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FEATURES

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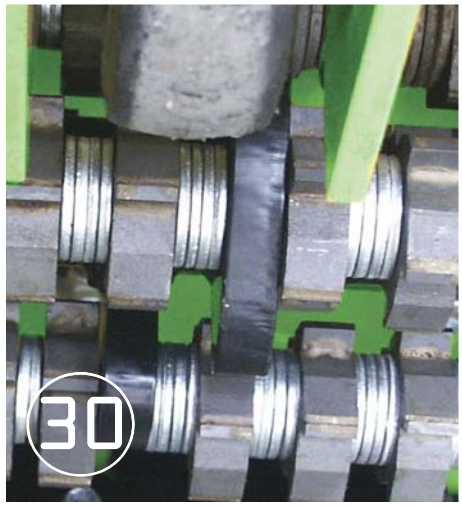

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Publisher: Marian Welsh / mwelsh@paintsquare.com
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SSPC Individual Membership: Terry McNeill / mcneill@sspc.org
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In Memory
Sandy Hook Elementary School
Newtown, Connecticut

Thoughts from a Newtown Resident

While the world reacts with justified horror at the Sandy Hook school shooting, this event has a personal connection for me. My children and their mom live in Newtown. I lived there for some years. A good friend of ours, along with children of friends of ours, were in the building that day. My son was in the High School, two miles away. My daughter was around town shopping for Christmas.

Part of me wants to forget that this tragedy ever happened, to move on and return to feeling normal. No doubt no one wants this more than the good people of Newtown, and yet there is no going back, and for many there will be no forgetting. I count myself in this camp, and I do so with civic pride for a town that has meant so much to me and my family. If remembering this day will honor the victims and families who gave so much, then I gladly pledge never to forget. The acts of sacrifice and courage displayed by the teachers and administrators at Sandy Hook leave me speechless and humbled. These and the actions of the first responders tell you all you need to know about Newtown and the people who live there.

I offer this page as a permanent memorial to the 27 victims. As long as one copy of this January '13 issue exists, so too will this remembrance. I'm headed to Newtown for the Christmas holiday, to hug my kids and give thanks that I am able to do so. I will also, in my own way, spend time with my larger Newtown family, the ones who won't forget.

Peter Mitchel
President and CEO
Technology Publishing/PaintSquare

*Charlotte Bacon, F, 6 yrs old, Daniel Barden, M, 7 yrs old, Rachel Davino, F, 29 yrs old,
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Jesse Lewis, M, 7 yrs old, James Mattioli, M, 6 yrs old, Grace McDonnell, F, 7 yrs old
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Noah Pozner, M, 6 yrs old, Caroline Previdi, F, 6 yrs old, Jessica Rekos, F, 6 yrs old
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Victoria Soto, F, 27 yrs old, Benjamin Wheeler, M, 6 yrs old, Allison N. Wyatt, F, 6 yrs old*

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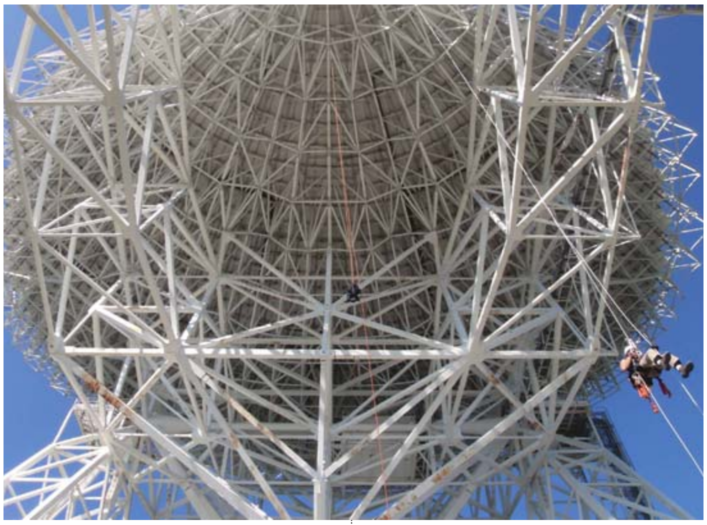
PBT Announces Photo Contest Winner



A dizzying view of an inspection team member rappelling from one of the world's largest telescopes has captured the grand prize in Paint BidTracker's 10th Anniversary Photo Contest.

"Green Bank Telescope, West Virginia," taken by Anthony Schoenecker and submitted by Mike Beitzel, received the most popular votes since the final round of the contest started in the first week of November.

Paint BidTracker collected a total of 687 votes for the contest.

The Winning Photo

Schoenecker is a field services engineer and inspector with Modjeski and Masters in New Orleans, LA. Every two years, the company inspects the coatings, welds, and structure of the Robert C. Byrd Green Bank Telescope in West Virginia.

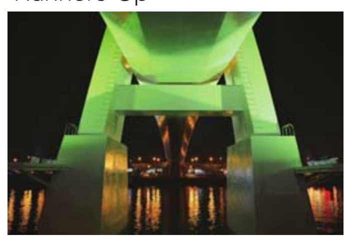
After rappelling down from the 480-foot-high structure—the world's largest fully steerable radio telescope—Schoenecker snapped this photo of another team member descending.

"The whole scene is so picturesque and beautiful; it's just so easy to get a good shot up there," said Schoenecker.

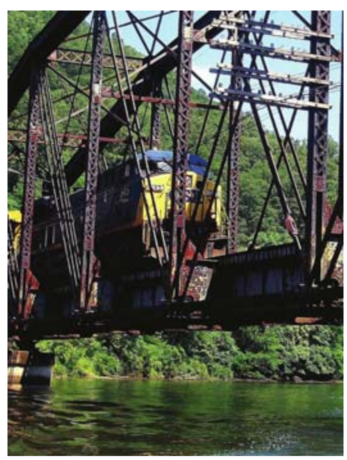
Coincidentally, the photo was shot with the same camera being awarded in the contest: an Olympus TOUGH TG-1 iHS digital camera.

In addition to the camera, Schoenecker also gets two admission passes to SSPC 2013 featuring GreenCOAT in San Antonio, TX, on Jan. 14-17, 2013.

Runners-Up



Runners-up included "Taiwan Bridge" (above) by Leka Huie and "Train Bridge" (below) by Brent Baker.



Last month, a panel of judges, which included Paint BidTracker and *JPCL* editors, selected six finalists to compete for the grand prize. The finalists were chosen from 130 photos submitted to the Project Showcase between Sept. 10 and Nov. 1.

Judges looked for photos that captured the creativity and beauty of industrial and commercial structures and the hard work that goes into painting them.

Watson Standard Acquires Delta Coatings

Century-old coatings maker Watson Standard is expanding its portfolio and re-entering the general industrial coatings marketplace with the acquisition of Delta Coatings Corp.

The deal was effective Dec. 3, Pittsburgh-based Watson announced in a press release the next day.

Based in Melrose Park, IL, Delta Coatings specializes in the development and manufacture of coatings for the general industrial and packaging industries.The acquired business will operate as Watson Standard Industrial Coatings.

Dur-A-Flex Names New R&D Manager, Expands in Asia

Resinous flooring manufacturer Dur-A-Flex Inc. has

Most of the stories on pp. 6 and 7 and more news can be found on *PaintSquare News*, *JPCL*'s sister publication, a free daily e-newsletter. To sign up for the newsletter, go to paintsquare.com/psn.

appointed Murty Bhamidipati, Ph.D., as its new manager of research and development.

Dr. Murty Bhamidipati was recently made manager of R&D for Dur-A-Flex.

Bhamidipati has 18 years of industrial experience in coatings development and has worked for the company for five years. He earned a Ph.D. in chemistry from the University of Massachusetts at Amherst and a BS in chemistry from Andhra University in India.

Dur-A-Flex also announced that it had recently appointed IL DO Trading Co. Ltd. (Seoul, South Korea) and Hiep Hiep Phat Trading Co. Ltd. (Ho Chi Minh, Vietnam) as exclusive distributors and installers for the company's systems in those countries.

Both companies will offer all of Dur-A-Flex's flooring systems, including urethane, epoxy, methyl methacrylate and colored aggregates.

Based in East Hartford, CT, Dur-A-Flex has more than 40 years of experience in seamless commercial and industrial flooring systems and polymer components—epoxies, urethanes and methyl methacrylates (MMA) plus premium colored quartz aggregates. The company is the principal supplier of colored quartz aggregate to the seamless flooring industry.

General Equipment Appoints Sales Manager

General Equipment Company has appointed Phil Scudder as national sales manager in the construction-related marketplace.

Scudder has 20 years of experience in the construction equipment industry.

In his new position, Scudder will be responsible for the development and coordination of sales and marketing for both national and independent accounts. He will also oversee General Equipment's network of sales representative organizations in North America.

Scudder was previously vice president of sales for a leading manufacturer of specialized construction products. He has worked in the construction equipment industry since 1982 and has more than 20 years of experience in professional sales management.

Based in Owatonna, MN, General Equipment manufactures portable and mobile hole digging equipment; confined-space and positive pressure type ventilation products designed for use in non-hazardous and hazardous locations; and a variety of surface preparation equipment for the construction marketplace.

JPCL

Tesla Adds Three to Management Team

Tesla NanoCoatings Ltd. has announced the addition of three top managers to its team.

Charles Simpson has been named chief technical director; Michael Wright is the new director of business development and government sales; and Stephen Stohla joins the company as military sales specialist.

The Massillon, OH-based company produces high-tech, anti-corrosive coatings for a variety of industrial and military uses.

Simpson was previously the technical manager, product development specialist, and chemist for The Sherwin-Williams Company since 1984 and specialized in the anti-corrosion field. He holds a BS and MS in chemistry from Cleveland State University.

Charles Simpson

Wright has over 18 years of experience as a project manager relating to design and construction. He has 26 years of military service.

Most recently, Wright was the government services program manager for EQ–The Environmental Quality Company in Wayne, MN. Wright holds a BS from The Ohio State University and is a graudate of Command and General Staff College at Ft. Leavenworth.

Michael Wright

Stohla was regional vice president and executive coach for Mosaic Education Inc., based in Youngstown, OH. He has served in various positions in the U.S. Army National Guard and the Ohio National Guard. He holds an MS in educational administration from the University of Dayton and a BA in liberal arts from Baldwin Wallace College. Stohla attended the U.S. Army Senior Service College, University of Texas, and the U.S. Command and General Staff College.

Stephen Stohla

Sealing Metalizing on Steel

How soon after application does metalizing of steelwork need to be sealed or coated, and why?

From Dave Wixson
TMS Metalizing Systems Ltd.

Thermal spray coatings, applied by arc spray and flame spray equipment, are inherently porous. Feedstocks of aluminum and zinc are typically used for corrosion protection of steel substrates, and these coatings are normally applied to a thickness of 10 mils.

Sealing of the thermal spray coatings is often accomplished to extend the life of the coating or to achieve a desired finish. When sealers are used, they must have low viscosity to be able to be easily absorbed into the pores of the thermal spray coating.

If the coating is left unsealed, its pores will "self seal" as the coating naturally begins to oxidize. In general, this oxidation is lightly adhered to the metalized coating. The seal coat would subsequently not have as good of a bond to an oxidized coating as it would to a non-oxidized coating.

When a seal coat is specified, it should be applied as soon as

Dave Wixson is president of TMS Metalizing Systems Ltd., based in Bremerton, WA. He is a frequent contributor to *JPCL*. The company has been an equipment and consumables supplier in the thermal spray market for over 25 years. Wixson is involved with technical committees for organizations such as AWS, SSPC, and NACE.

possible to minimize the chance of contamination or corrosion. SSPC-CS-23.00 recommends that a seal coat be applied as soon as possible upon completion of the thermal sprayed coating application, preferably within 8 hours. When necessary, the specification does allow for an extension of this eight-hour window, but the contractor must make sure that controls are in place (and verifications are made) to keep the thermal spray coating dry, uncontaminated, and dust-free.

Before application of the seal coat, the surfaces must be blown down with clean, dry compressed air to remove dust. All surfaces must be clean, dry, and free from contamination.

Metalized coatings have become a worldwide, cost-effective solution for long-term corrosion control of steel structures. Adherence to our industry guidelines and specifications is important to maintain a degree of consistency and quality in the application of these long-life coatings.

Problem Solving Forum (PSF) is published monthly in *JPCL* and daily in its sister publication, *PaintSquare News* (*PSN*), a daily electronic newsletter (paintsquare.com/psf).

Upcoming PSF questions include the following.

- What are smart coatings?
- What is the most effective practice for crack sealing in concrete to prevent water intrusion in wastewater collection systems?
- Whose responsibility is safety on a bridge coating site?
- Do water treatment processes to stop the transfer of invasive marine species in ballast water affect the performance of ballast tank coatings, and if so, how?
- How soon after application of metalizing to concrete bridges does the metalized coating need to be sealed or coated, and why?

SSPC Protective Coatings Specialist

Q&A with Dan Zienty

By Charles Lange, JPCL

This month's SSPC PCS is Dan Zienty, an associate at Short Elliott Hendrickson Inc. (SEH). SEH is an engineering firm based in St. Paul, MN. As a project manager and supervisor within the SEH water and wastewater department, Mr. Zienty is responsible for coordinating marketing, running facility evaluations, developing specifications, and providing inspection services for all coatings and telecommunications-related projects in the region.

Mr. Zienty is also an SSPC Supervisor for Deleading Industrial Structures, a past Chair of the North Central Region Chapter of SSPC, and a NACE-certified coatings inspector. With more than 20 years of experience in the coatings industry, he has won numerous engineering awards, and several of his articles have been published in *JPCL*.

JPCL: What is your background in the protective coatings industry? Specifically, when did you decide that you wanted to be involved in the industry, and how did you get your start?

DZ: I started with SEH in 1992 as a civil-related inspector. I was approached internally in 1993 about going for coatings training, as SEH had previously been subcontracting the services locally and wanted to do the work in-house. My first NACE class was in May of 1993, and after that, I was hooked. It was something that few people were doing, or understood.

JPCL: What interests you about water tanks and tank coatings?

DZ: They may not be bridges, but they're big structures! In the beginning, I did all of the evaluations by floatdown method, in a rubber raft—I was the "Ty-D-Bowl Man." Also, the view from the top of most tanks is unbelievable. Over time, and being involved at times from initial construction through completion, they have their own inherent issues. Working to solve them through industry networking over the last 20 years has made it truly a rewarding experience.

JPCL: What are some of the main challenges that you face in your area of work, either in the field or in the planning and specification stages?

DZ: Coordination respective of telecommunications equipment on water towers is a challenge, as is making the right call in terms of reconditioning versus maintenance on a tank. Finding and maintaining an experienced staff is challenging as well. It's also important to keep up with new guidelines and regulations in developing a specification that is concise and well understood, yet draws good bids without compromising on the need for contractor qualifications. Lastly, it's a challenge making deadlines, since we have a shorter construction season in this region.

JPCL: What are some of the recent technological advances that have been beneficial to your line of work?

DZ: I'm sure there have been some regarding coatings formulations, but there have definitely been advances in inspection equipment. We recently purchased new DFT gauges that measure surface profile, take coating thicknesses, and give ambient conditions, and all of the information is downloadable. It wasn't like that when I started. What has really changed is methodology. We don't "blow and go," or blast and prime, anymore. There is more use of dehumidification equipment for interior work and greater attention paid to surface blowdown and decontamination.

JPCL: What would you say has been the highlight or proudest moment of your career?

DZ: The highlight so far has been the opportunity I had in 2007 to work overseas on a project, inspecting a Polar crane in Shanghai, China. As for proud moments, just getting a call from your peers for advice after all this time works for me.

JPCL: When you drive past a water tank or similar structure, do you find yourself looking out for corrosion, deterioration, or coatings flaws?

DZ: That's easy…all the time. With other disciplines, you wait for the call. With a water tower, most times you can feel real comfortable in making a cold call. The need is obvious.

JPCL: What do you enjoy most about what you do?

DZ: Networking, facilitating projects, and problem solving. These days, everything seems to be a fire drill. Seeing all the planning come to fruition in the end product and having a happy client is very rewarding. So is being on target with my project estimates against the contractor's bid.

JPCL: With plenty of work to keep you busy, what do you do in your free time for leisure?

DZ: When I can pull away, I enjoy family time, as well as fishing, playing bad golf, reading, listening to 50's era Miles Davis, and riding my Yamaha 1700 Roadstar along the backroads of Minnesota and Wisconsin.

