Quality and Responsibility

I recently read an interesting article titled, "Who is Responsible for Quality?" by David C. Crosby that was published on qualitydigest.com. In the article, Crosby points out that the CEO or the boss is responsible for quality because that person is in control of all the resources in the company. Those resources include money, standards of discipline, performance standards, and standards of quality. To properly understand quality, we must define it. One of the definitions of quality by the American Society for Quality (ASQ) is: "free of defects, or zero defects, or a product or service free of deficiencies."

I was in an organization that used to have themes each year. One year was the "Year of Training." The next was the "Year of the Wrench," and finally there was the "Year of Zero Defects." No one ever told us what this meant or what we were supposed to do differently. We all wanted to do well and do the job right. Howard was my boss, and all I knew was that I wanted to please Howard because he determined my fate and how far I would progress in my career. The CEO, Edwin, was the responsible party because everything flowed out of his office. While we all shared the responsibility for zero defects, Howard's share of responsibility was greater than mine; Edwin's was the greatest, and he could not share or pass on his responsibility.

Many of you have heard of Admiral Hyman Rickover, the father of our nuclear Navy. He stated, "Responsibility is a unique concept: it can only reside and inhere within a single individual. You may share it with others, but your portion is not diminished. You may delegate it, but it is still with you. You may disclaim it, but you cannot divest yourself of it. Even if you do not recognize it or admit its presence, you cannot escape it. If the responsibility is rightfully yours, no evasion, or ignorance, or passing the blame, can shift the burden to someone else."

General Bruce C. Clarke said, "When things go wrong in your command, start searching for the reason in increasingly large circles around your own desk." This could be shortened into a phrase I use quite frequently, "You can delegate authority, but you cannot delegate responsibility." How many bosses try to deflect responsibility by blaming employees for what happens? I am the "CEO" of SSPC, and everything that happens or fails to happen is my responsibility.

How does this relate to the coatings industry? I have heard so many times from different CEOs of firms who have unfortunate situations or have had bad things happen say, "It's not my fault! What do you expect from me? I can't be there 24 hours a day." I say to them, you are responsible for setting up those standards of discipline, performance, and quality expected. If you do not have them, then how are people expected to act and know what "good" looks like?

Those employees are no different than I was when I did not know what was to be done differently in the "Year of Zero Defects." If you don't know the standard, then how do you determine if you have, in fact, completed the job and to what level of quality? In that same organization, we had tasks, conditions, and standards. The task was what was to be done. The condition was the factors that affected the completion of the task, and the standard was level of quality or excellence in some measurable or objective means. A task could be: dig a four-foot ditch, three feet deep. The condition would be: given one person and a shovel in normal soil conditions with no rock or other impediments, dig the ditch. The standard was to complete the ditch in two hours. If the condition changed to be frozen tundra, the standard may change to eight hours or if the condition was to use two people then the standard might be to have it completed in one hour. If you could not meet the standard you could then determine if you had a training or discipline problem. This assisted the leader in setting up performance standards or standards of quality expected in the organization and thus helped with quality.

It could be said that quality is everyone's job, but it really rests with one person—the guy or gal at the top. It cannot be delegated, and it is always the top person's responsibility.

As an aside, another quote by Admiral Rickover that I enjoy is, "It is necessary for us to learn from others' mistakes. You will not live long enough to make them all yourself."

Bill Shoup
Executive Director, SSPC

Phillips Industrial Wins DuPont Safety Award

DuPont Company presented Phillips Industrial Services Corp. with the Top Gun Safety Performance Award in recognition of Phillips Industrial's safety record at DuPont's Cooper River Kevlar® site in South Carolina.

Phillips Industrial has been active in surface-preparation and painting activities at the new plant site for newly two years, according to Phillips Industrial. The Phillips crew, led by Supervisor Roman Monne', has applied coatings to roofs, structural steel, floors, and walls. Construction at the site is ongoing.

Criteria for the safety award included injury performance; audit results; safety attitude; response to safety concerns; safety plans; safety improvement; and overall demonstrated safety leadership and performance.

The crew had to work in 100-plus degree heat, climb stairs, and work on roofs with the proper training, supervision, and teamwork required to prevent and recognize heat stress.

Phillips Industrial Services is an SSPC-QP 1- and QP 2-certified contractor.

Paint Shortage, Roadwork Delays Persist

A global shortage of highway paint is expected to continue through the summer and possibly into the fall, squeezing contractors and transportation departments, upending project schedules, and increasing production pressure on manufacturers nationwide.

At issue is a shortfall in the production of methyl methacrylate (MMA) and titanium dioxide (TiO2), critical raw materials in acrylic-based highway paint, the leading pavement marking material.

The shortages arise from a perfect storm of factors: spiking demand, slumping production, cost increases, litigation, plant malfunctions, and a natural disaster.

Hardest hit has been global MMA market leader Lucite International, which supplies 25% of the world's MMA. That company suffered a double whammy in late April, when its Memphis MMA plant—already scheduled for a four-week shutdown for updates—was caught up in the deadly flooding of the Cumberland River. The disaster forced Lucite to declare a force majeure, shut down the plant for an additional week, and resume with only limited production that required rationing MMA to customers.

A force majeure ("greater force") clause relieves a party of liability if it is unable to perform its obligations in cases of natural disaster or other factors outside the company's control.

Dow also announced a force majeure in early May, due to unspecified "production issues" at the company's MMA plant in Deer Park, TX.

Across the industry, inventory was reduced and production capacity slowed as construction plummeted in 2008 and 2009. Price increases followed.

That was the situation when billions of dollars for "shovel-ready" projects were suddenly approved and released with the passage of the American Recovery and Reinvestment Act in 2009. Production could not be ramped up in time for the busy road-construction season this year.

The shortage has led state and local departments of transportation to defer projects and relax some rules, according to the Associated General Contractors of America. Texas, for example, has halted all road repaints, saving its paint for new roads only. And Virginia has chosen to use a lower-quality paint for its repaints.

Concerned that private (non-DOT) contractors would be held responsible for the delays and on the hook for the price increases, Associated General Contractors contacted the American Association of State Highway and Transportation Officials in mid-May, seeking flexibility for contractors and projects.

ASTM Seeks Labs for Blast Cleaning Study

ASTM International and its Committee D01.46 on Industrial Protective Coatings are seeking laboratories to participate in an inter-lab study on measurement of certain abrasive blast-cleaned surfaces.

The panel is looking for laboratories able to perform D7127, Measurement of Surface Roughness of Abrasive Blast Cleaned Metal Surfaces Using a Portable Stylus Instrument.

The study will involve obtaining five standard-defined measurements of surface roughness for five different test

Cavallo to Teach SSPC–*JPCL* Webinar on Nuclear Coatings

Jon Cavallo, recent winner of the ASTM Award of Merit, will present the SSPC-*JPCL* Education Series Webinar, "Nuclear Coatings," on Wednesday, July 21 from 11:00 a.m. to noon. The webinar on nuclear coatings is one of 20 webinars in the series to be offered during 2010.

Education Series Webinars provide continuing education for SSPC recertifications as well as technology updates on important topics.

Jon R. Cavallo

Participation in the webinar is free, but for those who wish to receive continuing education credits from SSPC, a test is available after the webinar. Cost of the test service is $25. All participants, however, will receive a free certificate of completion.

The webinar on nuclear coatings will explain how to select coatings for nuclear environments and structures. Those who wish to participate in the webinar can register free at paintsquare.com/education.

panels, using Taylor-Hobson Surtronic 25, Mitutoyo SJ201, and Mahr PocketSurf instruments. Each standard-defined roughness measurement is comprised of five surface traces.

Required test specimens will be supplied free of charge to the participating laboratories. The committee hopes to start sending the materials in a few weeks.

Membership in ASTM International is not required for participation. Interested parties should submit the lab name and a contact, telephone number, and e-mail address. For more information, contact ASTM International's ILS manager, Phillip Godorov, at 610-832-9715, email ils@astm.org.

Want News?

What's the fastest way to sign up for our daily enewsletter, *PaintSquare News*? Download a 2D barcode-scanning app for your smart phone and give it a shot! Capture the barcode for a link to sign up for *PaintSquare News*.

Correction to the June 2010 *JPCL*

On p. 5 of the June 2010 print edition, Paul Robb's name was misspelled in the title, "Blastrac Promotes Rippman, Rob." *JPCL* regrets the error.

Proposed Rule for Power Plants Generates Questions for Blasting, Coating, Other Industries

The EPA seeks comments on two proposed options for regulating residuals from coal-burning electric utilities while retaining the EPA-determined beneficial use exemption status of the residuals, which includes their currently approved use in blasting grit, paint, and other construction products, according to a proposed rule the Environmental Protection Agency published in the June 21, 2010, *Federal Register*.

While seeking to retain the beneficial use exemption, EPA is clarifying this determination and considering potential refinements for certain beneficial uses.

The coal residuals—fly ash, bottom ash, boiler slag, and flue gas emission control wastes—are the subject of "Hazardous and Solid Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals [CCRs] From Electric Utilities," which falls under the Resource Conservation and Recovery Act (RCRA).

The EPA seeks comments on several aspects of its proposed rule, including the two options ("co-proposals") for regulating CCRs: either as hazardous waste (Subtitle C of RCRA) or as solid waste (Subtitle D of RCRA).

The proposed rule is directed primarily at coal-burning power utilities, with the main purpose of preventing catastrophic spills of CCRs at those utilities. Such a spill discussed in the preamble to the proposed rule, occurred when a retaining wall from an impoundment for storing fly ash failed at the Tennessee Valley Authority.

The EPA is also trying to address the broad spectrum of CCRs and beneficial use, and to incorporate risk assessment and leaching-potential research on CCRs. Some CCRs have been found to exhibit hazardous properties that could adversely affect the environment unless the CCRs are properly managed, according to the agency.

The proposed rule's possible implications for blasting and coating work will be discussed in an upcoming issue of *JPCL*.

Comments and Requests for Meetings

To download the official proposed rule, go to http://edocket.access.gpo.gov/2010/pdf/2010-12286.pdf.

The deadline for public comment is September 20, 2010. The deadline for requesting a public meeting is July 21, 2010. Instructions for submitting comments and requests for public meetings are included in the proposed rule.

Continued

Technology Publishing Announces Plans for Launch of *Durability + Design*

Technology Publishing Company, publisher of the *Journal of Protective Coatings and Linings* (*JPCL*); *Painting and Wallcovering Contractor* (*PWC*); the daily e-newsletter, *PaintSquare News*; the online *Journal of Architectural Coatings* (*JAC*); and Paint BidTracker will launch *Durability + Design*, a daily e-newsletter and accompanying Web-based publication, on Aug. 2.

The launch of a semi-monthly print journal, also titled *Durability + Design*, will follow, with publication scheduled to begin with a Jan.-Feb. 2011 edition.

The publications will carry the subtitle, *The Journal of Architectural Coatings*.

Focus on Architectural Coatings

The daily e-newsletter, website (www.durabilityanddesign.com) and print journal will mark the evolution of Technology Publishing Company's *PWC* and *JAC* titles into a single, Web-centric title focused on the technology, specification, and application of architectural coatings and related materials.

60,000 Readers

Durability + Design will reach 60,000 professionals who have an interest in architectural coatings, including architects; specifiers; interior designers; residential and commercial painting contractors; artisans and specialty contractors; and facility owners, coatings suppliers, and consultants.

Content Plan

The e-newsletter and journal will offer a wealth of information and the immediacy of the Internet, with news from the coatings, design, and construction communities, and features on the key subject areas of: Color & Design, Building Envelope, Decorative Finishes, Coatings Technology, Good Technical Practice, and Maintenance and Renovation. The newsletter and website also will include links to the archives of *JAC* and *PWC*.

"We know from our *PaintSquare News* e-newsletter and other online venues that our audience is extremely receptive to getting their information online," said Sharon Steele, publisher of *Durability + Design*. "For this reason, the daily e-newsletter will be a primary content driver of this publication."

"*Durability + Design* will go to a minimum of 60,000 email addresses every business day, Monday through Friday," Steele said. "This will be the only publication geared to suppliers, specifiers, owners, and applicators of architectural coatings and related materials. No one else has databases that compare to ours, and we have the resources in place to make this a powerful publication."

Staff

Joining Steele in leading *Durability + Design* is Editor Joe Maty, who served as editor of *JAC* from the publication's launch in 2005, and who has also worked as a contributing editor of *PWC* and *JPCL*; and Dr. Harold Hower, CEO of Technology Publishing, who assumes a leadership role in the new publication's management, content, and design.

Peter Mitchel, president of Technology Publishing, said *Durability + Design* will prove to be an innovative, timely, and valuable resource in a rapidly evolving business world. "Technology is changing media consumption and marketing," he said. "We will deliver the entire value chain like no one else can. *Durability + Design* will incorporate the latest technology to supply information 24/7, on demand when you want it and how you want it."

Technology Publishing Company will continue daily publication of its highly successful e-newsletter, *PaintSquare News*, which will focus on protective and marine coatings, in tandem with *JPCL* and www.paintsquare.com. *PaintSquare News* was launched in 2009, and reaches 25,000 readers. PaintSquare will remain the online home of *JPCL* and Paint BidTracker, the only project-leads service designed specifically for the coatings industry.

To receive the *Durability + Design* daily e-newsletter beginning Aug. 2, go to www.durabilityanddesign.com.

On Cleaning Rates with Abrasive Recycling

How does abrasive recycling affect cleaning rates when steel is blast-cleaned in the field?

Barry Barman
Barry Barman & Associates

Whether blast cleaning takes place in the field or in a shop (with centrifugal wheel machines), recycled abrasive media becomes contaminated and breaks down in size, such that the ratio of smaller to larger particles in the work mix increases, thereby reducing cleaning efficiency. These changes in the abrasive necessitates passing the abrasive through equipment that adequately removes fines and debris ("cleaning the media"). In the process, new, larger media should be added back to keep the work mix in the proper ratio. Failure to do so will result in poor production rates and an excessively "dirty" and undersized abrasive media that will leave the steel with a shallow profile and contaminated with the same material that was initially removed from the steel.

Pieter van der Poel
Danieli Far East

Depending on the initial size and type of the abrasive, after proper recycling with a recycling system to remove the dust, the remaining abrasive, reduced in size, would result in more abrasive particles impacting the substrate, thereby increasing the cleaning rates. However, the finer abrasive particles will reduce the profile, so a mixture of new abrasive should be added to the recycled abrasive. Further recycling would prove counterproductive in terms of cleaning rates due to the loss of mass of the finer particles (kinetic energy).

H.K. Saxena
PSL Limited

An improper working mix after recycling will reduce the profile. Also, dust levels will increase due to the finer particles in the recycled abrasive.

Editor's note: these answers first appeared in PaintSquare News*, our daily electronic newsletter in the column, "Got Answers?" Participate in* JPCL's *Problem Solving Forum.*

Continued

Got Questions and Answers? PSF Is Now Online and in Print

If you have answers for *JPCL's* Problem Solving Forum questions, or if you have questions of your own, you can now submit them online through our electronic newsletter, *PaintSquare News*. In addition to the July 2010 question, recently posted questions include the following:

- I have several water tanks constructed with carbon steel for demineralized water storage. The tanks are about 20 years old, and the original coating has started to blister. For refurbishment of the coating, what material should be used and at what dry film thickness? The original coating is unknown.
- If I apply a zinc-rich epoxy primer at 3 mils' dry film thickness in the shop with air temperature of 90 F, what checks can I make to determine when it is safe to handle and stack the primed steel components?

