same problem.

Structural Steel Support for Porcelain-Enameled Panels

The supports for the porcelain enamel-coated panels were to receive a more conventional coating system that included a zinc-rich primer and an unknown topcoat. Undercutting corrosion was found where total coating thickness was consistently below 4 mils. Severe undercutting (Fig. 7) indicated the absence of a zinc-rich primer. The underside of the peeled coating chips had no visible gray primer, providing further evidence that no zinc-rich primer was present.

The gray tubular steel frame that supported the wall panels was generally in good condition. However, the gray frames around windows at the station exhibited extensive breakthrough and undercutting corrosion. The window frames had a total coating thickness of 1 mil or less, whereas a tubular frame that was in good condition had 7 to 14 mils of coating.

Corrosion was active on an overhead, galvanized pipe support (carbon steel) for lighting fixtures. It appeared the galvanizing had been damaged, and an uneven application of a metallic-pigmented touch-up coating was too thin in some places, which caused breakthrough rusting (Fig. 8).

Stainless Steel

Uncoated stainless steel panels exhibited an overall poor appearance. Many of the stainless steel panel surfaces had scratches and abrasions (Fig. 9). Lack of careful handling during installation caused surface scratches on the stainless steel and, in some instances, resulted in impact with carbon steel items. In addition, stainless steel components, such as the mitered joints of framework, had probably been polished with carbon steel pads. Polishing with these pads and/or impact with carbon steel items caused rusting on the stainless steel framework that surrounded each colorful glass architectural panel on the exterior of the train station wall. Carbon steel embedment in the panel frames was probably also the result of polishing the field-welded, mitered connections using regular steel wool instead of stainless steel wool.

Carbon Steel Footings for Porcelain Panel Support Structure

The steel footings on which the wall panel structures are mounted were not sufficiently coated. Extensive rust bleeding occurred (Fig. 10).

Fig. 11: Corrosion at base of steel column began in its hollow interior

Laboratory Investigation

The laboratory investigation consisted of visual and microscopic examination and Fourier transform infrared spectroscopy. The visual and microscopic examination was used to correlate observations to coating thickness by measuring prepared cross-sections of samples. Infrared spectroscopy was used to determine the chemical consistency of the coating and to confirm whether the coating specified had been applied and was on the sample.

Structural Columns: Corrosion

Corrosion and resultant metal loss at the base of carbon steel columns originated on the interior of the hollow columns (Fig. 11). Whether through faulty design or faulty installation, rain water collected inside the columns, creating an aggressive corrosive environment. The dry film thickness measurements ranged from 7.8–12.8 mils. Infrared spectroscopic analysis revealed that there was nothing chemically inconsistent with the exterior ceramic coating system.

Solid Wall Panels: Coating Adhesion

The coated solid panels at the train station were reported to be substitutes for glass wall panels. The coating system on the solid panels was not the specified porcelain enamel. Instead, the coating system consisted of a zinc-rich primer and a white-pigmented organic alkyd

Continued

finish coat. The system may have had inherent design flaws because alkyd coatings are susceptible to alkaline hydrolysis (saponification) in the presence of alkalinity and moisture. When wet, the zinc primer is a source of alkalinity, and the environment is the source of moisture. Saponification was likely the root cause of failure.

Because the coating system was not performing and was not specified, the saponification was not analyzed. Total removal was warranted. The coating problems on these panels were unrelated to problems with porcelain-enameled wall panels containing the grating/screen, holes, or louvers. The coating detachment at solid wall panels consisted of separation within the primer. A layer of the zinc-rich primer was attached to the underside of the peeled chips of the finish coat, and the zinc-rich primer was also attached to the wall (the plane of failure was cohesive—within the primer layer—not adhesive, between the primer and the steel). The alkyd finish was 3.5 to 5.5 mils.

Porcelain Enameled Panels: Corrosion Problems

The shop-applied porcelain enamel system was too thin along the edges of the architectural penetration features in the wall panels. The lack of a uniform finish coat thickness was evident: the gray primer was exposed (Figs. 4 and 5).

Figure 12 shows a louvered porcelain enamel panel with rust spots and rust stain. Figure 13 shows a microscopic cross-sectional view of a coated louver edge. The dark primer was thinner at the edges, but covered the corner edges; the lighter colored finish coat did not consistently cover the corner edges. Corrosion occurred in the areas where the protection was minimal. The thickness of the dark porcelain primer averaged less than 2.0 mils at the edges and 2.5—4.0 mils overall; the lighter finish coat was discontinuous and, when present, measured less than 1.0 mil at the edges. Overall, the lighter porcelain finish coat averaged 2.5—4.0 mils thick.

Steel Supports for Enameled Panels: Corrosion

Rusting on the conventionally coated framework that supports the porcelain panels was a direct result of insufficient coating thickness. Furthermore, the contract requirements for the protective coating system were not met. The project specifications required that these members receive a galvanized coating. There was no evidence of galvanizing beneath the coating. The thickness of the light blue coating system on the structural steel frame wall ranged from 2.5 to 8 mils (Fig. 14).

Stainless Steel: Corrosion

The austenitic stainless steel door panels, panel frames for architectural glass, and window frames exhibited reddish-

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Fig. 12: Sample piece of louver with rust spots and rust stain

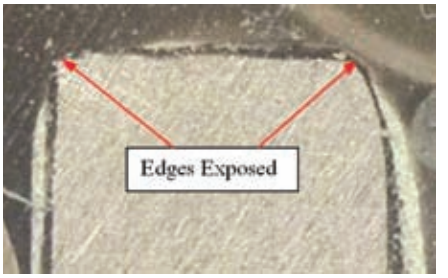


Fig. 13: Microscopic cross section view of coated louver edge

Fig. 14: DFT of light blue coating system on structural steel frame

brown corrosion products normally associated with carbon steel (Fig. 15). The corrosion at these sites was characteristic of abrasion by carbon steel, which embedded ferrous iron particles in the grain structure of the stainless steel.

Austenitic stainless steel does not produce red corrosion deposits in urban environments unless the grain structure of the stainless steel has been altered by forcible contact with carbon steel. Embedded particles of carbon steel function as anodes and quickly corrode, producing visible corrosion and staining.

Fig. 15: Abrasion and corrosion on stainless steel

Summary of Coating Failure Issues

Coating-related problems are differentiated by the type of substrate: steel columns, structural steel frame supports, window frames, solid steel wall panels, and wall panels with a porcelain enameled coating that incorporate grating/screen or architectural holes.

The coating failure that caused the most visible widespread corrosion occurred on porcelain enameled wall panels with grating/screen. Additional coating deficiencies were discovered.

The primary cause of corrosion on the porcelain enameled grating/screen wall panels was insufficient coating thickness, especially on edges. Significantly, all of these panels were coated and fired off site by a single supplier. Handling damage during loading, shipping, unloading, or erection contributed to corrosion, but to a lesser extent.

The coating peeling from the solid wall panels at a single station was not the specified coating system. The coating system consisted of a zinc-rich primer and an organic finish coat as opposed to the specified porcelain ceramic enamel system.

Corrosion and metal loss on the base of some columns was caused by poor design or improper installation procedures, which permitted rainwater to enter through the top and collect in the base of the hollow columns.

Corrosion products were evident on several stainless surfaces. This corrosion was caused by mechanical contact with carbon steel, which embedded iron into the stainless steel and altered the grain structure.

Recommendations

The coating-repair recommendations, also categorized by the type of substrate, are described below.

Steel Columns

The water ingress into the columns had to be eliminated before coating repairs could be made to the steel columns. Once alterations to the columns were made to ensure the interiors remained dry, then structural repairs to the columns could be made. If there was any opportunity for water to continue to enter the column interior, it was recommended that drain holes be installed and an immersion grade epoxy applied to the interior surfaces, near the base to protect the substrate from prolonged exposure to water.

Continued

Solid Wall Panels

Adhesion problems on the solid panels at the station appeared to be systemic; therefore, complete removal and replacement of the coating was recommended. Specifically, it was recommended that all existing coatings be removed by abrasive blast cleaning to achieve a "Near-White" (SSPC-SP 10) degree of cleanliness. A three-coat system consisting of an epoxy zinc-rich primer, epoxy intermediate, and urethane or polysiloxane finish was recommended. The surface preparation and coating work could be performed offsite.

Alternatively, replacement panels with the specified ceramic enamel coating system could have been obtained and installed at this station.

Porcelain Enameled Panels

The baked porcelain enamel coating applied to wall panels and columns was selected to provide excellent corrosion protection because the firing process fuses the inorganic constituents that make up the coating into a barrier film that is nearly impervious to moisture. The cured film is resistant to acids, alkalis, and organic solvents largely because the molecular backbone is silica based and not carbon based. In fact, the porcelain enamel finish is resistant to virtually all organic solvents used in the formulation of epoxies, urethanes, and other organic coatings.

Thus, these coatings are not able to penetrate the inorganic enamel and can only lie on the surface. In terms of adhesion, the best that is hoped for with an organic coating is secondary hydrogen bonding, which is the bond formed when two pieces of clean glass are placed together.

Accordingly, repairs to the ceramic enamel panels were not recommended until trials were conducted to determine the most appropriate method of surface preparation and coating application. If an overcoating strategy was considered, compatibility between the overcoat and the existing ceramic enamel finish coat needed to be determined by conducting trial overcoat applications and evaluations of those areas after the overcoat material had sufficiently cured. A polysiloxane coating was recommended for overcoating. This coating has a silica backbone similar to the ceramic coating and the ability to achieve good adhesion by forming covalent bonds with the existing porcelain ceramic enamel finish. It was recommended that panels be coated with trial applications to help ensure the desired results will be achieved.

Because examples of poor coating adhesion to the ceramic enamel were

found on columns (Fig. 16), application of organic coatings, such as epoxies, to the ceramic enamel finish was not recommended. Complete overcoating of the wall panels with organic coatings (epoxies, urethanes, etc.) was also not recommended, since they would not have been compatible with the existing enamel and sufficient adhesion could not be guaranteed.

Fig. 16: Poor coating adhesion to ceramic enamel

Steel Framework Support for Porcelain Enameled Panels

Repairs to the light blue steel framework to correct undercutting corrosion problems could be accomplished by power tool cleaning to remove all visible corrosion and loose coating followed by the application of two coats of surface tolerant epoxy. A finish coat matching the color of the existing finish coat was recommended to be applied over the repaired areas.

Stainless Steel

Repairs to stainless steel for the purpose of removing red rust and preventing future rusting at these sites could be accomplished by milling the surface to remove the embedded carbon steel and affected grain structure of the stainless steel. After milling the surface, the application of a clear sealer was recommended to provide a barrier to moisture and reduce the possibility of subsequent rusting at the repaired sites. Scratches could also be removed and sealed using this process. While it may not be necessary to repair all of the scratches, the overall appearance of the train station could be significantly improved if repairs were made to the stainless steel window frames and door panels, which are in the most visible and heavily traveled areas.

Cynthia O'Malley, laboratory services manager with KTA-Tator, Inc., is responsible for coating failure investigations and coatings testing services. An SSPC-Certified Protective Coating Specialist, she is a member of SSPC, the American Chemical Society, ASTM, and the American Coatings Association. She frequently presents coating failure investigation workshops and papers on related topics at SSPC conferences.

Crack Work with Polyurea on High-Profile Project

By Murphy Mahaffey, WIWA Wilhelm-Wagner GmbH & Co. KG

When cracks were discovered in a historic concrete dam in the French Alps, repair called for extraordinary safety precautions, sensitivity to the environment, athletic as well as coating skills, quick and careful work, special application equipment, and a fast-curing coating that could withstand harsh exposure conditions for a long time. The project was a success because it was put together by a team that included specialists in material specification and manufacturing, equipment design, material application, and all the other requirements for the repair work.

Gray and orange horizontal stripes are crack repair areas on Girotte Dam in France
Photos courtesy of WIWA Wilhelm-Wagner GmbH & Co. KG ©2010

A Short History of a High Dam

The Girotte Dam in France is in the Rhone-Alpes region near Hauteluce, situated in the foothills of the French Alps southwest of Chamonix-Montblanc. A multiple arch and buttress design, the Girotte Dam is on Lac de la Girotte (Girotte Lake), which has an elevation of approximately 1,747 m (5,732 ft).

Lac de la Girotte has been used in production of electricity since 1903 and is the first sub-glacial inlet structure ever to be developed in the world. Construction of the 45-meter-tall (148-foot-tall) dam began in 1942 and was completed in 1949. It consists of 18 arches held by buttresses that are fixed in the ground. It stretches 510 m (1,675 ft) across a mountain ridge. The reservoir has a surface area of 75 hectares (8.7 million sq ft). The dam was designed by Albert Caquot. Its specification called for unreinforced concrete, reportedly because of the shortage of steel during much of the construction period.

Project and Environment

The weather conditions in the scenic mountains near the border with Switzerland and Italy are demanding on any concrete structure, and especially on one that is not reinforced. The cycling temperatures and elevation provide challenges to the structure, and several coating solutions have been used over time to protect the concrete from the aggressive glacial waters.

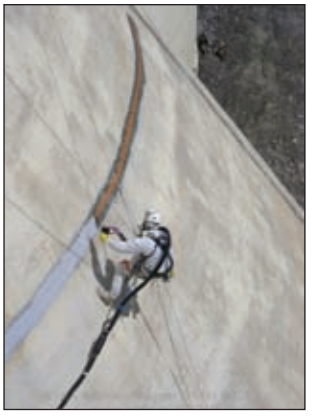
In March 2006, a condition report noted that cracks were observed in the wall and escapes (leaks) were observed at some of the membranes. As a result of these observations, the process of material specification and budgeting to repair the cracks began. The material selection group needed a coating that was best suited to their requirement and to the sensitive environment where it would be applied. The coating also had to be the best fit for a project of such importance and with such difficult application conditions. The polyurea

Continued

Editor's Note: This article is based on a paper the author will present at SSPC 2011 featuring GreenCOAT, the conference of SSPC: The Society for Protective Coatings. The conference will be held in Las Vegas, NV, January 31-February 3.

Girotte Dam set in Alps

selected was a fast-setting, sprayable, high-build membrane with an exceptional service life compared to the alternatives that had been used. The polyurea's service life would also allow for longer intervals between maintenance projects over time.



From overhead angle view of worker applying polyurea to area marked for crack repair

Safety

A safety plan was in place before the start of the job so that all people involved were prepared to work on the potentially dangerous application. The work had to be done via rope and harness, which makes communication with the equipment and safety operators difficult. Changing wind conditions were also a concern because of the height of the dam, so the safety plan had to include a strategy to allow the worker to get to safety in the event of heavy gusts.

Application

The cracks first had to be identified and marked by doing individual drops via harness and rope to visually inspect each of the 18 arches and the buttresses between them. After the cracks were marked, they were ground down and primed with a two-component epoxy-based coating.

The polyurea was then applied over the marked areas using a high-pressure, two-component spray machine with an impingement mix gun. The application equipment specified had 48 m (150 ft) of high-pressure, heated hose. The unit was situated on the deck of the dam during the application process, with the spray gun and hoses traveling with the applicator as he rappelled down the wall. The long hose and position of the machine allowed access from the top to the base of the dam wall.

Jobsite safety was always the first concern because of the high elevation and the difficult access to the areas to be sprayed. The conditions required attention to the proper safety gear and procedures. In addition, the polyurea was sprayed at 110 Bar (1,600 psi) with a material temperature of 70 C (160 F), so the equipment required safety features such as over-pressure shutdown, over-temperature shutdown and material monitoring. Temperature as well as wind and other weather conditions changed throughout the day, with morning temperatures starting at 10 C (50 F). It was critical to avoid applying any off-ratio material in this environmentally sensitive area.

Continued

Worker had to rappel to repair cracks

The work took place over 5 days, and required 1,200 Kilos (2,645 lb) of polyurea. Inspectors from the French authority that managed the dam determined that the material was applied according to specification, and the job was completed in June 2010. As of this writing, performance remains as specified and will be checked at regular intervals.

Tradecc supplied the coating material. Michel Laksander, Rob Jansen, Herbert Mann, all from WIWA Wilhelm-Wagner & Co. KG, designed the spray equipment, which WIWA manufactured, and they provided technical support. BMS was the distributor for the spray equipment. SPIE Batignolles was the application contractor.

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Murphy Mahaffey is the director of International Sales for WIWA Wilhelm-Wagner GmbH & Co. KG. He is active in SSPC and has written several articles for *JPCL*.