JPCL

Can In-Process Quality Control Prevent Premature Coating Failure?

By William D. Corbett, PCS, KTA-Tator, Inc.
Richard Burgess, KTA-Tator, Inc., Series Editor

For decades we have heard that the incidence of premature coating failure would decline by explicitly requiring the contractor to control the quality of workmanship (via contract document language) using properly trained (and equipped) quality control personnel. In this Case from the F-Files, we'll take a brief look at five case history failures and assess whether quality control inspection of the work as it proceeded could have prevented the failure from occurring, or whether it would have happened despite the efforts of knowledgeable quality control personnel.

Defining Quality Control

The ISO definition states that q*uality control* is the operational techniques and activities that are used to fulfill requirements for quality.[1] This definition could imply that any activity, whether serving the improvement, control, management, or assurance of quality could be a quality control activity. Quality control is a process for maintaining standards and not for creating them. Standards are maintained through a process of selection, measurement, and correction of work, so only the products or services that emerge from the process meet the standards. In simple terms, quality control prevents undesirable changes in the quality of the product or service supplied. The simplest form of quality control is illustrated in Fig. 1. Quality control can be applied to particular products; to processes that create the products; or to the output of the whole organization, by measuring its overall quality performance.

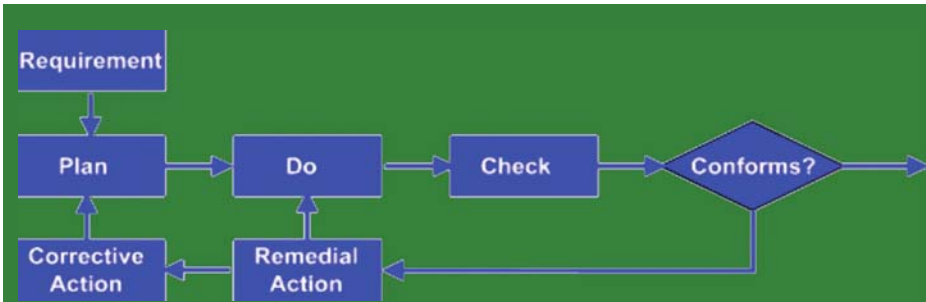


Fig. 1: The generic control process
Figure and photos courtesy of KTA-Tator

Quality control is often regarded as a post-event activity, that is, a means of detecting whether quality has been achieved and taking action to correct any deficiencies. However, one can control results by installing sensors (e.g., inspection check points) before, during, or after the results are created. It all depends on where you install the sensor, what you measure, and the consequences of failure.[1]

The Joint Certification Standard for Shop Application of Complex Protective Coating Systems (AISC SPE/SSPC-QP 3 420-10)

Bill Corbett is the Professional Services Business Unit Manager for KTA-Tator, Inc., where he has been employed for 31 years. He is an SSPC-approved instructor for three SSPC courses, and he holds SSPC certifications as a Protective Coatings Specialist, Protective Coatings Inspector, and Bridge Coatings Inspector. He is also a NACE Level 3-certified Coatings Inspector. He was the co-recipient of the SSPC 1992 Outstanding Publication Award, co-recipient of the 2001 *JPCL* Editors' Award, recipient of SSPC's 2006 Coatings Education Award, and recipient of SSPC's 2011 John D. Keane Award of Merit.

defines quality control as the inspection of work. Inspection includes but is not limited to confirming that procedures are met; workers are properly qualified; equipment is appropriate and in acceptable working order; and the proper materials are used and are in compliance with inspection criteria.

Let's take a look at a few case studies to see whether implementation of a quality control program using trained, properly equipped inspectors makes a difference.

Case Study No. 1: *Mirror, Mirror...*

Background: A contract was awarded to remove and replace the existing coating system on a large riveted structure. The specification required abrasive blast cleaning to achieve a Near-White blast (SSPC-SP 10/NACE 2), followed by two coats of a polyamide epoxy (standard gray) and one coat of polyurethane topcoat. Six months after the contract was completed, corrosion was observed (Fig. 2).

Cause: Corrosion products remained on

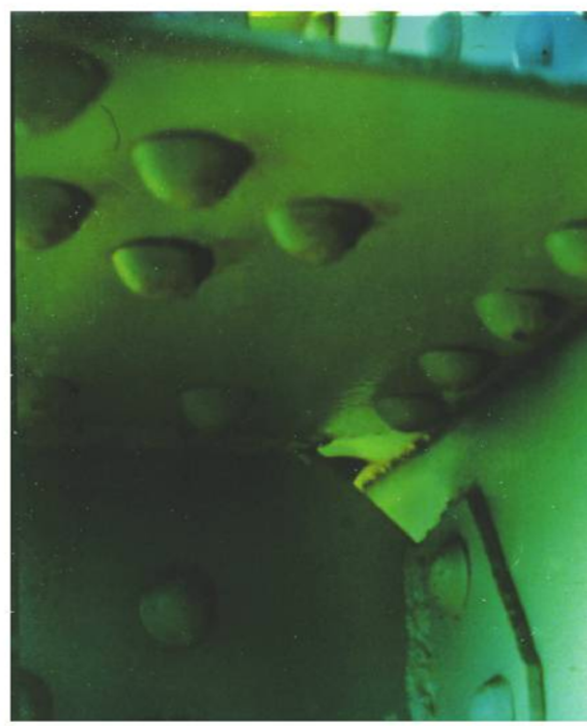


Fig. 2: Corrosion products on the back sides of the rivets and edges after six months' service

the back side of the rivets that were not subjected to direct impact by the abrasive stream during blast cleaning. The coating was also applied from one direction, causing thin areas of coating on the back side of the rivets and the adjacent flat areas of the steel plate. Inadequate attention was given to the coating along the edges.

Avoidance Through Quality Control Inspection? The QC inspector should have carefully examined the "difficult access" areas after surface preparation and application of each coating layer. As a general rule, if the quality control inspector has difficulty accessing the areas, then the coating applicators likely had difficulty as well. Verifying coverage on an abrasive blast-cleaned surface with a gray coating can be challenging. Good lighting and the use of an inspection mirror would likely have revealed the missed areas. The specifier could have selected a contrasting color for the primer and may have required stripe coating in these areas (in accordance with SSPC-Guide 11) to help protect the edges.

Case Study No. 2: *The Fix is in, and That's the Problem!*

Background: The project specification required abrasive blast cleaning to achieve a Near-White blast (SSPC-SP 10/NACE 2), and the application of a single coat of an inorganic zinc primer to piping. Surface preparation and coating application were performed in the shop. Once the piping was installed in the field, damaged areas (caused by the installation) were abrasive blast cleaned and touched up with an organic (epoxy) zinc-rich primer. All of the touch-up areas performed well. However, within one

Fig. 4: Spontaneous cracking of the coating along the fillet weld

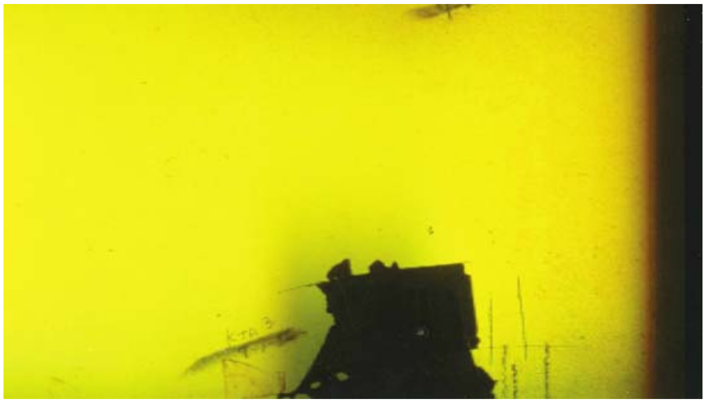


Fig. 5: Poor adhesion of the coating on the top of the bottom flange

Fig. 3: Close-up of rusted area, with the edge of a repair area also shown on left

year, portions of the piping showed extensive pinpoint rusting and rust-through.

A closer examination of the pipe (Fig. 3) shows one of the rusted areas, with the edge of a repair area also shown (left portion of Fig. 3). As illustrated, the repair area is performing well, but the surrounding area is exhibiting rusting.

Cause: When repairing damaged areas, the blaster failed to start and stop the flow of abrasive from the blast nozzle when moving from one damaged area to another. Instead, the blast nozzle was moved to the next location while the abrasive was still flowing at maximum pressure, which caused considerable damage to the coating. This is apparent in Fig. 3, where a round patch of coating had been effectively removed by the abrasive impact, with the surrounding area nicked by the abrasive.

Because the zinc primer is essentially the same color as the steel, the damage went unnoticed until the electrolyte (water) contacted the surface and caused the formation of corrosion.

Avoidance Through Quality Control Inspection? Many would point to a misplaced repair procedure as the culprit in this case; and perhaps, even with diligence, the overblast damage may have been unavoidable. However, during the start-up of the repair procedures, the QC inspector should have observed the abrasive blast cleaning operations, recognized the potential for overblast damage, and discussed the issue with the owner/specifier before work continued. The owner and inspector could have discussed alternative methods of preparation. Anticipating potential problems and proposing resolutions before a widespread problem occurs are intangible values that quality control inspection can bring to a project.

Case Study No. 3: *You Know What They Say: Dry Heat Is More Comfortable*

Background: The project specification required abrasive blast cleaning to achieve an SSPC-SP 10/NACE 2 Near-White blast and the application of an inorganic zinc primer to structural steel components in the fabrication shop. Application of the intermediate coat was also performed in the shop, while the topcoat was scheduled for application in the field after erection and bolting of the steel. The work was done in the winter, and the shop was heated. The fabricator's quality control specialist kept documentation revealing that the shop coating had conformed to the thickness and recoat times recommended by the coating manufacturer's technical representative, who visited the shop during coating application. The steel was loaded onto trucks and shipped to the site. When the coated steel arrived at the construction site, spontaneous cracking of the coating along the fillet weld (where the web and flange are joined) was discovered (Fig. 4). Figure 5 illustrates the spontaneous cracking and lifting along the fillet, and the poor adhesion of the coating system on the top of the bottom flange. Examination of a disbonded coating chip revealed the presence of zinc primer on the back side of the chip and on the steel surface, indicating that the location of break was cohesive within the zinc primer.

Cause: Ethyl silicate inorganic zinc-rich primers require moisture to cure. In this case, insufficient time was allowed before the application of the epoxy midcoat. Once the epoxy was applied, no more moisture could react with the primer because the epoxy sealed off the primer. The zinc primer remained in a dry but uncured (and weakened state). The solvents from the epoxy midcoat penetrated the uncured primer, and the contractive curing stresses imparted by the epoxy caused the zinc primer to cohesively split. Because a web and flange are adjacent to one another, the thickness of the epoxy was slightly higher along the fillet weld area. The higher thickness exacerbated the problem and resulted in the cracking and detachment. When other areas were evaluated, it became evident that the entire system was at risk for failure.

Avoidance Through Quality Control Inspection? Inorganic zinc-rich primers dry very quickly (especially in a heated environment); however, they may not cure for many hours or even days if the humidity is too low within the prevailing environment. The key is to verify that temperature and humidity (listed on the product data sheets) are present in the shop before application and to verify the cure has been achieved, rather than relying on cure time tables provided by the coating manufacturer, or assuming that drying and curing are synonomous. Quality control inspection by the fabricator should have included a curing test. In fact, there is one specifically designed for the primer in this case study (ASTM D4752, Measuring MEK Resistance of Ethyl Silicate (inorganic) Zinc-Rich Primers by Solvent Rub). Once a resistance rating of “4 or 5” is achieved (after 50 double rubs), the zinc-rich primer can be considered cured and ready for recoating. Some manufacturers rely on pencil hardness data instead of solvent resistance to assess cure. Either way, a competent QC Inspector knows how specific coating types cure, the conditions necessary for the reactions to occur, and the tests available to verify coating film properties before applying the next coating.

Case Study No. 4: *A Picture’s Worth Thousands of $$$*

Background: The project specification required abrasive blast cleaning to achieve a Commercial Blast (SSPC-SP 6/NACE No. 3) and the application of a single coat of alkyd primer in the joist fabrication shop. The joists were shipped to the project site, where they were stored outdoors (on the ground) for six months. Corrosion was visible within six months (Fig. 6).

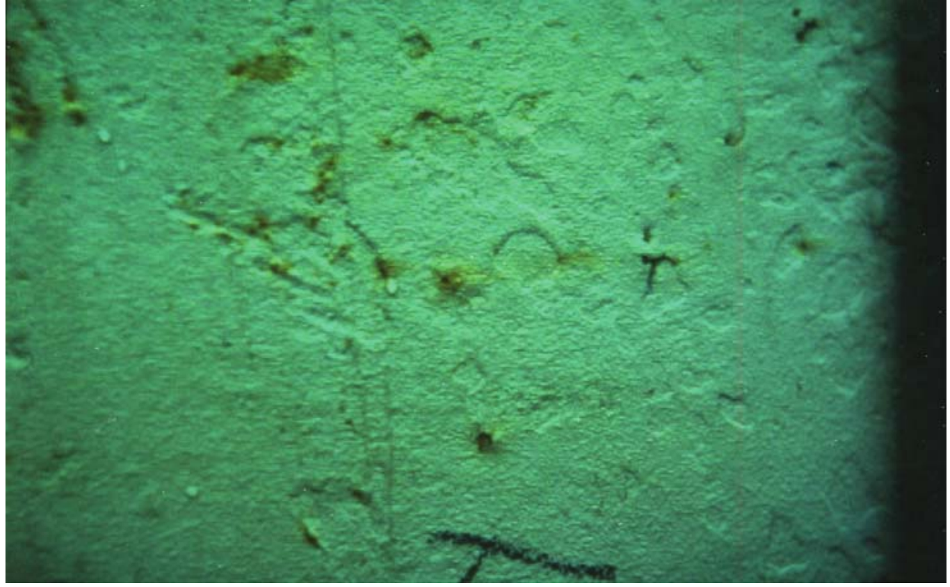


Fig. 6: Corrosion of steel beneath alkyd primer evident within six months

Cause: SSPC-SP 6/NACE No. 3 requires removal of all mill scale. The surfaces may have staining from mill scale (provided it does not exceed 33% of each 9 square inches). In this case, the "pock marks" in Fig. 6 clearly indicate that mill scale was left on the surface and coated over. The "hollow" areas represent those locations where the mill scale was removed, while the surrounding areas contain mill scale. The areas containing mill scale exhibit corrosion products. In a mild environment (and with the proper thickness), this system should have lasted longer than six months. However, the application of a thin (3- to 5-mil) film alkyd primer combined with damp storage conditions led to water permeation of the alkyd. The result was the formation of a corrosion cell at the mill scale/steel interface. Mill scale is cathodic to steel, which means that the base steel becomes the anode in the corrosion cell and begins to deplete, generating the corrosion products. Ironically, had the joists been stored indoors (or installed upon receipt), the lack of quality may have never been revealed, because it is unlikely that corrosion would have occurred due to the lack of electrolyte.

Avoidance Through Quality Control Inspection? Careful visual inspection of the steel surfaces by the quality control inspector after surface preparation (including the use of SSPC-VIS 1) would have revealed the presence of mill scale, which is not permitted by the specified cleanliness standard. That is, quality control personnel need to know industry standards and need to use tools (in this case, visual guides) for help in making intelligent decisions. While additional surface preparation before application of the primer would have required additional labor and more abrasive, it would have been done at a significantly lower cost than the cumulative costs associated with the failure investigation, transportation of the joists back to the fabrication shop (and then back to the project site once the rework was done), the material and labor costs associated with re-application of the primer, and potential for liquidated damages due to project schedule delays.

Fig. 7: Condition of the coating on the underside of the viaduct before brush-off blast cleaning

Case Study No. 5: *Hey! I Followed the Spec; It Wasn't My Fault.*

Background: The underside of a viaduct containing an aged lead alkyd coating was brush-off abrasive blast cleaned to remove loosely adhering corrosion and paint (SSPC-SP 7/NACE No. 4), followed by the application of an epoxy mastic overcoat. Figure 7 illustrates the condition of the coating prior to abrasive blast cleaning. Figure 8 illustrates lifting of the old alkyd by the epoxy mastic overcoat. The number "10" written on the coating in Fig. 8 is in an area where the epoxy mastic was applied directly to the steel, rather than the aged lead alkyd. Directly beneath that area is an area where the mastic had lifted the alkyd, and was removed by scraping during the failure investigation. The area beneath the hand in the same photo represents epoxy mastic applied over the aged lead alkyd. This area was not probed during the investigation.