Earlier PSFs can be found through the *JPCL* archives on www.paintsquare.com.

Get to the Forum Even Faster with Your Smart Phone

Download any barcode app, aim the camera on your phone at the barcode below, and tap "continue" when your phone screen prompts you.

Not Online Much?

That's ok. We still like to hear from you: call 800-837-8303, ext. 129; fax 412-431-5428; email kkapsanis@protectivecoatings.com; or send a note through regular mail to Karen Kapsanis, Editor, *JPCL*, Technology Publishing/PaintSquare, 2100 Wharton St., Suite 310, Pittsburgh, PA, 15203.

The Case of the Failing Railing

By Ray Tombaugh, KTA-Tator, Inc., Senior Coatings Consultant
Richard Burgess, KTA-Tator, Inc., Series Editor

When a premature, catastrophic coating failure occurs, there is a logical sequence of questions that an investigator asks and seeks to answer to track down the contributing factors. Let's see what happens as we follow that process in the "Case of the Failing Railing."

- What was supposed to be done? The project specification and other contract documents describe what was supposed to occur related to coating system installation. Unfortunately in this case, there was no specification. However, there was reliance on the manufacturer's recommendations and presumably guidance on what was to be done.
- Does it make sense? Based on the prevailing service environment and the structure itself, does what was specified, or used for guidance, make sense—or was the coating system doomed from the start because of the degree of surface preparation specified or coating system selected? Based on what products were reportedly used and surface preparation recommended, the rusting should not have occurred; that is, the guidance made sense.

More information needs to be gathered from field and laboratory investigations to answer the next questions

- What happened?
- Who's responsible?
- How will the failure be repaired?

Background

A small drawbridge in the San Francisco Bay area was fitted with new handrails and guardrails. Although there was no written specification for the coating work, a three-coat, moisture-cured urethane system was required and reportedly applied. The system included a zinc-rich primer; an intermediate barrier coat; and a semi-gloss, UV-resistant finish coat. The railings were fabricated and painted in a shop, installed on the bridge, and then touched-up in the field. The same coatings were used for the field touch-up.

The product data sheets for the coatings require that (1) the primer be applied at a dry film thickness (DFT) of 3–5 mils, (2) the intermediate be applied at 3–5 mils' DFT, and (3) the finish be applied at 2–4 mils' DFT. A total system DFT between 8 and 14 mils was to be applied.

After only a few months of atmospheric exposure, the painted steel handrails and guardrails exhibited pinpoint rusting. The bridge was adjacent to the San Francisco Bay and was exposed to salt fog throughout the spring and summer months. The rusting was common to both the shop-and field-applied coatings.

Field Investigation

A site visit to examine the condition of the coating system revealed infrequent areas of pinpoint rusting on the west handrail from the north end of the bridge down to the midpoint of the drawbridge portion. The pinpoint rusting was only found on 1–3 of the 5 pickets of the railing sections running the length of this section of the bridge (Fig. 1). However, along the south end of the bridge and the entire length of the east handrail, almost every section exhibited pinpoint rusting, as did every picket in the affected rail sections (Fig. 2).

When the rusting was evaluated in accordance with SSPC-VIS 2, it ranged between 6-P and 5-P, which corresponds to less than 1% and less than 3% of surface rust, respectively. Interestingly, when the handrails were viewed from the outside, no rusting was observed.

Fig. 1: The west handrail on the northern end of the bridge showing the typical conditions where the rusting was restricted to only a few of the pickets. All photos are courtesy of KTA-Tator, Inc.

Fig. 2: An example of the condition of the handrail on the east side of the bridge and along the southern end of the west side. At this location, rust was observed on almost every picket.

When the coating was forcibly disbonded from the rusted area, only two coating layers were clearly visible (Fig. 3). In some cases, there may have been some traces of a thin gray primer. The substrate was to have been abrasive blast cleaned to SSPC-SP 6, Commercial

Continued

Blast Cleaning, and have a profile indicative of blasting with shot and grit.

Numerous adhesion tests were performed at random locations on the bridge in accordance with ASTM D 6677, Standard Test Method for Evaluating Adhesion by Knife. All indicated excellent coating adhesion (rating of 10). When forcibly disbonded, the coatings were difficult to remove, even with a chisel. Once the coatings were

Fig. 3: The substrate had been profiled, but only two coats of paint were visible with the naked eye. The gray primer appeared to be missing.

removed, the substrate was free of rust, and was profiled.

Measurements taken on the pickets at various locations along the handrail with prevalent rusting ranged from 3.3–4.4 mils' DFT. In non-rusted areas, including the outside face of the pickets, DFT measurements were much higher, ranging from 7–16 mils. The top rail and bottom rail were free of rust. The coating thickness measurements in these areas were similar to or greater than those measured on the pickets in non-rusted areas (Fig. 4). Three coats of paint were found in non-rusted locations when the coating was forcibly disbonded.

The guardrails were essentially free of rust except at a couple of welds and at the ends. General rusting was observed on each of the end pieces where the guardrail terminated at lighting standard locations (Fig. 5). When the rusting was evaluated in accordance with SSPC-VIS 2, it ranged between 6-G and 4-G (less than 1% and less than 10% of surface rust, respectively).

Fig. 4: An example of the conditions found on the bottom rail of the handrails.

When the coating was forcibly disbonded from the rusted area, the substrate displayed scratches, but islands of rust were still present beneath the coating. When the coating was forcibly disbonded from non-rusted areas, three coats of paint were observed. The substrate appeared profiled and was free of rust and mill scale.

Fig. 5: Typical condition of the end pieces on the guardrail showing general rusting.

Laboratory Investigation

Laboratory investigation consisted of visual and microscopic evaluations of the coating samples. The microscopic examination was conducted using a digital microscope with magnification capabilities up to 200X.

The laboratory testing determined that the primer coat had been omitted in areas where there was rust on the pickets (Fig. 6). The primer, when present, and intermediate coat were deficient in thickness on all of the samples that were evaluated. Specifically, the primer coat ranged from 1.2–3.7 mils' DFT.[1] The intermediate coat ranged from 0.8–3.8 mils' DFT with most samples ranging between 0.8 and 2.8 mils'. The finish coat was deficient on six out of nine samples. The finish coat ranged from 1.1–4.0 mils' DFT.

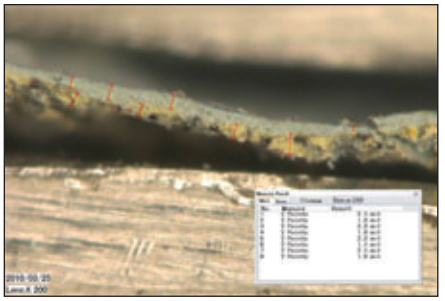


Fig. 6: A cross section of the paint removed from a rusted area. Only two coats of paint were found—the intermediate and topcoat.

The Failure Mechanism

Results of the laboratory and field investigations yielded the following failure mechanism.

The premature rusting of the railing surfaces was the result of the omission or the insufficient thickness of the zinc primer, which was essential to provide long-term corrosion protection in the marine environment in which the bridge was located. It is important to note that the outsides of the pickets (rust-free areas) were largely compliant with the system thickness recommended by the manufacturer. The omission of the primer was likely due to the shop not rotating the components after application of the primer to one side.

The painting shop also applied thin coats of paint in the remaining non-rusted areas. Excluding the pickets, fewer than half of the measurements were compliant with the coating manufacturer's recommended thickness. While rusting has yet to form in the areas of low film build, a reduced service life of the coating could be expected, and corrosion would likely occur over the next 5–10 years.

The rusting on the ends of the guardrail was a result of the surface preparation performed in the field.

Continued

Although the surface was abraded (scratched), it was not prepared to the degree recommended by the coating manufacturer to provide long-term corrosion protection. Some rust was still present, and the usual peak and valley profile that is required for steel in exterior exposure was not imparted to the surface.

Recommendations for Repair

Two options were recommended for remediation of the rusted surfaces and thin coatings.

The first option involved spot repair and overcoat of the complete handrail and guardrail surfaces, which was not likely to disrupt bridge use. The option required the painted bridge surfaces to be pressure water washed to remove loose coating, salts, and contaminants. It also called for all rusted areas to be power-tool cleaned to meet SSPC-SP 15, Commercial Grade Power Tool Cleaning. The edges of the surrounding intact coating were to be feathered smooth and gloss removed from the existing sound coating.

Once properly prepared, the exposed substrate surfaces were to be spot primed with a corrosion inhibitive moisture urethane primer for field application and the current intermediate coat. After spot priming, a complete coat of moisture-cured urethane finish was needed over all of the painted railing surfaces to bring the entire coated area within the specified thickness. A test patch was recommended to be applied in a representative area, allowed to age, and then tested for adhesion.

This option was not necessarily cost effective because 40% of the surface required spot repair. Generally, if a surface requires greater than 10% spot repair, it is more cost effective to perform complete coating removal and replacement. It was also noted that the surfaces requiring the repair were intricate (pickets) and needed tedious surface preparation activities to meet the required standards. Damage to adjacent surfaces was possible, resulting in additional repairs. Successful completion of this option was expected to still result in periodic maintenance over the lifetime (10 years) of the current coating system.[2] Some maintenance painting would probably be required every 3-4 years; however, the scope of the painting would be much less than the initial remediation. The advantage of this operation was the likelihood of performing work in place using power tools with vacuum attachments and some containment.

The second method involved complete coating removal by abrasive blast cleaning to SSPC-SP 6, Commercial

Continued

Blast Cleaning, and coating replacement. This method also recommended removing the handrail and guardrails and shipping them to a shop for surface preparation and recoating. Sharp edges at welds had to be ground smooth prior to a final abrasive blast cleaning.

The original coating system was recommended to be applied to the properly prepared surfaces. Performing the operations in place, required full containment, possibly disrupting the full use of the bridge.

Failure Avoidance

This Case from the F-Files clearly illustrates the importance of a well-prepared, thorough, performance-based specification to communicate to the shop and field contractors the specified degree of surface preparation and the coating system to be installed. Coating manufacturers' product data sheets (PDS) contain recommendations that may cover a variety of industries and service environments. The specification takes the information from the PDS and makes it project specific, as well as confirms that the recommendations are appropriate for the project and site conditions. This case also demonstrates the importance of implementing quality assurance inspection during shop and field painting to verify that the contactors are controlling the quality of workmanship and conforming to (in this case) the PDS. The cost of the rework on the now-installed handrail and guardrails will likely exceed the initial cost of surface preparation and painting and will affect the operation of the drawbridge.

Endnotes

1. Some of the primer may have remained on the surfaces of the steel when the sample was removed.
2. It was estimated that the moisture-cured urethane coating system, if applied correctly, would have an expected service life of approximately 10 years. At that point, some maintenance painting would be necessary to allow several more years of service without the need for coating replacement. The repairs after the 10-year period are generally not considered warranty repairs since paint warranties usually last no more than 1-3 years.

Ray Tombaugh is a Senior Coatings Consultant for KTA-Tator, Inc. He holds a B.S. in chemical engineering from Lehigh University, is a member of SSPC, and is a NACE-Certified Coatings Inspector Level 3 (Peer Review).

Safety Monitoring and Remote Control Systems for Blasting in Shipyards

Blast cleaning is a critical process to remove mill scale, slag, and pre-existing coatings on steel surfaces and to prepare substrates for the subsequent application of a protective coating. Dry abrasive blast cleaning is known to provide the best surface roughness for an ordinary organic or inorganic coating, although it is considered a very dangerous process.

In shipyards, dry abrasive blast cleaning is especially dangerous. Modern shipbuilding practice is to construct vessels as a series of "blocks," coat these, and then join up to finish the build. Workers must contend with a very poor environment because of a mist of paint debris, spent abrasive particles, noise, and the danger from blasting media traveling at a high speed. Also, their work can involve moving through narrow access holes (600 mm x 800 mm hole) in the steel blocks. Moreover, blasters work alone for a long time. There is virtually no visibility inside these steel blocks during blasting, so developing a safety system for blast cleaning workers is more essential than for many other types of projects.

Basing a remote workers' safety and contact system on wireless technology is more difficult to develop than such a system for other work areas because of the possibility at shipyards of wireless data transmission errors by reflection, refraction, and diffusion of the radio waves in the blasting area (cell). There are also technological limits in building the safety system for shipyard job areas, but developments in IT (Information Technology) and RFID (Radio-Frequency Identification) technology have made remote control safety systems possible.

This article summarizes work carried out by Won-Jun Yun, Byung Hun Lee, and Dong-Min Kim of Hyundai Industrial Research Institute, Hyundai Heavy Industries, Co. Ltd. Korea, and Young-Shick Ro, School of Electrical Engineering, University of Ulsan, Korea, into such a system. The summary will concentrate on the features of such a safety system, rather than on the technical aspects.

The summary is based on a presentation given at PACE 2010, the joint conference of SSPC and PDCA, held Feb. 7–10, 2010, in Phoenix, AZ. The full paper is published in the Proceedings (www.sspc.org).

> *In shipyards, dry abrasive blasting is especially dangerous.*

The Safety System Features

The complete safety system is composed of three sub-systems: the monitoring system for checking the blast worker's safety, the remote control system of the blasting nozzle(s), and the special bone conduction ear-set system for voice communications among workers and managers. Additionally, the safety system has a function to analyze the actual result of a blast cleaning job.

The Safety Monitoring System

The safety monitoring system features emergency call signaling, sensing vibration data, and checking location data for blast cleaning workers in the blasting cell.

When the worker with a 2.45GHz RFID active tag is working in the blasting cell, the safety system works as follows: information about working conditions is transmitted from the active tag through a network to the monitoring system, where the manager can check workers' safety using computer-analyzed emergency signal data with the workers' location information.

The monitoring system consists of three functions to check workers' safety and to send the emergency signal to the manager. First, it's a function for storing and analyzing information; second, it's a function for monitoring workers' location and their safety information; and third, it's a function for sounding a buzzer and sending SMS (Short Message Service) to the manager. Also, it can give an alarm by analyzing the vibration sensor on a worker, including direct emergency calling. Finally, it can monitor remaining battery capacity of the active tag and temperature of the working conditions.

The Remote Control System for Blasting Nozzles

The remote control of blasting nozzle(s) is integrated with the safety monitoring system to cut compressed air when an emergency situation occurs. Managers also can check the blasting nozzle status and turn it off remotely using PC when emergencies occur. The remote control system can control the blasting nozzle valve directly after checking the condition of blasting nozzles one by one or altogether.

The Special Bone Conduction Ear-Set Communication

The special bone conduction ear-set system with neck microphone is necessary to communicate about blast working conditions in the cell with a person in the managing office.

Working conditions in the blasting cell and protective clothes for blast cleaning work are not conducive to easy voice communication. So it is more difficult to communicate using normal methods inside the steel block. Thus, a special system that the worker can use while wearing a mask, earplugs, and a helmet had to be developed.