Using Robots in Ballast Tanks:

Project Under Way to Automate Inspection of Surface Prep and Coating Work

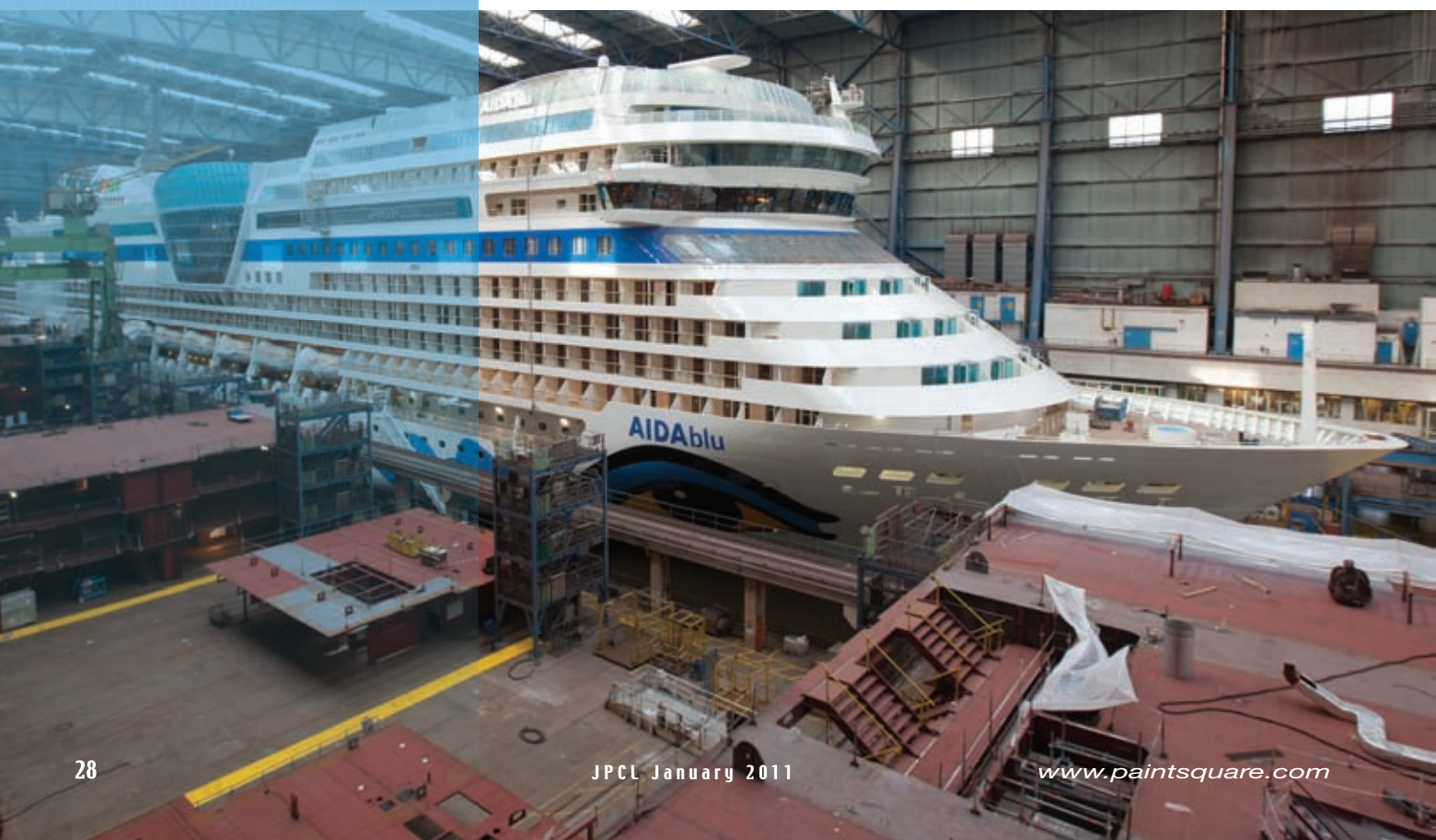
By Lars-Eric Etzold,
Meyer Werft GmbH

The aim of the project "RObots in Tanks" (ROT) is to foster the development, application, and integration of new manufacturing and inspection processes for narrow, highly inaccessible, dirty, and complex enclosed spaces on vessels, such as ballast water tanks (BWTs). These processes will use a new generation of mobile robots that can operate autonomously under the specific conditions of such spaces.

The main focus of the project to date has been inspection at newbuild and during the life of the vessel. Therefore, two of the partners, DNV and Meyer Werft, have issued System Requirements for the inspection as well as for the robot's finding its way throughout a BWT.

This initial article will cover two aspects of the project: the inspection requirements, including criteria identified for a robot inspecting surface preparation and coating work, and finding its way within a BWT. On the basis of these aspects, a third partner, DKFI—Germany, will issue a proposal for the capabilities of robots in the ROT project.

Courtesy of Meyer Threw GmbH



The Inspection Requirements

Inspections at new building and during service have different requirements. Nevertheless, both have one common requirement: the health and safety of the inspector. The correct oxygen level, lighting, and slip-resistant surface are major items. Tanks must be ventilated, lighting must be provided and the tank after use must be washed. Robots could deal with these items in a different way than human inspectors deal with them.

The New Building Inspection

During all inspection stages, there must be sufficient oxygen, a maximum level of gases, sufficient lighting, and safe access. Generally speaking, coating work inside a BWT consists of the following steps.

- Pre-prep for appropriate steel condition—removal of weld spatters, grinding of edges, etc., according to ISO 8501-3 or the Production Standard of the German Shipbuilding Industry (VSM)
- Cleaning of oil and grease
- Surface preparation by blasting according to ISO 8501-1 (full blasting)/2 (partly blasting)
- Inspection to check the roughness (ISO 8503-1) and cleanliness (ISO 8502-3 for dust and 8202-6 for salt)
- Inspection of coating after each application of two stripe coats and two full coats. The robot might need to inspect the stripe coat for proper application or measure the full coating thickness (or do both).
- Measurement of ambient temperatures: during the whole process after the blasting and until the paint has cured, the ambient temperatures must be measured at least once a day.

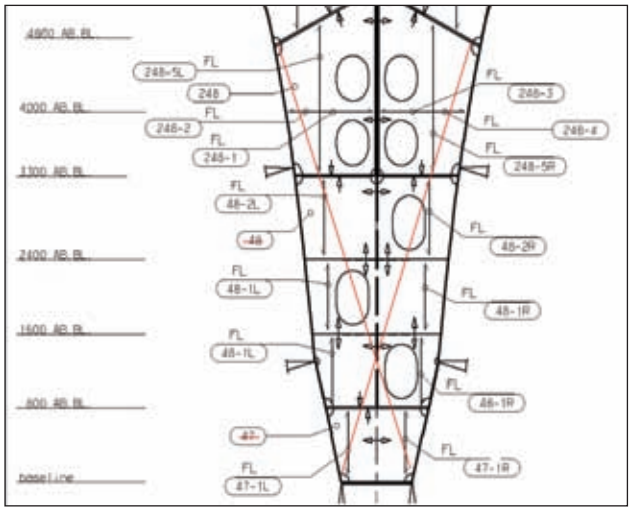


Fig. 1: Section of the aft peak of a cruise liner
Figures 1-4 courtesy of Meyer Werft GmbH

According to the International Maritime Organisation (IMO), all dedicated BWT for vessels of not less than 500 gross tonnage must be coated as described in the IMO PSPC MSC.218(82) Standard.

Below are tasks in the newbuild process and survey process, and requests for capabilities needed by a robot in the ROT program to take over BWT inspection during these processes. The complexity of BWTs is shown in Figs. 1-4.

The Steel Condition before Blasting

The ISO 8501-3 P2 and the VSM Standard XIV provide several pictorial guidelines for welding and grinding the steel before the surface preparation work can start. The inspection would be done visually.

Request for a robot: the ability to correctly identify and mark the imperfections.

Cleaning of Oil and Grease Contamination

Before the blasting work can start, any oil and grease contamination must be removed. Otherwise, the oil and grease will contaminate the blasting abrasive and the substrate. Depending on the abrasive specified, it can be used either once (like copper slag) or several hundred times (like steel grit). The oil and grease is removed mainly with solvent-soaked cloths.

Request for a robot: the ability to identify the areas of oil and grease contamination.

Surface Preparation

In the shipbuilding industry, mainly shot blasting is done automatically to prepare and profile plates.

- Cleanliness: After abrasive blasting, the grit must be taken out of the tank, primarily by vacuuming. Afterwards, dust on the steel must be removed. During the visual inspection of the work the dust content as well as salt level and roughness must be measured. *Request for a robot:* the ability to measure the cleanliness of the steel.
- Shop priming: Another part of surface preparation is protecting the prepared steel from damage or corrosion in the shop before coating work. To protect the steel, a 15-micron layer of shop primer is applied. The priming will be also be done automatically in plants.

The shop primer must be overcoatable, non-saponifying, weldable and suitable to be cut by thermal equipment, and able to protect the steel for six months against rust.

All damaged shop primer, welds, and areas of fairing work must be blasted again. Any shop primer damaged by fairing work must be removed completely since this is completely destroyed material due to the heat. Mechanically

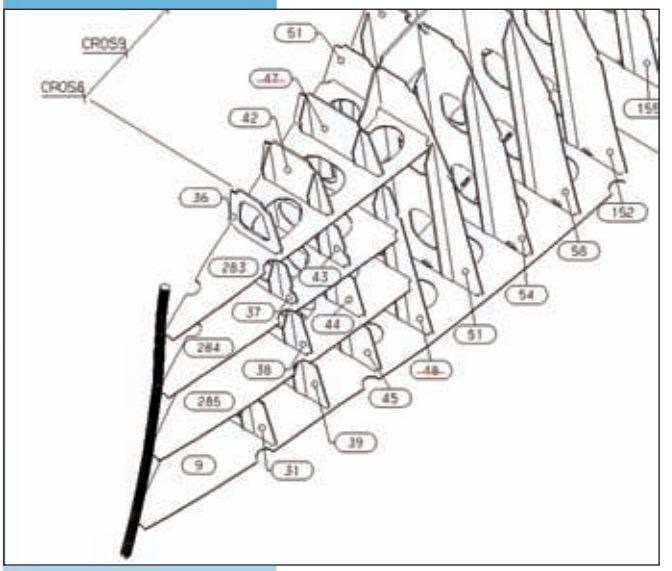


Fig. 2: Isomeric view of section of aft peak shown in Fig. 1.

damaged shop primer can reveal bare steel, and the steel will rust. The same is true for welds where no roughness exists.

If the shop primer is approved, the IMO PSPC requires only partial blasting of welds and the damaged shop primer, as well as a cleaning of the intact shop primer.

If the shop primer is not approved, 70% of it must be removed, and the removal must be uniform.

Request for a robot: the ability to verify that the blasting standard has been achieved.

Paint Application

After the blasting standard has been met, the shop-primed steel is ready for coating application. First, all edges and corners of cut outs, manholes, lighting holes, limber holes, flat bars, related appurtenances, and all weld seams must get a stripe coat (S/C) either before or after the full coat. This will ensure that the dry film thickness (DFT) will also be achieved in these areas. The IMO PSPC Standard for dedicated sea water BW tanks requires a minimum of two SCs.

The full coat (F/C) is mainly applied by airless spray to the whole tank in two layers.

The IMO PSPC gives guidance about where and how many DFT readings must be made.

Request for a robot: the ability to evaluate the correct thickness and full coverage of the S/C and the F/C.

Ambient Conditions

After the blasting and until the final coat has been fully cured, the ambient conditions must be measured.

Continued

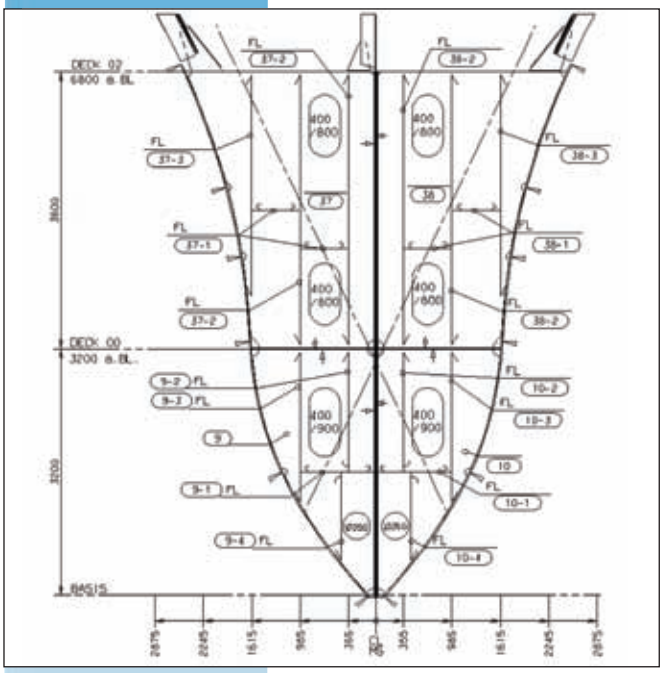


Fig. 3: Cross section of fore peak tank

These conditions are the

- air temperature,
- substrate temperature,
- humidity,
- dew point (will be calculated by the gauge—this is the air temperature where the humidity will be 100% on the substrate), and
- the Delta temperature or temperature difference. The Delta temperature will be calculated by the gauge and must be higher than 3°C, above dew point, which is equal to 85% humidity.

Moreover, the ambient conditions must be measured at the areas where the steel is cold.

Request for a robot: the ability to measure ambient conditions.

The In-Service Inspection

All ships are, according to international regulations of the IMO, subjected to two types of surveys, those defined by statutory requirements and those defined by specific classification societies' requirements. Classification societies carry out this task on the behalf of Flag States in their role as Recognised Organisations (RO). In this respect, ships shall be subjected to periodic surveys in accordance with requirements of the different classification societies to confirm that the hull, machinery, equipment, and systems remain in satisfactory condition and in compliance with approval or accepted standards.

Within the ROT Project, only BWTs of the ship's hull structure are being considered. Hence, with reference to BWT, periodic surveys belong to one of the following categories, according to the level of survey requirements, and shall be carried out at prescribed intervals and within applicable time windows.

Annual Survey

The due date in general corresponds to the anniversary date of the class assignment or the expiration of the previous classification certificate if different.

Intermediate Survey

The due date corresponds to the date 2.5 years before the expiration date of the classification certificate. The intermediate survey shall be completed concurrently with the second or third main class annual survey in each period of the classification certificate.

Fig. 4: Interior of a coated fore peak tank with ladders and climbing irons

Renewal Survey

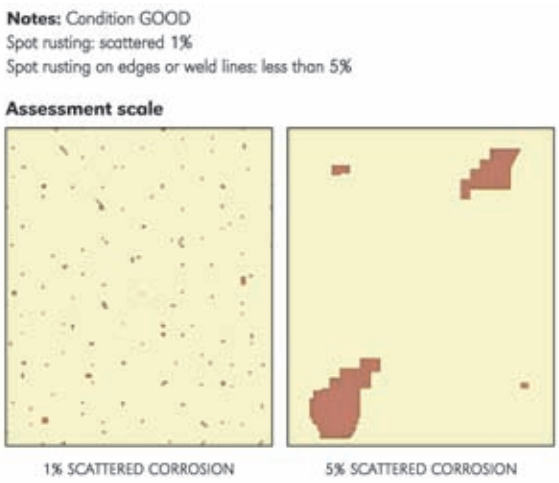
The due date is set at a five-year interval and corresponds to the expiration date of the classification certificate. The renewal survey shall be completed concurrently with the last main class annual survey in each period of the classification certificate.

Surveying the BWT

In preparation for the survey and for a thorough examination (depending on the survey category), the operator (i.e., shipping company) must clean all spaces and areas. Cleaning includes removing from the surfaces all loose, accumulated corrosion scale. Spaces should be sufficiently clean and free from water, scale, dirt, oil residues, and other contamination to reveal corrosion, deformation, fractures, damage, or other structural deterioration. Also, the oxygen level must be considered for man entry.

The survey consists of examination and measurements as required for different survey categories to ensure that the BWT structure is in satisfactory condition with respect to corrosion, deformation, fractures, damage or other structural deterioration as per classification requirements.