Cause: The aged lead alkyd coating was in poor condition, as illustrated by Fig. 8. While brush-off abrasive blast cleaning removed the loosely adhering materials, the impact of the abrasive on the "intact" alkyd weakened (fractured) it, but did not affect it enough to consider it "loose" by the dull putty knife test. Application of the epoxy mastic imparted curing stresses that weakened the cohesive strength of the aged lead alkyd, causing it to lift and disbond from the surface.

Avoidance Through Quality Control Inspection? Because the QC inspector does not have the authority to change the specification, this project was doomed from the minute the work was awarded. Even though the QC inspector may have questioned the specification, it is doubtful that that owner would have altered the spec unless the fracturing of the aged lead alkyd had been visible to the unaided eye and the inspector had informed the owner of the damaged coating. Inspection personnel cannot use magnification (according to the SSPC Surface Preparation Standards).

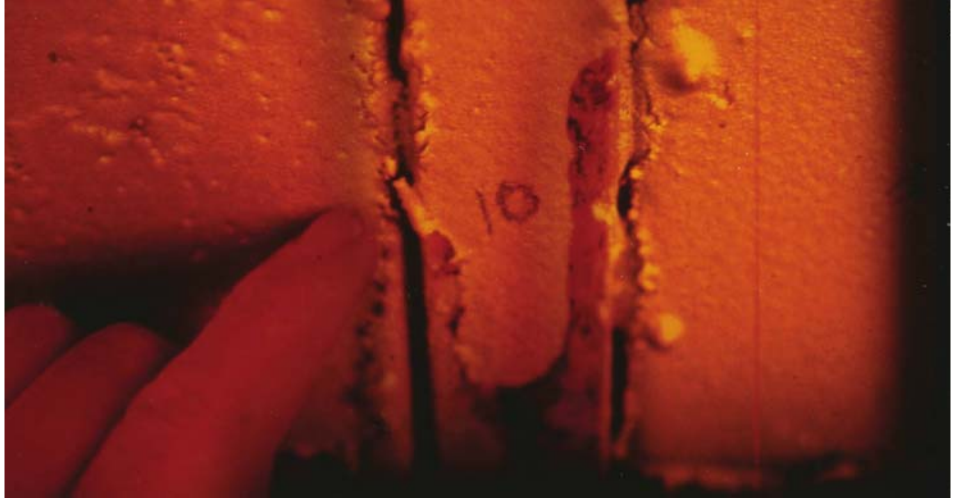


Fig. 8: Area where epoxy mastic was applied directly to the steel rather than the aged alkyd

Conclusion

So while it appears that controlling quality as the work is performed reduces the opportunity for coating failure, quality control cannot be a substitute for a well-written specification, quality coating materials, and quality workmanship.

Note

1. www.transition-support.com/Quality_control.htm

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This Cases from the F-Files article and previously published F-Files articles in the *JPCL* are available to read at www.paintsquare.com. Click on the Issues and Archives tab.

Preparing Concrete Floors for Coating

By Tracey Glew, Group Managing Director, The Preparation Group, UK

The successful application and durability of resins, coatings, and screeds on concrete floors depends on a sound surface. The key to success is in the preparation. When selecting the correct equipment and methods, consideration must be made for potential problems such as uneven joints, high spots, contaminants, worn coatings, sticky residues, old tiles, and friable substrates, which all need to be tackled to achieve a clean, profiled surface suitable for the application of the specified coating or covering.

There is a wide range of surface preparation machines and accessories on the market and a vast array of techniques that can be employed, with each unit and technique producing a different result. The model, size, and power requirements of the machine, together with the accessories selected and the type, thickness, and composition of the material to be removed, will determine production rates achievable. Other important factors to consider are area size; location and accessibility; the power supply available; and, critically, the profile required for the coating specified. It is important to note that surface preparation machines are also designed to work with dust collection and filtration units to minimize the dust contamination common in the preparation of concrete surfaces.

When concrete is not finished correctly, or if it has been broom finished/tamped (packed down and having a light rippled effect), the surface may have a large degree of laitance. To achieve a sufficient bond for the specified material to be applied, this laitance must be removed.

This article describes common techniques and equipment for preparing concrete before applying a coating or other system.

Multi-Stripping

The multi-stripping method is used to remove material from a surface or to clean it. Often, multi-stripping is selected when there are no other effective options available.

There are 110-volt, hand-operated, walk-behind machines for clearing small areas, and large, ride-on, three-phase electrical or propane-powered machines for clearing large areas.

Blades or picks are attached to the front of the machine and their type, weight, and position affects the removal of the designated surface. A flat blade should be selected to scrape off tiles, latex, adhesives, and elastomeric systems, while a curved blade cuts material into manageable lengths as it strips, so it is ideal to lift up membranes, carpet, and sheet vinyl. Picks are employed to break up hard materials such as ceramics and terrazzo tiles.

The operator positions the machine to cut or lift the material as the machine drives forward. In this way, multi-strippers can remove floor coverings such as waterproofing membranes, epoxies, polyurethanes, sticky residues, thermoplastic materials, asphalt, bituminous materials, adhesives, and the various other coverings such as wood, vinyl, carpets, ceramic tiles, latex, and screeds.

Once the floor is stripped, additional techniques for floor preparation are often specified in order to provide a suitable surface for application of the resin or screed, etc., such as the following.

Fig. 1: (Above): Underside of small planing machine showing milling flail drum
Photos courtesy of the author

Planing

You would select planing to remove materials in excess of 2 mm in thickness, when there are multiple layers of coatings, and when a rippled profile is required. Applications include removing old screeds, asphalt, latex, and adhesives, and reducing tamped surfaces and levels.

Machines range from small 110-volt, single-phase, to larger three-phase electrically powered petrol or diesel walk-behind models and ride-on versions for large-scale projects and heavy-duty applications.

The planing operation is based on a drum rotating at high speed within the body of the machine. The profile or texture is created by the accessories fitted to the drum known as flails (Fig. 1), or picks in the case of ride-on models (Fig. 2). Once contact is made with the surface being treated, the flail configuration cuts with a downward rotary action.

There are different shapes and sizes of flails and picks available for specific tasks and they can be arranged on the drum for light cleaning applications through to heavy-duty grooving. Generally, milling flails are for the removal of thermoplastic line markings (Fig. 3), bituminous materials, and rubber deposits; tungsten carbide-tipped flails are for cleaning, texturing, and roughening concrete; and star flails and beam flails are for removing soft material compositions.

Fig. 2: (Above): Profile created by ride-on planing machine fitted with pick drum

Fig. 3: (Left): Walk-behind planing machine removing thermoplastic line markings

Picks can remove and reduce materials in excess of 2 mm and up to 25 mm.

It is important to note that hard surfaces may be a problem for smaller planing machines because there is not enough weight to cut into the surface. This can result in the machine malfunctioning and becoming a hazard to the operator.

Fig. 4: Paint removal by a single-head, three-phase grinding machine

Fig. 6: Shotblasting machine removing surface laitance

Grinding

Grinding would be selected when a flat, level, and smooth concrete surface is required. It is used for removing surface contaminants, adhesives, paint (Fig. 4), sealers, and coatings, and for cleaning.

Grinding models are available in single-phase or three-phase electric and in single-head, double-head, and multi-head versions. There are also diesel- and petrol-powered alternatives and variable speed models that can be fitted with provisions for wet grinding and polishing applications.

Fig. 5: Underside of grinding machine showing diamond plate

Grinding is achieved by diamond (Fig. 5), tungsten, or resin-bonded plates or discs that are secured to the single or multiple rotating heads. There is a wide range of grades of diamond, resin-bonded, and PCD (Polycrystalline Diamond) shoes for removing adhesives and coatings, and for grinding, smoothing, and polishing decorative screeds and concrete screeds.

As a general rule, hard composition surfaces will require a soft bond diamond segment or disc, and soft compositions will require a hard bond. The correct diamond accessory is important because incorrect selection will either simply glaze over the surface without creating the profile or wear out extremely quickly in the initial stages of the operation.

Grinding is not recommended if the surface is uneven or if the concrete has been tamped.

Shotblasting

In the correct conditions, shotblasting is one of the most cost-effective methods of preparation. It is often selected to clean and profile power-floated concrete, to remove laitance (Fig. 6), coatings, and light surface contaminants. Surfaces to be shotblasted must be sound and hard. Shotblasting is not suitable for removing or treating soft compositions or materials thicker than 2 mm.

Shotblasting machines are available in walk-behind, 110-volt single-phase and three-phase electric and ride-on versions, and all offer different operating widths.

The process involves propelling steel shot or abrasive at high velocity (by a rotating wheel contained in the body of the machine) onto the surface to produce the desired profile. The debris removed is then collected in a dedicated vacuum/filtration unit for disposal upon completion of the process, and the shot is recycled.

Many profiles can be achieved; each profile is determined by the size or grade of shot or abrasive selected and the speed at which the machine is propelled.

Shotblasting will also highlight surface defects in the substrate being prepared, and cannot be carried out in wet or damp conditions. For optimum results, the process requires a smooth, even surface; otherwise, the shot will escape from the machine.

Summary

Selecting the correct technique for the nature of the concrete surface to be prepared is essential for obtaining the optimum substrate for coating or further treatment. JPCL

Innovative Coating Systems for Steel Bridges: A Review of Developments

By Mike O'Donoghue, Ph.D., International Paint LLC, Canada; Vijay Datta, M.S., International Paint LLC, USA; Stan Walker (now retired), Terry Wiseman, and Peter Roberts, International Paint LLC, Canada; Norb Repman, International Paint LLC, USA

Opposite page and below:
Photos courtesy of International Paint LLC

For the bridge community, advances in the world of high-performance coating systems have led to a dramatic technological and economic impact on new construction and bridge rehabilitation projects. The present article was condensed from a much longer and more detailed paper. The present article summarizes several key advances in bridge coating systems made mainly throughout the past 15 years. Conventional three-coat systems for bridges are described briefly, with a longer discussion of relatively recent advances in topcoat technology and two-coat technology for rapid recoating. Special attention is given to polyaspartic-polyurethane topcoats, polysiloxane topcoats, and a high-ratio calcium sulfonate alkyd system (to solve corrosion problems in crevice corroded structure-critical connections, complex geometries, and frozen bearings). Laboratory results for conventional and more recently developed systems are given, practical issues bridge engineers face for coating new bridges and recoating existing bridges are discussed, and three case histories are used to illustrate the performance of systems that incorporate polyaspartic and polysiloxane technologies. The longer report is available from the authors.

Editor's Note: A version of this paper has been published in the Proceedings of the 8th International Conference on Short and Medium Span Bridges, 2010, and the present paper is published with the permission of the Canadian Society for Civil Engineering.

Background

For over a century, protective coatings have been the primary means to afford effective and economical corrosion protection on steel bridges. In fact, from around the turn of the 18th century until the 1960s, shop- and field-coated bridge steel has invariably been coated with lead-based or lead-chromium paint systems (or both) applied directly to intact mill scale.[1] Significantly, despite the lack of surface preparation before coating application, bridges thus painted have performed well for decades. Why? The reason is simple: the corrosion inhibitors in early oil or alkyd primers imparted truly outstanding corrosion resistance to the coating system.

Because of health concerns associated with lead and chromium pigments in the 1960s and 1970s, the coating industry moved away from systems based on lead- or chromium-bearing primers, and alkyd mid and finish coats, to what was termed "high-performance coating systems."[2] The latter initially consisted of zinc-rich primers followed by one or more vinyl topcoats. Realities associated with the new coating systems have proved costly at times. First, the steel surface preparation, unlike that for the lead-based paint and conventional alkyd systems, was more expensive—abrasive blast to either an SSPC-SP 6, Commercial standard or, for better long-term coating performance, an SSPC-SP 10, Near-White Metal standard. Second, the vinyl mid and topcoats cost more than the alkyds.

Vinyl coatings later disappeared from the landscape of protective coatings because of volatile organic compound (VOC) issues, and epoxy coatings replaced vinyls. Although epoxy coatings provide excellent anticorrosive barrier properties, they do chalk and fade. Therefore, a polyurethane finish was necessary to furnish the desired aesthetic qualities of good gloss and color retention.

And so the three-coat zinc, epoxy, and polyurethane system (considered the top-of-the-line by the protective coating industry) was born. In the main, the system has been used on bridges to this day with great success and still deservedly enjoys favor with many specification authorities despite new and innovative two-coat and one-coat systems and despite concerns regarding free-isocyanate content in

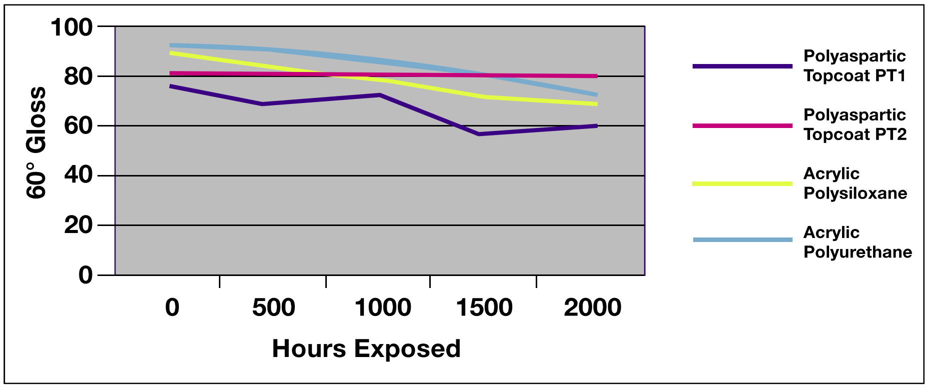

Fig. 1: Gloss retention of various aesthetic topcoats (QUV-313B laboratory testing)

polyurethane finishes.[3]

Significant strides have been made where coating formulators have developed innovative low VOC coating systems for bridges based on new gloss-retentive resin technologies such as polysiloxanes and polyaspartic polyurethanes.[4] See Fig. 1.

With almost half the bridge inventory in North America requiring field painting, rapid curing and rapid recoat systems have been developed for new and blast cleaned steel.[5] Alternative bridge coating practices such as overcoating and zone painting have also been successfully employed. The overcoating system is applied to cleaned, aged, and intact lead-based paint systems.[6]

Spurred on by the bridge community, it has been no trifling feat for coating formulators to (a) satisfy tougher accelerated laboratory test requirements to have coating systems specified, (b) meet stricter VOC and HAPS (hazardous air pollutants) regulations, and (c) reduce coating and application costs to be economically attractive. In a nutshell, the desire of "more for less" is the basis for this approach.

Coating Technology for Bridges

Modern day bridge coating systems for new construction and maintenance projects are largely the following.