For communication among workers and managers during the blast cleaning job, the special voice communication system using the existing infrastructure with TRS (Trunked Radio System), which can communicate with a group, was used. Workers wearing masks and earplugs can still listen with the aid of the bone conduction mechanism and speak using a neck microphone, which makes communication possible through the vibration of vocal cords.

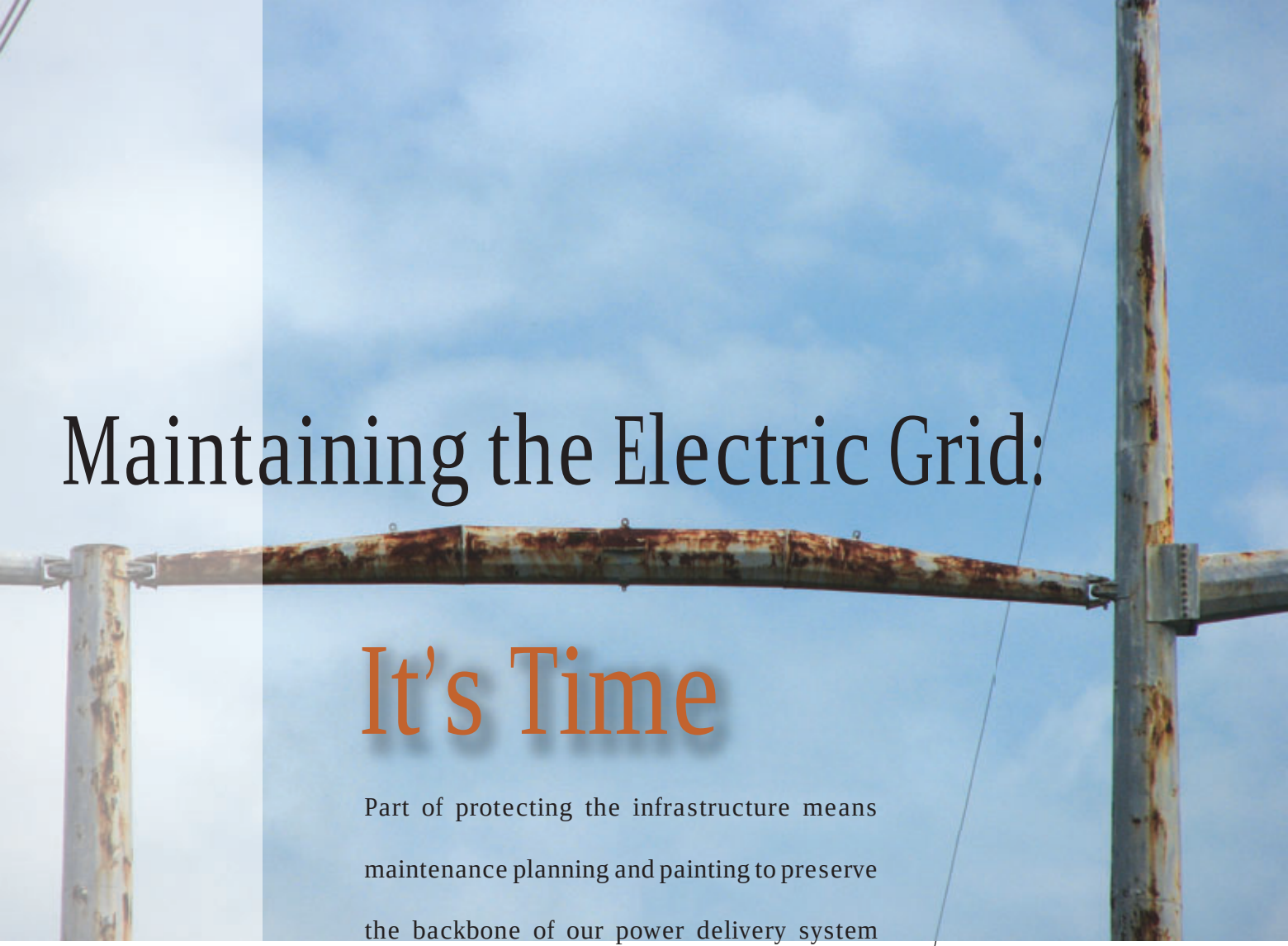
Because blast cleaning workers must pass through small access holes to work in the steel block, the developed system is small and has the added conveniences of portability and noise interception.

Operation Procedure of the Safety System

To confirm workers' safety, there are three ways to check the emergency signals from workers in the blasting cell: sensing the active tag emergency call, analyzing a sensed danger signal automatically by vibration sensor, and using voice communication with a special bone conduction ear-set.

The monitoring system can sense various emergencies, ring alarms, and send the information about the emergency to managers. After the manager checks the SMS or the emergency signal on the monitoring system, he or she can reconfirm the worker's safety by having a conversation through the bone conduction ear-set. If an emergency occurs, the blasting nozzles can be controlled remotely by a manager. Also, actions can be taken for workers to be safely evacuated from the life-threatening emergency, as well as for the urgent rescue of nearby co-workers. Emergency signals can be transmitted to all managers to prevent sudden accidents and to inform them of the rescue process.

This innovative safety system for workers blasting in shipyards allows managers to communicate with workers in real time and thus also allows managers to properly distribute the workload and make a contribution to the improvement in productivity.



Maintaining the Electric Grid: It's Time

Part of protecting the infrastructure means maintenance planning and painting to preserve the backbone of our power delivery system

Courtesy of the author

By Curt Hickcox, Public Utilities Maintenance Inc.

The high voltage steel structure electric transmission system, also known as the electric grid, crisscrosses virtually all of North America, as well as most other regions of the world. It provides the line or circuits by which electricity is delivered from the generation plants to the substations and ultimately to homes and businesses. The system is the backbone of the power delivery system, connecting and interconnecting each utility company and each customer.

The worldwide electric transmission system has been called one of the greatest feats of engineering in history. When you consider the design and construction requirements and obstacles that have been overcome, the system is truly a marvel. But on the fast-approaching horizon is a large obstacle to the system's reliability—that of its aging infrastructure. As with most things, age brings its own set of issues. The issues are significant and, if left un-addressed, can have a far reaching and dangerous impact.

A Brief History of the Construction of the Electric Grid

Since the early 1900s through World War II, many materials have been used to construct transmission and distribution structures throughout North America. In the early years, wood was the predominant structural material due to its availability and the strength requirements of

structures to hold the lines. Steel (black iron) was also used to construct select transmission line structures and most substation frames. The designs were basic in nature and were small in comparison to today's standards. Some utilities even ordered steel windmill structures from Sears Roebuck catalogues and made design changes to accommodate the transmission conductors. Many utilities still have some of these older structures in service today. These are what I will refer to as the first generation structures.

After the war, as the economy rapidly expanded, the demand for electricity grew in proportion. Power plants were built, and the transmission infrastructure had to keep up. The number of new line support structures exploded, and construction continued nearly unabated for the next 3 decades. Utilities were moving to higher voltage transmission line voltages with larger and heavier conductors to transport the electricity to meet this growth in demand. The need for a stronger structure to support these heavier conductors, an increased conductor spacing for higher voltages, and longer span lengths dictated the need for a material that could easily obtain height and strength requirements. This translated to erecting tens of thousands of steel structures throughout North America in a relatively short period. This period saw the largest number of steel structures installed on the transmission line system. These are the second generation structures and the second part of the equation.

The electric utility industry generates nearly 4,000 billion kilowatt hours of electricity from 2,100 power plants in the U.S. and Canada alone, delivering power through more than 300,000 miles of high voltage transmission line. If we assume an average of eight structures per mile on transmission lines alone, that would translate into approximately 2.5 million structures, conservatively speaking. Even with many transmission structures made of wood or concrete, it is reasonable to estimate that there would be hundreds of thousands of steel transmission structures and supports (such as stub poles) in just the U.S. and Canada.

In reality, transmission line failures are on the horizon unless we take action and take it soon. The electric utilities must have inspections that identify potential issues before they happen, allowing time for corrective repairs to be made prior to a facility failure. There are several contributing factors:

- Aging Infrastructure
- Past Design Practices
- Environmental Conditions
- Understanding
- Inspection and Maintenance Practices
- Maintenance Budgets

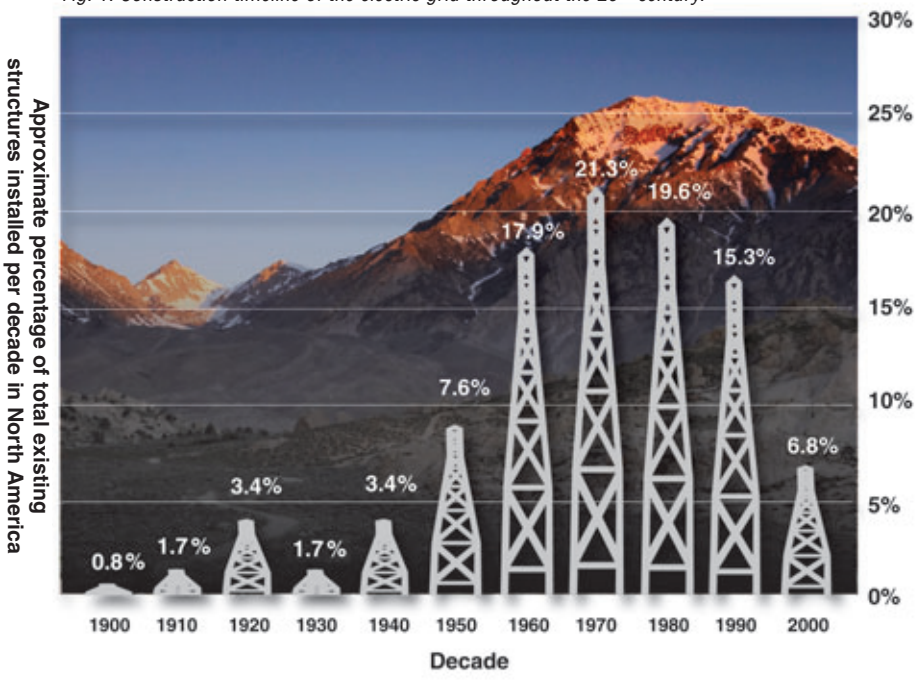
Aging Infrastructure

The aging infrastructure and the assumption that steel structures will last forever must be addressed. In reality, there are periodic maintenance requirements for these structures, carbon or galvanized steel. Utilities have been performing maintenance on their lines, but mostly on the first generation structures, those built in the first half of the 1900s. The bigger ticket items are usually 20 to 30 years into the life of the structure. Based on the grid's construction time line since the 1900s, an enormous number of structures are now 30 to 40 years of age (Fig. 1).

The majority of North American transmission lines were built from the 1960s thru the 1990s. Many utilities report a larger number of transmission structures erected during 4 decades than in the other 70 years since 1900 combined, with construction concentrated in the '60s through '80s. These second generation lines, due to their current age and large number of structures, will significantly increase the overall maintenance work required to keep the transmission system safe and reliable, as many structures will require attention all at once.

When discussing the maintenance of steel transmission structures, there are two major areas of concern: the above grade or atmospheric exposure portion of the structure and the below grade surfaces, commonly referred to as footings

Fig. 1: Construction timeline of the electric grid throughout the 20th century.



or foundations (Fig. 2). It is important to address both areas as part of a maintenance program. Protecting the above grade section of a structure does no good if it topples over due to failure from corrosion at the groundline, just as maintaining the footings does not succeed if the arms fall off from rust-through. A comprehensive program involving inspection, repair, and maintenance of both structure sections is imperative. NACE International and IEEE (Institute of Electronic and Electrical Engineers) have recognized this and have formed two joint committees to author standards on corrosion control of existing structures addressing both areas of concern. These standards are well on their way to publication.

Fig. 2: The below grade surface, often called the footing or foundation, is a major area of maintenance concern. Figs. 1-5 courtesy of the author.

Past Design Practices

Many of the electric utility design practices did not take into consideration potential issues associated with maintaining steel structure components. Many of the earlier steel structures were designed with the steel footing in direct contact with the earth (Fig. 3). In many cases, depending on the chemical make-up of the soil, the steel footing in the earth may not be a big issue, but with the simple addition of a copper ground field, the structure becomes exposed to galvanic reaction, which may cause the steel components to be compromised.

Fig. 3: On some older steel structures, the steel footing is in direct contact with the ground.

On other designs, with foundation, the specification was to have the reveal (portion of concrete footing above ground) 6 inches to 1 foot above the ground. With all of the activities along the utility line right-of-ways, combined with natural erosion, many foundations became covered by soil, thus allowing corrosion to begin.

Fig. 4: Steel latticework can trap moisture, causing accelerated corrosion.

Other aspects of structure design also often did not account for maintenance issues. Tight steel latticework was used many times, causing accelerated corrosion because of moisture trapped in the latticework, which itself is exceptionally difficult to properly clean and coat (Fig. 4). Ladder clips, arm attachments, and other design factors also contributed to maintenance difficulties and costs.

Environmental Conditions

In the early 1900s environmental conditions were not a major focus or concern. After WWII and the rapid economic growth, many factories were built and the economy was flourishing. Families that had traveled by foot and horse-drawn carriages were now buying automobiles. Large plants of all types were being built, and towns and cities were bursting as people moved in to fill the job market. From this time forward, the air quality would be an issue for steel structures, although its significance was not known originally. But the effects of atmospheric emissions from the rapid growth can be seen on many older steel structures.

Agricultural practices were continuing to change in an effort to grow more vegetables per acre of land. This effort introduced products to help speed up growth, but now we know that some of the chemicals used can also cause or accelerate corrosion of the structure, especially the critical groundline portion of steel structures.

Understanding

It is understandable that in an effort to keep up with the demand for new products, the North American economy was, and is, operating at full speed. With the increased demand for manufacturing also came the increased demand for electric power to run the factories. With the accelerated growth of computer and other electronic technology, we are even more energy hungry today. Thanks to extensive and continuing research, we

better understand how to design and maintain the steel components of the electric system. We now have a better understanding of what to look for prior to selecting a groundline coating for a new structure and what type of footing for the steel structure will require the least maintenance while giving the utilities a more reliable and safe system. We have a better understanding of how stray currents can affect the steel structures and other design considerations that will ultimately result in longer structure service life, improved reliability, and significantly reduced maintenance costs.

Inspection and Maintenance Practices

With the large, second generation steel structures aging to the point at which many maintenance issues will become more noticeable, utilities must develop innovative inspection and maintenance practices that will save time as well as keep the system both safe and reliable. Many electrical utilities are spending research dollars to develop new inspection and maintenance tools and procedures. This research is helping to improve the way the industry identifies and evaluates age-related issues.

The costs associated with the maintenance of these second generation lines will be significant because of their large numbers, but with good inspection processes, tools, and innovation, along with thorough, long-lasting maintenance programs, the costs can be minimized. Because of the growing system needs, some of the older lines will be rebuilt to a higher standard than their original standard and others will have major maintenance projects performed on them. Crews will have to be trained to understand what to look for when performing inspection as well as to understand the critical aspects of a steel structure. Steel structures coating programs will have to be utilized more to decrease future maintenance expenditures and prevent premature failures of the system. A continued focus must be on the inspection and maintenance of the critical groundline termination of the structure.