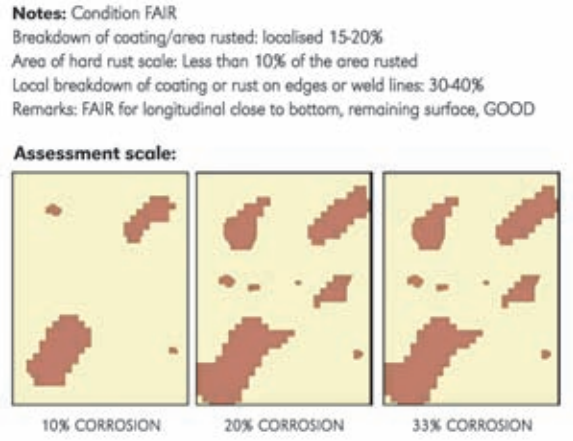
When close-up examination is specified by the rules or required by the surveyor, the structure or object is visually examined from a distance normally within reach of hand. Thickness measurements of steel plates for general assessment and recording of corrosion pattern shall be taken as specified by the rules as part of the survey. The surveyor may require thickness measurements in any portion of the structure where signs of wastage are evident or in areas

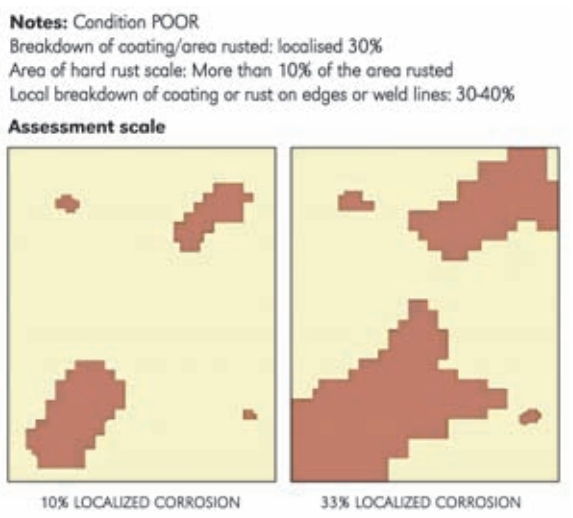


Appendices 1–3 reproduced with permission from IACS "Guidelines for coating maintenence and repair"

where wastage is normally found. The surveyor may extend the scope of the thickness measurements if considered necessary.

For structures where original protective coating is in GOOD condition (condition with only minor spot rusting, Appendix 1), the extent of close-up examination and thickness measurements may be specially considered. If not otherwise specified, the same applies for re-coated structures (by epoxy coating or equivalent), provided that the condition of the protective coating is in GOOD condition and that documentation is available stating that the scantlings were assessed and found satisfactory by a surveyor before recoating, and that the coating was applied according to the manufacturer's recommendations.





Two other coating conditions are specified.

- FAIR: Condition with local breakdown at edges of stiffeners and weld connections and/or light rusting over 20% or more of areas under consideration, but less than as defined for POOR condition (Appendix 2), and
- POOR: Condition with general breakdown of coating over 20% or more of areas or hard scale at 10% or more of areas under consideration (Appendix 3).

Depending on the survey type (annual, intermediate or renewal), the extent of and time taken for the inspection increases. In addition to visual inspection, ultrasonic measurements must be made to evaluate the steel thickness.

Request for a robot: the ability to conduct close-up surveys and/or perform ultrasonic thickness measurements by remote means, depending both on the expected condition of the ship and on the methods, equipment, and experience of the company offering the service. These remote means could include the following.

- Climbers using a camera
- Remotely operated vehicle equipped with camera in filled ballast tanks
- Divers operating in filled ballast tanks

It should be also noted that the cleaning and de-scaling condition should be described and documented by pictures.

BWT Structure

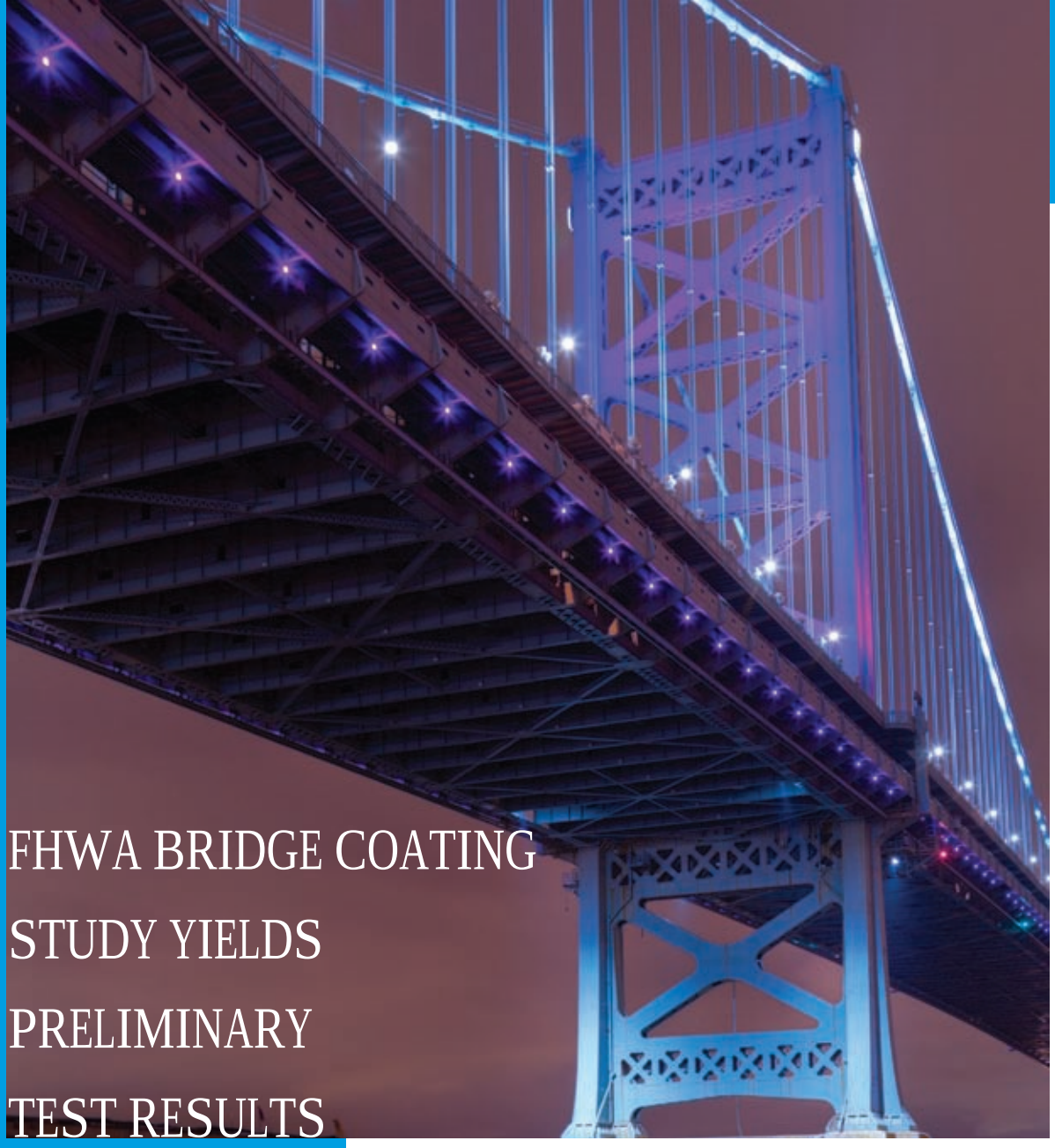
The complexity of the design of BWTs of a cruise liner is shown in Figs. 1-4. Figure 1 (p. 29) shows a section of the aft peak of a cruise liner. The red marking identifies the BWT, with the higher area being a void space. The figure does not show any pipes, ladders or other fittings that further complicate access. Figure 2 (p. 30) shows the isomeric view of the same section as in Fig. 1, with the outer shell missing and viewed from upside down. Figure 3 (p. 32) is a cross section of a fore peak tank. Figure 4 (p. 34) shows the interior of a coated fore peak tank with ladders and climbing irons installed.

Current Status

Due to the complex tank design, the partners agreed as a first step that the robot must be able to find its way within the tank. Therefore, a test bed was designed, and with this mock-up, several alternatives were investigated. Among the questions asked are what kind of robot can be used, and how can the robot avoid getting lost? For the time being these aspects are under investigation. The first results were expected to be available late 2010.

Editor's Note: This article is based on one published in the October–December 2010 issue of Protective Coatings Europe (PCE). *The* PCE *article was based on a presentation at the September 2010 Marine Coatings Conference during the SMM Trade Fair in Hamburg, Germany. The Coatings Conference was organized by the MPI Group and co-sponsored by* PCE, Drydock Magazine, *and* JPCL. *The article appears here with permission.*

JPCL



FHWA BRIDGE COATING STUDY YIELDS PRELIMINARY TEST RESULTS

By Pradeep Kodumuri,
SES Group & Associates; and
Seung-Kyoung Lee,
Federal Highway Administration,
Turner-Fairbank Highway
Research Center

Since the coatings industry changed in the 1970s from coating systems with lead-based primers to systems with zinc-based primers, the typical service life of a zinc-rich coating has been assessed to be about 30 years before a major touch-up is required. Typical concerns with zinc-rich systems include the cost of removing mill scale before coating application, the time and space required for shop application, and the logistics of moving heavy steel members from the shop to the field. A good alternative to addressing these cost issues is to extend the service life of the existing coating system on steel before any maintenance or replacement is required of the existing coating system.[1]

To search for inexpensive and durable coating systems, the FHWA Coatings and Corrosion Laboratory (CCL) at Turner-Fairbank Highway Research Center initiated the FHWA 100-year coating study. This in-house study was initiated in August 2009 under the U. S. Congress's mandated program on high-performance steel. The objective of this study is to identify and evaluate coating materials that can provide 100 years of virtually

Table 1: Selected Coating Systems

System Number	Category	Generic Coating Name	Acronym
1	Control: conventional 3-coat shop system	Inorganic zinc / epoxy / aliphatic polyurethane	IOZ/E/PU
2	Control: 3-coat organic zinc shop system	Zinc-rich epoxy / epoxy / aliphatic polyurethane	E/E/PU
3	3-Coat fluoro-topcoat system	Moisture-cured urethane-zinc / epoxy / fluorourethane	MCU/E/F
4	2-Coat fast dry coating	Zinc-rich epoxy / aliphatic polyurethane	E/PU
5	2-Coat polysiloxane	Inorganic zinc / polysiloxane	Zn/PS
6	Metallizing (conventional) + topcoat	Thermal sprayed zinc / linear epoxy	TSZ/LE
7	Organic zinc-rich epoxy (zinc flake) / linear epoxy	Experimental primer / topcoat	ZnE/LE
8	Calcium sulfonate alkyd	High-ratio, single-coat CSA	HRCSA

maintenance-free service life for the steel bridge structures at costs comparable to those of existing coatings. Coating systems were selected based on past experience and results from previous FHWA studies that had evaluated coating systems such as moisture-cured urethanes, waterborne acrylic and epoxy systems, two-coat zinc-rich rapid deployment systems, overcoating systems, and one-coat systems.[2-6] This article presents an overview of the work plan as well as the first data sets collected through six 360-hour accelerated test cycles and one 6-month outdoor exposure test cycle. The article also describes design innovations in test panels and testing.

Experimental Procedure

Selected Coating Systems

Table 1 summarizes eight coating systems studied. Two 3-coat systems were used as controls; the remaining coating systems included another 3-coat system, four 2-coat systems, and a 1-coat system. The acronyms used for all the coating systems can also be seen in the far right column of Table 1. This article will use these acronyms to identify the coating systems. All the coating systems were applied to steel substrates prepared to SSPC-SP 5 (White Metal Blast).

Editor's Note: This article is based on a paper the authors will present at SSPC 2011 featuring GreenCOAT, the conference of SSPC: The Society for Protective Coatings. The conference will be held in Las Vegas, NV, January 31-February 3.

Test Panels and Test Conditions

Typically, for its in-house coating studies, FHWA uses conventional, rectangular-shaped, 4-inch x 6-inch test panels. For this study, in addition to using conventional panels, FHWA adopted a new test panel design to closely simulate the steel coated on highway bridges. The new panels are 18 inches x 18 inches, with a welding joint and two angle attachments. All 4-inch x 6-inch panels will be referred to as Type I; 18-inch x 18-inch panels will be referred to as Type II panels. Figure 1 shows a typical Type II panel with a v-notch (welding joint), a T-shaped angle attachment and a wide-angle attachment. The corresponding dimensions of each component are also shown.

All Type I test panels were coated according to each manufacturer's recommendations for dry film thickness (DFT). The test surface of a Type II panel consisted of three areas of varying DFT values:

(a) Area 1—Target DFT
(b) Area 2—DFT is 20% less than the target DFT
(c) Area 3—DFT is 20% more than the target DFT

Test results from these three DFT areas will help show how DFT areas thinner than target DFT and DFT areas

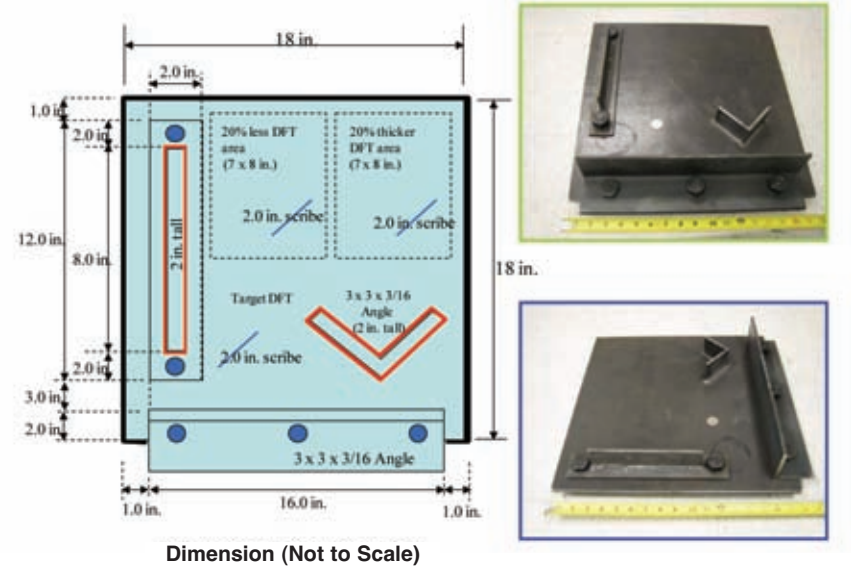


Fig. 1: Type II Test Panels

Table 2: Type I Test Panels

Group	Number of Coating Systems	Accelerated Lab Test[a]	Outdoor Tests		Physical Testing[d]	Total Number of Test Panels
		ALT	NW	NWS		
Uncoated steel			2[b]	2[b]		4
Control	2	10	5[c]	5[c]	4	24
Others	6	30	15[c]	15[c]	12	72
Subtotal	8	40	22[c]	22[c]	16	**100**

ALT – Accelerated Laboratory Testing; NW – Natural Weathering; NWS – Natural Weathering with Salt Spray

[a] 3 scribed + 2 unscribed = 5 panels/coating system

[b] 2 panels for periodic salt spray outdoor exposure and 2 panels for natural outdoor exposure (no salt spray), respectively

[c] 2 scribed and 1 unscribed panels/coating system for periodic salt spray outdoor exposure and 1 scribed and 1 unscribed panels/coating system for natural outdoor exposure = total 5 panels/coating system

[d] 2 unscribed panels/coating system

Table 3: Type II Test Panels

Group	Number of Coating Systems	NW	NWS	GGB*	Total
Uncoated steel		1	1	1	3
Control	2	2	2	2	6
Others	6	6	6	6	18
Subtotal	8	8	8	8	27

*GGB – Golden Gate Bridge

Table 4: Accelerated Lab Testing of Type I Panels

Item	Freeze Exposure (Hours)	UV-Condensation Exposure (Hours)	Prohesion Exposure (Hours)	Total Exposure (Hours)
Each Cycle	24	168	168	360
Target Duration (20 cycles)	480	3,360	3,360	7,200

thicker than target DFT compare to the target DFT area for the coating systems tested. Figure 1 also shows the physical locations of these test areas on the surface of the Type II test panel.

In all, 100 Type I and 27 Type II test panels were prepared for accelerated and outdoor testing, respectively. Tables 2 and 3 list the types and number of test panels. Outdoor exposure tests were arranged in the backyard of Turner-Fairbank Highway Research Center (TFHRC) with and without salt spray. Another outdoor test was conducted at Golden Gate Bridge (GGB) in San Francisco, California.

Each coating system was sprayed on 12 Type I panels. Five panels were tested in accelerated conditions, and five panels were tested outdoors in natural weathering and natural weathering with salt spray. None of the Type I panels were tested at the Golden Gate Bridge. The two remaining Type I panels were used exclusively for physical testing such as adhesion strength and Fourier Transform Infrared Spectroscopy analysis. Four uncoated steel panels were also deployed on the outdoor exposure racks, two on each exposure rack with and without salt spray.

For outdoor exposure testing on three racks—two for natural weathering (with and without salt spray) at TFHRC and one at GGB—3 Type II panels were coated with each coating system; 3 uncoated steel panels were also employed for each, making a total of 27 panels.

An independent coating laboratory prepared the test panels and delivered them to TFHRC. After their as-received condition was documented, half of the Type I test panels were scribed and the other half remained unscribed. DFT areas of all of the Type II test panels were scribed.