(a) New Construction—Shop-applied (abrasive blasting to SSPC-SP 5, White Metal)

- Zinc/Epoxy/Polyurethanes (3-coat)
- Zinc/Polysiloxanes (2-coat)
- Moisture-Cured Urethanes (3-coat)
- Water-Based Systems (3-coat)

(b) Maintenance—Field-applied (abrasive blasting to SSPC-SP 10, Near White, or SSPC-SP 6, Commercial)

- Zinc/Epoxy/Polyurethanes (3-coat)
- Moisture-Cured Urethanes (3-coat)

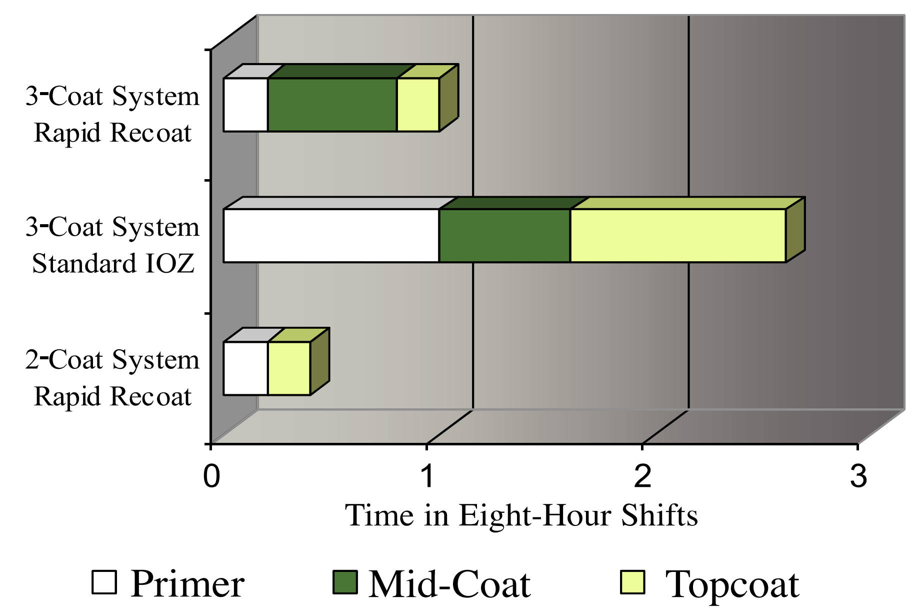

Fig. 2: Shop production

- Zinc/Epoxy/Polysiloxanes (3-coat)
- Zinc/Polysiloxanes (2-coat)
- Zinc/Epoxy/Polyaspartics (3-coat)
- Zinc/Polyaspartics (2-coat)
- Zinc/Polyurethanes (2-coat)

(c) Maintenance—Field-applied (overcoating)

- Epoxy Penetrant Sealers/Epoxy/Polyurethanes (2- or 3-coat)
- High-Ratio Calcium Sulfonate Alkyds (HRCSA) and CSA coatings (1- or 2-coat)
- Moisture-Cured Urethanes (3-coat)

Two-Coat Bridge Systems

Two-coat reinforced inorganic zinc (reinforced with a small amount of organic polymer to enhance the effectiveness of zinc) and high-build polyaspartic-polyurethane (or acrylic-polyurethane) finish coats have excellent industrial track records for large projects where rapid recoat of the inorganic zinc-rich primer and rapid curing is required to increase shop throughput. These coatings systems can be shop-applied in one shift and potentially shipped to a job site the next day (Fig. 2).

The coating innovation provided for DOTs and MOTs is that the same level of protection of a three-coat system can be obtained in two coats and at a reduced overall cost. Success has been reported where bridge sections received a two-coat rapid return to service moisture cured zinc-rich/polyaspartic topcoat in lieu of a NEPCOAT- (North East Protective Coating Committee) approved (traditional) three-coat zinc-rich/epoxy/polyurethane system. The two-coat system saved the owner 26% in direct costs and 24% in indirect costs.[7]

Rapid Deployment® (KTA-Tator) is a relatively recent term used in bridge maintenance painting.[8] It describes a process that has been investigated by many DOTs and MOTs. The need for such a process was brought on by the excessive costs related to traffic control during abrasive blasting and painting of bridges over multi-lane highways. The cost of "permanent" type barriers for traffic control has been reported to be about $600.00 per foot, and so a new bridge painting methodology was sought.

The concept of abrasive blasting and coating the underside of structural steel on bridges over multi-lane highways while "on the go" was attractive and ensured that only one lane of traffic would need to be controlled (and then only during off-peak times such as between 6 p.m. and 6 a.m. in most jurisdictions).

Another need quickly became evident: a mobile setup to abrasive blast the bridge structure, which in turn was followed by yet another mobile setup that would contain the painting process. There was also the requirement for confinement to satisfy environmental concerns and to prevent egress of waste and overspray materials otherwise offensive to traffic in adjacent traffic lanes. The containment proposed was to be part of the mobile setup on both the abrasive blasting and application vehicles.

The focus then became: 'Could an innovative two-coat high-performance system provide the necessary dry-to-recoat and cure times while providing the long-term corrosion protection afforded by the traditional three-coat zinc/epoxy/urethane system?' The answer lay in the real-life and successful coating applications in other industrial settings using a reinforced zinc primer or appropriate organic zinc primer at 3 mils' DFT followed by a polyaspartic-polyurethane finish at 6 mils' DFT. This approach achieved the corrosion protection, gloss retention, and color stability desired by MOTs and DOTs.[9]

The reinforced inorganic zinc can be topcoated within 60 minutes at temperatures as low as 40 F (5 C), and the polyaspartic-polyurethane topcoat can then be applied at 6 mils' DFT, also at temperatures as low as 40 F (5 C). Alternatively, the more traditional and slower-curing high-build acrylic polyurethanes may be used in lieu of the faster-curing polyaspartic polyurethanes.

In addition, the desirable mechanics of the mobile rigs have proven to be attainable as a result of innovation abilities of the painting contractor community in North America.

Table 1: CPTP Test Results

Test Panel	Zinc Primer	Epoxy Midcoat	Finish Coat	Scribe Undercut
R4	Reinforced Inorganic Zinc	Phenalkamine	Acrylic Polyurethane 1	1 mm
R8	Reinforced Inorganic Zinc	NA	Polyaspartic Polyurethane	1.5 mm
R9	Organic Zinc	NA	Polyaspartic Polyurethane	1 mm
C26	Organic Zinc	Epoxy Polyamide	Acrylic Polyurethane 2	1 mm
C27	Organic Zinc	Epoxy Polyamide	Acrylic Polysiloxane	1 mm

Accelerated Laboratory Testing

CPTP Cooperative Paint Testing Program 2008

The Alberta Transportation and British Columbia Ministry of Transportation invited coating manufacturers to submit candidate systems for accelerated laboratory testing which, if accepted, would be placed on the CPTP Recognized Product List.[10] The CPTP committee elected to test coating systems for steel infrastructure. The tests consisted of preparing coated panels and scribing to bare metal with a Tungsten carbide lathe tool. The scribe was 5 cm long and on the lower third of each panel at 45 degrees from the vertical.

The high-performance coatings submitted by the authors' company were as follows.

- Reinforced inorganic zinc/hydrocarbon-modified epoxy/acrylic polyurethane
- Reinforced inorganic zinc/modified phenalkamine epoxy/acrylic polyurethane*
- Reinforced inorganic zinc/modified phenalkamine epoxy/acrylic polyurethane
- Reinforced inorganic zinc/hydrocarbon-modified epoxy/polyaspartic polyurethane
- Organic zinc/hydrocarbon-modified epoxy/polyaspartic polyurethane
- Reinforced inorganic zinc/polyaspartic polyurethane*
- Organic zinc/polyaspartic polyurethane*
- Reinforced inorganic zinc/adducted phenalkamine epoxy/polyaspartic polyurethane
- Organic zinc/epoxy polyamide/acrylic polysiloxane*
- Organic zinc/epoxy polyamide/acrylic polyurethane*

All the systems listed above passed the CPTP test regimen. They were subsequently placed on the Recognized Product List. For the sake of brevity in this article, the scribe undercut results of only five representative coating systems (asterisked above) are shown in Table 1. The scribe resistance for the coating systems was similar (ranking 8 out of 10 or exhibiting approximately 1 mm of undercutting after 3,015 hrs in cyclic weathering), whether or not the zinc primer was an organic zinc, with approximately 90% zinc by weight in the dry film, or a reinforced inorganic zinc, with 62% zinc in the dry film. This resistance accords well with the position held by Hendry that the performance by zinc coatings is more a function of the total coating formulation than that of the zinc content alone.[11]

The high-build polyaspartic polyurethanes and polysiloxanes and high-quality, thin-film acrylic polyurethane finish coats all had very similar initial gloss and gloss-retentive properties. The corrosion and UV results obtained with the three-coat organic zinc/epoxy/acrylic polysiloxane were excellent. This system is popular where isocyanate-free topcoats are either preferred, or mandated, by bridge authorities.

The overall results for the two-coat rapid recoat systems were very similar to the results for the more traditional three-coat systems. Other things being equal, this lends further support to the notion that for new construction or field maintenance bridge projects, the two-coat systems yield similar results to those using three-coat systems. However, while accelerated test results are good indicators of performance, it is important not to over-interpret the data in terms of real-life performance.

Overcoating

Bridge coatings that contain lead pigments have been used for more than 100 years. The choice facing DOTs and MOTs is whether to refurbish bridge structures by abrasive blasting and application of suitable coatings or to high-pressure water wash/power tool clean them and apply an overcoat system. The cost of surface preparation is markedly different for either scenario. For instance, in 1994, costs ranged from \$4–\$13/ft^2 for abrasive blasting, full removal of the lead-based paint coating, and application of the replacement coating system, to \$2–\$7/ft^2 for a pressure wash and an overcoat option).[12,13] As with most costs, these figures likely have risen substantially.

The crux of the matter for successful overcoating is twofold. First, the best candidate overcoat systems for bridges are those that, even under extreme hygrothermal stress from inclement weather conditions, will indefinitely exert minimal stresses on the underlying and intact lead-based paint systems. Second, coatings (typically, penetrant sealers) must perform year-round in structure-critical connections and pack-rusted areas where crevice corrosion has occurred. Preference must be given to low viscosity and high wetting systems with the ability to remain flexible in crevice-corroded joints. Hare emphasized the importance of low viscosity and high wetting penetrant sealers for successful overcoating.[14]

Epoxy Penetrant Sealers and HRCSA Sealers

Given the importance of a coating to penetrate structure-critical connections and consolidate rusty surfaces, the authors have conducted three studies that compared a variety of sealers, including epoxy penetrant sealers and HRCSA sealers. Key results from these three studies are combined in Table 2.

In one study, the authors compared and contrasted the viscosities of epoxy penetrant sealers and several other sealers, but not HRCSA.[15] In the 1998 study, the best all-around penetrant sealer was one of several ultra-low viscosity 100% solids epoxies. As evidenced in scanning electron microscope photographs in the study, the sealer possessed air- and water-displacing properties and the ability to impregnate and bind loose rust surfaces.

To maximize the penetration, wetting, and capillary action of two-component, 100% solids epoxy penetrant primers (or any primer) on rusted steel or on aged coatings, viscosities of less than 30s in a #4 Ford Cup are required. One of the epoxy penetrant sealers in the 1998 study (Coating A in Table 2) had a viscosity of 13s, i.e., approaching that of the 7s measured for water. This water-thin epoxy technology in the 1998 study was also tested in a low-temperature-curing version (Coating B). Both are suited to applications to structure-critical connections on a bridge.

In another study, the authors compared the overcoating properties of HRSCA (Coating K in Table 2), with generic epoxy penetrants, moisture-cured urethanes, thinned high-build epoxies, and methyl methacrylates, including their viscosities.[16] Overall, the study showed that the best overcoating technology is afforded by

Table 2: Penetrant Sealers: Viscosity, Surface Tension and Contact Angle Measurements

Coating	Epoxy Penetrant Sealer	Viscosity(s)	Surface Tension (dynes/cm)	Contact Angle (degrees) Rusted Steel
A	Epoxy Penetrant Sealer	13	36	<2
B	Epoxy Penetrant Sealer	17	38	<2
C	Epoxy Penetrant Sealer	334	40	8.5
D	Epoxy Penetrant Sealer	54	36	<2
E	Epoxy Penetrant Sealer	49	40	<2
F	Epoxy Penetrant Sealer	Not measured	41	20
G	Moisture-Cured Urethane Sealer	63	37	28.8
H	Polysiloxane	38	39	30
I	Phenalkamine Epoxy (10% thinned)	43	45	35.3
J	Phenalkamine Epoxy (30% thinned)	14	39	32.5
K	High-Ratio Calcium Sulfonate Alkyd	22	30	12.3

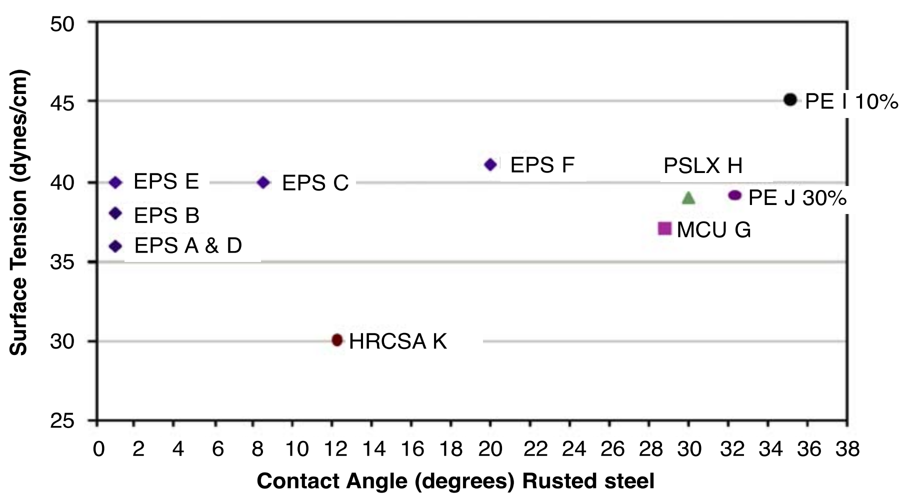

Fig. 3: Overcoat study: Surface tension vs contact angle for penetrant sealer coatings

HRCSA coatings. These single-component coatings cure by air oxidization and have a tremendous record of success, not only as bridge overcoat systems but when the specified surface preparation is abrasive blasting to either SSPC-SP 10, Near-White Metal standard, or SSPC-SP 6, Commercial standard. Flexible and exerting minimal shrinkage stress on aged lead-based paint systems, HRCSA coatings do not delaminate even when the full overcoat systems are subjected to large hygrothermal stresses. Moreover, HRCSA penetrants continuously release corrosion inhibitors into joints and connections.

An unpublished study by the authors[17] showed that an HRCSA penetrant sealer possessed a similar viscosity value to two of the two-component, modified aliphatic amine 100% solids epoxy penetrant sealers from the 1998 study, Coating A and Coating B in Table 2. The authors determined that the viscosity effect of penetrant sealers did not fully predict the capillary and wetting effect of the penetrant sealers, and further work was undertaken to measure the contact angles and surface energies of the penetrant sealer coatings applied to rusted steel (Fig. 3). Surface tension and contact angle results are summarized in Table 2.

A bridge engineer's perspective is invariably that mitigating corrosion in crevice-corroded joints is paramount. This is especially true in any overcoat project. Overcoat systems based on HRCSA and the modified aliphatic amine 100% solids penetrant sealers are best applied over steel surfaces prepared to SSPC-SP WJ4. Care must be taken to first clean the joints and connections by high-pressure water cleaning with specialized soluble salt removers (soluble salts are kept below 10 $\mu g/cm^2$) and then flush joints with clean water.

Importantly, overcoating projects and laboratory research have shown that coating adhesion, while important, is one of the least important factors in successful coating applications.[18] Based on Reference 18, the present authors hold that the following factors identify the suggested new paradigm for successful overcoating: Wetting and Penetration > Inhibition and Passivation > Moisture Tolerance > Flexibility > Benign Influence > Barrier Properties > Adhesion.

General Discussion

Bridge engineers have many critical decisions to make with respect to their field inventory, safety, and selection of the high-performance coating. For instance, when in need of maintenance, should bridges be abrasive blasted and painted or should their old lead-based paint be overcoated? In the case of the former, the relatively new two-coat high-performance coating systems have the potential to provide decades of excellent corrosion protection. To maximize the potential for success, stripe coating must be undertaken.[19]

Stripe coating is even more crucial in the case of a two-coat system than a three-coat system. This is especially so if the individual coats have been applied at somewhat higher

"General Discussion" continues on p. 46

Case Histories

Case History 1: Complete Removal of Old Coating System

In a 2007 bridge coating project in the U.S., the original specification sought a polyurethane finish, but due to the deep, forest green color of the bridge, the parties to the contract decided to switch to the more color-fast acrylic polysiloxane finish (Fig. 4). Full containment was used, and the surface preparation was abrasive blasting to SSPC-SP10, Near-White Metal. A three-coat system was employed: an organic zinc-rich primer, an epoxy polyamide midcoat, and an acrylic polysiloxane. As anticipated, five years later, the high gloss and deep green color of the acrylic polysiloxane are outstanding.