New tools and technologies will be required to improve inspection and maintenance practices and many are currently being tested. The industry standards under development will help the industry understand key issues in maintaining the steel structure above and below ground. These standards will also provide best practices for the proper atmospheric and below ground coatings applications to better maintain and support the reliability of utility steel structures.

Purpose and Methods of Corrosion Control

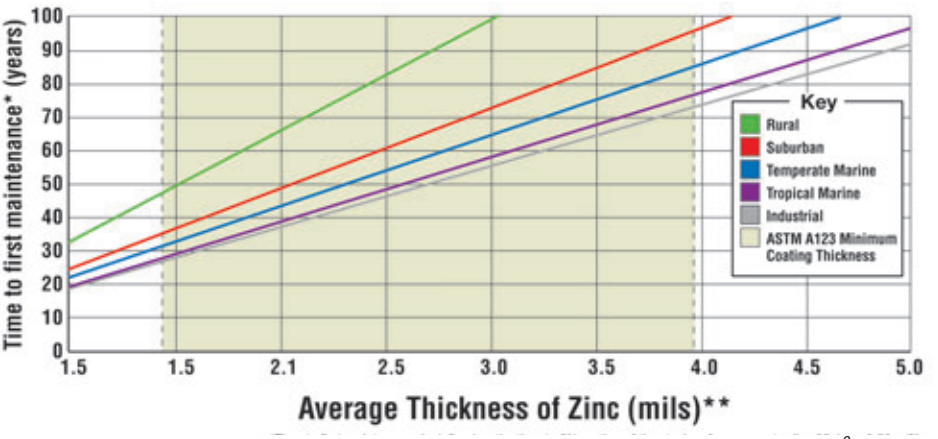
First and foremost, electrical utilities must keep the steel structures standing to deliver the electricity to the customer. One of the main tools to accomplish the task is corrosion protection. Most often, corrosion protection of electrical transmission structures involves the application of a protective coating over weathered and/or previously painted galvanized steel. Although many transmission structures, mainly tubular poles, are painted carbon steel, most structures, especially lattice-type towers, are galvanized and are either unpainted and weathered or previously painted.

The history of painting galvanized structures over the past 60 years and the evolution as well as usage of different paint systems play an important role in the selection of present day coating systems. Cost evaluation of different generic paint types is necessary, as is the application characteristics of each, because painting these structures is labor intensive. The ultimate goal is to minimize overall cost over the life span of the structure by applying coatings that will provide the lowest applied cost per year protection.

Galvanizing and paint serve the same function: the protection of the carbon steel substrate from corrosion attack. Each protective material works as a barrier to separate the components of the electrolytic cell that causes corrosion. When properly specified, manufactured, and applied, this barrier of paint or zinc iron alloy will keep the moisture (electrolyte) from contacting the anode and cathode (steel and its impurities—corroding surface). When this is successfully accomplished, corrosion cannot occur and the substrate will not be detrimentally affected.

Over time, both galvanizing and paint will degrade to a point at which they will not adequately protect the steel substrate. The rates of degradation will vary widely. Exposure conditions have the

Fig. 5: Time to First Maintenance of Galvanized (Zinc) Coating.



**Time to first maintenance is defined as the time to 5% rusting of the steel surface. 1 mil = 25.4μ = 0.58oz/ft²*
***Chart developed using the Zinc Coating Life Pedictor Model developed by Dr. Gregory Zhang of Teck Caminco.*
Courtesy of the American Galvanizers Association

greatest effect on the longevity of protection, but the quality of product and its application are other critical factors (Fig. 5).

When the galvanizing or paint film can no longer adequately protect the substrate, a new barrier must be applied to fend off the costly ramifications associated with corrosion. The most practical and cost-effective method of "re-protecting" the structure is the application of a paint or coating specifically intended for this use. When properly formulated, specified, manufactured, and applied, certain coatings can protect a transmission structure for 25 years or more.

Surface Preparation and Repainting to Reduce Corrosion

The surface preparation methods recommended for weathered galvanized or previously painted structures normally entail hand tool cleaning (wire brushing or scraping) in accordance with SSPC-SP 2. Some structures may require more advanced methods, but because surface preparation is the slowest, hardest, and most costly aspect of painting a transmission structure, the primary objective is to paint with a coating designed for minimal surface preparation. The goal is to paint BEFORE the galvanizing or the existing coatings have deteriorated to the point where involved surface preparation and multiple coat paint systems are required. The most cost effective time to paint a transmission structure is when spot scraping or wire brushing is all that is required. This practice is one sure way of reducing system life cycle costs.

To further complicate the situation, the original coatings on transmission structures may contain lead. If the specification requires the removal of old paint from the structure, it is essential to determine whether or not there is lead present in the old coating. If present, procedures in accordance with the OSHA and other applicable regulations must be implemented to protect workers from overexposure to lead. A job-specific lead compliance program is a required submittal on today's transmission structure painting projects.

Fig. 6: State and Federal laws require containment of lead paint to protect workers, residential areas, and the environment.
Courtesy of Savannah River Crossing, Georgia Power Company

State and Federal environmental laws also require the contractor to take necessary steps—with an appropriate method of containing the lead paint, usually through an acceptable containment system—to prevent lead paint from polluting the environment (Fig. 6). On a complex structure such as a transmission tower or pole, this is extremely costly, not to mention the costs and ramifications due to required outages. For structures located in a residential area this issue becomes even more sensitive. The old paint, which is contained and collected, must be tested for its level of toxicity, and the waste must be handled in compliance with EPA requirements.

Furthermore, if lead is involved, total removal might be specified. More extensive surface preparation will result in much higher concentrations of airborne lead that put workers and the environment at risk. Protecting workers and the environment will require much more elaborate and expensive procedures. Again, costly circuit outages will also be required due to the use of power tools and

other required equipment. Thus, total job costs will rise exponentially if significant surface preparation procedures are required.

The application of paint to a transmission structure is more complicated than it might seem. This type of painting involves climbing lattice type towers or tubular poles that vary in size and configuration depending on voltage. Most often, these structures are painted while energized when appropriate phase to structure distance, or the Minimum Approach Distance (the safe distance specified by OSHA or the utility that a worker must stay away from the energized conductor—varies depending on circuit voltage) can be satisfied. Painting a lattice-type structure is a team effort. For example, a crew of 3 or 4 painters will paint a standard 100 ft lattice tower in 2-3 hours.

For the most part, application is accomplished using a paint mitt. Brushes or rollers are used on certain structure components. Experience is an important factor in using either method of application as it very important that the specified film dimension is achieved and a smooth consistent film is obtained.

Protection of workers and the environment is paramount. Safety associated with the coating application to a structure involves, among other things, proper procedures and equipment for climbing elevated complex structures and working around energized lines. Additional safety and environmental protection measures must be taken because contact with potentially hazardous materials is possible during surface preparation as well.

Years ago, climbing and painting was accomplished generally without the aid of rigging and most of the time without safety belts. Each year, OSHA and/or power company safety regulations have become more stringent. Today, safety belts, hard hats, and safety glasses are mandatory, as are written safety programs, fall protection plans, hazard communication plans, and lead compliance plans. Workers must be thoroughly trained in the hazards associated with this work, especially the dangers of working around high electric voltages. Documented experience in performing this work should be required of any worker, especially when the painting of energized structures is involved.

Maintenance Budgets

Maintaining the system takes money. Maintenance budgets were developed based on expected maintenance needs. These budgets, for the most part, were developed based on past practice. Budgets must continue to grow to keep up with the massive expansion of steel structures from WWII to now. Utilities will have to be both forward and backward looking. Utilities must be backward looking

from the standpoint that they need to see the large numbers of second-generation steel structures, many now over 40 years old and with little maintenance performed since construction, and the maintenance that is now required because of their age. This is where the utilities will need to be forward looking to develop maintenance budgets to address maintenance problems in a timely fashion. If performed correctly, these maintenance functions will save money for the utility owners by reducing outages and costly emergency repairs. It is always more cost effective to be proactive rather than reactive. The government has also begun to take notice of the need for maintenance to prevent and control corrosion, from both an economic perspective and a security standpoint. Talk of potential government mandates for structure corrosion control increases as the importance of the reliability of the electric grid is better understood.

The Good News

The reality of a transmission system comprising aging structures is here and that is just a natural process of time. Line failures can be prevented by a proactive approach that includes correct inspections and proper maintenance. The good news is there are proven methods of ensuring the long-term, cost-effective protection of these structures. Experience has proven the viability and benefits of formal atmospheric and groundline maintenance coatings programs for steel transmission structures.

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JPCL

Comparing Test and Field Performance of Thick-Film Elastomeric Polyureas

Spray-applied, proprietary aliphatic amina-modified polyurea on sea wall in southern U.S. Before (top) and after 5 years of service (bottom). System is still in service.
All photos courtesy of the author.

The author reports on real life exposure data that is accumulating to compare field performance of polyureas to their performance in accelerated weathering testing.

By Dudley J. Primeaux II, PCS, CCI
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For years, people have relied on a variety of standard accelerated testing methods to predict the useful service life of coating and lining systems. Tests include, among others, heat aging, Atlas Cell immersion testing for lining products, and accelerated weathering testing for coating systems. Spray-applied elastomeric polyurea materials have been no exception to accelerated testing. One of the most important testing evaluations has been accelerated weathering exposure for products used in outdoor application areas. However, some of the data on specific weathering testing may be misleading or at least misunderstood. Exposure for a given number of hours in an accelerated weathering cabinet does not necessarily point to a specific number of years of real-time field performance service unless there is comparative data from actual performance in the field that verifies the test data.

This article will compare earlier accelerated weathering testing (QUV) for UV stability to real time outdoor exposure on spray-applied polyurea elastomeric coating and lining systems. Included in the comparison is background on weathering testing along with early and more recent uses and types of polyurea systems.

The reader must note that the information presented in this article

Editor's note: This article is based on a paper given at PACE 2010, the joint conference of SSPC: The Society for Protective Coatings and the Painting and Decorating Contractors of America, held February 7-10, 2010, in Phoenix, AZ.

is based on properly formulated polyurea spray elastomer systems, which are NOT typical base formulations provided by industry for a starting point; moreover, there is absolutely no implied warranty or guarantee in the information presented.

Early Accelerated Testing of Polyurea

Among the accelerated tests for outdoor weathering are ASTM G 53, "Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV Condensation Type) for Exposure of Nonmetallic Materials"[1] (withdrawn in 2000); its replacement, ASTM G 154, "Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials"[2]; and Xenon Arc.[3,4] Regardless of the tests used, the above procedures either describe how to run an apparatus or give protocols for evaluation. They do not provide pass-fail criteria. Formulators, specifiers, or others concerned with the performance of a particular system must establish the pass-fail criteria for each type of relevant test.

The first known information published related to QUV exposure of polyurea systems was from 1991.[5-7] The 1991 publications compared elastomer properties of a formulated aromatic polyurea elastomer system after 3,871 hours' of weathering exposure against the initial elastomer properties of the system. An additional table reported on QUV exposure of an aliphatic polyurea spray elastomer after 5,280 hours and noted the color change. This testing followed ASTM G 53 using UVB-313 bulbs. But these reference publications lack any information about the comparison of the UV testing to real time exposure. Of course, the test data was reported in 1991, when no extended real life exposure existed.

Without comparative real time exposure data, however, the accelerated test data is not very helpful as a predictor of field performance. That's because the accelerated weathering testing and data are meant as a *comparative* tool, not as an absolute predictor of UV stability in the field. You must have a known standard with both real time life data as well as accelerated weathering data for simultaneous comparison. Keep in mind, though, that comparative data is still a very valuable and powerful laboratory tool.[8,9] And the fact is that the polyurea spray elastomer technology is relatively new, and we are just now seeing long-term, real life applications of successful exposure.

There also may be some confusion over what the term "UV stable" really means. Most might agree that it means that the systems will not be adversely affected by outdoor exposure. In this sense, UV stability would include the physical properties of coatings and linings as well as their color stability and aesthetics. However, UV stability can also simply mean that a material's mechanical properties are not significantly affected, while color fade would be acceptable. So we need to qualify what is meant by UV stable, as will be shown below.

Weathering Tests: QUV Lamp Sources: UVB-313 vs. UVA-340

While much of the data presented in this article is based upon QUV accelerated weathering testing, a UVB-313 lamp source was utilized. It is known now that most current QUV testing employs UVA-340 lamps, but this article focuses on data derived from the introductory stage of polyurea elastomer technology. At the time (e.g., 1991), the UVB-313 lamp source was standard. The test data obtained (UVB-313) in the early stage of polyurea does correlate with real-time test exposure and is considered valid.

The use of the UVB-313 lamps was based upon the fact that these were the most economical lamps designed specifically for the QUV weathering and would produce the fastest exposure results. The UVB-313 lamps provide for the most UV output and faster testing, as well as reported improved uniformity in exposure—operating in the UVB region of 280 to 315 nanometers. UVA-340 lamps are reported to be the best simulation of sunlight in the critical short wavelength UV region, and are used more in coating application work between formulation comparisons. They have been shown not to degrade materials as fast as the UV-B Lamps, and are claimed to give better correlation to actual outdoor weathering. These lamps operate in the UV-A region of 315 to 400 nanometers.[10]

One must keep in mind, though, that QUV exposure testing should be used as a comparative tool, like other accelerated testing, and should not be a stand-alone procedure to determine real-life exposure results. Additional work is in the process of comparing the results from the UVB-313 testing to current UVA-340 exposure results.

Aromatic Polyurea Systems: Early Testing and Later Field Performance

Aromatic polyurea elastomer systems are not traditionally known for color stability when exposed to sunlight or accelerated

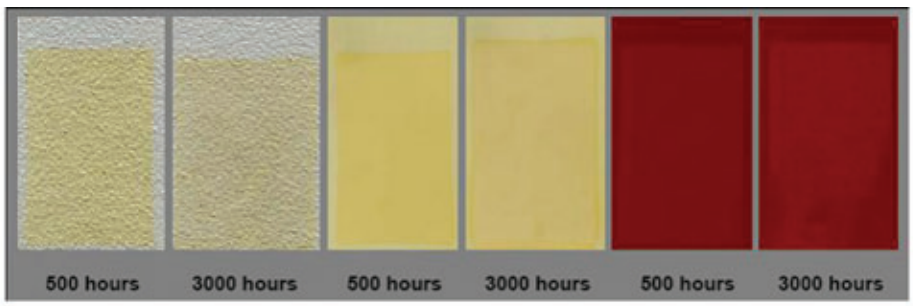

Fig. 1: Aromatic QUV Exposure—Light Gray, Beige, Tile Red

Table 1: Percent Thickness Loss, Aromatic Polyurea QUV Testing, 30 mil (762 µm) Sample

250 hours	500 hours	1000 hours	2000 hours	3252 hours
0	0	< 5%	5%	< 9 %

Table 2: Aromatic Polyurea Spray Accelerated Exposure Elastomer Physical Property Results

		QUV, UVB-313[1]		Xenon Arc[2]
	Initial	1000 hrs	3800 hrs	1000 hrs
Tensile strength, psi	2265	2260	2175	2260
Shore D Hardness	52	50	50	47
Elongation, %	190	165	150	160
Tear strength, pli	460	450	450	450

[1] QUV using UVB-313 bulbs, 4 hour cycles
[2] Heraeus SUNTEST CPS, 765 W/m²

weathering testing. The primary culprits responsible for UV color instability in the aromatic-based systems are the aromatic chain extenders used in the resin blend component, not the isocyanate components.[11] Depending on formulated color, a typical aromatic polyurea spray elastomer system will turn yellow after exposure to sunlight or accelerated exposure using weathering testing. Some systems will actually turn green because of the modified secondary aromatic amine chain extender used to slow the system reactivity. But what matters is that the color change is uniform throughout the exposed area. It is also important to apply the polyurea systems at the proper dry film thickness (dft) to achieve the required performance.[12]

Figure 1 shows the results of QUV exposure on a gray, beige, and tile red aromatic polyurea elastomer systems, using UVB-313 bulbs.