Three out of the 5 (Type I) panels for accelerated testing and 3 out of 5 (Type I) for outdoor testing were scribed

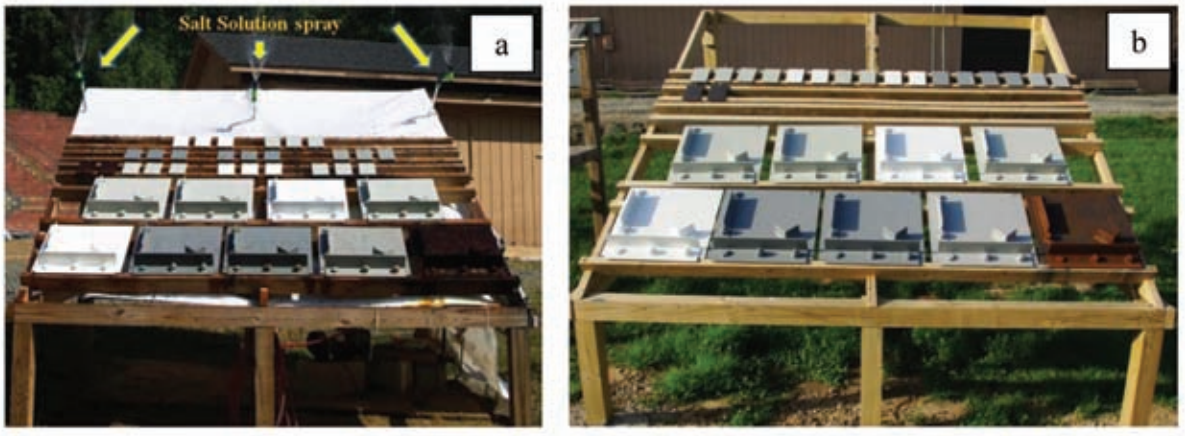


Fig. 2: (a) Natural weathering with salt rack and (b) natural weathering rack

according to ASTM Method D 1654. Using a mechanical scriber, researchers made a 2-inch long, diagonal scribe on each panel.

All test areas of Type II test panels were scribed (Fig. 1). A mechanical scribing tool used for Type I panels was not suited for the large size test panels; hence, the Type II test areas were scribed using a high-speed Dremel tool with a rotary bit. C-clamps were used to support a metallic guide, along which the scribing was done using the Dremel bit.

The exposure conditions used in the 100-year study are summarized in Tables 2 and 3.

Accelerated Testing

Table 4 summarizes the test conditions for accelerated testing and the total number of cycles. Each accelerated laboratory test cycle was carried out for 360 hours and a total of 20 cycles will be carried out. Upon completion of every 360-hour cycle, the panels are examined for their performance. A detailed description of each 360-hour test cycle is shown below.

1. Freeze: 24 hours
   Temperature: -23 C (-10 F)
2. UV/Condensation: 168 hours (7 days)
   Test cycle: 4 hours

UV/4-hour condensation cycle
   UV lamp: UVA-340
   UV temperature: 60 C (140 F)
   Condensation temperature: 40 C (104 F)

3. Prohesion (Cyclic Salt-Fog, ASTM G85): 168 hours (7 days)
   Test cycle: 1-hour wet/1-hour dry
   Wet cycle: A Harrison Mixture of 0.35 wt% ammonium sulfate and 0.5 wt% sodium chloride was used. Fog was introduced at ambient temperature.
   Dry cycle: Air was preheated to 35 C (95 F) and then was purged to the test chamber.

Natural Weathering with and without Salt Spray

Type I and Type II test panels were deployed on wooden racks inclined at 30 degrees facing south. Figures 2(a) and 2(b) show the test panels deployed initially in the back yard at Turner Fairbank Highway Research Center in Mclean, Virginia.

A 15 wt% sodium chloride solution was sprayed onto these test panels every 24 hours by an automatic salt spray system. This system was built in-house. It works with a timing switch turning on an electro-mechanical pump every 24 hours to spray these test panels for a short period (15 seconds) with the salt solution. After a week of salt spray, due to excessive salt deposit buildup, the salt solution was changed from 15 wt% sodium chloride to the Harrison mixture (0.35 wt% ammonium sulfate and 0.5 wt% sodium chloride). Test panels are evaluated every 6 months for coating performance.

Golden Gate Bridge

The outdoor exposure test conditions at Golden Gate Bridge can be considered harsh because of the severe fog, which also contains airborne chlorides. Figure 3 shows Type II panels deployed near the south abutment at the Golden Gate Bridge. Test panels are evaluated every 6 months for coating performance.

Initial Coating Characterization and Performance Monitoring

Coating systems in this study were characterized through Fourier

Fig. 3: Type II panels deployed at the Golden Gate Bridge

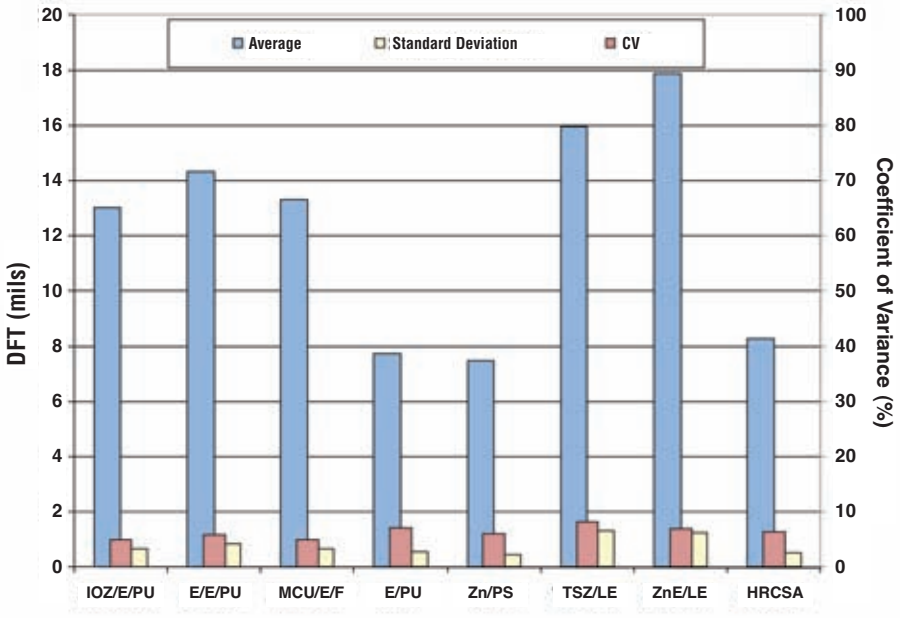


Fig. 4: Mean DFT values (Type I panels)

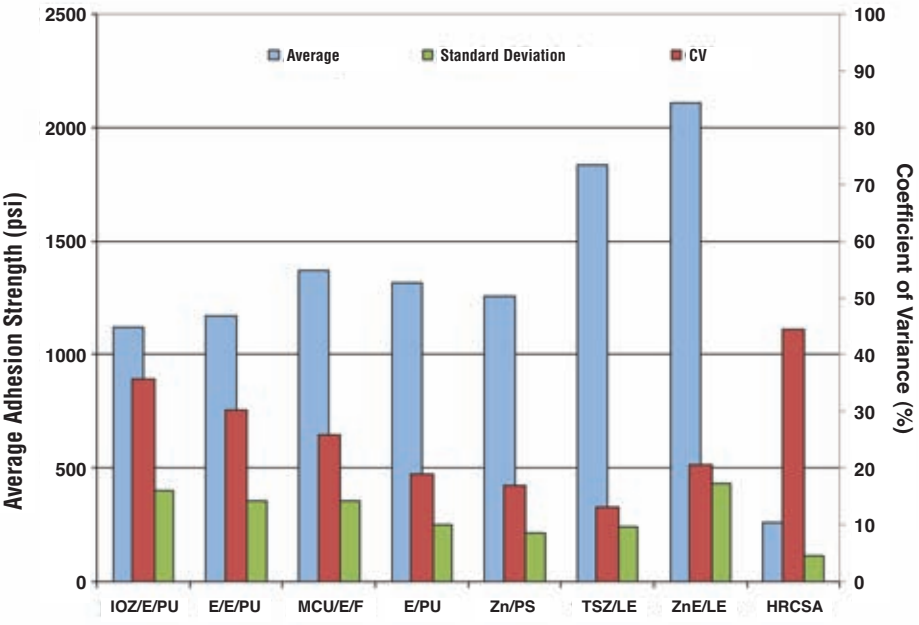


Fig. 5: Mean adhesion strength values (Type I panels)

Transform Infrared (FTIR) Spectroscopy and pull-off adhesion.[7] The tests were performed on two extra panels for each coating system. The adhesion tests were conducted with a hydraulic pull-off adhesion tester, and the nominal adhesion strength of a coating system was calculated by averaging six readings from two panels.

DFT and the number of holidays were measured on individual panels using SSPC-Paint Application Specification No. 2 and ASTM D5162[8,9] before the panels were exposed to accelerated or outdoor testing. Digital photographs were also taken before testing to document their as-received conditions. A low voltage holiday detector was used for the holiday measurement. Electrochemical Impedance Spectroscopy (EIS) was used to determine initial impedance properties of selected test panels and monitor their subsequent changes upon exposure. The gloss and color of each panel were measured by methods described in ASTM D523 and D2244, respectively.[10,11]

During the tests, test panels were evaluated periodically by monitoring changes in the number of holidays and physical condition. Measurements were made after every 360 hours of laboratory testing and after every six months for outdoor exposure testing. Digital photographs were taken to document progressive changes of individual panels. Growth of rust creepage at the scribe was monitored according to ASTM D7087.[12]

Preliminary Test Results

This section presents initial coating characterization results and preliminary test results from accelerated testing and outdoor exposures pertaining to color and gloss, DFT, pull-off adhesion, surface appearance, holidays, and creepage. Some supplementary photographs are included.

DFT

Figure 4 shows the mean DFT, standard deviation, and coefficient of variance (CV) of each coating system. DFT varied significantly, from 7.5 mils to 17.8 mils, depending on the coating system. None of the mean DFTs were less than 7 mils, and three systems (E/PU, Zn/PS, and HRCSA) were between 7 and 10 mils. All three-coat systems (IOZ/E/PU, E/E/PU, and MCU/E/F) had mean DFTs between 10 mils and 15 mils. The remaining two-coat systems (TSZ/LE and ZnE/LE) had DFTs exceeding 15 mils. Variation of DFT data, in terms of CV and standard deviation, was the highest for the last group of coating systems.

Pull-Off Adhesion

Initial mean adhesion values and their variability are shown in Fig. 5. ZnE/LE exhibited the highest adhesion strength of 3160 psi (CV 20%) while HRCSA demonstrated the lowest adhesion strength of 259 psi (CV 44%). All remaining three-coat and two-coat systems except TSZ/LE showed adhesion strengths from 1,000 to 1,500 psi (CV 15–25%). TSZ/LE had the second highest adhesion strength of 1,834 psi (CV 13%). The two control coating systems had adhesion strengths of 1,119 and 1,173 psi respectively (CV 30 and 35%).

Holidays

Figure 6 shows the cumulative (preliminary) number of holidays detected during the accelerated laboratory testing. When excessive holidays were detected, discrete defect spots could not be identified, and an arbitrary number of 100 was entered in the data sheet. Excessive numbers of holidays were observed on the surface of the TSZ/LE coating system. Initial assessment of this coating system showed no holidays on the surface. However, one of the panels demonstrated more than 20 holidays after 1,080 hours of testing, and the number of holidays increased excessively after two accelerated cycles that followed (after 1,440 and 1,800 hours of testing). These surface defects were then followed by excessive blistering and cracking of the surface of the coating system.

The rest of the three-coat, two-coat, and one-coat systems demonstrated either zero or minimal coating defects on the surface after 2,160 hours of accelerated testing.

Test panels coated with the Zn/PS coating system had initial defects to begin with on the low DFT area of Type II panels. After outdoor exposure of six months, none of the test areas on the Type II panels had developed any new holidays. All Type II test panels

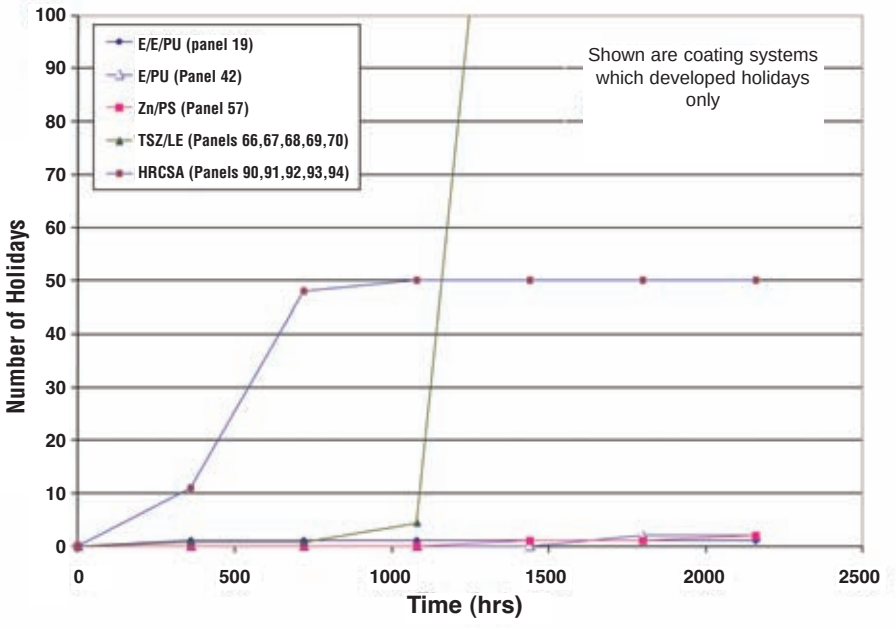


Fig. 6: Cumulative holiday development during accelerated testing

had coating defects in areas such as nuts, bolts, the underside of the T-attachment, and the wide angle attachment. These areas appeared to have developed rusting in areas of improper coating application. They will be carefully monitored over time for coating degradation and rusting.

Rust Creepage

Figure 7 shows rust creepage data for eight coating systems after 2,160 hours of accelerated testing. MCU/E/F (2.0 mm) and E/E/PU (1.42 mm) have shown more than 1.0 mm creepage at 2,160 hours. HRCSA, IOZ/E/PU, E/PU and Zn/PS showed creepage growth of less than 1 mm. Based on the creepage values at the end of 2,160 hours of accelerated testing; the coating systems can be ranked in the following order of highest to lowest rust creepage:

MCU/E/F > E/E/PU > E/PU > Zn/PS > HRCSA > IOZ/E/PU

It is interesting to note that the inorganic zinc three-coat control has the best performance for rust creepage, followed by the HRCSA. The latter coating system has performed well in earlier studies,[5] and a similar trend is being observed here up to 2,160 hours of accelerated testing.

The surface of the TSZ/LE coating system at 2,160 hours of accelerated testing indicated surface blistering and peeling off of the coating system all over the surface for both scribed and unscribed panels.

After six months of outdoor exposure at TFHRC in natural weathering with salt spray, two of the Type I panels coated with ZnE/LE coating system developed severe rust creepage of 7.6 mm. On a high DFT area of ZnE/LE on Type II panels, high rust creepage (11.8 mm) developed. The high DFT area of the three-coat control IOZ/E/PU was the only other coating system that showed moderate creepage of 1.9 mm after six months of exposure in natural weathering with salt spray.

Surface Deterioration

Figures 8 through 10 show selected Type I test panels representing coating systems with the best (HRCSA), moderate (E/PU), and worst (TSZ/LE) performance during the accelerated laboratory testing at 0; 1,080; and 2,160 hours. Similarly, Figs. 11

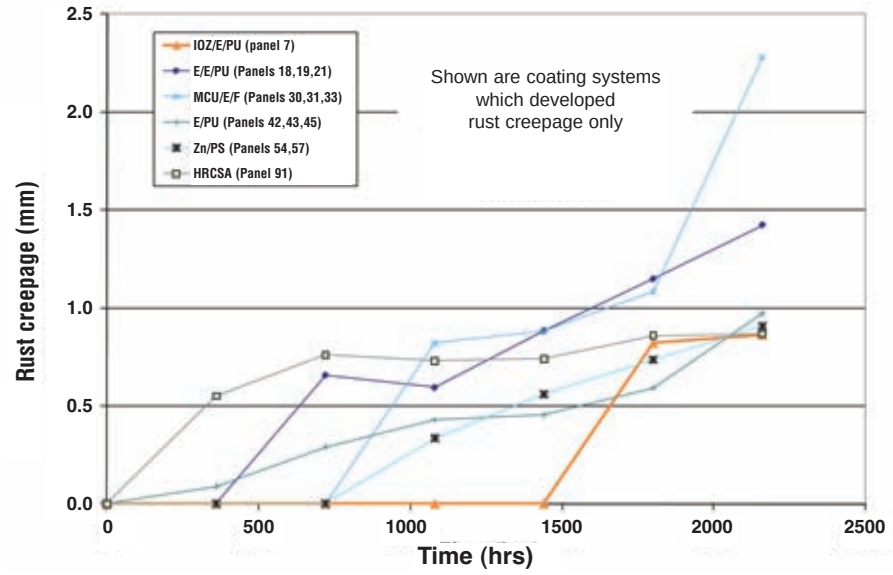


Fig. 7: Rust-creepage growth with time accelerated testing

and 12 are representative of Type II panels that showed the best (HRCSA) and worst (ZnE/LE) surface deterioration after six months of exposure in natural weathering with salt spray.