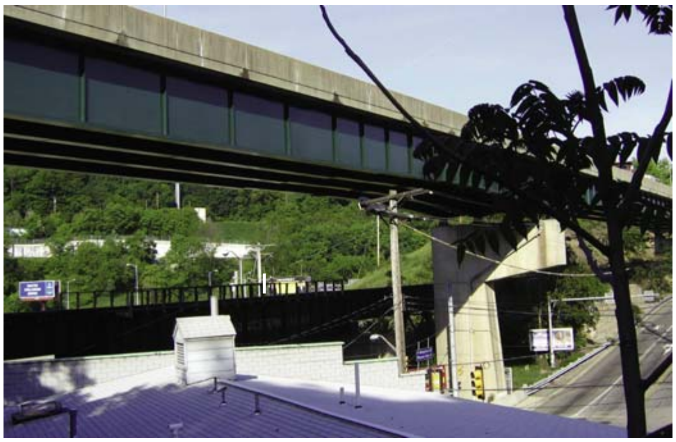

Fig. 4: SSPC-SP 10/organic zinc/epoxy polyamide/acrylic polysiloxane
Photos courtesy of International Paint LLC

Case History 2: Maintenance

The first phase of a bridge re-paint began in Saint John, New Brunswick, Canada in 2006. The steel was abrasive blasted to SSPC-SP 10, Near-White Metal, and coated with an inorganic zinc primer, an epoxy midcoat, and a polyurethane finish. The system performed well throughout the summer and fall but during the winter, on the inside spans (above high tide water levels), the humidity exceeded the manufacturer's recommendations for a thin-film polyurethane application. As a result, in the following year, the owner and engineer changed the finish coat specification, replacing the acrylic polyurethane finish with a polyaspartic polyurethane topcoat that would not be adversely affected by the high relative humidity resulting from proximity to water from the high tide (Fig. 5).

Fig. 5: SSPC-SP 10/inorganic zinc/epoxy/polyurethane on sides, and inorganic zinc/epoxy/polyaspartic polyurethane underneath

Case History 3: Complete Removal of Old Coating System

In 2010, a bridge coating project in Canada was specified with the options to use a traditional three-coat system with a polyurethane finish or a recently tested and approved (by the local highways authority) two-coat system using a polyaspartic polyurethane. The successful contractor determined that the two-coat system was the most efficient system for this bridge project. Surface preparation was abrasive blasting to SSPC-SP 6 Commercial Standard and the two-coat system employed was an organic zinc-rich primer and a polyaspartic polyurethane finish coat (Fig. 6). The contractor used an epoxy to stripe edges and welds between coats.

Fig. 6: SSPC-SP 6/organic zinc/polyaspartic urethane

continued from p. 42

DFT's than recommended by the coating manufacturer. In fact, overly thick coating films have excessive internal stresses, which can cause tensile adhesion failures and lateral cohesion failures of the overall coating system. Hence, to derive the full benefit of a two-coat system, it is crucial to apply the correct film builds of both the zinc-rich primer and high-performance finish coat.

As stated earlier, a two-coat system consisting of a reinforced inorganic zinc and a polyaspartic polyurethane system is one of the answers well suited to rapid return to service projects and wet-on-wet coating applications where the primer is topcoated immediately after application. Thousands of tons of structural steel have been coated with this system to provide corrosion protection in harsh industrial and seacoast environments; it is well suited to the use on bridges.

However, a key decision for the bridge engineer is whether or not to use one of the newer technology high-gloss finish coat technologies such as a polyaspartic polyurethane or polysiloxane. (See "Case Histories," p. 44.)

Given that the polyaspartic and polysiloxane technologies do not have as many case histories as the older technology types, an understandable reticence exists on the part of many bridge engineers not to be the 'guinea pig.' The authors propose that a smart approach would be for DOTs and MOTs wishing to cautiously adopt new coatings technology to partner with reputable coating manufacturers. Both parties can share the responsibility that the coatings will perform satisfactorily for at least 15 to 20 years. Therefore, any initial hesitancy to stray from the proven realm of three-coat zinc/epoxy/polyurethane systems to innovative two-coat systems is overcome.

One simple way to indicate whether or not an existing bridge is a good candidate for overcoating is to abrasive blast test areas on the steel. If holes are blown through the steel on the bridge in question, then forget an overcoat system. Success or failure with respect to overcoating is thought by some to be unpredictable. Poor coating choices and premature overcoating failures gave rise to this perspective. Failure to understand the chemistry of the overcoating system is at the heart of the issue. As highlighted earlier, the use of penetrant sealers for crevice-corroded joints and connections, pack-rusted sections, and bearings cannot be overemphasized. It is in these structure-critical connections areas that bridges invariably fail.[20]

The use of de-icing road salts is a huge issue as far as corrosion of steel in joints, connections, and bearings. Many DOTs have a team that every two years pressure wash the bridges and remove the salts. The solution to reducing the costs of the cleaning operation is to use superior coating systems and thereby extend the interval between pressure washings. This will save considerable time and money.

While industry creates new grades of steel (developments in weathering steel, etc.), coating manufacturers develop new coatings technology; meanwhile, corrosion is an ever-moving and costly target. Against this backdrop, during the past few years, the Ministry of Transport in Canada has identified certain areas of concern over the corrosion of weathering steel. Thus far, the coating systems applied to weathering steel have been used only above concrete areas to eliminate or reduce concrete staining. The Ministry has found evidence of pitting corrosion and flaking of steel elements on the steel as a result of ongoing corrosion. Consequently, it has now undertaken a study program in conjunction with steel producers and universities to develop yet another new grade of weathering steel to overcome this critical issue. The recently completed (although not formally reported on at the time of writing) test results will confirm that VOC-compliant materials in either two- or three-coat applications at a total DFT of 9 mils did satisfactorily protect the weathering steel.

Based on single-component technology, the old lead-based alkyd paint systems were simple to apply, gave long-term corrosion protection, and provided cost-effective corrosion protection to bridges for some 100 years. Ironically perhaps, in the present era of high-performance zinc, epoxy and polyurethane coatings—as well as other coating types such as moisture-cured urethanes, polyaspartics, polysiloxanes, and high ratio calcium sulfonates— research is underway to find a 100-year bridge coating system, albeit in a single-coat application.

Kline has discussed how to obtain the desired 100 years of service life using zinc-rich coatings currently available.[21] He was instrumental in the rapid return to service approach for bridges.[22]

In other work, Lee has shown that a single-coat system of HRCSA technology has performed particularly well in comparison to single-coat systems of thermoset coatings such as polyaspartic polyurethanes and epoxy polysiloxanes.[23]

Conclusions

As the worldwide bridge inventory continues to age, the manufacturers of high performance protective coatings have developed three- and two-coat systems based on zinc primers and polyaspartic, polyurethane or polysiloxane finish coats. The finish coats have more history in three-coat systems than in two-coat systems but are proving their effectiveness in both types of systems.

Accelerated laboratory test procedures currently available allow the industry to provide owners a comparison of bridge systems used in yesteryear with innovative, present-day high-performance systems.

Overcoating is a viable bridge painting option to give long-term corrosion protection. The best overcoat systems are those based on HRCSA technology.

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Mike O'Donoghue, PhD, is the Director of Engineering and Technical Services for International Paint LLC, Canada. He has more than 30 years of experience in the protective coatings industry.


Vijay Datta, MS, is the Director of Industrial Maintenance for International Paint LLC, USA. He has more than 40 years of experience in the marine and protective coatings industry.


Stan Walker, formerly of International Paint LLC, Canada, has over 50 years of experience in the protective coatings industry. Now retired, he offers his services to companies that market and evaluate protective coatings systems.


Terry Wiseman is the Canadian Manager of Strategic Marketing for International Paint LLC, Canada. He has over 20 years' experience in the protective coatings industry


Peter Roberts is the Engineering & Technical Services Representative for International Paint LLC Canada in British Columbia, Canada. He has 20 years of experience in the protective coatings industry.


Norb Repman is the Regional Sales Manager for International Paint LLC, USA. He has 25 years of experience in the protective coatings industry. **JPCL**

BY GERALD L. WITUCKI,
DOW CORNING CORPORATION

Formulating Options for Polysiloxane Coatings

The industrial protective coatings market has established silicone-organic hybrid systems as premium topcoat technology. Product offerings designed for use in these hybrid systems are available from both organic and silicone suppliers. For a coatings formulator seeking to create a high-performance finish, the potential combinations of silicon-based and organic materials present a daunting number of options and technical challenges.

Over the last quarter century, the role of silicon-based technologies has evolved and expanded in the protective coatings markets. Widely known as additives to reduce the coefficient of friction and enhance the durability of coatings, silicon-based technologies also include: monomeric silanes with organic and inorganic reactivity to serve as adhesion promoters, pigment treatments, cross-linkers and water repellents, resinous silsesquioxanes for improved thermal and weathering performance and an array of additives comprised of polydimethyl siloxanes (both loved and reviled), silicone polyether copolymers and organo-functional siloxanes, supplied neat, as elastomers, solvent solutions, or aqueous dispersions and emulsions. Each specific technology provides enhanced functionality and performance to coatings formulations across the industry. While most of these materials are utilized at incremental levels, silicone resins are typically included as a significant portion of the coatings' resin binder.

While silicone resins exhibit excellent thermal and ultraviolet radiation resistance, their physical properties are less than ideal for the protective coatings market. Silicone resins formulated to be hard and abrasion resistant are typically inflexible and brittle; soft and flexible silicone resins are easily abraded. The chemical and corrosion resistance of silicones can be described, at best, as fair. Fortunately, valuable performance benefits can be achieved by the hybridization of the siloxane with organic resins. This article describes the development, properties, and uses of siloxane resins, with a focus on formulation options and recent research into new amine silicon functional resins for polysiloxanes.

Here and opposite page: Polysiloxane finishes have found a wide array of protective coating applications. Photo: Akiyoko74 / Dreamstime.com

Early Silicone Hybrids

Through the 1960s, traditional silicone-organic copolymers relied on the condensation reaction of hydroxyl functional silicone (solid flake) resins with hydroxyl functional organics, such as alkyds and polyesters. While traditional silicone alkyds can be considered hybrids,

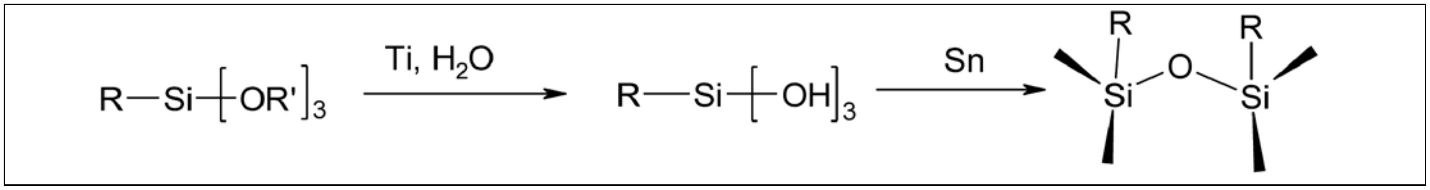


Fig. 1: Hydrolysis and condensation of alkoxy silane to form silicone resin

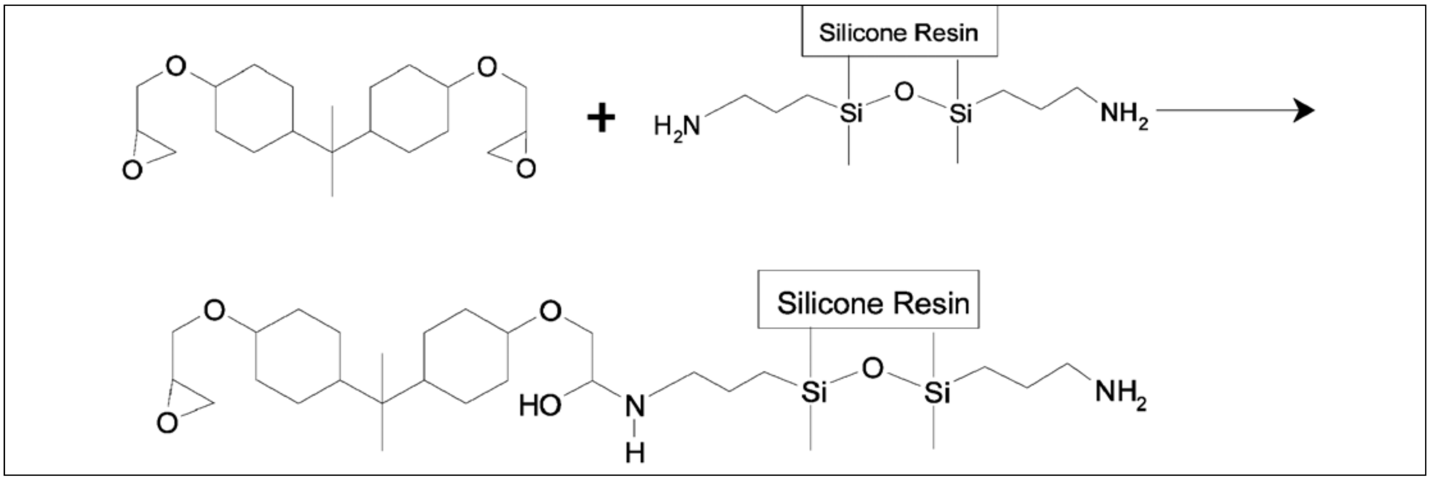


Fig. 2: Initial reaction of amine-functional silicone resin with aliphatic epoxy resin

in the sense that two dissimilar materials are copolymerized to achieve improved properties, the oxidation cure chemistry of the alkyd remains essentially unchanged. And all of these systems rely on high levels of solvent to ensure miscibility and stability of the siloxane.

This technology was augmented in the 1970s with alkoxy functional siloxanes. These silicone resin intermediates were introduced as solventless liquids that allowed for easier loading, lower solvent requirements, and better miscibility in organic systems. This approach resulted in a dual-cure system—the oxidation or melamine-crosslinking of the organic, along with the hydrolysis and condensation of residual silylalkoxy functionality (Fig. 1). This technology provides coatings with excellent weathering and chemical resistance, but relies on atmospheric moisture, requires the inclusion of titanate (hydrolysis) and tin (condensation) catalysts, and suffers from the potential for post-cure drift and embrittlement.

Table 1: Coatings Resins by Functional/Reactive Chemistries

System	Amine	Carbinol	Epoxy	Carboxy	Acrylate	Isocyanate	Aldehyde	Phenol
Polyurethane	•	•				•		
Epoxy	•	•	•				•	•
Polyester	•	•	•	•				
Alkyd	•	•		•				
Acrylic	•	•	•	•	•			
Amine	•	•			•		•	

Formulating for Compliance and Performance

To achieve the proper balance of regulatory compliance with long-term performance, it is necessary to create organo-reactive, low-viscosity polymers with low levels of volatility and outstanding durability. Owing to the inherent stability and flexibility of the siloxane (Si-O-Si) bond, silicones are well-suited to meet this challenge. In addition, silicon-based chemistry allows for the inclusion of many reactive functional groups. The question is: Which reactive groups have the greatest utility across coatings systems?

Table 1 shows the six major resin classes typically utilized in the protective coatings market. While the "black box" chemistry sets of many formulators contain many secret combinations of ingredients, generally the systems can be distinguished by the reactive groups employed to achieve the basic chemistries.