Also, we see that color change is only at the surface of the polyurea polymer and not throughout. The longer hours of exposure do exhibit more loss of gloss in the surface of the polyurea elastomer system, but color fade is uniform, and there is no surface micro-cracking. Uniform fading and lack of surface micro-cracking are important characteristics of the polyurea elastomer technology. It should also be noted that some colors, light colors in particular, will exhibit more apparent color fade than darker colors.

The samples were also evaluated for thickness loss. Table 1 gives the initial sample thickness and then thickness loss after exposure. Very little thickness is in fact lost, indicating that QUV attack is only at the surface of the polymer system, and good polymer stability is present. The surface has oxidized, as would be noted in any FT-IR analysis of the sample surface.

Thus, color retention can be an issue. What about retention of elastomer properties after exposure? Since the color change/oxidation is only at the polymer surface, it is expected that there may be good retention of elastomer properties. Table 2 shows some initial data presented during the promotion of the polyurea spray elastomer technology.[13] This data showed greater than 80% retention of elastomer physical properties after the noted exposure conditions.

As a result of this initial work, a major automotive company started the GMT-800 Bedliner Program in 1994. The aromatic-based technology was to be used for bedliners applied in an OEM environment. All were ready to proceed but the selected material supplier to the program backed out after finding out that isocyanates were going to be involved in the system. Use of isocyanates was very unusual (see aliphatic polyurea systems section below). So the program did not take off at the time.

In the meantime, a specific aromatic polyurea system was formulated and used to spray a pickup truck bedliner in 1992. The black aromatic polyurea system was applied at a nominal dft of 60 mils (1.5 mm). Before application, the painted steel bed was prepared to SSPC-SP 1, Solvent Cleaning, with no abrasion to the surface. Again, special considerations were given to the formulation. One area included an aluminum surface prepared by solvent cleaning before application of the polyurea elastomer system.

After more than 17 years, that truck,

Fig. 2: Bedliner—before and after

Table 3: Aromatic Polyurea Spray Real Time Exposure Elastomer Physical Property Results

Test Property	Initial Results	17 Years Service*
Tensile strength, psi	2265	1710
Elongation, %	190	105
Tear strength, pli	460	407
Shore D Hardness	52	50

** Paint attached to back of test sample, results could be affected*

Table 4: Aliphatic Polyurea Spray Accelerated Testing (16,17)

	QUV[1]	Xenon Arc[2]	Xenon Arc[3]
Appearance	6000 hours	1000 hours	SAE J 1885 (18)
Chalking / Cracking, visual	none	none	none
Color Change, ΔE	< 2.0	< 2.0	< 2.0

[1] QUV using UVB-313 bulbs, 4 hour cycles [2] Heraeus SUNTEST CPS, 765 W/m^2 [3] SAE J 1885, 1993 KJ/m^2

with the original bedliner, is still in operation (Fig. 2). The truck has been exposed to the outdoor elements of Central Texas the entire time. This exposure includes the normal weather patterns (heat, humidity) as well as extra abuse from hauling, chemicals, and animal body fluids.

One area in the center of the bed had the applied polyurea system on a metal repair area for an originally installed gooseneck hitch. After time, the polyurea has lost some adhesion due to the nature of the repair area, and this sample was then removed for testing. Table 3 compares test results of the removed sample after more than 17 years of exposure with the reported initial elastomer properties. The results show that the aromatic polyurea elastomer system has held up quite well during the real time exposure. Adhesion of the applied liner system has also remained quite good, considering only an SSPC-SP 1 surface preparation procedure was used. Some areas of originally thinly applied systems (<10 mils) have exhibited degradation and some removal. It was determined that these thin areas are primarily due to application error or spray technique and not that of the polymer system itself. The rest of the area is still at >55 mils (1.4 mm). Generally, the applied bedliner system has held up much better that the factory-applied paint finish, with no surface micro-cracking.

Aliphatic Polyurea Systems: Early Testing and Later Field Performance

The concept of 100% solids, fast-set, plural-component aliphatic polyurea spray systems was first introduced in 1989.[14] Some industry leaders suggested at the time that aliphatic polyurea elastomer systems based on polyetheramines would not exhibit good UV stability. Some raw material supply companies reported that these systems would exhibit chalking, cracking, and poor color stability—interesting comments, but they are partially untrue.

The reports about poor UV stability were perhaps based on work done by these same companies and on the nature of the polyetheramine materials. They are prepared by the amination conversion (introduction of the amino group into a molecule) of the starting polyether polyol.[15] For the amination to succeed, the starting polyol must be virgin, i.e., containing no typical antioxidants for preserving the stability of the polyol. Therefore, the resulting polyetheramines used in formulating the coating/lining systems do not contain the required performance antioxidants. These must be added to the formulated system.

Fig. 3: Aliphatic modified aromatic polyurea QUV weatherometer exposure, UVB-313 Bulbs

While one of the first uses for the fast-set aliphatic polyurea spray technology was in roofing applications over spray-applied polyurethane foam, the technology was evaluated in high end automotive work. This was specifically for the production of automotive interior trim skin, i.e. dashboard panels.[16,17] Data showed incorporation of an antioxidant and UV stabilizer package yielded excellent performance (Table 4).[16-18]

Today, one of the large applications for the aliphatic polyurea spray elastomer technology is in pickup truck bedliner systems.[19] Accelerated weathering testing has shown excellent color and gloss retention with no chalking or cracking. One such evaluation report shows that after Xenon Arc exposure of 1,440 hours, the aliphatic polyurea system exhibited no chalking or cracking with no change in sample gloss or color. It goes further to state that the Xenon Arc exposure of 1,440 hours will equate to well past 5 years service life.[20]

Further data has shown no loss of gloss or chalking after 4,000 hours' exposure under SAE J 1960 for an automotive specification.[21] The requirements under the specification are 3,600 hours exposure with a 2.0 delta E (ΔE) color change maximum and a 90% gloss retention at 60 F angle.[22-24] This would be equivalent to automotive paint specifications, and we all expect the paint on our automobiles to last a long time and not fade or wash out within a few years. None of the aftermarket, spray-applied, aromatic bedliner systems will meet the testing and require-

ments above. Many of the bedliner systems have been evaluated in the above-discussed testing procedures.

In the traditional world of coatings and linings is SSPC-Paint 39,[25] a performance-based specification for the two-component, aliphatic polyurea topcoat system. Under accelerated weathering requirements, three different levels of performance are noted: Level 1A, Level 2A, and Level 3A, corresponding to exposures of 500, 1,000, and 2,000 hours respectively. Maximum color change of ΔE of ≤3.0 with a maximum gloss loss of 40% after 2,000 hours exposure is noted. From the above data on the fast-set aliphatic polyurea elastomer systems, properly formulated products will easily meet the requirements in SSPC-Paint 39.

Other Mixed Systems: Testing and Field Performance

In recent years, people have been modifying the aromatic-based polyurea systems with "aliphatic content" to improve UV resistance for color stability. The first attempts were to modify the aromatic isocyanate component with an aliphatic isocyanate. While this has worked to slow the reactivity of the system, it has done little to help with color stability because the resin blend still contains the aromatic amines, in which color stability is just not present.

Figure 3 shows a white, aliphatic-modified, aromatic polyurea spray elastomer after just 20 and 97 hours exposure in a QUV Weathering. Significant yellowing— noticeable change—is occurring quickly, much like that for a white aromatic-based polyurea system. So the only real purpose for this type of modification would be to slow the reactivity of the aromatic-based polyurea system without improving color stability because aromatic amines remain in the formulation. The systems are still good, but not, as the term "aliphatic" might suggest, color stable.

The better alternative would be to modify the resin blend component with suitable aliphatic amine chain extenders in place of the aromatic amines. This will provide the slower reaction times, as well as add color stability. Of course specific formulation details are proprietary. The photos on p. 32 illustrate the condition of the proprietary aliphatic-modified system before and after outdoor application along a coastal area in the Southern U.S. The system has been in service now for over five years.

Conclusion

Properly formulated and applied aromatic and aliphatic polyurea elastomer systems hold up very well in outdoor exposure application. While the aromatics may not be color stable, their retention of elastomeric physical properties is excellent. The real-time exposure has correlated very well with accelerated testing. Even though the UVB-313 Lamps have been used for accelerated weathering testing, their harsh exposure and short test time has been a valuable tool in development work. Accelerated weathering exposure testing of aromatic polyurea elastomer systems has shown excellent correlation to real time exposure results.

The aliphatic-based polyurea systems will provide the ultimate UV stability for both elastomer properties and color/gloss retention. Testing comparisons for the aliphatic based systems have shown more than 5 years' service at present. In any case, the polyurea coating/lining elastomer systems MUST be properly formulated and not just a base chemistry system, and applied under the proper processing conditions and minimum film thickness for exposure applications.

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JPCL

Renting Equipment for Painting Projects?

By Joe Maty, *JPCL*

Call it one of those lessons on how not to fall victim to the temptation to "jerry-rig" a machine in a way it wasn't intended to be modified.

That was one of the messages offered by Nancy Pescinski, co-owner of Rapid Prep LLC, regarding an equipment failure involving the "makeshift" use of an enclosure around a vacuum machine to reduce noise levels. The action, in a job that did not involve her company, resulted in a fire that shut the job down.

Pescinski is one of a number of rental-company representatives interviewed by *JPCL* regarding important issues related to rental and use of equipment used in protective and marine coatings projects. Such equipment can range from air compressors, application gear, lift devices, scaffolding, on up to dust-collection and abrasive-recycling systems, to massive suspended-access platforms for major bridge projects.

In these discussions, representatives of painting contractors and equipment-rental companies shared insights, experiences, and insider clues on the big picture and the "fine print" of rental relationships. A number of the suggestions would appear to be something less than revelatory and more along the lines of basic common sense, such as the oft-heard admonition to "know the company you are renting from" and "make sure they provide solid service to back their products." Other advice is more nuanced, such as the concept of renting say, not just one compressor for a remote-location jobsite, but including a second machine "just in case."

"Our biggest caveat is that we want to understand the level of productivity being sought by the customer," Pescinski says. "They want to 'blow and go' and spend as little time setting up

Photos clockwise starting on opposite page, top left: Bridge project, in New York, where an air dryer has been serviced and returned to the project. Courtesy of Rapid Prep, LLC
Dehumidification equipment set up for project at process facility. Courtesy of Munters.
Access equipment set up on drilling rig. Courtesy of Safway Services LLC.
Dehumidifier on water tank that is being blasted and coated on the inside. Courtesy of DRYCO Group.
Plural-component equipment set up on site. Courtesy of WIWA LP.

Here are views from both sides of the rental contract.

as possible. The contractor's money is made during blasting, not during setup and takedown. And they want the equipment to be in good shape."

The contractor should take the time to read and understand the rental agreement, says Mike Challoner, vice president of Virginia-based contractor Main Industries Inc. Contractors may be tempted to "just sign it to get the job done, and worry about things later on," he says.

"When we rent, we take on insurance ourselves," Challoner says. "We get a value on the piece of equipment, and send an insurance certificate to the rental company, because we can insure it cheaper than what the rental company would charge for insurance."

Also important is awareness of who's paying the freight from the rental company to the jobsite, and who is responsible for safety systems for the manlifts, scissor lifts, and other equipment, Challoner says.

"If the rental company is not providing proper service, you've got 10 guys standing around because the air compressor is not running, so service is of the utmost importance," he says. "You need to know your supplier, who it is you're dealing with. If a guy is 300 miles away, you better ask him how he's going to service the unit."

Supply-Side Policy

Recommendation: Know Your Needs

Rapid Prep's Pescinski and her partner in the business, Chris McNamara, place much weight on the customer's active participation in the rental relationship.

"The lesson is, beware, equipment needs to be in good shape," McNamara says. "It's important that the rental company provide excellent service capabilities. The customer needs to be educated on how to use the product." He emphasizes that the contractor should ensure the equipment is in good working order and is the right piece of equipment, with the right-size blast equipment, dust collector, and containment.

Nancy Pescinski

McNamara says the overwhelming majority of his customers are already knowledgeable about the equipment, and problems encountered by the customer or the rental business are the exception.

In these types of business transactions, he says, the customer must provide a certificate of insurance to cover any damage or mishaps, and the equipment company's job is to supply the equipment the user is counting on to do the job. "Beyond that, if anything breaks down, you want the supply company to provide any service needed. The flip side is if the end user does something to the equipment and operator error is involved. Either way, the service company needs to be there to address any problems."

If equipment comes back damaged, then the user bears responsibility, McNamara says. "But in practice we don't often see damage. From time to time, yes, but that's not the norm."

Chris McNamara

It's important for contractors to rent from companies that have the infrastructure and field-service capabilities, says McNamara. Downtime due to equipment snafus exacts a steeper cost to the user.

"If I could stress one thing to contractors, it's that on jobs where the rental cost is high, they need to make sure that whoever they get equipment from will be able to service the equipment quickly and effectively."

Also important is awareness of "overtime" policies, as rental rates can be based on "single-shift" use—eight hours a day. If the contractor is running more than that, the bill will reflect it. The contractor may be able to negotiate a reduced overtime rate up front, however.

Contractors may be tempted to rent from another contractor or a company located some distance away. "They should be cautioned that they may be spending a dollar to save a dime" that won't pay off, he says.

"You need to be aligned with a good supplier of this equipment, one that understands your business, understands the level of productivity you need to get, and make sure it's a supplier of good equipment."

Too Much Information? Not in This Business

Jerry Dolly

For Jerry Dolly, Safway Services LLC, details about the contractor's project are crucial to optimizing the rental experience. The company is a major supplier of suspended-access equipment and scaffolding. "We hang a scaffold upside down from the structure," he says. "The contractor is going to need a place to work from; we provide ability for him to do that work."

"From the very beginning, the first thing we need to know is the details of the structure—drawings and photos of the site, so that we can define properly the equipment he needs. Site drawings and photos are a tremendous help to us.

"The next thing is the scope of work, the type of work he's going to do; the loading he's going to put on the system—loads to the structure he's painting—and what we're going to attach to it. He may be just the painter, but this may involve structural work.