The three-coat inorganic zinc control (IOZ/E/PU) had the best surface retention properties in terms of holidays, rusting, and blistering. However, this is expected of a control coating system. The next best performing coating system among the candidate coating systems was identified as the HRCSA. The E/PU had a moderate development of holidays and rust creepage growth. The TSZ/LE coating system had the worst surface deterioration, as indicated by the development of holidays, surface blistering, and coating peel-off.

The visual observation of surface changes was followed up with digital microscopy of the surface of the test panels. Digital microscopy of the TSZ/LE coating system showed the phases of its progressive deterioration. Certain areas still had blisters intact while some areas had half-peeled off coating or detachment of the coating from the surface. White residual zinc oxide was forming on the surface in the areas where coating had peeled off.

Digital microscopy at 1,440 hrs of accelerated testing yielded another important experimental observation. The surface of the ZnE/LE coating system demonstrated micro-cracks all over the surface of the coating system. Cracks appeared to have spread across the coating surface. The central points at which these micro-cracks originated seemed to be a few microns in size, and the cracks themselves were a few hundred microns in size. However, the surface of these test panels did not demonstrate any holidays, indicating that the

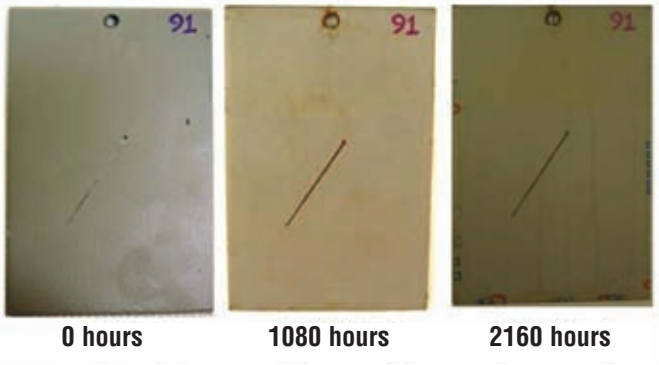


Fig. 8: Progressive changes of HRCSA (1-coat system)

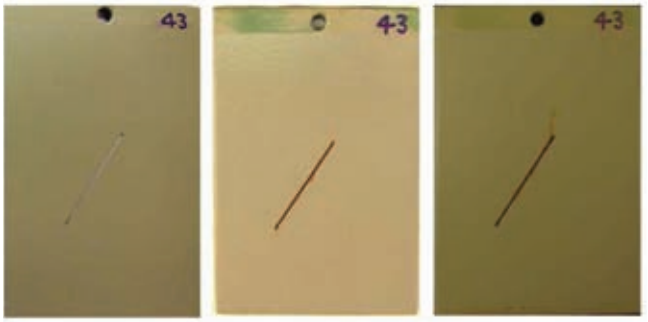


Fig. 9: Progressive changes of E/PU (2-coat system)

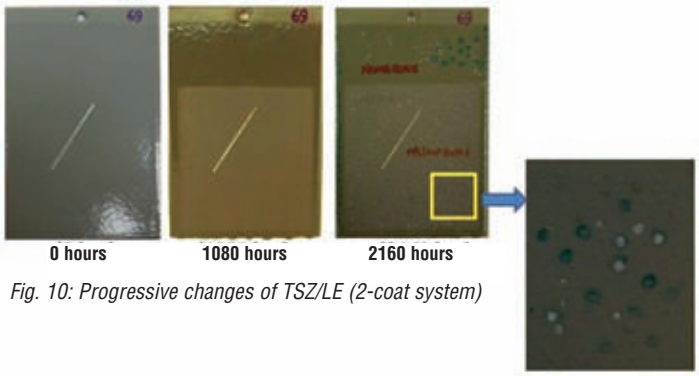


Fig. 10: Progressive changes of TSZ/LE (2-coat system)

cracks did not develop through the coating thickness and may have originated only on the surface. The density of the cracks seemed to increase as the time of accelerated testing increased.

Comparison of digital microscopy images before and after exposure indicated that these crack-originating locations were on the panel surface before testing. However, the cracks that propagated from these locations have appeared after accelerated testing. During outdoor exposure testing, except for ZnE/LE, none of the Type I panels and the Type II panel test areas developed holidays or rust creepage at the scribe. Figures 11 and 12 show the Type II test panels for the HRCSA and ZnE/LE coating systems.

Summary of Preliminary Findings

In this study, a new test panel was designed, and 27 of the new panels were used. They include welding joints and angle attachments. On the new design, three DFT areas of varying thickness were selected to simulate field conditions. Based on the initial coating characterization—six accelerated test cycles and one 6-month outdoor exposure cycle—some preliminary findings are summarized below.

1. Two three-coat systems were cho-

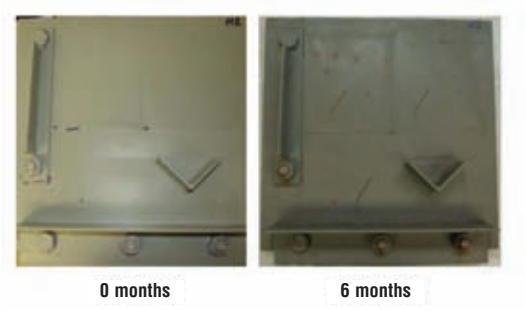


Fig. 11: Progressive changes of HRCSA

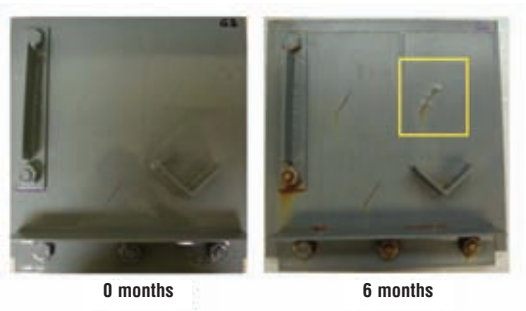


Fig. 12: Progressive changes of ZnE/LE

sen as the controls, and another three-coat system, four two-coat systems, and one one-coat system were selected as candidate coating systems.

2. Adhesion strength of the three-coat systems was comparable to that of the three-coat systems, but four times higher than the adhesion strength of the one-coat system.

3. The TSZ/LE coating system developed the highest number of defects during accelerated testing up to 2,160 hours, but no holidays developed on the surface after outdoor testing. The defect formation was progressively followed by blisters and by the coating peeling from the surface.

4. MCU/E/F developed the highest amount of rust creepage (almost twice) in comparison to the rest of the coating systems in accelerated testing. As was expected, the inorganic three-coat control (IOZ/E/PU) had the lowest creepage, followed by the HRCSA.

5. In outdoor exposure testing, ZnE/LE developed severe rust creepage on both Type I and Type II panels.

6. During accelerated testing, ZnE/LE developed micro cracks on the surface.

7. All coating systems developed no new holidays and surface deterioration after the first outdoor exposure cycle at the TFHRC and the Golden Gate Bridge.

[Note below received close to press time—Ed.]

Note: Due to unexpected premature failures of certain coating systems, the FHWA 100-year coating study has been terminated in December 2010.

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9. ASTM D5162-01, "Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates."
10. ASTM D523-89 (1999), "Standard Test Method for Specular Gloss."
11. ASTM D2244-07, "Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates."
12. ASTM D7087-05a, "Standard Test Method for an Imaging Technique to Measure Rust Creepage at Scribe on Coated Test Panels Subjected to Corrosive Environment."

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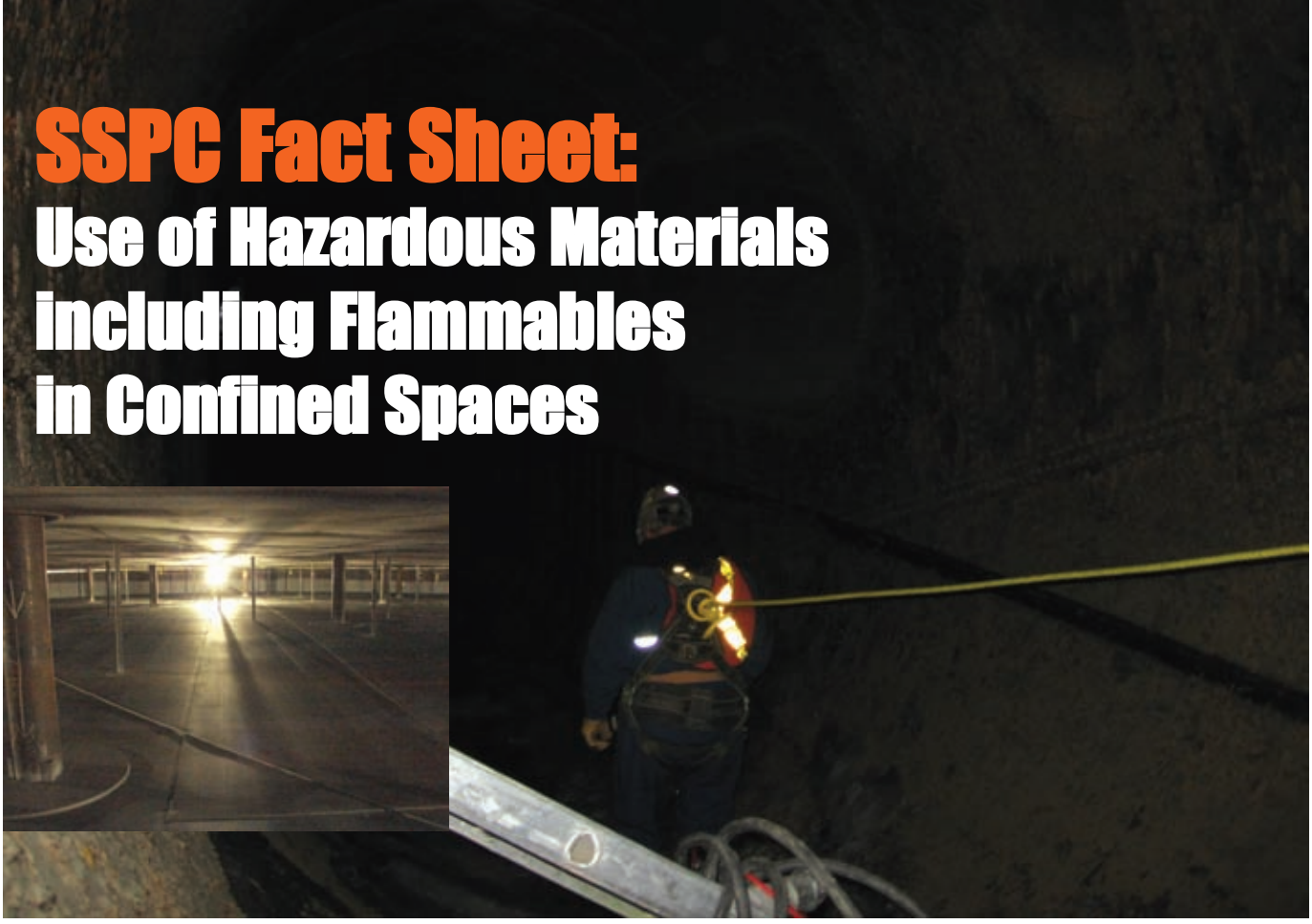
JPCL

SSPC Fact Sheet:
Use of Hazardous Materials including Flammables in Confined Spaces



Editor's Note: These photos are not from the accident described below, but show examples of confined spaces. Confined spaces can include manholes, sewer lines and tanks, ballast tanks, penstocks, and many other structures.

Editor's Note: *An 11-person crew was conducting maintenance painting on Oct. 2, 2007, in a penstock at the Xcel Energy Cabin Creek Hydroelectric Plant (Georgetown, Colorado) when a fire broke out. Five workers, trapped by the fire, died from smoke inhalation; of the six workers who escaped, three were injured, according to the August 2010 report issued by The U.S. Chemical Safety Board (CSB). (The CSB investigates industrial chemical accidents for their root causes.)*

In its synopsis of the accident, the CSB reports that the crew was in the early phases of recoating the 1,530-foot steel section of the 4,300-foot penstock tunnel with an epoxy coating and using flammable solvent to clean the application equipment. The CSB concluded that a flash fire occurred and spread: "Flammable solvent being used to clean the epoxy application in the open penstock atmosphere ignited, likely from a static spark. The initial fire quickly grew as it gained additional buckets of solvent and substantial amounts of combustible epoxy material, trapping and preventing five of 11 workers from exiting the single point of egress within the penstock."

The accident and its aftermath were reported by many media outlets, including JPCL *(Nov. 2007, Nov. 2009) and* PaintSquare News *(Oct. 29, 2009, Aug. 26, 2010).*

The CSB recommended that SSPC (sspc.org) prepare the Fact Sheet that follows.

Note from SSPC

SSPC developed the Confined Space Fact Sheet in response to the Chemical Safety Board's (CSB) Final Report on the Xcel Energy Hydroelectric Plant Penstock Fire in Oct. 2007. It has been designed to provide you with guidance in addressing the hazards present and controls necessary when working in confined spaces. It is also meant to reinforce the importance of conducting a job-site safety analysis, developing project-specific safety plans and training field personnel, communicating the key information about your job to local authorities, and having a trained attendant in place and rescue teams nearby.

The Fact Sheet further stresses following OSHA's guidance for fire protection and avoiding confined space hazards of penstocks and concludes by discussing OSHA's General Industry Standard for permit-required confined spaces.

SSPC hopes that you find this document a useful addition to your job-safety planning process, and SSPC looks forward to continuing to provide you with quality training, standards development, and insights into industry best practice.

Introduction

SSPC has always been committed to fostering industry safety through its training programs and standards development, in addition to requiring safety plans of its certified contractors. This fact sheet has been developed in response to the Chemical Safety Board's (CSB) Final Report on the Xcel Energy

Hydroelectric Plant Penstock Fire in Georgetown, Colorado, on October 2, 2007, which left five workers dead and three injured. The CSB report reviews key factors to consider when working with flammable materials in confined spaces. To receive a copy of the CSB report and to watch the video simulation of the Georgetown accident, visit www.csb.gov.

The CSB recommended that SSPC issue guidance addressing the hazards and controls for using hazardous materials in confined spaces. This SSPC Fact Sheet is meant to respond to CSB's request and serve as additional guidance. It is not meant to replace a safety plan as described in SSPC-Guide 17: Guide to Developing a Corporate Safety Program for Industrial Painting and Coating Contractors, nor is it to be used in place of relevant government regulations. SSPC assumes no responsibility for the interpretation of this Fact Sheet.

Working with Flammable Materials

Most solvent-based paints and paint-solvents are flammable. Their vapors can burst into flame when exposed to sparks or flames. They are especially dangerous in confined spaces. Before beginning work, a job safety analysis (JSA) must be performed taking into consideration the equipment and materials to be used. Always perform operations and maintenance of equipment in accordance with the equipment manufacturers' safe operating procedures.

To reduce fire hazards:

- Use paints and solvents with high flash points (above 100 F).
- Provide good ventilation that is explosion proof (electrically ground and bond blowers and duct work).
- Avoid flames or sparks in work areas.
- Use explosion proof lighting that provides adequate illumination. See SSPC-Guide 12 for further information.
- Use non-sparking tools where feasible in close proximity to the work.
- Electrically ground spray guns and coating containers.
- Ground and bond containers when transferring contents from one container to another.
- Ground hoses, duct work, or piping that carry material such as paints, solvents, and abrasives that can create a static charge while material is moving through them.
- Implement the fire protection plan requirement described in 29 CFR 1926.150.

Avoiding Confined Space Hazards

Confined spaces are defined as being large enough and so configured that an employee can enter and perform assigned work; having limited or restricted means for entry; and not designed for continuous occupancy. Confined spaces that are large, or part of a continuous system, such as a penstock, should always be managed as permit required as defined in OSHA's confined space standard. Such spaces should always be monitored for hazardous atmospheres both prior to entry and continuously in areas where work is being performed.

Whenever a hazard is present in the confined space, it should be considered a permit-required confined space. Examples of hazards include flammable vapors, airborne concentrations of materials above their occupational exposure limits, oxygen concentrations below 19.5% or above 23.5%, or any other atmospheric condition that is immediately dangerous to life or health. Confined spaces, as may be found in the industrial coatings industry, frequently contain such hazards during surface preparation and coatings application, and therefore should be treated as permit-required confined spaces (PRCS). Remember that you can create a permit-required confined space by changing the conditions or introducing new hazards such as solvents, combustible dusts (due to blasting or other surface preparation methods), or engulfment hazards.

Some examples of permit-required confined spaces commonly encountered in industrial and marine coating operations include interiors of storage tanks, silos, ship holds, boilers, and penstocks.