Amine and carbinol chemistries have the broadest utility across coatings markets. Both moieties possess excellent potential as the reactive chemistry on a siloxane polymer. Carbinol chemistries are beyond the scope of this article. The remainder of the discussion focuses on properties obtained from recent research on a liquid, amine functional silicone resin designed to improve the flexibility and durability of organic resins, and to have potential utility in the majority of coatings chemistries and applications. Initial formulating work was conducted using a standard aliphatic epoxy resin (Fig. 2). No titanate

Table 2: Chemical Resistance of Pigmented Topcoats

Chemicals	Epoxy/ Silicone Amine	Epoxy/ Organic Amine	Polysiloxane/ Epoxy
Hydrochloric Acid (50%)	4.5	2	3
Formic Acid (10%)	4	2.5	4
Nitric Acid (50%)	2.5	2	2.5
Phosphoric Acid (50%)	3	2	3
Acetic Acid (10%)	4	5	4
Sulfuric Acid (50%)	4.5	2	4.5
Sodium Hydroxide (20%)	5	5	4.5
Potassium Hydroxide (20%)	5	4	4.5
Ammonium Hydroxide (20%)	5	5	5
Avg rating for all chemicals	4.17	3.28	3.89
Avg rating for acids only	3.75	2.58	3.50
Avg rating for bases only	5	4.67	4.67
Rating: 0—total film failure, 5—No effect			

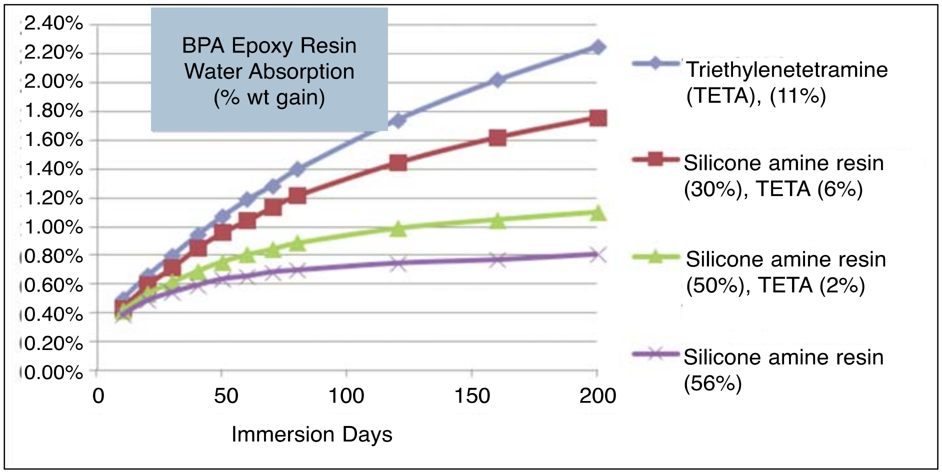


Fig. 3: BPA epoxy water absorption (% wt gain)

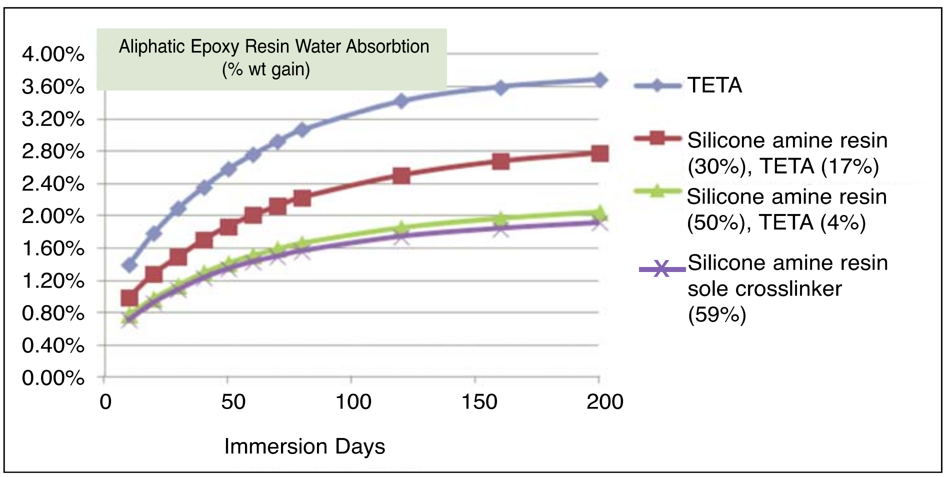


Fig. 4: Aliphatic epoxy water absorption (% wt gain)

or tin catalyst is required, and the reliance on ambient moisture is eliminated.

Extensive evaluation of silicone prototypes was conducted to sort through the wide range of potential siloxane structures. Identifying the performance attributes and test methods was critical to understanding the relationship of structure and performance. Compatibility with organic resin systems and cure rates, along with improving the coating's resistance to water and weather, were selected as the priority benefits.

Absorption of water into a coating can result in degradation of the film appearance and lead to subsequent attack and corrosion of the substrate. Figure 3 shows that by replacing a traditional aliphatic amine crosslinker with the amine functional silicone resin, the water uptake of a BPA epoxy was reduced from 2.5% to less than 0.5% over a 3,000-hour test period. Figure 4 shows comparable results with an aliphatic epoxy resin.

Lab data in Table 2 shows that this water resistance translates into improved resistance to aqueous chemical attack. Three drops of various aqueous chemical solutions were placed on the panels; next, the test panels were covered with a watch glass for 24 hours and then evaluated. The data

Table 3: Salt Spray Resistance

	% Si	Aliphatic Epoxy Topcoat Crosslinked with:	Scribe Creep (mm)
	50	Amine functional silicone resin and organic amine	55
	60	Amine functional and alkoxy functional silicone resins	48
A	70	Amine functional and alkoxy functional silicone resins	37
B	0	Organic amine (control 1)	57
C	0	Two-component polyurethane (control 2)	67

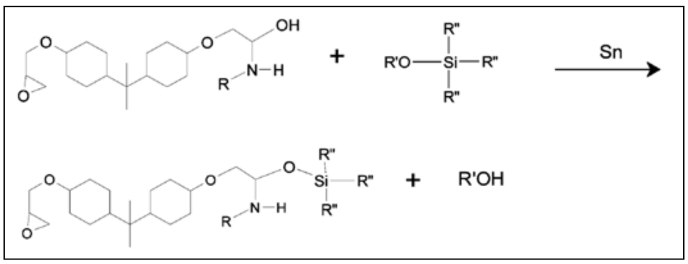


Fig. 5: Alkoxy-capping of residual hydroxyls

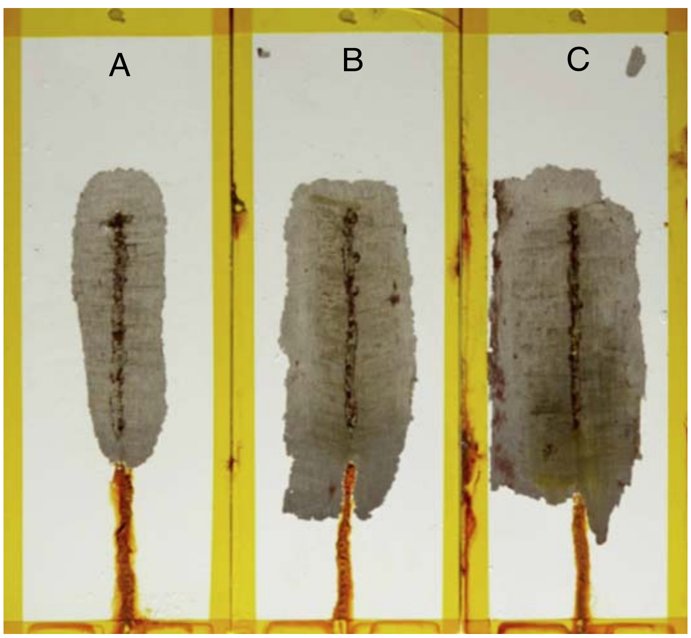


Fig. 6: After 1,500 hours' salt spray

shows that the silicone amine resin provided chemical resistance superior to that of the epoxy/organic amine coating. The polysiloxane sample that is comprised of an epoxy resin, an amine functional alkoxy silane monomer, and an alkoxy functional silicone resin exhibits the best chemical resistance. This result suggests the use of tailored formulations to attain specific performance benefits.

As shown in Fig. 2 (p. 56), the reaction of epoxy and amine functional groups results in the formation of secondary hydroxyl groups. This residual functionality serves as a point of chemical attack. The inclusion of alkoxy functionality through a silane monomer or a

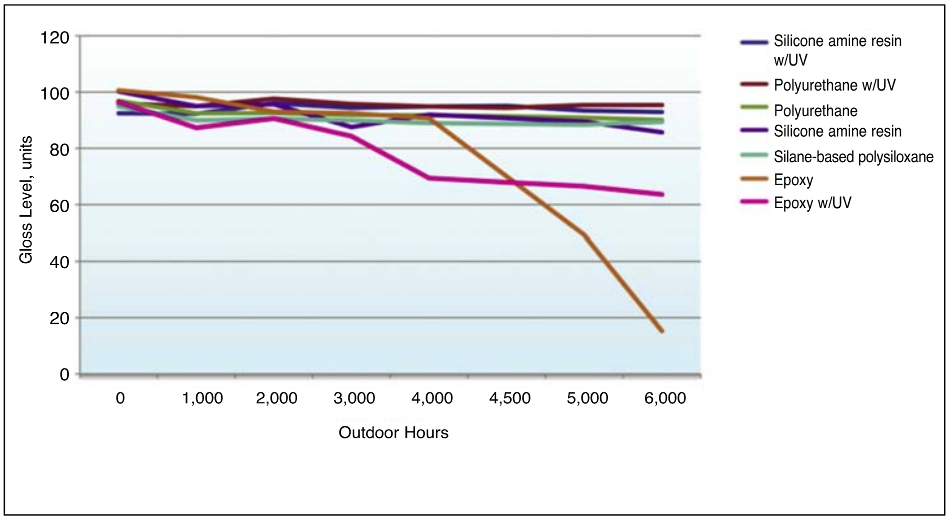


Fig. 7: Gloss retention of cycloaliphatic epoxy topcoats

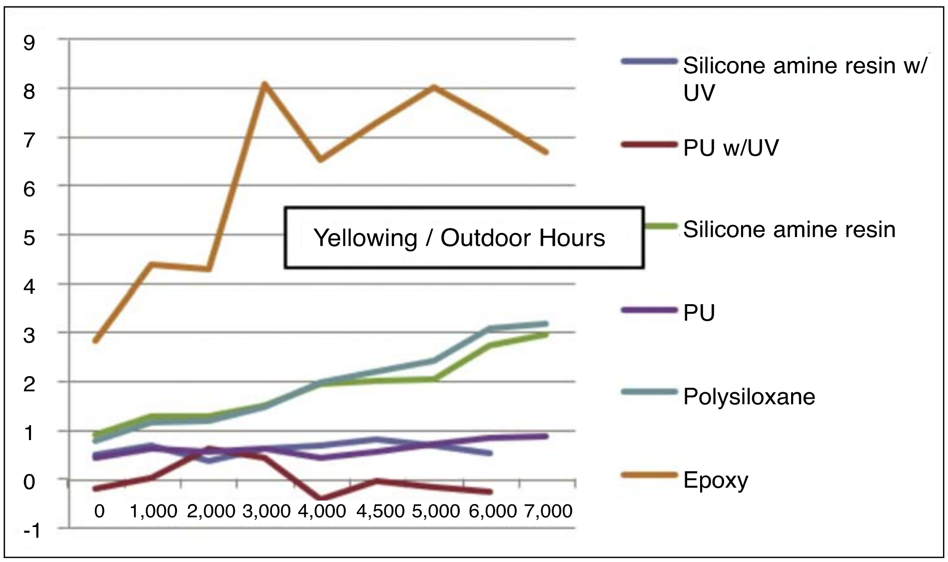


Fig. 8: Yellowing of cycloaliphatic epoxy topcoats

siloxane provides a means by which to cap off the hydrophilic hydroxyl group, increase crosslink density, and thereby improve chemical resistance (Fig. 5) and corrosion resistance (Table 3 and Fig. 6).

The reaction rate of the epoxy-amine chemistry is affected by concentration. As a result, polymeric reagents (either organic or siloxane) with a high amine equivalent weight will result in a slower cure rate compared to curing agents with low amine equivalents weights. This is simply due to the fact that at a more dilute concentration, the amine and epoxy groups are less likely to contact each other and allow reaction. For example, with an amine hydrogen equivalent weight of 262 (grams/NH), the cure rate of a coating containing the novel amine functional silicon resin would be expected to be much slower than a coating based on ethylene diamine (15 grams/NH). Along with concentration, amine structure (primary, secondary, or tertiary) will also affect the cure process.

Preliminary data (Fig. 7) shows that the silicone amine resin in combination with the aliphatic epoxy provides the anticipated gloss retention after external exposure. Weather induced yellowing (Fig. 8) is much less for the siloxane containing formulations

as compared to the control. The silicone amino resin is comparable to the polysiloxane hybrid formulation. The addition of one percent of a UV absorber further reduces yellowing and improves gloss retention comparable to that of a two-component polyurethane.

Utility for polysiloxane topcoat finishes has been found in a wide array of protective coatings applications such as bridges, oil platforms, water towers, and other industrial and municipal facilities—anywhere steel structures are exposed to environmental conditions. This technology facilitates the shift from the three-coat (primer/basecoat/topcoat) system to a two-coat (primer/topcoat) operation with less labor cost and downtime.

The polysiloxane coatings are applied via spray, brush, or roller—much like any conventional two-component coating.

The amine-epoxy cure of this resin system eliminates the isocyanate exposure concerns related to polyurethanes. Concerns about methanol exposure from alkoxy silane hydrolysis in traditional polysiloxane coatings are also eliminated. As with any coating system, proper care should be taken to minimize exposure and by using personal protective equipment.

Conclusions

The known benefits of siloxane technology involving thermal, weather, and chemical resistance can provide coatings with outstanding performance on industrial structures. An amine functional silicon resin allows coatings formulators to create simplified polysiloxane hybrid coatings without relying on titanate and tin catalysts. This technology also eliminates the reliance on ambient moisture resulting in a more robust system. Test results with complementary materials demonstrate the potential to tailor the performance needed for specific applications.

Gerald (Jerry) Witucki, Associate Coatings Scientist at Dow Corning Corporation, has provided technical support and product development of silicone additives and resins for the paint and coatings industries. He has been with the company for more than 28 years. He has written numerous articles on the use of silicon-based technologies, presented at many industry events, and holds more than 20 patents in the field. He is a graduate of Central Michigan University with an MBA and bachelor's degrees in Business Administration and Chemistry. JPCL

Editor's Note: This article marks the return of JPCL's Applicator Training Bulletin, a series first published from 1988 to 1992. The series was intended to help industrial contractor firms train blasters and painters. The original series was developed and written by the Coatings Society of the Houston Area in collaboration with SSPC, and Lloyd Smith edited it. The series was subsequently collected in one volume. From 1992 to 1993, a separate series on safety was developed and written under the direction of KTA-Tator. In 1997, the series was updated and expanded. Beginning this month, the series will again cover the basics of corrosion, surface preparation, application, quality control, and safety. The series will be updated and expanded where necessary. Because the basic theory of corrosion, how coatings protect steel, and the importance of surface preparation have changed little since 1988, some of the original articles will also appear with minor revisions, including this first one on what applicators need to know about corrosion. Written by Joe Pikas, with Transco Corporation at the time, the article was first published in the July 1988 JPCL*, then updated and re-published in the April 1997* JPCL.

Basics of Corrosion of Steel for Applicators

By Joe Pikas

A good coating job requires the right steps to be performed to achieve the protection needed. It is important to know why things are done, as well as how the various steps are performed. A primary reason for using protective coatings is corrosion protection.

For the purposes of this series, corrosion of steel is defined as "the destruction of steel by an electrochemical process that is characterized or recognized by the formation of rust or pits." To understand how protective coatings protect a steel surface, the nature of corrosion must be understood—why it occurs and how it can be prevented.

Steel is manufactured by taking the mined ore and adding a large amount of energy to

Fig. 1: One approach to slowing the natural corrosion of steel and appearance of rust is the use of protective coatings. Courtesy of JPCL

it in the blast furnace. This produces an unstable metal. Nature does not like all that energy stored in the steel. So upon exposure to the atmosphere, especially moisture and oxygen, this energy is released, and the iron returns to its natural stable state—iron ore. Rust, therefore, is nothing more than a pure form of iron ore (oxides). Protection of steel from corrosion involves methods to retard this natural release of energy (Fig. 1).

To understand how coatings protect steel, we must understand the four conditions required for corrosion to occur. Unless all four of these conditions are present, corrosion will not occur. These four conditions are:

- a positive pole (a cathode),
- a negative pole (an anode),
- an electrical conductor, and
- an electrolyte.

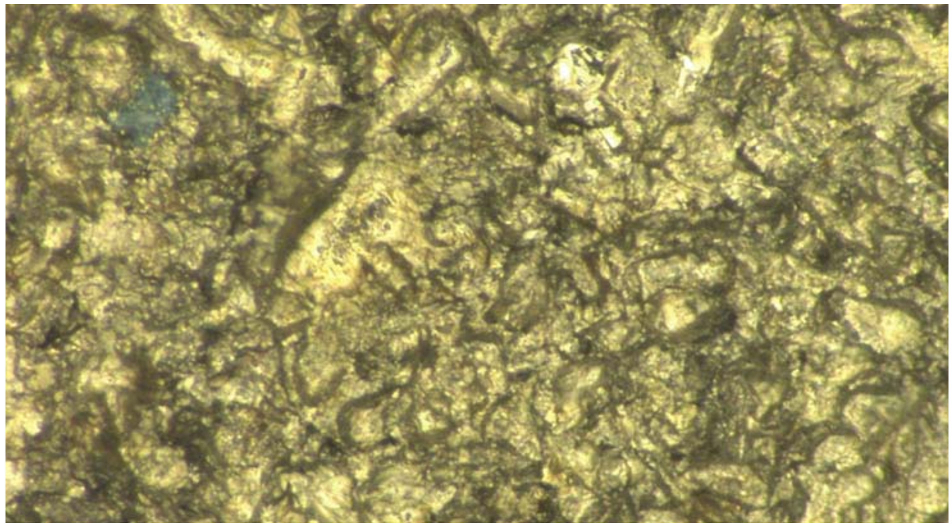


Fig. 2: Peaks and valleys of profiled clean steel
Courtesy of KTA-Tator

The terms "anode" and "cathode" have technical definitions in electrochemistry, but for our purposes, we will use them to refer to areas on a substrate or materials of different electrical potentials. The "electrical conductor" is a means of conducting electricity, similar to the copper wiring in your house. An "electrolyte" is a liquid solution (usually water) that also can conduct electricity.