"If we arrive at an understanding of what he needs, there's the schedule. This can't be overstressed. We're constantly under the gun for delivery tomorrow. The more time a contractor has to plan ahead and prepare for the job, the more likely his success will be high. This ensures equipment delivery, installation, and training of employees for safe access."

Also a key to success in the relationship of supplier and renter is an understanding of the most efficient way to do the job, "whether it's the whole structure or phasing"—in other words, whether economics work in favor of renting enough access equipment to do the whole job, or rather renting a smaller system that is disassembled and moved as the job progresses.

The company provides training in installation and use. "Sometimes we install the equipment; sometimes we train the contractor on installing, and he removes the platform. It depends on what the contractor prefers," Dolly says.

The customer must provide liability and loss coverage when renting, as insurance against injury or loss of equipment. "If it falls into the water, it could be a loss of $100,000 to $1 million," Dolly says. "We require a binder of proof of insurance with acceptable limits; this can vary with the value of the asset and the liability associated the risk."

Equipment loss is a chronic issue, Dolly says, and can result from "simple misplacement of equipment," or worse.

"You'd be amazed at how often that happens. At no fault of the contractor, something walks away—tarps, aluminum, scaffolding, platforms. People will walk off with all kinds of things if the con-

Mind the Contract

By George MacDonald, QC, McInnes Cooper, Halifax, Nova Scotia, Canada

It is always important to read the provisions of any contract carefully before it is accepted. Nowhere is this attention to detail more imortant than with contracts covering rental of equipment. It is absolutely essential that each party to the contract for the rental equipment knows what risks are being assumed.

If you, as the lessor, own a piece of equipment, naturally you will assume all risks of damage, loss or liability. Normally, these risks are covered by insurance. Your insurance may not respond, however, if, for example, you permitted unqualified people to operate your equipment and damage resulted. Your insurance may not respond either if an accident is caused because the designer or manufacturer of the piece of equipment made errors that rendered the piece of equipment inherently dangerous. In those circumstances, however, you probably would have a claim-over against the manufacturer or designer of the piece of equipment.

The lessor should attempt to pass on to the lessee liability for those risks that would not be covered by the lessor's insurance, or by way of a claim for liability against some other party. Very often, however, persons offering equipment for lease attempt to pass along to the lessee responsibility for virtually any risk which could result in damage, and arising out of the use of the equipment.

For example, the contract covering the rental of a mobile crane may provide that the lessee is responsible for any damage that occurs to the crane during the rental period. Such a contract could render the lessee liable even if damage results from an inherently defective part of the crane.

The contract may also call for the lessee to indemnify the lessor from any claims made resulting from injury or damage caused by the failure of the crane. The lessee's insurance policy may well contain exclusions that would deny the lessee coverage for these types of risks.

Regardless of which party to the contract you are, read the contract carefully and have your insurer review it also. Together, you can identify the risks which you should not take on, and make certain you have appropriate insurance coverage for the risks you have assumed.

George MacDonald, QC, is involved in all aspects of the practice of construction law in Canada and the U.S.

tractor doesn't have strong site control. Keeping good site control on the asset will reduce if not eliminate loss of product, and expense to the contractor."

Loss of this type is a more common issue than damage to the rented equipment, he says.

Also critical is precise planning. "It's fairly common for jobs to start later than expected, and take longer than was planned for," Dolly says. "This can be the result simply of optimism, or aggressive bidding on their part."

"The contractor may have to have additional rental if he's not on schedule, and he needs to be prepared."

Also important, he says, is ensuring that contractors take an accurate count of the pieces being rented. "If they are supposed to get 100 of a certain thing, they need to make sure they didn't get 95, or they'll have to pay for five they didn't get."

He calls equipment failure a rarity normally attributable to incorrect use. "If you do something wrong, as a supplier or user, you are liable."

"The range of sophistication is pretty wide out there," Dolly says of contractors that find they need to rent equipment.

Renting equipment gives the contractor the opportunity to compete on projects with a lower capital cost to his company, Dolly says. "He still has the responsibility to take good care of the equipment, but rental gives him options he may not have with his own equipment."

Giving too much information is not a complaint a coatings contractor will ever hear from Paul Hrvatine, market and product support manager with Sunbelt Rentals.

Hrvatine, who says he handles "anything to do with air"—compressors and HVAC, dehumidification, and related equipment—says the details are crucial to making sure the contractor obtains the right equipment for the job. These details include specifications for the "skin" temperature of the surface being coated; the color and reflectivity of the surface; the ambient temperature and humidity conditions; whether the structure is tented. "That tells me how much energy is needed" for heating, cooling, and dehumidification, he says.

The same goes for compressors for blasting operations, he says. Here, critical details in determining air-compression needs to include the size of blast nozzles and the number of nozzles to be operated. "The more information you give us, the better service we can provide."

"You also have to keep in mind that all this equipment is mechanical, and it can fail," Hrvatine says. "In critical applications, we always suggest redundancy—a backup system."

Know the Rate and Know the Spec

Brandon Willis, director of marketing for DRYCO Group, cites awareness of billing rates and structures as a key issue in the rental relationship. The company rents climate-control systems, including dehumidification, heating, and cooling equipment. His colleague, Scott Arendt, emphasizes the importance of the project specifications as crucial to obtaining the proper climate systems for the job.

Brandon Willis

The customer needs to know the "shift rate" being charged—single, double, or triple—to ensure he gets the best deal, says Willis.

Arendt, the company's Midwest and Gulf regional manager, says rental of climate-control systems also comes with some unique requirements, such as awareness of job specifications on air


Scott Arendt

changes per hour, air temperature and humidity, surface temperature, and other factors that can affect coating application. "We do the engineering on our side to make sure we have the right equipment for the job," Arendt says. Such specifications can originate with the on-site engineer, a consulting engineer, or another representative of the owner.

"You don't want the painter to show up and find that the wrong equipment has been delivered," Arendt says, emphasizing the critical role played by the job specs.

The contractor is responsible for maintaining the equipment when it's on site, with such tasks as filter and oil changes, Arendt says. "They need to understand that there's responsibility on their end. If they want us to handle maintenance, we can do that, but most of the time they choose to handle it themselves. Part of the training process is to go over maintenance requirements, how it's done."

"I liken it to renting a car," Willis says. "Whoever is doing the renting is taking on responsibility for the equipment. If there are air contaminants, they need to know they have to check the filters, or if there are generators on site, they have to ensure the right kind of fuel is used. Our responsibility is to provide equipment that is in good operating order."

"The people who deliver the equipment should set it up before they leave," Arendt says. "Having a good supplier means going through the set-up and operation with the customer."

Garrett Freeman, industry sector manager for Munters—a supplier of dehumidification and other climate-control systems—says detailed information from the contractor and rental company "will make the best marriage of the companies' business relationship and the best environment for the job to take place."

"From the contractor's standpoint, it's crucial that they know the total project price, including operating cost," Freeman says. "What we've run into quite often is that contractors have made decisions based on what they think is the best solution on the initial rental price on equipment, but they did not take into account the operating cost."

Theoretically, a piece of equipment could cost $5,000 to rent, but $20,000 to operate, Freeman says, noting that contractors typically pay separately for the power or fuel to operate the rented equipment.

"It's like buying a vehicle; there's the sale price, but what also needs to be considered is miles per gallon, where it's 8 for a hummer and 40 for a hybrid."


Garrett Freeman

Looking to bring some focus on the issue, Freeman says his company has sought to provide more specific information about operating costs up front.

"We started this within the last year—providing more information about operating costs, and about new technology on controls and equipment where you have a shut-off unit attached." These remote monitoring and control devices can maintain the desired humidity and temperature conditions, and switch equipment on as needed to maintain those conditions. "That way, it's not running 24 hours a day," he says.

Still, Freeman advises contractors to make sure this issue is addressed up front, because operating-cost figures are not typically spelled out in the rental proposal.

Freeman also emphasizes the need for the contractor to provide details on the job spec to ensure the proper systems are ordered. The spec will show the required application parameters for the coating system in terms of temperature, humidity, and dew point, he says.

Safety First, Safety Always

Randy Fulmer, vice president of the equipment rental company CESCO, and Tim Poor, operations manager, say that when the customer signs the rental agreement, he is assuming liability and responsibility and indicating he knows how to properly use the equipment being rented. Cases where this does not prove true are the rare exception, they say.

As with any equipment—rented or owned—proper use and safety are critical. High-pressure water-blasting systems can "cut like a knife" and cause serious injury in an instant of improper use.

The company's business is built on abrasive- and water-blasting equipment. Fulmer says painting equipment is less commonly rented due to the complexity of such systems and the propensity to have maintenance and operational problems stemming from inadequate cleaning and flushing. Drying and hardening of paint residue in such systems carries major maintenance and repair implications. As a result, CESCO has veered away from rental of paint-spray equipment, where such issues can "turn into an argument with the customer over condition and responsibility."

"It's important for the contractor to return the equipment in the same condition it was received," Poor says. "Any misuse or non-maintenance will result in charges."

The key to success in the rental relationship, Poor and Fulmer say, is "communication with the customer up front, that we understand what he's doing with the equipment, and have answered all his questions correctly about the equipment. If it's misapplied it's not going to work, and we'll have an unhappy customer."

The company in effect "certifies" the user by "asking questions to determine that they know what they're doing. If they have a problem on the jobsite, it's in our interest to make sure up front they know

how to use the equipment. With our customers, 90% are industrial contractors and know how to use it."

Doing the Homework on the Coatings Specs

Jeffrey Wold, general manager of WIWA LP, a company that sells and rents standard and plural-component application equipment for coatings and mortars, says the contractor should ensure that the equipment meets "all parameters" set by the coatings manufacturer, in terms of proper storage, the "pre-heating window" of the product prior to application, and other specifications.

The company is the U.S. representative of Germany-based Wilhelm Wagner GmbH Co., KG (WIWA).

Also important is the contractor's planning for the work—making sure the supplies of coating material and solvent are adequate, and that other equipment needed—compressors and generators, for example—is on site and properly rated, with adequate power, for the application equipment. The power requirements are based on the air-consumption rate of the pump and the power needed to run auxiliary equipment, such as the heating element for the coating.

Jeffrey Wold

Other keys to getting the job done correctly are proper enclosures for the equipment in the event of bad weather, and communications capabilities linking the spray personnel to those operating the pump system. This is particularly important when the workers applying the coatings are located some distance from the pump, or are inside tanks or other structures.

Other priorities are the availability of trained personnel to run the equipment, and adherence to safety procedures, Wold says.

Coatings spray-application equipment presents particular issues for contractors and equipment-rental companies, due to the complexities of some of the coatings and their application procedures and the importance of proper equipment cleanup, Wold says. Rental documents spell out the responsibilities of the contractor with regard to liability for any damage to the equipment, which can result from improper mixing of plural-component coatings systems or inadequate cleaning of the equipment following use.

A fee for routine cleaning of the equipment is built into the rental agreement, but additional charges would result if the equipment is returned damaged or if catalyzed coating material remains in the system.

WIWA's rental arrangements frequently include the participation of one of its technicians in the project, particularly in the case of more advanced plural-component coatings materials and application systems, Wold says.

Wold says it's impossible to overemphasize the significance of following coatings handling and application specifications from manufacturer, and providing as much advance notice as possible when arranging rental of equipment. This is particularly significant when an on-site technician from the equipment company is needed, he says. "I know this can be difficult for the contractor, but this is very important."

The Contractor's View

Service after the Signature

Mike Challoner, of Main Industries, also gives safety high priority in equipment-rental arrangements, along with equipment reliability and service, and attention to the details of agreements.


Mike Challoner

"We want to be sure that the rental company has got maintenance capabilities and that service is provided by a local mechanic. All of that should be in the agreement or covered with some kind of understanding," he says.

Also a key is proper training in the operation of equipment. On-site training should be given. "You've got a man 100 feet in the air in a JLG, and without proper training somebody can get hurt very, very quickly.

"One of the central issues in rental of air compressors for you as the contractor using blast hoods and paint hoods, is whether you have Grade D air, breathable air, and monitoring equipment. You don't want carbon monoxide from air compressors. You must have filters and monitors to ensure you're getting proper breathing air."

High-pressure water-blasting equipment can be particularly dangerous, Challoner says, adding that Main Industries owns its UHP blasting rigs. "When you get into ultra-high-pressure water-blasting equipment, if you're not trained, it can be disastrous." With pressures of up to 40,000 psi, "you can cut off a finger or leg in the blink of an eye. We have training on it, certifications on it, with SSPC testing and certification.

"You have to look after employees like they are your own children, because the employer is responsible for them."

From a business standpoint, Challoner advises a careful read of the rental equipment agreement, so there are no surprises. "The contractor needs to read and understand the terms, and discuss the operation time required and negotiate the best rate possible rate based on that.

"We don't just rent from a company we happen to see on the road," he says, citing lessons learned from Main Industries' 35 years of experience.

Joe Doherty, safety manager at Main, says that whenever a rental company delivers a piece of equipment, "we examine it to make sure it's like something we've operated before. The rental company is supposed to give a briefing on its use, and provide a manual." Here, the safety department should be in the loop, he says.

"Know what you are working with, and if you don't, don't be afraid to ask questions about it," Doherty says.

"Safety is part of the fabric of our company," he says. "Make sure personal protective equipment is on correctly, that the monitor is being used correctly. The employee has to be trained and authorized. Don't put a blaster in charge of a paint pot."

If the job spec requires a new type of pressure washer, the company must know if the user is experienced, and give him the needed training and orientation, Doherty says. "It's crucial to check out equipment and all aspects of its use, along with OSHA and SSPC requirements and customer requirements," he adds.

The SSPC-C 13 course addresses the use of UHP blasting, but Main Industries' procedures also encompass other relevant procedures as outlined by the EPA, Navy, Coast Guard, SSPC-QP 1, and any other standards set by the individual customer, he says. Main Industries is SSPC-QP 1 certified.

Costs: Staying Focused on the Big Picture


Tom Sulkowski

Tom Sulkowski, owner of U.S. Tank Painting, says reliability—not driving a hard bargain to save a small amount of cost on the rental—should be the top priority in any rental trans-

action. He also advises doing business with a rental company that will agree to favorable terms on equipment overtime, and one that can supply the piece of equipment when it's needed. The ability and willingness of the equipment company to meet such needs can affect the bottom line more than the rental rate, he says.

Sulkowski says his company tends to rent large air compressors, due to the cost of maintenance connected to ownership and the relative affordability of rental. The equipment is typically used for blasting and vacuuming. Newer machines are preferred due to advances in air quality and air separation, he says.

A solid relationship with the rental company can mean a great deal in obtaining favorable rates and billing terms, Sulkowski says. "Good rental-equipment companies have newer and well-maintained pieces of equipment. We learn who they are, and find that the higher price actually costs a lot less. It's also important to get good service."

Jamie Goodison

Jamie Goodison, owner of contractor J. Goodison Company, agrees that it often pays to spend a little more to rent from a company with a strong reputation and track record.

Even a minor issue with a sensor or connection "can shut down the whole process," he observes. Goodison says his company occasionally rents blast-recovery and dehumidification equipment for its bigger jobs. "We can't afford to have equipment breaking down on us," he says.