To eliminate these hazards:

- Employ the controls described in 29 CFR 1910.146 Permit-Required Confined Spaces.
- Use lockout/tagout controls as described in 29 CFR 1910.147(c)(3)(ii) to secure valves and piping that may otherwise introduce mechanical and/or electrical hazards into the space.
- Always try to substitute with less hazardous materials or methods.
- Perform work outside of the confined space wherever reasonably practicable or substitute a non-flammable for a flammable material whenever possible.
- Try to control the hazards by ventilation alone.
- If it is not possible to control the hazards by ventilation alone, establish a maximum permissible percentage below the <10% acceptable LEL (Lower Explosive Limit) for safe entry and occupancy of permit-required confined spaces.
- Establish and implement a written confined space rescue plan and written permit system that is reviewed annually.
- Ensure all field personnel are trained in every aspect of each project-specific confined space safety plan, including the rescue plan and each person's role in the event that the plan has to be implemented.
- Visit the closest fire station and provide the chief with a briefing about the job, including all entries. Be sure to give the chief a package including all MSDSs. Make every attempt to have a site visit with the fire chief to review the entry permit and stage a simulated fire drill. This prepares everyone for the worst-case scenario of fire or serious injury.
- Follow the rescue service requirements outlined in 29 CFR

1910.119 (k). When a potential flammable atmosphere exists in a permit-required confined space a properly trained attendant needs to be available to take action immediately when an emergency situation develops inside the space.

- Communicate with the attendant as necessary to enable the attendant to monitor entrant status and to alert entrants of the need to evacuate the space.
- Require that confined space rescue teams be readily available for call out within five minutes at the permit spaces where the hazards pose an immediate threat to life or health, including the hazard of a potential flammable atmosphere.
- Employ appropriate, properly operating, and calibrated (when necessary) safety equipment for air monitoring, ventilation, and emergency retrieval, including special winches for workers entering the confined space through a vertical access more than five feet in depth.
- Continually monitor air quality within the work space.
- Whenever feasible, use safety harnesses with lifelines attached to a fixed point outside the confined space. Examine the workspace for snags and appurtenances that could make retrieval difficult. If obstructions render lifelines unusable, require entrants to wear the harnesses regardless to facilitate rescue.
- Have properly operating fire extinguishers, appropriate for the flammable material, available within the confined space.

Unique Hazards of Penstocks

The tragic accident that was the subject of the CSB investigation took place in a penstock, or enclosed tunnel that delivered water to power turbines in a hydroelectric plant. Confined spaces that are large, or part of a continuous system such as a penstock, pose particularly difficult conditions. They should *always* be managed as permit-required as defined in 29 CFR 1910.146, OSHA's Permit-Required Confined Spaces Standard. Such spaces should always be monitored for hazardous atmospheres both *prior to entry and continuously* in areas where work is being performed. The evacuation plans for penstocks that have only one egress (exit) point must provide for alternative escape routes or refuge chambers. This is key to avoiding serious injury and death.

OSHA's Confined Space Standard

SSPC recognizes that the only comprehensive federal regulation currently governing work in confined spaces is outlined in OSHA's General Industry Standard 29 CFR 1910.146 Permit-Required Confined Spaces. The agency is working on a proposed rule on confined spaces more specific to construction as part of its upcoming revisions to 29 CFR 1926, Safety and Health Regulations for Construction. OSHA has also issued a Compliance Directive stating that the PRCS rule applies to certain industrial painting performed as maintenance work (see Appendix E, section (a) paragraph 8 of OSHA compliance directive CPL 02-00-100). In the interim, SSPC continues to believe it is prudent for both facility owners and painting contractors to voluntarily adopt the comprehensive requirements of 29 CFR 1910.146 during industrial painting work in confined spaces.

Summary

Accepted industry practices and regulatory requirements should be implemented prior to and during all surface preparation and coating application operations in confined space which may create a hazardous atmosphere, including at a minimum:

- Proper training of workers in the recognition and control of fire and explosion hazards.
- Proper training of workers in every aspect of each project-specific confined space safety plan, including the rescue plan and each person's role in the event that the plan has to be implemented.
- A job safety analysis (JSA) conducted by the company safety director, site safety officer, and supervisor to determine the hazards of the space, the equipment, and materials to be used. This should be conducted prior to the start of the project and on an ongoing basis when there are changes.
- Proper design and operation of ventilation equipment to reduce concentrations of flammable vapors to less than 10% of the LEL.
- Proper grounding and bonding of paint containers, spray equipment, and blowers.
- Use of explosion-proof lighting and equipment.
- Constant monitoring of the concentration of flammable vapors.
- Implement a project-specific confined space entry permit establishing the specific controls required for the subject project.

Resources

OSHA Confined Space Regulation
www.osha.gov/pls/oshaweb/searchresults.relevance?p_text=Confined%20space&p_status=CURRENT&p_title=

OSHA Compliance Directive
www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=DIRECTIVES&p_id=1582

Pre-Entry Checklist
www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9801

Proposed Rule: Confined Spaces in Construction (29 CFR 1926) www.osha.gov/pls/oshaweb/owadisp.show_document?p_ table=FEDERAL_REGISTER&p_id=20174

Monitoring Confined Spaces for Atmospheric Hazards
by Michael J. Platek, Industrial Scientific Corporation, *JPCL* Mar 1995

SSPC Guide 12: Guide for Illumination of Industrial Painting Projects

SSPC Guide 17: Guide to Developing a Corporate Safety Program for Industrial Painting and Coating Contractors

Updates Issued for SSPC 2011

The following pages include the known updates and a special section on concrete education for SSPC 2011 featuring GreenCOAT, held in Las Vegas, NV, on Jan. 31 to Feb. 3. All information is current as of press time. Additional updates and a complete schedule can be found at www.sspc2011.com.

Photo courtesy of the Las Vegas News Bureau

Additional Exhibitors

• **Aggreko LLC** is a global leader in rental power, temperature control, and oil-free compressed air systems, providing 24/7 service support from over 50 locations worldwide. Houston, TX; phone: 800-244-7356; aggreko.com/northamerica. Booth 429.

• **Blastrac NA** has been a global leader in the design and manufacture of portable surface preparation equipment for concrete and steel surfaces for nearly 35 years. Oklahoma City, OK; phone: 800-256-3440; blastrac.com. Booth 1125.

• **Ervin Industries** is a leading producer of AMASTEEL cast steel shot and grit abrasives used for steel surface preparation prior to coating. Ann Arbor, MI; phone: 734-769-4600; ervinindustries.com. Booth 560.

• **Farrow System** has products to quickly remove protective coatings, oxidation, and graffiti from surfaces without damage. The Farrow System® makes cleaning and cleanup safe, fast, and cost-efficient. West Chester, PA; phone: 610-431-1672; farrowsystem.com. Booth 1060.

• **Fast Wrap** is a nationwide shrink wrap provider operating in over 70 locations with onsite service providing abatement, containment, and environmental controls. Tempe, AZ; phone: 877-FST-WRAP; fastwrapusa.com. Booth 859.

• **Paul Gardner Co.** (Gardco) distributes, manufactures, and designs physical testing instruments, such as quality control instruments used in laboratory and field for testing and measurement. Pompano Beach, FL; phone: 954-946-9454; gardco.com. Booth 644. See our display ad on p. 45.

• **Grace Distributing** is a U.S. distributor of LifeGuard Active Rust Primer, a waterborne, 2% VOC, acrylic copolymer universal marine primer that converts rust as it primes. Charlottesville, VA; phone: 434-825-1529; gracedistributing.com. Booth 1110.

• **Graco Inc.** manufactures protective coatings equipment with advanced technology for spray coatings and foam, including plural-component proportioners, spray guns, transfer pumps, and accessories. Minneapolis, MN; phone: 877-84GRACO; graco.com. Booth 542. See our display ad on p. 26.

• **Green Solve LLC** Booth TBD.

• **Hi-Temp Coatings Technology** manufactures a wide variety of industrial and OEM heat-resistant coatings, including Hi-Temp. Boxborough, MA; phone: 978-635-1110; hitempcoatings.com. Booth 543.

• **Max Access, Inc.** offers rental, sales, and service of suspended scaffolding (top rigging, modular, traction hoists, drum hoists, safety equipment, etc.), confined space, man baskets, air tuggers, and E&D. Houston, TX; phone: 713-640-1005; max-access.com. Booth 960.

• **Pacific Dust Collectors** provides work on aged wood beams, brick, architectural concrete, barges, coating removal, Dunn blasting, epoxy, fire damage, heady-duty coatings, heavy equipment, lead removal, and pools. Damascus, OR; phone: 503-318-3860. Booth 743.

• **The TDJ Group, Inc.** manufactures Blastox®, an abrasive additive to stabilize lead-based paint. As one step lead abatement, it has been an industry leader for two decades. Cary, IL; phone: 847-639-1113; blastox.com. Booth 412.

• **Trimaco** offers drop clothes, Easy Mask® masking products, protective wear, building and flooring papers, wiping products, and other paint sundries for total jobsite protection. Morrisville, NC; phone: 314-534-5005; trimaco.com. Booth 1027.

• **WIWA LP** manufactures airless paint spraying equipment, including standard airless pumps, plural-component equipment, and other industrial systems. Chesapeake, VA; phone: 757-436-2223; wiwa.com. Booth 620. See our display ad on p. 21.

Committee Meetings

Five more committee meetings have been added: SSPC/NACE TG 006, Dry Blast Standards; SSPC C.1.1, Zinc Rich Coatings; SSPC C.2.13, Impact of Water Soluble Salt

Contamination on Protective Coatings; SSPC Instructors (Open for Approved SSPC Instructors); and SSPC Instructors (Invitation Only).

The Daily Schedule, also in this section, lists the rooms and dates for them (current as of press time).

Technical Program Updates

As of press time, all presentations not listed here remain the same. Abstracts, presenters and their companies, and more can be accessed at www.sspc2011.com.

• Mike Doolittle, of Tank Industry Consultants, will present "Environmentally Friendly Tank Recoating Project" during Session 2 on Tuesday, Feb. 1, from 1:30-2:00 p.m. This replaces "LEED, Coatings & the Contractor."

The presentation will discuss challenges in applying environmentally friendly coatings on two "twin" industrial tanks in Venture, CA.

• Eric Hernandez, NAVFAC ESC, PW54, has been added as a co-speaker for "Installation of a Primary Containment System in Existing Underground Concrete Storage Tanks" from 4–4:30 p.m. during Session 1 on Thursday, Feb. 3.

• On Wednesday, Feb. 2, a presentation has been added to Session 1: Bridge. From 5–5:30 p.m., Derrick Castle, Kentucky Transportation Cabinet, and Lynn M. Hagan, Elcometer, Inc., will present "Bridge Coatings Inspection, Where is Your Data?"

The presentation will discuss a project conducted to evaluate the application of digital coatings inspection equipment and electronic reporting during an ongoing bridge coatings project.

• "Finding a New Market Niche," with Peter Blattner from Alaron Corporation has been cancelled. It was scheduled for Session 5 on Wednesday, Feb. 2, from 4–4:30 p.m. "Managing Construction Risk Through Aggressive Schedule Management," will now run from 4–5:00 p.m. instead of starting at 4:30 p.m.

Concrete Education Planned

Monday, January 31

Session 4: A Sure Bet with Polyurea Technology includes the following presentations related to concrete.

• "Spray Polyurea System for Challenging Applications," Mario Lefebvre and Kevin Grillo, Wasser Coatings

• "Polyurea is Specified as the Best Dam Coating," Murphy Mahaffey, WIWA Wilhelm Wagner, GmbH & Co. KG

• "Polyurea Great Wall: Beijing-Shanghai High Speed Railway Polyurea Protection Project," Prof. Weibo Huang, Qingdao Technological University

Tuesday, February 1

Session 1: Commercial Building Seminar—Painting of Big Box Stores includes two presentations related to concrete.

• "Identification of the Coating Problems Faced by Commercial Building Owners," Kevin Brown, Lowe's, and Ken Trimber, KTA-Tator, Inc.

• "The Science of Moisture Migration in CMU Walls of Commercial Buildings," Kevin Knight, Architectural Testing

Wednesday, February 2

Session 2: Workshop—Waterborne Technologies for Protective Coatings, Leo Procopio and Thomas Tepe, The Dow Chemical Company

Session 4: Workshop—Failure Analysis of Paints and Coatings on Concrete, Randy Nixon and Mark S. Schilling, Corrosion Probe, Inc.

Session 1: Bridge—Assuring Performance and Quality Projects has one presentation related to concrete. "Crevice Corrosion in Concrete and Steel Structures," Thomas D. Gibbons, P.E., Greenman-Pedersen, Inc.

Thursday, February 3

Session 1: Protecting Concrete has three presentations scheduled.

• "Concrete Repair is Sustainably Green," Fred Goodwin, BASF Construction Systems

• "Installation of a Primary Containment System in Existing Underground Concrete Storage Tanks," Sean J. Massey, Shaw Environmental and Infrastructure Group, and Eric Hernandez, NAVFAC ESC, PW54

• "Reinforced Concrete Corrosion Assessment, Re-Passivation and Monitoring in an Industrial Environment," Bruce A. Collins, Restruction Corporation

Daily Schedule (as of press time)

Monday, January 31

8:00 a.m.–7:00 p.m. Registration Open (Outside Bayside B)

8–10:00 a.m. SSPC Standards Review Comm (South Pacific D)

10:30 a.m.–1:30 p.m. First Annual Business Mtg & Awards Luncheon (Islander FG)

2–3:30 p.m. SSPC C.2.0 Surface Prep Steering Comm (South Pacific D)

2–4:30 p.m.

Session 1: Workshop—Prot Ctgs (Islander Ballroom H)

Session 2: Workshop—Failure Analysis of Paints and Ctgs (Islander Ballroom C)

Session 3: Workshop—An In-Depth Look at Standards Most Frequently Used by Industrial Painters (Islander Ballroom D)

Session 4: A Sure Bet with Polyurea Technology (Islander Ballroom E)
Session 5: Workshop—Suspended Scaffold Access in Power Plants, Bridges, and Offshore (South Pacific Ballroom)
3–4:00 p.m. Local Chapter Chairs Mtg (Tradewinds F)
3:30–5 p.m. SSPC C.1.0 Ctgs Steering Comm (South Pacific C)
4:30–5:30 p.m. Greenhorn Reception (South Pacific B)
5:30–7:30 p.m. Welcome Reception (Islander FG)

Tuesday, February 1

7:00 a.m.–7:00 p.m. Registration Open (Outside Bayside B)
7:30–10:00 a.m. Keynote Breakfast (Islander FG)
9:00 a.m.–Noon. Las Vegas City Highlights Tour
10:00 a.m.–Noon. Session 1: Commercial Building Seminar—Painting of Big Box Stores (Islander Ballroom H)
10:00 a.m.–12:30 p.m. Session 2: Green from Start to Finish (Islander Ballroom C)
10:00 a.m.–Noon.
Session 3: Challenges in Protecting Ships & Marine Structures (Islander Ballroom D)
Session 4: Bridges—Engineering Marvels & Community Assets (TBD)
Session 5: Leadership Network Program, Part 1 (South Pacific Ballroom C)
10:30 a.m.–Noon. Comm Chairs' Workshop (South Pacific D)
1:30–3:00 p.m.
SSPC C.1.3.D Polyurethane Ctgs Comm (Tropics A)
SSPC C.2.15 Rev of SSPC-Guide 15 (South Pacific D)
1:30–4:30 p.m. Session 1: Commercial Building Seminar—Painting of Big Box Stores (Islander Ballroom H)
1:30–5:00 p.m. Session 2: Green Opportunities & Sustainability for Growth (Islander Ballroom C)
1:30–4:30 p.m.
Session 3: Modern Marvels—How High Performance Ctgs Work in the Marine Industry (Islander Ballroom D)
Session 4: Environmental Health and Safety (Islander Ballroom E)
Session 5: Leadership Network Program, Part 2 (South Pacific Ballroom)
3–5:00 p.m.
SSPC C.2.11 Determining Compliance with Steel Profile Requirements (South Pacific B)
SSPC C.3.5 Contractor Pre-Qualification, QP 1 Rev (South Pacific A)
5–8:00 p.m. Exhibit Hall Reception/Opening (Bayside B)

Wednesday, February 2

7:00 a.m.–5:00 p.m. Registration Open (Outside Bayside B)
7:15–8:30 a.m. Prot Ctgs Specialists Breakfast, Invitation (South Pacific D)
7:30–8:30 a.m. SSPC/NACE TG 006 Dry Blast Standards Comm (Tropics A)
8:00 a.m.–Noon. Red Rock Canyon/Spring Mt. Ranch Guest Tour
8:30–10:00 a.m.
- SSPC C.3.7 Qualification of Inspection Companies Comm, QP 5 Rev (Shell Seekers A)
- SSPC C.1.1 Zinc Rich Ctgs Comm (Mariner B)
- SSPC C.2.13 Impact of Water Soluble Salt Contamination on Prot Ctgs Comm (Shell Seekers A)

9–11:00 a.m. SSPC Govt Affairs Comm (South Pacific B)
9–11:30 a.m. Session 1: Corrosion Prevention & Prot Ctgs for the Military (Islander Ballroom H)
9–11:00 a.m. Session 2: Workshop—Waterborne Tech for Prot Ctgs (Islander Ballroom C)
9–11:30 a.m. Session 3: Alternative Ctgs in Water (Islander Ballroom D)
9–11:00 a.m.
- Session 4: Developing the Ctgs Industry Workforce (Islander Ballroom E)
- Session 5: Women in the Ctgs Industry (South Pacific Ballroom C)

10:00 a.m.–Noon. SSPC PCCP Advisory Comm Open Mtg (South Pacific A)
10:30 a.m.–Noon. SSPC C.1.9 Polyurea Ctgs Comm (Islander A)
11:00 a.m.–4:00 p.m. Exhibit Hall Open (Bayside B)
11:30 a.m.–1:00 p.m. Lunch in the Exhibit Hall (Bayside B)
1:30–3:00 p.m.
- SSPC PCCP Advisory Comm Executive Session (Tropics A)
- SSPC C.1.13 Ctgs for Wastewater Facilities Comm (South Pacific B)

3–5:30 p.m. Session 1: Bridge—Assuring Performance and Quality Projects (Islander Ballroom H)
3–5:00 p.m.
- Session 2: Conquering Corrosion with Ctgs (Islander Ballroom C)
- Session 3: Ctgs & Tech for the Offshore/Marine/Navy Marketplace (Islander Ballroom D)
- Session 4: Workshop—Failure Analysis of Paints and Ctgs on Concrete (Islander Ballroom E)

3:30–5:00 p.m. Session 5: Best Practices for Thriving in a Challenging Economy (South Pacific Ballroom C)
3:30–4:30 p.m. NBPI Inst Mtg, Invitation (South Pacific B)
3:30–5:00 p.m.
- SSPC C.1.4.C Waterborne Acrylic Ctgs Comm (Shell Seekers A)
- SSPC C.2.1 Abrasives Comm (Mariner B)

Thursday, February 3

7:00 a.m.–2:00 p.m. Registration Open (Outside Bayside B)
8–9:30 a.m. Facility Owners Peer Forum Breakfast, Facility Owners Only (Rooms vary by industry)
8:30–10:00 a.m.
- SSPC C.2.12 Location and Number of Soluble Salt Test Measurements on Steel Substrates Comm (Tradewinds C)
- SSPC C.1.8 Fluoropolymer Ctgs Comm (Tradewinds A)

9–11:00 a.m.
- Session 1: Workshop—Creating an Inspection Plan; Strategic Planning for the Ctgs Inspector (Islander Ballroom H)
- Session 2: Water Storage—Tanks & Reservoirs (Islander Ballroom C)
- Session 3: Painting in Nuclear Facilities (Islander Ballroom D)
- Session 4: On the Surface—The Challenge of Getting Ready to Coat (Islander Ballroom E)

9–11:00 a.m. SSPC Instructors Comm Mtg, Open (Tradewinds D)
10:00 a.m.–3:00 p.m. Exhibit Hall Open (Bayside B)
10:30 a.m.–Noon. SSPC C.2.3 Power Tool Cleaning Comm (Islander A)
- SSPC C.1.12 Painting Galvanized Steel Comm (Islander B)

Noon–1:30 p.m. Lunch in the Exhibit Hall (Bayside B)
12:30–1:30 p.m. SSPC Instructors Comm Mtgs, Invitation (Tradewinds C)
1:30–3:00 p.m. SSPC C.3.2 Film Thickness Measurement Comm, PA 2 Rev (Islander B)
- SSPC C.2.14 Specifying and Installing Dehumidification on Prot Ctgs Projects Comm (Islander A)

3–5:00 p.m.
- Session 1: Protecting Concrete (Islander Ballroom H)
- Session 2: What We All Need—Safety Programs & Fall Protection (Islander Ballroom C)
- Session 3: The Past, Present, and Future of Bridge Coating Tech (Islander Ballroom D)

3:30–5:00 p.m. SSPC C.6 Education Comm (Tradewinds A)
9:00 p.m. Closing Reception (Islander FG)

SSPC 'Paperless QA' Course Announced

SSPC and Elcometer Instruments have announced the availability of "Protective Coatings Paperless QA and Digital Data Collection," a new training course that focuses on instrument use and inspection reporting.

The course will debut at SSPC 2011 featuring GreenCOAT in Las Vegas. The course will be offered as post-show training on Feb. 4–5 at the Mandalay Bay Resort. Those interested in the course should contact SSPC at 877-281-7772 or www.sspc.org.

The course focuses on coupling digital instrumentation with paperless inspection reporting and emphasizes the benefits of incorporating industry standards while maximizing the instruments' capabilities and potential to perform common daily inspection tasks. It also focuses on the importance of proper inspection reporting and the successful integration of a paperless quality assurance inspection program to reduce the man-hours incurred in the inspection process and the introduction of human error.

Bill Shoup, Executive Director of SSPC, stated, "This new course is the first of its kind for this industry. It's important for SSPC and its members to keep pace with the changing landscape of coatings inspection. We're thrilled to partner with Elcometer on this project."

SSPC Saudi Arabia Held First Technical Meeting

The SSPC Saudi Arabia International Chapter held its first technical monthly meeting on Oct. 12, 2010, at Le Meridien Al Khobar Hotels. The meeting and dinner were sponsored by Jotun Powder Coating S.A. Co. Ltd.

Bakr Hammad, the chapter chair, opened the meeting with welcoming remarks. Vice chairman Mana Al Mansour presented some of SSPC's services and the benefits of SSPC membership.

Richard C. Cowl, business development manager of Jotun Powder Coating, Dubai, was the guest speaker and delivered a technical presentation entitled, "FBE Technology for Safer Pipelines." He received a plaque to commemorate his participation in the first technical meeting.

Approximately 65 delegates attended the meeting representing different industrial sectors, including Saudi Aramco and other petrochemical companies, coating manufacturers, and industrial service companies.

Training Update

SSPC held its Protective Coatings Inspector Course (PCI) on Nov. 22–Dec. 3 in Singapore. Abdul Quim and Muniandi Dewadas instructed the course, which had 23 students in attendance.

PCI in Singapore.

Twelve students attended the SSPC Marine Plural Component Program (MPCAC, C 14) in Sumitomo, Japan, on Dec. 9–10. Senior instructor Tom Jones led the class.

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C14 in Sumitomo, Japan

The Marine Plural Component Program was also held in National City, CA, at YYK Enterprises, Inc. on Dec. 9–10. Phil Parson taught the class of four students.

C14 in National City, CA

On Dec. 8, YYK Enterprises, Inc. hosted SSPC's Abrasive Blasting Program (C7) in National City, CA. Phil Parson taught the class, and six students attended.

C7 in National City, CA

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Golden State Bridge and F.D. Thomas Partner on Foresthill Road Bridge Job

Golden State Bridge, Inc. (Martinez, CA) was awarded a contract of $58,374,849 by Placer County (CA) to rehabilitate the Foresthill Road Bridge. The project includes coatings application, various repairs, and seismic retrofitting on the 2,428-foot-long by 75-foot-wide steel deck truss bridge that towers 730 feet above the North Fork of the American River in California's Sierra Foothills. The bridge, which was built in the early 1970's, has gained fame through appearances in movies and popularity with BASE jumpers. The contract is nearly $15 million below the engineer's estimate of $73,151,000.

Continued

Photos courtesy of Placer County

Golden State Bridge signed a subcontract of approximately $23 million with F.D. Thomas, Inc. (Central Point, OR), SSPC-QP 1- and QP 2-certified, to perform heavy metals abatement and coatings application. The bridge has not been repainted since its construction in 1973. The project, which will begin this winter and be completed in 2013 or 2014, includes coating approximately one million square feet of existing steel. The steel, including all structural elements, diaphragms, interior surfaces of box truss members, bearings, and guardrail/handrail posts, will be abrasive blast cleaned to a Near-White finish (SSPC-SP 10) and coated with an organic zinc-epoxy-urethane system. The contract includes containment and abatement of the existing lead and chromium bearing coatings.

The project also includes fabricating and erecting approximately 2,580,000 pounds of structural steel that will be shop-coated with inorganic zinc in a facility with an SSPC-QP 3 certification or AISC Sophisticated Paint Endorsement. The contract also includes applying a methacrylate penetrating sealant to deck surfaces.

Purcell to Recoat Granite Falls Bridge

Photo courtesy of Purcell Painting and Coatings

Purcell Painting and Coatings (Tukwila, WA), SSPC-QP 1- and QP 2-certified, secured a contract of $1,087,650 from Snohomish County (WA) to perform preventive maintenance services on the Granite Falls Bridge, a 340-foot-long steel arch over the South Fork of the Stillaguamish River. The project includes waterjetting and coating new and existing structural steel, steel bridge rails, and concrete piers. The contract includes containment of the existing lead-bearing coatings.

Seminole County Awards Containment Lining Job

Seminole County (FL) awarded a contract of $32,717.20 to Hot Spray Industrial Coatings, Inc. (Orlando, FL) to apply new linings to a total of 4,461 square feet of concrete surfaces in the tank containment and pump areas at a landfill. The concrete will be water or abrasive blast cleaned and lined with a 100%-solids epoxy system.

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SSPC Organizational Members as of December 31, 2010

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Energy Northwest
ExxonMobil Research & Engineering Co.
Fairhaven Shipyard
General Dynamics/Electric Boat Div.
Golden Gate Bridge Highway & Transportation District
Granite Mountain Quarries
Grant County Public Utility District
Guam Industrial Services, Inc. Guam Shipyard
High Steel Structures, Inc.
Hirschfeld Industries Bridge
Hyundai Samho Heavy Industries Co., Ltd.
Illinois Dept. of Transportation
Indiana Department of Transportation
Kentucky Transportation Cabinet
Louisiana Department of Transportation & Development
Luminant
Lyon Shipyard, Inc.
MODOT Maintenance Operations
Maine Department of Transportation
Marinette Marine Corporation
Marisco Ltd
Maryland State Highway Administration
Metro Machine Corporation
Ministry of Transportation Bridge Office
Minnesota Department of Transportation
Monroe County Water Authority
Moving Water Industries (MWI)
NAVSEA
NYC School Construction Authority
National Steel & Shipbuilding Co.
Naval Facilities Engineering Service Center
Nebraska Public Power District
Norfolk Naval Shipyard Production Department
North Carolina DOT
North Florida Shipyards, Inc. Mayport Naval Station
Ohio Department of Transportation Central Office
Oklahoma Dept. of Transportation
Oshima Shipbuilding Co., Ltd.
PEO CARRIERS PMC 312C
Pacific Gas & Electric Company
Pacific Ship Repair & Fabrication
Pacific Shipyards International
Pearl Harbor Naval Shipyard & IMF
Pearl Harbor Naval Shipyard Design Department
Pennsylvania Department of Transportation Materials & Testing
Portsmouth Naval Shipyard
Portsmouth Naval Shipyard Code 250
Puget Sound Naval Shipyard II
Roads and Traffic Authority of NSW
Southwest Shipyard L.P.
Steel Service Corporation
Sumitomo Heavy Industries Yokosuka Base Office
Supervisor Shipbuilding Gulf Coast
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Texas Department of Transportation
Textron Marine & Land Systems
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PRA Coatings Technology Centre
Painting & Decorating Contractors of America (PDCA)
Southern Sandblasting & Coatings Inc.

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G.C. Zarnas & Company, Inc.
Genesis Environmental Solutions, Inc.
Hames Contracting, Inc.
Harsco Minerals
Hempel USA, Inc.
Industrial Coatings Contractors, Inc.
International Marine and Industrial Applicators LLC
Jotun Paints, Inc.
Kolona Painting & General Construction, Inc.
Landmark Structures
Long Painting Company
MARCO
Manta Industrial, Inc.
Martin Specialty Coatings, Inc.
Mid-Atlantic Coatings, Inc.
Mobley Industrial Services, Inc.
Mohawk Northeast, Inc.
Muehlhan Marine, Inc.
Naval Coating, Inc.
North American Coatings CL Coatings Division
North Star Painting Co., Inc.
Odyssey Contracting Corporation
Ostrom Painting & Sandblasting
Polygon (formerly Munters MCS)
Puget Sound Coatings Inc.
Quality Coatings of Virginia, Inc.
R A K Corrosion Control, Inc.
RPI Coatings, Inc.
Redwood Painting Company, Inc.
Rust-Oleum Corporation
Shinko Company Ltd.
South Bay Sand Blasting & Tank Cleaning
Sperry Marine Northrop Grumman
StonCor Group Canada Carboline/Plasite Coatings Group
Surface Technologies Corporation
Tank Industry Consultants, Inc.

Termarust Technologies
The Brock Group
Unicorn Construction Enterprises Inc.
Universal Painting Corporation
V S E CORPORATION
V.H.P. Enterprises, Inc.
W W Patenaude & Sons, Inc.
Williams Specialty Services, LLC

CONTRACTORS/SUPPLIERS/ENGINEERS/ CONSULTANTS

Patron Members

360 Construction Company Inc.
A & B Coatings LLC
A & S Industrial Coatings
A. Laugeni & Sons, Inc.
A. W. Chesterton Company
AA-1 Services, Inc.
AAA Blast-Cote, Inc.
ABC Applicators, Inc.
ABS—American Bureau of Shipping
ACME Industrial Piping
ACOTEC nv
AIC Painting, Corp.
AIR Systems International
AJC Sandblasting Inc.
AM-COAT Painting, Inc.
APBN Inc.
APG, Inc.
ASCO—American Stripping Company
Aberfoyle Metal Treaters Ltd.
Absolute Equipment
Advanced Industrial Services, Inc.
Advanced Polymer Coatings, Ltd.
Advanced Protective Coating, Ltd.
Advanced Recycling Systems, Inc.
Aggreko LLC
Ahern Painting Contractors, Inc.
AirTech Spray Systems
Ajax TOCCO Magnethermic Corp.
Alabama Painting, Inc.
Alaron Corporation
All Pro Overspray Inc.
All-Safe Industrial Services, Inc.
All-States Painting, Inc.
Allied Inspection Corrosion Services (ALINCOR)
Allied Painting Inc.
Almig USA Corporation
Alpha Painting and Construction Co.
Alpine Painting & Sandblasting Contractors
Alta Vista Solutions
Amercoat Canada
American Bureau of Shipping
American Coatings and Supply
American Industrial Hygiene Assoc.
American Suncraft Const.
American Tank & Vessel, Inc.
Americlean
Amherst Maintenance Inc.
Amstar of Western New York
Anchor Paint Mfg Co
Anka Painting Company, Inc.
Applied Coatings & Linings
Arena Painting Contractors, Inc. (APC)
Arid Dry by CDIMS
Arizona Coating Applicators, Inc.
Arrow Construction Company, Inc.
Astron General Contracting Co., Inc.
Atlantic Design Inc.
Atlantic Painting & Sheeting Corp.
Atlas Painting & Sheeting Corp.
Aulffo Painting, Inc.
Automatic Coating Ltd.
Avant Guards Coatings
Axxiom Manufacturing Inc.
B&B Korea Co. Ltd.
B. R. Flowers & Co., Inc.
BARS Company, LTD
BASF Corporation
BELL FLOORING SCIENCES GROUP
BGRS, Inc. Blast Grit Recovery Systems
BIS Salamis, Inc.
BYK Additives & Instruments
Barnes Painting
Barnices Valentine C/Provenza s.n.
Barton Mines Company, LLC
Basic Industries of South Texas, LTD.
Bass Rocks Construction Corporation
Bay Decking Company, Inc.
Bayer MaterialScience Trading (Shanghai) Co., Ltd.
Baytown Painting, Inc.
Bazan Painting Company
Beach Coatings, Inc.
Beam, Inc.
Blastal Coatings Services, Inc.
Blastech Enterprises, Inc.
Blastline Institute (BISP)
Blastrac NA
Blastrite Pty. Ltd.
Blendex Industrial Corporation
Bloomfield Painting Inc.
BridgePLATFORMS, Inc.
Bridges R Us Painting Co., Inc.
Buckman Laboratories, Inc.
Bulldog Projects
C & K Johnson Industries, Inc.
C S B Concepts LLC
C-Port Marine Services, LLC
C.W. Beal, Inc.
C3 Industrial Services
CB Tech Services, Inc.
CCS Consulting Service, Inc.
CMP Coatings, Inc.
CMV Blasting Inc.
CSI Coatings Group, LLC
CSI Services, Inc.
Cabrillo Enterprises, Inc. DBA-R.W. Little Company
Cactus Coatings Ltd.
Caldwell Tanks, Inc.
California Engineering Contractors, Inc.
Caligari Gerloff Painting, Inc.
Cambridge Heat Treating Inc.
CanAm Minerals/Kleen Blast Abrasives
Cape Environmental Management Inc.
Capitol Finishes, Inc.
Cardolite Corporation
Caribbean Insulation Services Ltd.
Carney's Point Metal Processing, Inc.
Carolina Equipment & Supply Co., Inc.
Carolina Painting Company, Inc.
Carr Coatings, LLC
Castra Security
Catamount Environmental, Inc.
Central Sandblasting Company, Inc.
Century Drywall, Inc.
Certified Coating Specialists Inc.
Certified Painting Company
Cetek LTD
Changzhou Paint & Coatings Industry Research Institute
Channel Coast Corp.
Chesapeake Mechanical & Coatings
Chicago Area Painting Apprenticeship School
Chlor*Rid International
Church & Dwight Company, Inc.
Cianbro Corporation
Clara Industrial Services Limited
Clark & Pattison (Victoria) Ltd.
Classic Protective Coatings, Inc.
Clemtex, Inc.
Coating Services, Inc.
Coating Systems, Inc.
Coatings & Painting, LLC
Coatings Unlimited, Inc.
Coblaco Services, Inc.
Colonial Processing, Inc.
Colonial Surface Solutions, Inc.
Color Works Painting, Inc.
Commercial Sand Blasting & Painting
Commercial Sandblast Company
Commodore Maintenance Corp.
Construction Technology Laboratories
Consulex
Copia Speciality Contractor
Corcon Inc.
Corporacion Peruana De Productos Quimicos S.A.
Corrocoat USA
Corrosion Control Products Company
Corrosion Specialties, Inc.
Crescent Coatings & Services, Inc.
Crossway Coatings
Crown Painting, Inc.
Custom Coating Applicators
Cypress Bayou Industrial Painting, Inc.
D E Eakin & Son's
DACA LLC
DESCO Manufacturing Company, Inc.
DRYCO, LLC
DUSTNET by EMI International
Dalian YuXiang
Dampney Company, Inc.
Darren Green Construction Ltd.
Daubert Chemical Company
Davis Boat Works, Inc.
Dawson-Macdonald Company, Inc.
De Koning Groep
DeFelsko Corporation
Dehumidification Technologies, Inc.
Delta Coatings, Inc.
Dennis C. Luxem
Derochie Painting Ltd.
Derrick Company Inc.
Detroit Painting & Maintenance, Inc.
Detroit Tarpaulin, Inc.
Devox S.A.
Diamond Vogel Paint Company
Distribuidora Kroma S.A. de C.V.
Diversified Container
Dixon Engineering, Inc.
Dunlap, Inc.
Dur-A-Flex, Inc.
Dura-Bond Pipe, LLC
Duromar, Inc.
E.B. Miller Contracting, Inc.
E. Caligari & Son, Inc.
E. E. Doerr & Associates, LLC
EBT Engineering Pte Ltd
EDCO-Equipment Development Co., Inc.
ENVIRO-TECH Services Inc.
EPAcoat, Inc.
EPMAR Corporation
Eagle Painting & Maintenance Co.
Eagle Specialty Coatings

Continued

SSPC Organizational Membership

Earl Industries, LLC
EcoQuip, Inc.
Elcometer Instruments Limited
Elite Contractors, Inc.
EnDiSys
EnTech Industries, LLC
Endura Manufacturing Company Ltd.
EnviroVantage
Environmental Coating Services LLC
Environmental Planning & Management
Envirosafe Stripping Inc.
Era Valdivia Contractors, Inc.
ErgonArmor
Erie Painting and Maintenance, Inc.
Ervin Industries
Euronavy-Tintas Maritimas e Industriais SA
Exceltech Coating & Applications, LLC
Extreme Coatings, Inc.
F & H Coatings
F.L. Crane & Sons, Inc.
F.T.I. District Council 57 J.A.T.F.
FCS Group LLC
FTI of DC77
Farr Construction Corporation
Farrow Systems
Fast Wrap USA, LLC
Fedco Paints And Contracts
Fine Metal Powders Company
Finishing Systems of Florida, Inc.
Fischer Technology, Inc.
Flame Control Coatings, LLC
Forecast Sales
Fox Brothers Painting
GMA Garnet (USA) Corp.
GTS Inc.
Gaditana de Chorro Y Limpieza S.L.
GapVax Inc.
Garden State Council, Inc.
Gemstone, LLC
General Coatings Corporation
General Dynamics/Information Tech.
General Insulation, Inc.
George G. Sharp, Inc.
Gibson & Associates, Inc.
Goodman Decorating Co., Inc.
Graco Inc China
Graco Inc.
Greenhorne & O'Mara, Inc.
Greenstar Coatings LLC
Groome Industrial Service Group
Gulf Coast Contracting, LLC
Guzzler Manufacturing, Inc.
H.I.S. Painting, Inc.
HCI Chemtec Inc.
HCI Industrial & Marine Coatings Inc.
Hadek Protective Systems Inc.
Hall Industrial Contracting, LTD
Hanes Supply, Inc.
Harrison Muir, Inc.
Hartman-Walsh Painting Company
Hempel-HaiHong
Hercules Painting Company
Hi-Temp Coatings Technology
Highland International, Inc.
Hiller Systems, Inc.
HippWrap Containment
HoldTight Solutions Inc.
Hong Hua Guan Marine & Engrg. Pte Ltd.
Honolulu Painting Company, Ltd.
Howell & Howell Contractors, Inc.
Hunstman Polyurethanes
IDS Blast Finishing
IMETECO S.A.
IMPREGLON USA
ISG dba Universal Inc.
IUPAT, District Council #5
Icarus Industrial Painting & Contracting Company, Inc.
Impresa Donelli, S.R.L.
Indian Valley Industries, Inc.
Induron Coatings, Inc.
Industrial Corrosion Control, Inc.
Industrial Marine, Inc.
Industrial Painting Limited, Inc.
Industrial Painting Services, Inc.
Industrial Painting Specialists
Industrial Technical Coatings, Inc.
Industrial Vacuum Equipment Corp.
Insl-X/Coronado Paint Co., Inc.
Insulating Coatings Corporation
Intech Contracting LLC
Inter-City Contracting, Inc.
Interior Finishes, Inc.
International Flooring & Protective Coatings, Inc.
International Protective Coatings China
Iowa Waste Reduction Center University of Northern Iowa
J. Goodison Company, Inc.
J. Mori Painting Inc.
J.N.A. Painting and Contracting, Inc.
JAD Equipment Co. Inc.
JOHN LEHNE & SON INC
JTR, INC.
Jag's Construction, Inc.
Jal Engineers Pvt. Ltd.
Jamac Painting & Sandblasting Ltd.
Jeffco Painting & Coating, Inc.
Jerry Thompson & Sons, Inc.
Jet De Sable Houle Sandblasting Ltd.
Joaquin Riera Tuebols S.A.
John B. Conomos, Inc.
John W. Egan Company, Inc.
Jotun Coatings China
Jupiter Painting Contracting Co. Inc.
K & K Painting Inc.
Kane, Inc.
Keene Coatings Corp.
Kelly-Moore Paint Company, Inc.
Kennametal Inc.
Kern Steel Fabrication, Inc.
Kimery Painting, Inc.
Kish Company, Inc.
Kiska Construction, Inc. (KCI)
Klicos Painting Company, Inc.
L & L Painting Company Inc.
L. Calvin Jones
L. F. Clavin & Company, Inc.
Larsen & Toubro Limited
Leighton Associates, Inc.
Liberty Maintenance, Inc.
Limnes Corp.
Lindner Painting, Inc.
Line-X Corp.
Liner Technologies
Llamas Coatings
LorRich Enterprise, LTD
Luckinbill, Inc.
M & J Construction Company
M & M Industrial Painting
M & R Painting, Inc.
M Shiroma Painting Company Inc.
M. Painting Company, Inc.
M. Pallonji & Company Pvt. Ltd.
MB Environmental Consulting
MCSA (Maintenimiento & Construcciones, S.A.)
MEC Construction, Inc.
METCO Materials Evaluation & Tech. Corp.
MIK Industrial LLC
MJM Construction LLC
MMLJ, Inc.
MST Inc (Modern Safety Techniques)
MacDonald Applicators Ltd.
Madison Chemical Industries Inc.
Maguire Iron, Inc.
Main Industries Inc.
Mandros Painting, Inc.
Manganas Enterprises, Inc.
Manolis Painting Company, Inc.
Mansfield Industrial
Manus Abrasive Systems, Inc.
Marine & Industrial Coatings, LLC
Marine Chemical Research Institute
Marine Specialty Painting
Marinis Bros., Inc.
Mascoat Products
Mason Painting, Inc.
Matheson Painting
Matrix Service Inc.
Matsos Contracting Corp.
Max Access, Inc.
McCormick Industrial Abatement
McCormick Painting Company
McElligott Partners Pty. Ltd.
McINNES COOPER
McKay Lodge Conservation Laboratory
Merkury Development
Metain S.A.
Michelman-Cancelliere Iron Works
Midwest Rake Company LLC
Mimosa Construction, Inc.
Minichi Inc.
Modern Protective Coatings, Inc.
Mohawk Garnet, Inc.
Monarflex by Siplast
Montipower Inc.
Moody International Inc.
Moody International-China
Municipal Tank Coatings
Murphy Industrial Coatings
N A Logan, Inc.
N G Painting, LP
NACE International-The Corrosion Society
NAG Marine
NIF Solutions
NOR-LAG Coatings Ltd.
NUCO Painting Corporation
Narkisos Inc.
National Coating and Linings Co.
National Coatings, Inc.
National Surface Treatment Center
Natrium Products, Inc.
Nelson Industrial Services, Inc.
NexTec Inc.
Niagara Coatings Services, Inc.
Norton Sandblasting Equipment
Novetas Solutions
O.T. Neighoff & Sons, Inc.
OPT CO
Odle, Inc.
Oesterling Sandblasting & Painting
Olimag Sand, Inc.
Olympus & Associates, Inc.
Olympus Painting Contractors, Inc.
Ontario Painting Contractors Association
Opta Minerals, Inc.
Optimiza Protective & Consulting, SL.

SSPC Organizational Membership

Orfanos Contractors, Inc.
P & S Painting Co., Inc.
P & W Painting Contractors Inc.
P S Bruckel Inc
P.C.I. International, Inc.
PCIRoads, LLC
PEC Ltd.
PPG Industries China
PROINBEL
PT Berger Batam
Pacific Painting Co Inc
Pacific Titan, Inc.
Paige Decking
PaintEcuador
Panco Resources and Engineering Consultancy Services
Panther Industrial Painting, LLC
Panthera Painting, Inc.
Paragon Construction Services of America Inc.
Park Derochie Coatings Ltd.
Paul N. Gardner Company, Inc.
Peabody & Associates, Inc.
Pen Gulf, Inc.
Performance Blasting & Coating
Petric & Associates, Inc.
Philips Industrial Services Corp.
Phoenix Development & Construction
Phoenix Fabricators & Erectors Inc.
Piasecki Steel Construction Corp
Pittsburg Tank & Tower Co Inc
Planet Inc
Pop's Painting
Poseidon Construction
Pratt Equipment Rental
Precision Industrial Coatings, Inc.
Preferred, Inc.-Fort Wayne
Prime Coatings, Inc.
Pro Coat, LLC
Pro-Tect Plastic & Supply, Inc.
Professional Application Services, Inc.
Providence Painting, Inc.
Prudent Engineering LLP
Public Utilities Maintenance, Inc.
Purcell P & C, LLC
QED Systems, Inc.
Quality Linings & Painting, Inc.
Quantum Technical Services
Quincy Industrial Painting Co
Quinn Consulting Services, Inc.
R & B Protective Coatings, Inc.
RBG
RECAL RECUMBRIMIENTOS, SA de CV
RML Construction
ROs Precise Painting, Inc.
Rahm Industrial Services, Inc.
Rainbow, Inc.
Raven Lining Systems
Raydar & Associates, Inc.
Razorback, LLC
Redi-Strip Metal Cleaning Canada Ltd
Regal Industrial Corporation
Reglas Painting Company, Inc.
Rhino Linings Corporation
Righter Group, Inc.
Rockwood Corporation
Rogers Industries
Rotha Contracting Company, Inc.
Roval USA Corporation
Royal Bridge Inc.
Rust Bullet, LLC
Ryno Tools
S & D Industrial Painting
S & S Bridge Painting, Inc.
S & S Coatings, Inc.
S. David & Company, Inc.
SAFE Systems, Inc.
SAIT Polytechnic
SME Steel Contractors
STS Steel, Inc.
SVMB
Sabelhaus West, Inc.
Saffo Contractors, Inc.
Sauereisen
Sayed Hamid Behbehani & Sons Mech. Div.
Schiff Associates
Scott Derr Painting Company
Seaside Painters & Sandblasters
Seaway Coatings, inc.
Seaway Painting LLC
Secondary Services, Inc.
Seminole Equipment, Inc.
Service Contracting, Inc.
Servicios Tecnicos Industriales y Maritimos, S.A. (SETIMSA)
Shenzhen Asianway Corrosion Protection Eng. Co., Ltd.
Sherwin-Williams Industrial & Marine Coating China
Shield Coatings & Weatherproofing
Simpson Sandblasting and Special Coatings, Inc.
Skinner Painting & Restoration
Sky Climber Access Solutions
Skyline Steel, LLC
Soil & Materials Engineers, Inc.
South Gulf, Inc.
Southern Paint & Waterproofing Co.
Southland Painting Corporation
Spartan Contracting, LLC
Specialty Application Services, Inc.
Specialty Finishes, LLC
Specialty Groups, Inc.
Specialty Polymer Coatings, Inc.
Specialty Products, Inc.
Spectrum Painting Corporation
Spensieri Diversified LLC
Spider
Sponge-Jet, Inc.
Stanley Consultants, Inc.
Steel Management System, LLC
Stopaq BV
Structural Coatings, Inc.
Stuart Dean Company, Inc.
Sulzer Mixpac USA, Inc.
Superior Industrial Maintenance Co.
Surface Prep Supply
Surface Preparation & Coatings, LLC
Swalling Construction Company, Inc.
Swanson & Youngdale, Inc.
Symmetric LLC
T-Tex Equipment L.P.
TCR Coatings
TDA Construction, Inc.
TDJ Group, Inc.
TJC Painting Contractors, Inc.
TMI Coatings, Inc.
TMS Metalizing Systems, Ltd.
TOA Paint (Thailand) Co., Ltd.
Tank Services fma Midwest Tank Services, Inc.
Tarpon Industrial, Inc.
Tarps Manufacturing, Inc.
Techno Coatings, Inc.
Tecnico Corporation
Tesla Nanocoatings Ltd
Testex
Texas Bridge, Inc.
The Aulson Company, Inc.
The Lusk Group
The Warehouse Rentals and Supplies
Theovas, Inc.
Thomarios
Thomas Industrial Coatings, Inc.
ThyssenKrupp Safway, Inc.
Tidal Corrosion Services LLC
Tioga, Inc.
Titan Industrial Services
Titan Tool
Tower Maintenance Corp.
Tractel Inc. Griphoist Division
Tri Star Engineering, Inc.
Tri-State Painting, Inc.
Trimaco LLC
Troy Painting Inc.
Turman Commercial Painters
Turner Industries Group, LLC
UHP Projects, Inc.
US Coatings, Inc.
US Minerals/Stan Blast
US Technology Corporation
USA Painting, Inc.
Unifab Industries, LTD
United Coatings Corporation
United Eagle Painting Corporation
United States Corrosion Engineers, Inc.
Universal Minerals, Inc.
Universal Silencer, LLC
Utility Service Company, Inc.
V. V. Mineral
VRSim, Inc.
Vanwin Coatings of VA, LLC
Venus Painting
Veolia ES Canada Industrial Services, Inc. Canada
Vermillion Painting & Construction
VersaFlex Incorporated
Vimas Painting Co., Inc.
Vulcan Painters, Inc.
Vulcan Pipe & Steel Coatings, Inc.
Vulkan Blast Shot Technology
W Abrasives
W Q Watters Company
W S Bunch Company
W W Enroughty & Son, Inc.
WGI Heavy Minerals, Inc.
WIWA LP
Washington Commercial Painters, Inc.
Washington Industrial Coatings, Inc.
Wasser High-Tech Coatings, Inc.
Waveland Services Inc.
Wenrich Painting, Inc.
West Coast Industrial Coatings, Inc.
Westcoast Industrial Maintenance Ltd.
Western Industrial, Inc.
Wheelabrator
Wheelblast, Inc.
Wooster Brush Company
Worldwide Industries, Inc.
Worth Contracting
Wuxi Ding Long Trading Co., Ltd.
YYK Enterprises, Inc.
YungChi Paint & Varnish Mfg
ZRC Worldwide
Ziegler Industries, Inc.