To help illustrate these terms and how corrosion happens, let's look at the dry cell (battery). A battery represents a beneficial use of corrosion, though the process is the same as corrosion that occurs with steel.

A battery has two terminals. Typically, one is connected to a carbon rod running down the center of the battery, while the other is connected to the outer casing, which is made of zinc. These are the two dissimilar materials of different electrical potential, which serve as cathode and anode. If you have ever taken a battery apart, you would have seen that there is a pasty material between the casing and the carbon rod. This substance is the electrolyte.

If you wanted to use the battery, you would connect the wires to something such as a flashlight. The wires are the electrical conductor. Once the wires are connected, the flashlight will keep on glowing until the battery has become corroded. In the battery, it is actually the zinc casing that is consumed and corroded.

How does this example of a battery relate to corrosion of steel? You would see that steel is not a smooth, uniform material if you looked at it under high magnification (Fig. 2). It actually consists of very small grains or grain boundaries. This means that steel has spots on it with slightly different electrical potentials.

Adding stresses to the steel also creates areas of different electrical potential. This normally occurs by such processes as differential heating of the steel during treatment, bending or cutting the steel, or even hitting it with a hammer. Any of these processes adds small amounts of energy to the steel. So by its very nature, steel contains spots of different electrical potential, or anodes and cathodes.

What about the electrical conductor? This was the wire in the example of the battery. Does steel conduct electrical current? It certainly does, so wires are not needed. As you can see from this explanation, steel contains anodes and cathodes, and is an electrical conductor. It already contains three of the four conditions necessary for corrosion.

The fourth condition needed is the electrolyte or liquid that can conduct electricity. Where does it come from? Normally, atmospheric moisture that condenses on the surface serves as an electrolyte. It can be in the form of rain, dew, or simply humidity in the air. Some structures either are used to hold water or are used in water. They are

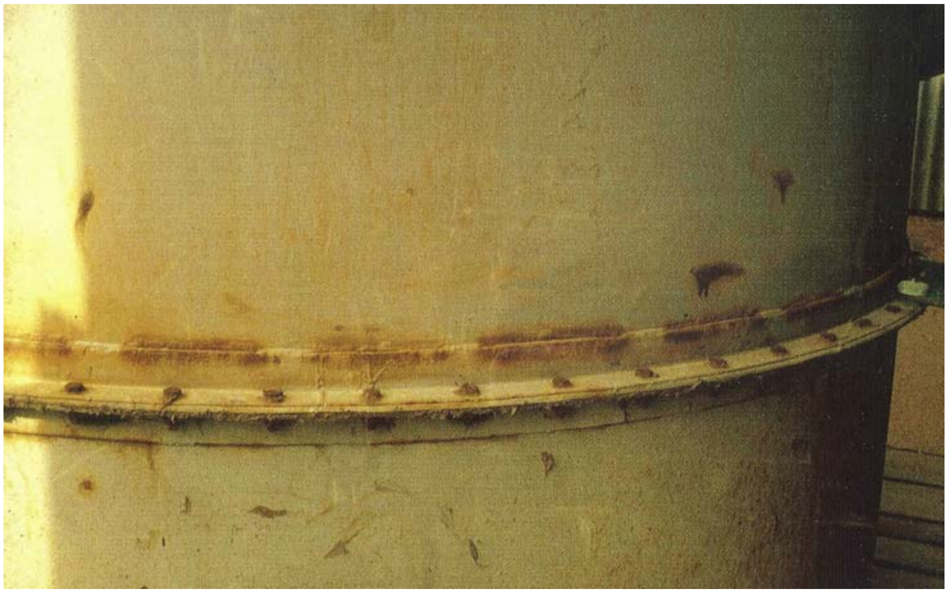


Fig. 3: Severe corrosion is seen at a weld seam. Courtesy of KTA-Tator

constantly exposed to an electrolyte.

Our atmosphere is laden with moisture at all times, even in desert areas, although to a lesser degree. Most steel surfaces are exposed to dew at night and water vapor during the daytime hours in addition to the normal rainfall. In highly industrial areas such as Houston, Los Angeles, and New York, airborne chemical contaminants contain substances called ions.

The point to be made is that steel (like most other manufactured metals) contains three of the four conditions needed for corrosion. The most common way to slow down corrosion is to isolate the steel from the electrolyte. Therefore, the major function of the coating is to keep moisture off the steel. Some coatings, such as zinc primers, perform other functions, which will be discussed in subsequent Bulletins.

There are a few common forms of corrosion that a painter will see regularly: general corrosion, galvanic corrosion, pitting corrosion, and crevice corrosion. General corrosion takes place fairly evenly over the metal. Usually, it begins as spots or freckles and becomes progressively worse.

Galvanic corrosion occurs when dissimilar metals are in contact. The more active metal (the anode) corrodes to protect the less active metal (the cathode). For example, if a brass valve were connected to a steel pipe, the steel would corrode to protect the brass. The steel at the fitting would be consumed rather quickly, first appearing as a thinning of the metal and ultimately resulting in penetration. Another example of galvanic corrosion is mill scale on steel. Steel is more active than mill scale, so when corrosion conditions are present, the steel will corrode to protect the mill scale.

Pitting corrosion occurs when the corrosion forces are concentrated in a small area. Metal loss is into the steel rather than over the surface. The rust pits that form have serious consequences because the pits represent metal section loss. This can result in perforation if the structure is a tank or a vessel, and loss of structural integrity no matter what the structure is.

Crevice corrosion (Fig. 3) is another common form seen on structures, and occurs when there is a small space between structural elements, be they metal-to-metal or metal-to-non-metal. Examples of places where crevice corrosion can occur are back-to-back angles, where steel plates overlap, around rivets and bolts, near tack welds, and any other place where a small opening is present. What happens is that moisture gets into the crack and completes the corrosion circuit. The moisture gets trapped in the crevice and accelerates the corrosion compared to the surrounding area. The corrosion reactions are greatest at the bottom of the crevice, so metal loss is concentrated in that area.

There are many other forms of corrosion that a painter may see, including microbiologically influenced corrosion (deep isolated pitting as shown in Fig. 4), cavitation corrosion, or erosion corrosion, to name a few. In most of these cases, the corrosion reaction is accelerated by another factor beyond the general corrosion reaction explained above.

To stop corrosion, all that is needed is to eliminate one of the factors that produce the reaction. It is impossible to eliminate the environment, and it is cost-prohibitive to make steels that corrode at a slow rate. Therefore, coatings are often used to prevent corrosion by eliminating contact between the environment (electrolyte) and the steel substrate. Coatings are therefore a barrier material.

A coating may also be applied to enhance

Fig. 4: Microbiologically influenced corrosion on piece of steel pipe
Courtesy of the author

appearance. However, to protect against corrosion for a period of time, it is necessary for coatings to possess features that make them effective barriers.

By isolating steel from the electrolyte, a good protective coating can prevent corrosion for extended periods of time. The better the application, the longer the coating will serve its useful purpose.

On the other hand, a poor coating job may lead to the expense of premature failure, which requires reblasting and recoating. On large projects, such premature failure can cost hundreds of thousands of dollars or more. Good coating work can also save steel structures from unnecessary and costly deterioration. It is estimated that the cost of corrosion in the U.S. each year runs in the billions of dollars. Your work as an applicator can help significantly to reduce these losses.

Upcoming Applicator Training Bulletins

The following are among the upcoming Applicator Training Bulletins.

Basics of Corrosion and Coatings

- How Coatings Protect Steel
- Basics of Concrete Deterioration for Applicators
- How Coatings Protect Concrete

Surface Preparation

- Why Surface Preparation Is Important
- Introduction to Surface Preparation of Concrete
- Mechanical Methods of Preparing Concrete
- Chemical Cleaning of Concrete
- Power Tool Cleaning for Steel
- Using Paint Strippers on Steel and Concrete
- Setting Up Air Abrasive Blasting Systems
- Techniques of Air Abrasive Blasting
- Containing Dust and Debris during Air Abrasive Blasting
- Setting Up and Operating Wet Blasting Equipment
- Using High Pressure Waterjetting

Application

- Product and Application Data Sheets
- Mixing and Thinning Paint
- Basic Training in Brush and Roller Application
- The Basics of Conventional Air Spraying
- Using High Volume, Low Pressure Spray Equipment
- Using Airless Spray Equipment
- Introduction to Plural Component Spraying
- Applying Two-Pack Epoxies and Polyurethanes
- Applying Zinc-Rich Coatings
- Applying Water-Borne Coatings
- Applying High Solids Coatings
- Applying Polyureas
- Applying Floor Coatings and Toppings
- Special Concerns about Applying Coatings in the Shop

Quality Control

- The Effects of Weather on Cleaning and Coating Work
- Conforming with Job Requirements
- Records of Work and Working Conditions
- Why Good Housekeeping Is Important
- Assessing Surface Cleanliness and Profile
- Assuring Quality during Abrasive Blasting
- Assessing Quality of Wet Methods of Surface Preparation
- Computing Film Thickness and Coverage
- Measuring Dry Film Thickness
- Measuring Adhesion of Coatings
- Recognizing and Correcting Paint Application Deficiencies
- Quality Control in Coating Concrete

Safety and Health

- Safety Considerations for Abrasive Blasting
- Anticipating Job Hazards
- Respiratory Protection: Hazards and Equipment
- Fit Testing Procedures for Respirators
- Job Hazards during Climbing and High Work
- An Introduction to Confined Spaces
- Identifying and Controlling Job Hazards When Working around High Voltage
- Using Lighting Safely
- Protection against Worker Exposures during Hazardous Paint Removal
- Safety for Applicators Working near Process Equipment
- Safety with Solvents and Paint Strippers
- Where To Get Help in Safety and Health

JPCL

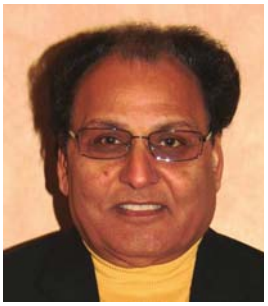
SSPC Honors Authors for Excellence

At SSPC 2013 in San Antonio, TX (Jan. 14–17), SSPC will present awards to several authors for writing exceptional articles dealing with protective coatings over the past year. One article will receive the SSPC Outstanding Publication Award, while five other articles will receive *JPCL* Editors' Awards. These articles serve as essential reference points for many important issues that arise across the protective coatings field.

The SSPC Outstanding Publication Award will go to Mike O'Donoghue, Ph.D., and co-authors Vijay Datta, MS, Adrian Andrews, Ph.D., Sean Adlem, and Matthew Giardina, International Paint LLC; Nicole de Varennes, CET, Linda G.S. Gray, MSc, and Damien Lachat, RAE Engineering and Inspection Ltd. (not pictured); and Bill Johnson, AScT, Acuren Group Inc., for their paper, "When Undercover Agents Can't Stand the Heat: Coatings in Action (CIA) and the Netherworld of Corrosion Under Insulation." The article was published in the February 2012 issue of *JPCL.* In this article, the authors explore the results of a series of accelerated laboratory tests designed to evaluate the performance and corrosion resistance of ultra-high-heat-resistant coatings applied under insulation. Along with these results, the authors also use some case histories to conclude that performance is greatly dependent on the coating agent and the operation temperature. This will be the fifth SSPC Outstanding Publication Award that Dr. O'Donoghue has co-authored, along with four *JPCL* Editors' Awards and two SSPC President's Lecture Series Awards. Dr. O'Donoghue is also one of the 24 recipients of *JPCL*'s 2012 Top Thinkers: The Clive Hare Honors, given for significant contributions to the protective coatings industry over the past decade.

Fred Goodwin, BASF Corp. Construction Chemicals, will be presented one of this year's *JPCL* Editors' Awards for his article, "Concrete Maintenance: Maintain to Sustain," which discusses concrete durability, some of the factors that may affect durability and concrete sustainability, and the importance of maintenance. The article

Mike O'Donoghue



Vijay Datta

Dr. Adrian Andrews

Sean Adlem

Matthew Giardina

Nicole de Varennes

Linda G.S. Gray

Bill Johnson

Pictured at left are eight of the nine authors of the SSPC Outstanding Publication Award, "When Undercover Agents Can't Stand the Heat," published in the February 2012 JPCL.

appeared in the January 2012 issue of *JPCL*. Mr. Goodwin explains the main


Fred Goodwin

causes of concrete durability issues—design and construction, deterioration, and damage—and encourages constant monitoring of concrete conditions and performing necessary maintenance and repairs. This is the third *JPCL* Editors' Award for Mr. Goodwin, and he is also a recipient of *JPCL*'s 2012 Top Thinkers: The Clive Hare Honors.


Lee Wilson

Another recipient will be Lee Wilson, Consultant, whose article, "Field Performance of Polysiloxanes: An Inspector's View," appeared in the March 2012 issue of *JPCL*. In this article, Mr. Wilson lays out the pros and cons of using polysiloxanes, otherwise known as hybrid protective coatings, from a coatings inspector's point of view. Mr. Wilson, another recipient of *JPCL*'s 2012 Top Thinkers: The Clive Hare Honors, explains the technology behind polysiloxanes, some problems encountered during field application, and the possible future for polysiloxane technology.

"Issues That Do Not Meet The Eye: Design Considerations for Lining Concrete Sludge Mixing and Storage Tanks in Wastewater Treatment Plants," by R.A. Nixon, Senior Consultant, Corrosion Probe, Inc., will also receive a *JPCL* Editors' Award. Published in the March 2012 issue of *JPCL*, this article covers the design considerations


R. A. Nixon

and other factors of selecting a proper protective lining system for concrete sludge mixing and storage tanks at wastewater treatment plants, including evaluation methods, surface preparation decisions, tank geometry, and high external ground water conditions around the tanks. Mr. Nixon is a recipient of the SSPC Coatings Education Award in 2001, as well as *JPCL*'s 2012 Top Thinkers: The Clive Hare Honors.


Alison B. Kaelin

Alison B. Kaelin, CQA, KTA-Tator, Inc., will be presented a *JPCL* Editors' Award for her article, "Enforcing Regulations in Steel Fabrication and Coatings Shops," which appeared in the April 2012 *JPCL*. In this article, Ms. Kaelin addresses some of the health and safety regulations that apply to steel fabrication, coating shops, and galvanizing operations. She describes the standards and enforcement activities, as well as pointing out some of the most frequently cited violations at shops. Ms. Kaelin was awarded SSPC's Technical Achievement Award in 2005 and is also a recipient of *JPCL*'s 2012 Top Thinkers: The Clive Hare Honors.

Another *JPCL* Editors' Award will be given to R.A. Francis, Ph.D., Aurecon;

R.A. Francis

Gianni Mattioli

Stuart Smith

G. Mattioli, Mattioli Bros.; and S. Smith, Melbourne Water, for their article, "Relining Potable Water Tanks: Research and Field Work," from the May 2012 *JPCL*. The authors discuss the options for lining above-ground potable water storage tanks and give advice for choosing a lining system with maximum strength, flexibility, and resistance to and compatibility with water. The authors also examine the issues that arose during a 2005 tank lining job in Australia, as well as the results of the most recent five-year inspection. Dr. Francis is a recipient of one SSPC Outstanding Publication Award in 2011, as well as *JPCL*'s 2012 Top Thinkers: The Clive Hare Honors.

JPCL

News

International Paint's Protective Coatings Centers Now Open

International Paint LLC, an AkzoNobel company, has announced the opening of International Paint-branded Protective Coatings Centers in strategic locations across the U.S. and Canada. The launch represents the first phase of what will eventually become a larger network of free-standing Protective Coatings Centers servicing customers in all major markets.