Also a key is training on equipment that personnel are not familiar with or don't use frequently. "We won't start work until the men are ready," he says. "If you don't provide the training you will have injuries. If I'm paying a higher rate for rental equipment, I would like to think the rental company provides training."

Goodison says his company has transitioned to the use of UHP water blasting due to concerns about dust hazards with some blast-media materials. But the company owns its water-blasting equipment, and safety is a top priority. High-pressure water-blasting can "turn a foot to hamburger," he says flatly.

"When it comes down to rental equipment, make sure it's from a company you know is reputable, and make sure they have a tech service guy available to take care of problems and keep things on track."

J. Goodison Co. is SSPC-QP 1 certified.

Don't Overlook the Paperwork

Deidre Dunkin, president of the major industrial-painting contractor Dunkin & Bush Inc., advises careful attention to the details of rental agreements—including the reverse sides of documents that accompany the agreement but may get "lost" in electronic transmission. "You want to make sure you're in possession of all the provisions," she says. Typically, the rental company will submit a quote, with an attachment carrying the terms and conditions on liabilities, risk, remedies, and other contractual obligations.

Deidre Dunkin

"Make sure you have the full set of terms and conditions before you take possession of the equipment," she says. Also critical is review of sections that address exclusions, indemnification (liability), and the limitations of remedies. "You have to go through this with a fine-tooth comb," she advises.

Tom Dunkin II

Tom Dunkin II, Dunkin & Bush vice president, emphasizes the importance of using any rented equipment in accordance with supplier recommendations, which can prove to be a "pivot point" in any settlement of malfunction or liability. Improper use or alteration of the equipment would take the supplier off the hook in any debate over such responsibility, he says.

Dunkin & Bush occasionally rents equipment that is typically expensive to own and maintain, and where considerable competition in the marketplace makes rental economically advantageous. This may include generators, lifts, compressors, and forklifts.

Tom Dunkin III

"Know your job, what your risks are, and what the costs are," says Tom "Tommy" Dunkin III, project manager. "With my rental equipment, it's relationship based. When you work together and communicate, they'll take care of you, and will help you out with equipment breakdowns."

Tom Dunkin II says the company often negotiates deals based on actual usage. In the Northwest, where work schedules are highly weather dependent, Dunkin & Bush will look to negotiate terms based on hours—not days—of use. "You can make good deals prior to the rental being made, based on logistics such as delivery and pickup," he says. Other important considerations are who pays for repairs and the availability of service technicians in the area.

"During shutdowns, where schedule is vitally important, we often will have redundant and/or back-up equipment on site in order to insure no disruption in the completion date," he says.

Dunkin & Bush is certified to SSPC-QP 1, QP 2, and QP 3.

JPCL

Testing Coatings for Zebra and Quagga Mussel Control

Allen Skaja, Ph.D. Coatings Specialist, U.S. Bureau of Reclamation, Denver, CO, USA

The U.S. Bureau of Reclamation, part of the U.S. Department of Interior, functions mainly to deliver water and hydropower in the 17 western states. The Bureau maintains 476 dams; produces 17% of the nation's hydropower; supplies irrigation water for 10 million acres of farmland (25% of fruits and 60% of vegetables produced in the U.S.); and serves 31 million people for municipal, residential, and industrial water use.[1] The Bureau's infrastructure consists of dams, power plants, pumping plants, canals, pipelines, storage tanks, fish hatcheries, desalination plants, and water treatment plants. The complex infrastructure is being affected by zebra and quagga mussel infestations.

Zebra and quagga mussels are freshwater fouling mussels that attach themselves using byssal threads. Zebra mussels got their name from the distinct striped pattern of their shell. The quagga mussel is also striped, but fades away towards the hinge. Quagga mussels are slightly larger than zebra mussels, about the size of a thumb nail.

Quagga mussels were first found in western waters during January 2007 in Lake Mead (Hoover Dam). Since then, the mussels have spread downstream and into the Colorado aqueduct to Los Angeles, the Central Arizona Project to Phoenix, and a few other reservoirs in the western U.S. The growth and reproduction rate of mussels in warm waters of the southwest are up to six times per year faster than observed rates in the Great Lakes and Mississippi River.

Fig. 1: Aerial photo of Parker Dam. Red line indicates static conditions; yellow line indicates dynamic conditions. All photos courtesy of the author

Currently, the greatest risk of mussel infestations is in small diameter piping, (such as cooling water, HVAC, and domestic water piping), fish screens, and intake structures. Due to the potential impacts mussels will have on Reclamation infrastructure, the Bureau began a research program on ways to use coatings to deter mussel attachment. This article reports on the research.

Editor's Note: This article is based on a paper the author presented at PACE 2010, the joint conference of SSPC: The Society for Protective Coatings and the Painting and Decorating Contractors of America, held February 7–10, 2010, in Phoenix, AZ.

Background

The Bureau of Reclamation's primary method for corrosion protection of metal infrastructure to provide the longest service life possible is protective coatings. Many coatings, including lead-based primers, coal tar enamels, and vinyl resins, have lasted 50 to 60 years with minimal maintenance. Now, we are investigating coatings for mussel control as well as corrosion protection.

The primary focus of the study to date is the effectiveness antifouling, foul-release, or fluorinated powder coatings. Many different antifouling coatings and technologies are available.[2]

Antifouling coatings rely on a biocide to deter the attachment of fouling organisms. Types of antifouling coatings include non-ablative, ablative, and self polishing. Non-ablative coatings are considered contact-leaching coatings where the binder does not degrade. The biocide leaches into the water, leaving the resultant exposed coating with a honeycomb appearance. Ablative coatings, considered controlled depletion coatings, have two erosion fronts, a pigment dissolution front and a binder dissolution front. Self-polishing coatings allow a controlled release of biocide at a constant rate—the polymer and biocide leach rate are approximately the same, allowing for a constant antifouling performance. The self-polishing coatings have the longest service life of the antifouling coatings for ships.

Foul-release coatings rely on low surface energy chemistries that cause fouling organisms to release in flowing water. The most common foul-release binders are based on poly (dimethyl siloxane) (PDMS). Fluoropolymer-based foul-release coatings are also available, but have a broader spectrum of chemistries.

Continued

Fig. 2: Coated square foot steel plates used for static testing. From left to right: zinc-rich epoxy, galvanized, 85-15 zinc-aluminum metalized, 100% zinc metalized, and copper metal.

Fig. 3: Coated steel floor grate used for dynamic testing.

In the mid 1990s, the U.S. Army Corps of Engineers determined that galvanizing and zinc metallizing also deterred the attachment of zebra mussels.[3] Longevity of antifouling coatings and zinc metallizing depends on flow rates, water chemistry, pH, water temperature, and salinity, whereas the longevity of foul-release coatings are not as dependent on these factors.

The goal of the present research is to find the coatings or technologies that work the best and longest for the Bureau of Reclamation's service conditions. Laboratory screening studies and field coupon testing have been conducted. The only way to determine if a coating will successfully resist the attachment of fouling organisms is to have the coating field tested to verify laboratory results.

Test Site and Exposure Conditions

The Bureau's coatings research program for zebra and quagga mussel control began in January 2008 at Parker Dam on the Colorado River. The test site was selected because of its rapidly increasing mussel infestation. There, quagga mussels can reproduce eleven months out of the year because of the warm water. The site also provided areas for static (non-flowing water) and dynamic (flowing water) testing.

Most antifouling coatings are designed for ships. Exposure conditions for ships vary with the purpose of the ship, but generally, ships travel at high speeds, 22 knots or higher, and then may sit for a period in static conditions in port. Exposure conditions for metal at Parker Dam differ from those for ships; at Parker Dam, in some areas, water is continually flowing (dynamic) through the trash racks, intakes, and power house to allow water downstream, while other areas see little or no flow. Velocities in dynamic areas vary between 0.1 and 6 ft/sec (Fig. 1).

The substrates for static condition testing are one-square-foot steel plates, 3⁄16 in. thick (Fig. 2). Three identical plates were hung by a rope off the face of the dam at 50 ft below the water surface. Steel floor grates for dynamic condition testing are 18 in. wide by 24 in. tall by 1 in. thick with one-inch spacing between grates (Fig. 3). The samples were tied behind the trash rack structure at 40 ft below the water surface. The samples were tied with two ropes so they would not spin from water flows through the grate spacing. Static and dynamic conditions were tested because different facilities have different requirements, and both conditions may exist at a site.

Copper, brass, and bronze were used as control samples to verify that mussels do not attach to these metals. Carbon steel was selected as a control to determine the rate of mussel attachment to the surface.

Table 1: Surface Materials and Coatings Tested May 2008

Metal or Metallic Coatings	Antifouling Coatings	Foul release Coatings
1. Copper	9. Copper Metal filled polyester resin	14. Fluoropolymer foul release coating
2. Brass	10. Cuprous oxide filled	15. Silicone foul release coating
3. Bronze	11. Ablative paint	16. Silicone epoxy waterborne coating
4. 90/10 Copper/Nickel	12. Zinc Omadine biocide coating	
5. Steel—uncoated	13. Sea-Nine 211® biocide coating	
6. Galvanized Steel		
7. 100% Zinc Metallizing on steel		
8. 85/15 Zinc/Aluminum Metallizing on steel		

Coatings and Materials in the Test

The first round of testing began in May 2008. Surface coatings and other surface materials investigated for mussel control were zinc metal coatings, copper metal alloys, copper-based antifouling coatings, biocide antifouling coatings, and foul-release coatings, all in contact with fresh water (Table 1).

All coatings were applied following the manufacturers' recommendations using compatible corrosion-resistant primers and compatible intermediate coats. Suitability of coatings was based on the performance criteria, shown below, developed through our experience of properties needed for a coating to be successful for our applications.

1. Proven antifouling performance of the coating in fresh water or marine environments.
2. Fouling resistance and/or easily cleaned.
3. Must not release unacceptable levels of toxins into the environment, i.e. meet EPA regulations for fresh water and canals for irrigation.
4. A minimum service life for two years with less than 10% mussel attachment on testing substrates.
5. Fouling resistance in static and dynamic flowing conditions.
6. Commercially available
7. Sufficient corrosion protection
8. Suitable for use with or without cathodic protection
9. Capable of being applied at 110 F and at a minimum of 40 F with humidity levels between 5% and 75%
10. Fully cured and hard for handling purposes. Coatings may be subject to a maximum temperature of 120 F and cannot get tacky at these high temperatures.

Results

After six months of exposure, it was clear that some materials and coatings worked while others did not. Only four

Continued

coatings remained in the study after six months, and only three coatings remained in the study in just over a year of exposure (Table 2).

Discussion of Results

Many coatings did not perform well for several reasons. For instance, exposure conditions are not the same as the shipping industry. Flow rates, water chemistry, pH, salinity, temperature, and related conditions play a key role in the leach rate of the biocides in antifouling

Table 2: Materials and Coatings Results

Metals or Metallic Coatings Tested	Plates	Grates
1. Copper	No mussels/no biofilm or algae growth. Remains in study after 12 months.	Not tested.
2. Brass	Few adults/ few juveniles/ minor. Remains in study after 12 months.	Not tested.
3. Bronze	Few mussels. Remains in study after 12 months.	Not tested.
4. 90/10 Copper nickel	Heavily fouled. Discarded at 4 months.	Not tested.
5. Steel—uncoated	Heavily fouled. Discarded at 7 months.	Heavily fouled 100% blockage. Discarded at 7 months.
6. Galvanized steel	Few mussels at 7 months; many mussels at 12 months. Discarded at 12 months.	Less than 10% blockage at 7 months; 80% blockage at 12 months. Discarded at 12 months.
7. Zinc metallizing on steel	Many mussels. Discarded at 7 months.	50% blockage. Discarded at 7 months.
8. Zinc/aluminum metallizing on steel	Many mussels. Discarded at 7 months.	75% blockage. Discarded at 7 months.
9. Copper metal-filled antifouling polyester	Few mussels, no biofilm and algae growth. Remains in study after 12 months.	Few mussels, some biofilm. Remains in study after 12 months.
10. Cuprous oxide antifouling coating	Bottom panel had many mussels attached; other 2 panels had only a few mussels attached, minor biofilm and no algae growth. Discarded at 7 months.	Few mussels, Druse (clumps of mussels), minor algae, 25% blockage. Discarded at 7 months.
11. Ablative antifouling paint	Several adults on bottom panel; few adults on other 2 panels, minor biofilm, no algae growth. Discarded at 12 months.	Many mussels, 25% blockage. Discarded at 12 months.
12. Zinc omadine biocide antifouling paint	Few adults/ minor biofilm or algae growth. Discarded at 7 months	Mussels, 20% blockage. Discarded at 7 months.
13. Proprietary biocide antifouling paint	Several adults attached on bottom panel that was in the mud line; no juveniles, minor biofilm, no algae growth. Discarded at 7 months.	Few mussel, 25% blockage. Discarded at 7 months.
14. Fluoropolymer foul-release coating	Few mussels with easy removal except in defected or damaged coating areas; minor biofilm and algae growth. Remains in study after 12 months.	No mussels; foul-release coat partially delaminated, some biofilm and algae growth, damage from concrete. Remains in study after 12 months.
15. Silicone foul-release coating	No mussels; damage from concrete. Remains in study after 12 months.	No mussels; damage from concrete. Remains in study after 12 months.
16. Waterborne silicone epoxy foul-release coating	Heavily fouled. Discarded at 7 months.	100% blockage; is not easier to remove than the other coatings. Discarded at 7 months.

coatings and zinc metals. Coating chemistries for antifouling and foul-release are vastly different. The self-polishing or ablative degradation mechanisms vary drastically with fresh water versus sea water. It is also possible that the manufacturers' testing conditions were not the same as ours.

The coatings that survived six months of continuous immersion were an ablative biocide antifouling, a copper metal-filled polyester, a fluoropolymer foul-release, and a silicone foul-release.

Metals or Metallic Coatings:

The copper, brass, and bronze controls remain mussel free for more than one year. The steel control sample was completely blocked from mussels at seven months (Fig. 4). The 90/10 copper/nickel was selected as an alternative metal for testing because it is stronger and more corrosion resistant than copper. In sea water, the 90/10 copper/nickel alloy is used as a construction material that resists fouling.[4] However, it fouled heavily at the test site after just four months of exposure (Fig. 5).

Fig. 4: Uncoated steel floor grate in dynamic conditions at 7 months of exposure.

Galvanizing, 100% zinc metallizing, and 85/15 zinc/aluminum metallizing were included because of the previous Army Corps of Engineers study. Because of the water chemistry, the zincs were passivated, possibly by zinc carbonate, and the zinc ions were not exposed at the surface to prevent settlement. Metallizing fouled at a faster rate than galvanizing because of the surface roughness. (Fig. 6)

Antifouling Coatings:

The copper metal-filled polyester coated

Continued

grate at one year of service had a few mussels attached, with only about 2–3% coverage. This product is nonablative; therefore, the binder matrix remains while the copper slowly leaches into the water. The service life will depend on the flow rate. At the time of this writing, the service life is unknown in static and dynamic conditions with this particular product. It remains in the testing past one year.