The new customer-direct distribution model is designed to help increase access to International Paint and Devoe Coatings's full-range of high-performance protective coatings, linings, and fire-protection products throughout North America, and provide a more streamlined, customer-centric process for product procurement, the company reports.

By leveraging the strengths and synergies of International Paint and Devoe High Performance Coatings under one consolidated location, industrial customers will have a variety of personalized services at their disposal, including onsite color and tinting assistance, hassle-free product ordering with just one easy-to-read invoice each month, and direct contact with International Paint's technical, engineering, and customer service support teams.

Power Climber Launches New Organizational Structure

Power Climber, a division of SafeWorks, LLC, announced a new organizational structure, appointing three senior leaders to key positions.

Mike Russell, eight year Power Climber veteran and President-elect of the Scaffold & Access Industry Association (SAIA), now oversees the sales and business management functions, responsible for increasing sales coverage and driving operational excellence throughout the U.S.

Colby Hubler, key account manager, brings over ten years of scaffold and access industry experience, taking on the dealership relationships.

Teresa Kinney, regional sales manager, puts to use over eight successful years of experience, sharing sales responsibility for the dealership network, reports Power Climber.

PPG Splitting Off Commodity Chemicals

On December 21, PPG announced that, after receiving a favorable ruling from the U.S. Internal Revenue Service, the company is finalizing plans to split off its $5 billion commodity chemicals business into a new company called Splitco, and then immediately merge the business with chemical maker Georgia Gulf or a Georgia Gulf subsidiary. Georgia Gulf confirmed the letter in a separate announcement.

PPG's commodity chemicals business produces chlorine, caustic soda, and related chemicals throughout the U.S., Canada, and Taiwan for use in chemical manufacturing, pulp and paper production, water treatment, plastics production and agricultural products.

The new company will be led by Georgia Gulf's President and CEO, Paul Carrico (center). Michael H. McGarry (right), senior VP of PPG's commodity chemicals business, will join the new board of directors. Charles E. Bunch (left) is PPG's chairman and CEO.

Splitco will be led by Georgia Gulf President and CEO Paul Carrico and a senior management team consisting of Georgia Gulf and PPG commodity chemicals employees. The board of directors will be comprised of the eight existing Georgia Gulf board members and three new members designated by PPG.

PPG, headquartered in Pittsburgh, PA, operates in more than 60 countries.

Georgia Gulf (Atlanta, GA) manufactures chlorovinyls, aromatics, and vinyl-based building and home improvement products.

Products

W. R. Meadows Releases New Concrete Floor Leveler

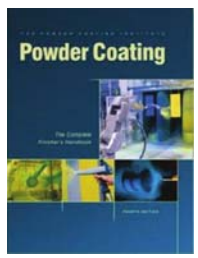
W. R. Meadows has developed Floor-Top STG, a standard traffic-grade, single-component, shrinkage-compensated, self-leveling concrete floor topping and underlayment that may be pumped or poured. It is ideal for smoothing out and leveling concrete and rigid-based interior substrates and cures to a hard, traffic-wearing surface suitable for foot and light rubber-wheeled traffic, according to the company.

Floor-Top STG accepts foot traffic as early as four hours, and floor coverings may be installed in as little as 18 hours. It can be applied up to 1" deep in a single application.

More information: wrmeadows.com

PCI Updates Powder Coating Handbook

The Powder Coating Institute's fourth edition of *The Powder Coating Handbook* is now available, PCI has announced.



The handbook is a comprehensive and up-to-date guide for the powder coating end user that was produced after an in-depth evaluation and collaborative effort by experts in the industry, PCI said.

As a finishing handbook, it was developed to help the reader specify and select equipment and materials that best meet their needs in all aspects of powder coating.

Most chapters start with general information and gradually provide more technical information as the chapter progresses, serving both beginners and more experienced users, according to PCI.

The handbook also includes several tables, figures, and a list of critical equations for production of powder-coated parts and surfaces.

PCI is a non-profit organization that represents the North American powder coating industry.

More information: powdercoating.org

JPCL

Project Preview

Atsalis Bros. to Repaint “Big Mac” Bridge

Photo courtesy of Wikimedia Commons

The Michigan Department of Transportation and the Mackinac Bridge Authority have awarded a $17,673,750 contract to Atsalis Bros. Painting Co. (Clinton Township, MI), SSPC-QP 1 and -QP 2 certified, to clean and recoat structural steel surfaces on the Mackinac Bridge, a 26,372-foot-long suspension bridge that connects Michigan's upper and lower peninsulas over the Straits of Mackinac. This 55-year-old bridge, nicknamed “Big Mac” or “Mighty Mac,” is the third-longest suspension bridge in the world, as well as the longest in the Western hemisphere.

This contract involves abrasive blast cleaning approximately 110,500 sq. yards of structural steel surfaces from pier 9 northerly to pier 18 to a Near-White finish (SSPC-SP 10). The steel will then be recoated with a MI DOT-standard zinc-epoxy-urethane system. The owners are currently seeking bids for construction inspection services for this project, including NACE-certified coatings inspection.

Absorption Towers Coating Contract Goes to P.R. Steelecoat

P.R. Steelecoat, Inc. (Tampa, FL) won a contract valued at $508,250 from the Jacksonville (FL) Electric Authority to clean and reline approximately 8,000 sq. feet of internal steel surfaces on existing absorption towers at two locations within the St. Johns River Power Park. The tower surfaces will be abrasive blast cleaned to a White Metal finish (SSPC-SP 5), high-pressure-washed with soluble salt remover or with diluted baking soda, and lined with a trowel-applied novolac vinyl ester lining system.

Rehab Contract Awarded for Historic Pedestrian Bridge

The Delaware River Joint Toll Bridge Commission and James J. Anderson Construction Co. (Philadelphia, PA) have agreed upon a $2,461,975 contract to clean and recoat the superstructure of the Lumberville-Raven Rock Bridge, a 688-foot-long x 10-foot-wide pedestrian bridge over the Delaware River. The bridge, which connects Raven Rock, NJ, and Lumberville, PA, was originally constructed in 1856, but three of its four main spans were washed away by flooding in 1903. The bridge was reconstructed on the original foundation in 1947 and last received major rehabilitation in 1993.

Photo courtesy of Wikimedia Commons

The contract involves cleaning and recoating steel surfaces with a three-coat organic zinc-rich system, as well as coating main cables with a high-build acrylic system. Containment is required to capture the existing lead-bearing coatings. The contract also includes membrane waterproofing application for bridge seat surfaces.

SSPC Training & Certification - February & March 2013
creating industry experts

Date	Course	Host	Location
February 16 - 17	Airless Spray Basics (C12)	SSPC Hampton Roads Chapter at Vanwin Coatings	Chesapeake, VA
February 25 - 26	Water Jetting Program (C13)	Central Arizona Project	Phoenix, AZ
February 25 - March 1	Fundamentals of Protective Coatings (C1)	Long Painting	Kent, WA
February 25 - March 1	Planning and Specifying Industrial Projects (C2)	West Coast Industrial Coatings	Hemet, CA
February 27 - 28	Abrasive Blasting Program (C7)	Central Arizona Project	Phoenix, AZ
March 1 - 2	Airless Spray Basics (C12)	Central Arizona Project	Phoenix, AZ
March 2	Protective Coatings Specialist Program (PCS)	West Coast Industrial Coatings	Hemet, CA
March 4	Lead Paint Worker Safety	Greenman Pedersen, Inc.	Annapolis Junction, MD
March 4 - 5	Applicator Train-the-Trainer (ATT)	The Sherwin-Williams Company	Norfolk, VA
March 4 - 8	Bridge Coatings Inspector Program (BCI) Level 1 Only	Kentucky DOT	Frankfort, KY
March 5	Coatings Application Specialist Certification Program (CAS) Refresher	Brock Services, Ltd	Sulphur, LA
March 6	Coatings Application Specialist Certification Program (CAS) Level 1	Brock Services, Ltd	Sulphur, LA
March 6	Using SSPC PA 2 Effectively (PA 2)	Vigor Industrial LLC	Bremerton, WA
March 7 - 8	Quality Control Supervisor (QCS)	Vigor Industrial LLC	Bremerton, WA
March 7 - 9	Abrasive Blasting Program (C7)	Vigor Industrial LLC	Portland, OR
March 9 - 10	Abrasive Blasting Program (C7)	SSPC Hampton Roads Chapter at Colonnas Shipyard	Norfolk, VA
March 11	Lead Paint Removal Refresher (C5)	Industrial Corrosion Control, Inc.	Gulfport, MS
March 11	Natural and Accelerated Weathering of Coatings	American Coatings Association	Rosemont, IL
March 11 - 12	Inspection Planning & Documentation	Vigor Industrial LLC	Seattle, WA
March 11 - 15	Fundamentals of Protective Coatings (C1)	Georgia Construction Products Inc.	Tucker, GA
March 11 - 15	NAVSEA Basic Paint Inspector (NBPI)	Midwest Industrial Coatings	Waukesha, WI
March 12	Basics of Estimating Industrial Coatings Projects	Long Painting	Kent, WA
March 13	Evaluating Common Coating Contract Clauses	Long Painting	Kent, WA
March 13	Protective Coatings Inspector Program (PCI) Workshop	SSPC Headquarters	Pittsburgh, PA
March 14 - 15	Project Management for the Industrial Painting Contractor	Long Painting	Kent, WA
March 15	Navigating Standard Item 009-32	Vigor Industrial LLC	Bremerton, WA
March 18 - 19	Water Jetting Program (C13)	BAE Systems Southeast Shipyards	Jacksonville, FL
March 18 - 21	Lead Paint Removal (C3)	The Northern California/Nevada Chapter at Jeffco Painting & Coating, Inc.	Vallejo, CA
March 18 - 22	NAVSEA Basic Paint Inspector (NBPI)	Vigor Industrial LLC	Bremerton, WA
March 18 - 23	Protective Coatings Inspector Program (PCI) Level 2	Polygon	Pasadena, TX
March 18 - 23	Protective Coatings Inspector Program (PCI) Level 2	SSPC International PCI	Balikpapan East Kalimantan/Borneo
March 19 - 20	Applicator Train-the-Trainer (ATT)	Vigor Industrial LLC	Portland, OR
March 20 - 21	Abrasive Blasting Program (C7)	BAE Systems Southeast Shipyards	Jacksonville, FL
March 22	Navigating Standard Item 009-32	Fleet Reserve Association	Honolulu, HI
March 22	Lead Paint Removal Refresher (C5)	The Northern California/Nevada Chapter at Jeffco Painting & Coating, Inc.	Vallejo, CA
March 22 - 23	Airless Spray Basics (C12)	BAE Systems Southeast Shipyards	Jacksonville, FL
March 23	Lead Paint Removal Refresher (C5)	The Northern California/Nevada Chapter. at Jeffco Painting & Coating, Inc	Vallejo, CA
March 24	Protective Coatings Inspector Program (PCI) Level 3	Polygon	Pasadena, TX
March 24	Protective Coatings Inspector Program (PCI) Level 3	SSPC International PCI	Balikpapan East Kalimantan/Borneo
March 25 - 29	NAVSEA Basic Paint Inspector (NBPI)	Fleet Reserve Association	Honolulu, HI
March 27	Using SSPC PA 2 Effectively (PA 2)	West Coast Industrial Coatings	Hemet, CA
March 28 - 29	Quality Control Supervisor (QCS)	West Coast Industrial Coatings	Hemet, CA

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For More Information Visit www.sspc.org/training or contact bodack@sspc.org | 1.877.281.7772 ext 2204

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Crossword

by Andy Folmer, PaintSquare

A Low Profile

ACROSS

1 Instrument used to measure surface profile
13 It rises in the Rocky Mountains
15 Move
16 Feeling prickly
17 Egyptian goddess of fertility
18 Father of twins in "The Comedy of Errors"
19 Zuider ___
20 Airer of "Mad Men"
23 Scot's denial
24 One method of achieving a surface profile
28 Abbr. on a letter to Moose Jaw
30 A famous Mouseketeer
31 Sven's domain?
32 Product used to pick up a surface profile
34 Way some meds. are sold
35 Golfer known as "The Big Easy"
36 ___ relief
39 "___ Into The Crypt": Red Clay Ramblers song
43 Invoice
44 Kind of sea bass
46 Cashew nut, in Paris
47 Offerings of the *Journal of Protective Coatings & Linings*
49 How to measure the height of a surface profile

DOWN

1 "Game" for Dell, HP, and IBM
2 Awaken
3 Song played on a 45
4 Gets cloudy
5 Anger
6 Randy Newman loves it?
7 Whoopi's "Ghost" character: ___ Mae Brown
8 Longtime MLB outfielder Manny
9 One of the Great Lakes
10 Light metallic sound
11 Penguins' center Malkin
12 Lends out again
14 Fail to carry out
20 Teen's worry
21 Short-tailed cat
22 Mediterranean island
24 Took a load off
25 Type style used for emph.
26 Transfers files, briefly
27 Author of "For God and Country: Faith and Patriotism Under Fire"
28 Those not showing feelings
29 Heinz product
33 Record keeper
36 Actress Phillips
37 With others
38 What city snow quickly becomes
40 "Born Free" lioness
41 Buss
42 Like some apples
43 Scott who was Chachi
45 Muscular guardians of the Buddha
46 Mid.
48 Eight of them make a gal.

(Answer next month)

1	2	3	4	5	6	7	8	9	10	11	12	■
13												14
15					■	16						
17				■	■	■	18					
19			■	20	21	22	■	■	■	23		
■	■	■	24				25	26	27			
28	29	■	30							■	31	
32		33								■	■	■
34			■	■	■	35			■	36	37	38
39			40	41	42	■	■	■	43			
44						45	■	46				
47							48					
■	49											

Answers to December's puzzle

I	R	O	N	■	T	S	A	■	I	R	A	N
N	O	V	O	C	A	I	N	■	N	E	T	S
O	B	E	D	I	E	N	T	■	U	B	A	C
■	B	R	A	N	■	■	■	B	R	A	T	■
■	■	■	L	E	E	C	H	E	E	■	■	■
A	F	R	O	■	A	L	E	E	■	L	P	S
B	E	A	T	■	G	A	M	■	S	E	A	T
S	E	W	■	K	E	R	I	■	L	A	D	Y
■	■	■	E	A	R	A	C	H	E	■	■	■
■	S	E	N	T	■	■	■	R	E	N	T	■
W	A	W	A	■	S	H	E	P	P	A	R	D
A	V	E	C	■	M	A	X	W	E	B	E	R
R	E	S	T	■	A	N	O	■	R	U	S	T

The Takeaway

Keeping Things in Perspective

By Karen Kapsanis
JPCL

There's a saying, roughly translated from the French, "The more things change, the more they stay the same." It helps keep "things" in perspective. Many people use that saying as a theme. I'm not going to do that, but I am going to use it to keep things in perspective.

Looking at this issue, I want to point out that some things stay relatively the same, and other things can and do change, in the world of corrosion protective coatings and beyond.

The need to protect steel bridges from corrosion hasn't changed, but the coating systems for them have changed. We get a review of how coating systems for bridges have developed over the past 15-odd years in the article by Mike O'Donoghue and his co-authors (pp. 34–52).

Similarly, while the generic names of coatings haven't changed, their formulations have, as shown in Jerry Witucki's article on advances in options for formulating polysiloxanes (pp. 54–61).

The basics of corrosion itself haven't changed, as described in the first article of our Applicator Training Bulletin series (pp. 63–69), a series we first published from 1988 to 1992 and that we subsequently updated 15 years ago. As you follow this reprisal of the series, you will see how many aspects of protective coatings work have changed.

The basic purpose of *JPCL* remains the same, to promote good practice and new technology in protective coatings work, but change is inherent in our purpose—helping coatings veterans and newcomers keep up with relevant advances in the industry.

By the time you get this issue, we will have greeted a new year, something we do every January. As Peter Mitchel's editorial (p. 4) eloquently illustrates, 2012 ended in profound sadness because of the deaths at Sandy Hook Elementary School, a sadness that will endure. But 2013, like every year, is also new and unique. My hope is that the changes any of us face this year will bring healing, hope, peace, and, yes, even joy.

And I hope that Newtown's tragedy, as well as tragedies before and after it, will help us keep whatever comes our way in perspective.