The cuprous oxide coating is an acrylic-based antifouling coating. It produced mixed results: in static conditions, two plates were mussel free while one plate was covered in mussels. In dynamic conditions, about 25% of the grate was covered with mussels, which does not meet the performance criteria.

Fig. 5: 90/10 Copper/nickel alloy in static conditions after 4 months of exposure.

The mechanism of the ablative coating is unknown. However, the majority of these types of coatings slowly hydrolyze or react with salts in the water, slowly eroding the coating. This particular product was withdrawn from the test at one year because it had over 10% mussel attachment in flowing conditions.

Zinc omadine is a biocide used in some antifouling coatings and other products. Unfortunately, it is unclear if zinc omadine actually works for mussel control because this product originally melted and glued all the panels together in the 115 F heat. The panels were pried apart with a screw driver but were still placed in the water for testing. The product fouled more than 10% at seven months, possibly because of surface roughness.

A proprietary biocide is gaining some major attention because it biodegrades relatively quickly. It uses the same binder as the zinc omadine coating and also melted in the desert heat. The panels were pried apart with a screw driver but were still placed in the water for testing. The product fouled more than 10% at seven months, possibly because of surface roughness.

Foul-Release Coatings

The fluoropolymer foul-release coating is non-toxic. It has remained mussel free for over one year and remains in testing. This coating requires a special tie coat and is relatively soft, so the fluoropolymer coating probably does not withstand gouging or rubbing of debris. The softness presents a problem because Reclamation is looking at using these coatings on trash racks, which will have debris such as branches, trees, weeds, and garbage. Another potential problem encountered is that the product requires a minimum of 30% relative humidity to cure properly. Some areas in the western U.S. have relative humidity levels of 15% or lower for at least part of the year, so localized humidifiers may be required to apply the fluoropolymer.

Fig. 6: 100% zinc metallized grate at 7 months exposure.

Table 3: Fluorinated Powder Coatings Tested May 2009

Fluorinated Powder Coatings
1. Poly vinylidene fluoride (PVDF)
2. Ethylene chloro trifluoroethylene copolymer (ECTFE)
3. Ethylene tetrafluoroethylene copolymer (ETFE)
4. Perfluoroalkoxy (PFA)
5. Fluorinated ethylene propylene (FEP)

The silicone foul-release coating is non-toxic but slowly releases its low molecular weight silicone oils. This coating has remained mussel free for over one year and remains in testing. This coating also requires a special tie coat. The silicone is also relatively soft and probably does not withstand gouging or rubbing of debris. The curing mechanism is a chemical cure and does not rely on moisture in the atmosphere. There do not appear to be any application issues related to the environmental conditions in the southwest deserts.

The silicone-epoxy waterborne coating is non-toxic, durable, and slick. However, the panels coated with it had mussel attachment levels equal to the steel plate controls. It was determined that the mussel attachment was just as high as a conventional epoxy coating and there was no benefit to continue testing, so these panels were withdrawn at seven months.

Current Testing

It has been a concern from the start that foul release coatings may be damaged easily during handling and installation, and from debris once installed. Reclamation, therefore, looked for coatings that would be more durable than the ones studied. Extensive literature reviews of the U.S. Naval Research Laboratory (NRL) documents were conducted because of their pioneering research with foul-release coatings for ships.[5,6,7] Evaluation of the physical properties of some of the polymers in the NRL documents indicated that NRL appeared to be investigating only relative adhesion for marine organisms.[7] According to NRL research published, poly (dimethyl

siloxane) was the best polymer for release properties even though it did not have the lowest surface energy.[7] Reclamation decided to investigate some of these polymers for resisting mussel settlement and durability in fresh water applications. Reclamation also decided that polymer sheets would not be useful as an end product; therefore, fluorinated powder coatings with similar chemistries would be investigated.

The second round of testing was started in May 2009, and aimed at investigating fluorinated powder coatings (Table 3). These fluorinated powder coatings are commercially available. The coatings would require metalwork to be small enough to fit into an industrial oven. These coatings are much more durable than the two foul-release coatings currently in testing. Initial results at six weeks showed some juvenile mussel attachment on two of the coatings while the other three coatings remained mussel free. Interim results to determine the ability of these coatings to resist the attachment of mussels will be discussed in a future paper.

Further Testing

Further testing involves evaluation of silicone foul-release coating, fluoropolymer foul-release coating, epoxy silicone foul-release coating, epoxy filled with PTFE powder, vinyl ester with a low coefficient of friction, and a fluorinated polyurethane. Panels and grates with these coatings were installed in November 2009, and some results will be discussed in a future paper. In addition, other products were incorporated into the testing in May 2010.

Conclusion

The Bureau of Reclamation has been evaluating commercial coatings and materials to deter the attachment of zebra and quagga mussels. The ultimate goal is to find coatings or materials to

Continued

obtain the longest service life mussel free. Reclamation has tested one metal alloy and eleven coatings. Only three coatings remain mussel free after one year in service. Current investigations are looking for coatings with greater durability that still prevents mussel attachment.

Disclaimer

The results of this research are site specific; some coatings may perform well in other service conditions, water chemistries, and service environments. The following data should not be used for advertising or promotional purposes. The information should not be construed as an endorsement of any product or firm by the Bureau of Reclamation, Department of Interior, or Federal Government.

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Allen Skaja earned his BS in Chemistry in 2000 and Ph.D. in Coatings and Polymeric Materials in 2005 from North Dakota State University. He joined the Bureau of Reclamation in June 2005 as a Coatings Specialist. Immediately he began evaluating coatings for corrosion protection. In Jan. 2008, he began testing coatings to deter the attachment of zebra/quagga mussels.

SSPC Awards Outstanding Student in Coatings

Andrew J. Comero received the Outstanding Student in Coatings Technology award from SSPC for his work at the Williamson Free School of Mechanical Trades (Media, PA). He was given a check for $50 and a 2-year membership to SSPC.

Andrew Comero receives the SSPC Outstanding Student in Coatings Technology award from Vice President of Education Thomas Wisneski.

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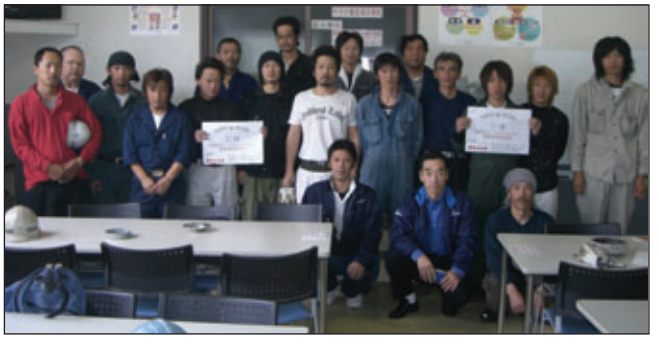
SSPC Trains on Both Sides of Pacific

An SSPC-C12 student in Seattle practices airless spray.

SSPC held its Airless Spray Basics C12 course in Seattle, WA, on May 12–13 and May 27–28. The course was hosted by Todd Pacific Shipyards Corp. and was instructed by Kieran Snow. Nineteen students participated.

SSPC held its Marine Plural Component Program (MPCAC), C14, in Sasebo, Japan, on May 29–30. There were 19 students in attendance, and the course was hosted by the SSPC Japan Chapter.



Students attend the SSPC-C14 course in Japan.

Two New SSPC International Chapters Established

The latest international chapters to join SSPC are the United Arab Emirates Chapter and the Saudi Chapter. UAE was awarded a charter on April 26, and Saudi was awarded a charter on April 28.

For more information on the Saudi Chapter, contact the chair, Bakr S. Hammad, at bakr.hammad@aramco.com. For details on the UAE Chapter, contact the chair, Pradeep Y. Radhakrishna, PCS, at wgarnet@emirates.net.ae.

SSPC Endorses KTA Nuclear Coatings Inspection Course

After a detailed review, SSPC has agreed to endorse the coatings inspection training course "Nuclear Power Plant Coatings Inspection," developed by KTA-Tator, Inc. (Pittsburgh, PA).

The course offers 4.5 days of interactive, hands-on training for nuclear facility owners, engineers, nuclear coatings inspectors, nuclear inspection supervisors, QA and QC personnel, and coating contractors who work in existing and new facilities. It provides the essential, nuclear-related instructional elements referenced in the ASME and ASTM standards for the plant certification of Level 1 nuclear coatings inspection personnel.

The curriculum addresses strategies for coating use in a nuclear plant; nuclear technology development; health physics; nuclear coatings inspector certification; the history of ANSI, ASME, and ASTM standards that regulate nuclear coatings operations; corrosion control through coatings; nuclear coating systems; surface preparation and cleanliness standards; the inspection of concrete surfaces; coating application; the coating work specification; and methods of preventing and correcting coating failures.

For the complete schedule, visit www.sspc.org or www.kta.com.

Training & Certification – August

August 9	Evaluating Common Coating Contract Clauses	Titusville, FL
August 9-13	Fundamentals of Protective Coatings (C1)	Phoenix, AZ
August 10-11	Project Management for Industrial Painting Contractors	Titusville, FL
August 11-12	Applicator Train-the-Trainer Program	Pittsburgh, PA
August 12-13	Quality Control Supervisor (QCS)	Port Orchard, WA
August 13	Coating Application Specialist Certification Program (CAS)	Pittsburgh, PA
August 15	Applicator Training Basics (online)	ecourse
August 15	Basics of Concrete Surface Preparation (online)	ecourse
August 15	Basics of Nonferrous Surface Preparation Short Course (online)	ecourse
August 15	Basics of Steel Surface Preparation (online)	ecourse
August 15	Marine Coatings (online)	ecourse
August 15	Planning and Specifying Industrial Coatings Projects (C2-online)	ecourse
August 15	Quality Control Supervisor (QCS-online)	ecourse
August 16-17	Concrete Coating Basics	Kent, WA
August 16-21	Protective Coatings Inspector Program (PCI)	Shanghai, China
August 18-21	Concrete Coating Inspector Program (CCI)	Kent. WA
August 21-22	Airless Spray Basics (C12)	Norfolk, VA
August 23-27	NAVSEA Basic Paint Inspector (NBPI)	Norfolk, VA
August 23-27	Planning & Specifying Industrial Coatings Projects (C2)	Henderson, NV
August 28	Protective Coatings Specialist (PCS)	Henderson, NV

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Planning Under Way for 38th Waterborne Symposium

The University of Southern Mississippi's School of Polymers and High Performance Materials issued a preliminary call for papers for the 38th annual Waterborne Symposium, scheduled for Feb. 28–March 4, 2011, in New Orleans.

The symposium chairmen—Dr. Shelby F. Thames and Dr. Robson F. Storey—said the symposium is seeking papers related to new and emerging technologies related to materials, processes, production, characterization, application, and markets in the field of surface coatings. Details on submission of abstracts were made available on June 25 in the official call for papers, the School of Polymers and High Performance Materials said.

More information is available from Melanie Heusser, phone 601-255-4475, email waterborne@usm.edu.

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International Paint Opens Marine Development Lab

Bob Taylor, managing director of International Paint's Marine and Protective Coatings Business Unit, presided at the formal opening of the new Worldwide Marine Laboratory, located in the Tuas industrial zone. The lab will focus on the development of the "next generation" of antifouling and foul release technologies, the company said.

The company said the new laboratory will be staffed by 20 chemists, with advanced equipment for measuring and assessing antifouling performance.

RPM Acquires Flooring-Systems Maker

RPM International Inc.'s Performance Coatings Group has acquired Hummervoll Industribelegg AS, a global supplier and installer of industrial flooring systems based in Bergen, Norway, with annual sales of more than $11 million.

Riley Joins Elcometer as Sales Manager

Michael Riley has joined Elcometer Inc. (Rochester Hills, Mich.) as sales manager for the U.S. and Canada, with respon-

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sibility for sales, marketing, and a stronger sales presence by the company and its expanded product pipeline.

Michael Riley

For the past nine years, Riley was a corporate account manager for Siemens Energy and Automation.

Barton Names Regional Sales Manager

Rick Miller

Barton Mines Company, a manufacturer of garnet abrasives for waterjet cutting and blast media, named Rick Miller regional sales manager for the Northwest region. Miller will be based at a regional office in Sultan, Wash.

Miller has more than 20 years of sales experience in the abrasives and industrial products industries.

Polyguard Wins U.S. 'E' Award

The Commerce Department has presented Polyguard Products Inc. with the President "E" Award, recognizing individuals, companies, or organizations that contribute to U.S. export trade.

The award, created by President John F. Kennedy in 1961, was presented by Commerce Secretary Gary Locke to Nate Muncaster, Polyguard global business development director, and Shawn Eastham, vice president of the company's Corrosion Products Group.

The company is based in Ennis, TX, and manufactures pipeline coatings, waterproofing, and related products.

Allied Painting Secures Delaware Memorial Bridge Contracts

By Alyssa Gallagher, Paint BidTracker

The Delaware River and Bay Authority awarded two contracts with a combined value of $2,853,600 to Allied Painting, Inc. (Franklinville, NJ), SSPC-QP 1 and QP 2 certified, to clean and recoat steel surfaces on the west girder spans of the Delaware Memorial Bridge. The 10,765-foot-long twin spans connect New Castle, DE, and Pennsville, NJ, over the Delaware River. The bridge is dedicated to veterans who gave their lives in World War II, the Korean War, the Vietnam War, and the Gulf War. Allied secured a contract of $951,800 to recoat 603,000 square feet of steel on the First Structure (Northbound) and a contract of $1,901,800 to recoat 659,500 square feet of steel on the Second Structure (Southbound). The steel, including the interior of piers, platforms, and ladders, will be spot power-tool cleaned (SSPC-SP 3), spot-primed, and coated with a 4-coat moisture-cured urethane system. The contractor will employ a third-party coatings inspector as part of the quality control plan.

Photo courtesy of Delaware River and Bay Authority

Crosno Construction to Rehabilitate Three Tanks

Crosno Construction Inc. (San Luis Obispo, CA) secured a contract of $569,501.04 with the City of Sunnyvale, CA, to repair and reline three 60-foot-diameter by 24-foot-high steel tanks at the Hamilton Water Plant. The interior surfaces will be abrasive blast cleaned to a Near-White finish (SSPC-SP 10) with a lead-stabilizing abrasive additive and lined with a 100%-solids elastomeric polyurethane system. The project also includes the application of an epoxy-polyurethane system to exterior surfaces. The contract, which requires containment of the existing lead-bearing coatings, includes furnishing a third-party NACE-certified coatings inspector to perform quality control inspection services.

Purcell Painting and Coatings to Line Fish Ponds

Photo courtesy of ODFW

The Oregon Department of Fish and Wildlife let a contract of $117,750.80 to Purcell Painting and Coatings (Tukwila, WA), SSPC-QP 1 and QP 2 certified, to repair and recoat 24 fish rearing ponds at Marion Forks Hatchery in Linn County, OR. The project involves abrasive blast cleaning and lining concrete wall and floor surfaces of the ponds with a 100%-solids elastomeric epoxy primer and a 100%-solids elastomeric polyurethane finish.

Project Information Source

Project Preview details coating contracts from the Paint BidTracker lead service. Sign up for a free trial at www.paintsquare.com/bidtracker/trial or use the bar code scanner app on your smart phone: