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Features

Departments

Also This Month

From the Offices of SSPC

Staff

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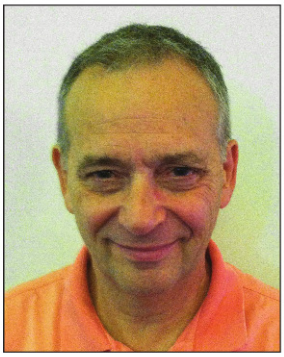


The Value of Coating Standards

Often taken for granted, coating industry standards are a crucial component of job success. They are the "universal language" of our industry and the keystone of every good specification.

Consider how difficult it is to estimate a job when the specification calls for a "commercial blast" or "power tool cleaning" with no referenced standard. Yet when specifications cite reference standards, everyone understands the exact requirements of the job.

Citing good standards in a specification removes ambiguity or the need for interpretation. If the specifier requires the contractor to achieve a "commercial abrasive blast," referencing SSPC-SP 6/NACE No. 3 in the specification leaves little doubt as to what is expected. The contractor can bid the work more accurately and the abrasive and equipment suppliers now know what material and supplies the contractor will need. Adding a reference to SSPC-VIS 1 gives everyone a visual comparator to supplement the written description of SSPC-SP 6/NACE No. 3. The inspector also has a clear baseline for what is acceptable.

There are also excellent standards and pictorial supplements available for hand and power tool cleaning (SSPC-SP 3, SP 15, SP 11 and VIS 3) or waterjetting (SSPC SP/NACE WJ-1, WJ-2, WJ-3, WJ-4 and VIS 5).

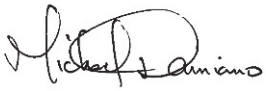
Rather than write a complicated requirement into a specification, the specifier can save time and avoid confusion by citing an industry standard that already contains the universal language that best describes the job requirement. By providing universal language and standardized wording for contractors, standards can also go a long way toward eliminating change orders and other claims that arise from ambiguous and unclear requirements.

Standards are beneficial to equipment and material suppliers as well, keeping them viable and in business. Specifying a coating material meeting the minimum requirements of SSPC Paint 29, Level 3 rather than asking the contractor to "coat it with a zinc-rich paint," permits the owner to establish a minimum level of performance and baseline compositional requirements. This, in turn, allows all coating suppliers of a given generic coating type to compete with one another on a level playing field.

Within the coatings industry, there remains a continuing need to develop pioneering standards that address new technologies and revise existing standards to make them better. Yet during these times when our companies are downsizing and each of us are asked to do more with less, we may be tempted to drop our involvement in standards development. This shortsightedness hurts our industry and its supporting organizations.

Owners should participate in standards development because good standards will help them achieve outcomes that meet their technical and budgetary expectations. Contractors need to get involved and press for better standards so they know how to properly bid on projects to achieve what the owner wants. Suppliers need to realize that standards set the performance requirements that all have to meet. Joining together in the coating standards development process encourages innovation, cooperation and quality work.

If we, as an industry, want to continue to improve the quality and reliability of our services, we need to understand the strategic value of continuing to develop and revise standards that set the tone for best coating industry practices in the years to come. To become active in the SSPC standards development process, contact Aimée Beggs at beggs@sspc.org or call 877-281-7772 for more information.



Michael Damiano
Director of Product Development, SSPC

New Webinar on UHP Waterjetting Available

Webinar Education Series

The 2014 SSPC/*JPCL* Webinar Education Series continues in September with the offering of a new, free online webinar.

"Addressing the Maintenance Challenge" will be presented on Thursday, Sept. 25, from 11:00 a.m. to 12:00 noon, EST.

The development of new technologies and methods to help overcome the challenges presented by the harsh environments of the offshore oil and gas industry — namely in the context of North Sea offshore fabric maintenance — include ultra-high-pressure (UHP) waterjetting as a surface preparation method prior to the application of protective coatings. This webinar develops an understanding of the potential benefits and main challenges posed by the adoption of UHP waterjetting and its implications in terms of coating materials selection. It includes an overview of the most common coating selection tools, highlighting limitations of conventional accelerated laboratory testing approaches in the context of UHP waterjetting. The webinar suggests adapted ways of selecting coatings for use over UHP-treated surfaces and presents an example of an existing technology to illustrate how specific coating materials can match the unique needs of UHP-treated surfaces. Additionally, information is shared about UHP wastewater treatment methods that enable an environmentally safe and economical way of managing UHP water on board offshore platforms. The conclusion points to UHP waterjetting as a preferred surface preparation method for offshore projects if properly selected coating materials and efficient water treatment systems are in place.

Joao Azevedo

Joao Azevedo, oil and gas market director (EMEA region), and Sandra Ball, product manager, both of Sherwin-Williams Protective & Marine Coatings, will present this webinar.

Azevedo joined Euronavy in 1999 as sales and marketing director, and from 2006 to 2008 he was director and one of the founders of Euronavy Coatings Singapore, managing mainly offshore projects. Since Euronavy's acquisition by Sherwin-Williams in 2008, he has assumed additional business development roles, with emphasis on protective coatings for offshore applications. He is a NACE Level 3-certified Coating Inspector, is qualified as a chemical engineer at the Technical University of Lisbon and holds an MBA specializing in marketing from the Catholic University of Lisbon.

Sandra Ball

Ball is responsible for driving profitable growth through active management of Sherwin's product portfolio. She works in close partnership with key stakeholders across the business to drive product vision and strategy for markets in oil and gas, infrastructure and marine. Her role oversees the complete protective coatings and passive fire protection portfolio for the EMEA region with regards to its lifecycle, continuous rationalization, positioning, new product development and competitive intelligence. Ball is a multi-disciplined Chartered Marketer with over 15 years' experience in B2B markets. She has also worked in the automotive industry where she was responsible for driving marketing and product strategies for business growth among original equipment and aftermarket clients.

Registration, CEU Credits

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

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

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

SSPC Training Round-Up

SSPC held its C14 Marine Plural Component Program (MPCAC) from July 30 to 31 at Pacific Shipyards International, LLC in Honolulu, Hawaii. Eight students attended the course, which was instructed by Douglas Eiss.

CIMTAS Pipe Fabrication and Trading Ltd. Co. in Bursa, Turkey, hosted SSPC's Protective Coatings Inspector (PCI) Levels 1 and 2 courses from July 21 to 26. There were 12 students present for these courses, which were instructed by Pradeep Radhakrishna, Tolga Diraz and Melih Iyigullu.

From July 28 to August 1, Gulf Engineers & Consultants, Inc. in Baton Rouge, La., hosted SSPC's Lead Paint Removal (C3) and Lead Paint Removal Refresher (C5) courses. Instructed by Fred Smith and Frank Rea, 14 students attended the courses.

From August 18 to 22, Vigor Industrial in Seattle, Wash., hosted SSPC's NAVSEA Basic Paint Inspector (NBPI) course, which was instructed by Gordon Kuljian and Charlie Harvilicz and had 20 attendees,

SSPC-QP 9 Revision Takes Effect

Effective July 1, new applicants for certification to SSPC-QP 9, "Standard Procedure for Evaluating the Qualifications of Commercial Painting and Coating Contractors," must meet the requirements of the January 2014 revision of the standard. Contractors already qualified to SSPC-QP 9 must meet the requirements of the January 2014 revision when their current certification period expires next March.

The revised standard eliminates the four qualification categories by requiring all painting contractors certified to the QP 9 standard to meet the same requirements. Commercial painting contractors who previously met the requirements of Category 1 through Category 3 now have the option to seek full QP 9 certification or apply for "introductory qualification" under SSPC-QP 7 until they gain enough experience to qualify for QP 9. Other changes to the standard include: formal training requirements for the QC Supervisor and Safety Manager; definitions of Quality Control Inspector, Quality Control Supervisor and Safety Manager; position requirements for Safety Manager; and a requirement that contractors have procedures in place for selecting and using subcontractors. A QP 9-certified painting contractor is then responsible for maintaining all program requirements when delivered directly by subcontractors. Contractors must also have a written craft worker assessment program.

For more information about these changes or to inquire about QP 9 certification, please contact Joe Berish at berish@sspc.org or 412-281-2331, ext. 2235.

The BUZZ on PaintSquare.com

HOT! This Month

Tower Coating Problem Probed *(Aug. 11)*

©iStockphoto/LPETTET

A reported coatings application error on a $99 million air traffic control tower at the Las Vegas McCarran International Airport may cost millions of dollars to repair and could set back the project a year, according to a Las Vegas newspaper. The problem was discovered in January and is now the subject of meetings by representatives of union workers, the contractor and subcontractors and the U.S. Federal Aviation Administration, the Las Vegas Review-Journal *reported Aug. 7 in a copyrighted investigative article. The tower project is under contract to Chicago-based Walsh Construction and Archer Western Contractors.*

From the Blogosphere...

Confined Space: Have We Learned Our Lesson Yet? *(Aug. 14)*

The clicks came rolling in for Michael Halliwell's recent blog, which addressed safety concerns for working in confined spaces and questioned why so many industry professionals remain ignorant or unaware of these considerations.

Thomas Murphy: *"As a frequent confined-space entrant, it is a constant concern when dealing with supervisors who are more focused on production and profit margins. The risks in confined-space work are obvious and no shortcuts or deviations are acceptable. Workers are forced to "hold the line" in the face of complacency."*

M. Halliwell: *"It's too bad that the almighty dollar has taken such a high precedence...even above human life. Hopefully, with the right people doing the right things, we can at least make a dent. It would be nice if the regulators 'had our back' on occasion too....a few more criminal charges might get supervisors' and managers' attention."*

PSN TOP 10 *(as of Aug. 29)*

- **Feds Suspend Painting JV for Fraud**
- **Bridge Issues Raise Criminal Concerns**
- **New Charges in PennDOT Scandal**
- **Contractor Must Rehire Whistleblower**
- **Poor Paint Storage Draws $90K Fine**
- **Construction Tabs Silica Paint at $3.9B**
- **Rare Order Targets Painter Intimidation**
- **Sherwin-Williams Launches Pipe Line**
- **DuPont Accused in Bridge-Tipping Storage**
- **Coatings Power Up Valspar's Q3**

Now Buzzing on PaintSquare...

Feds Suspend Painting JV for Fraud *(Aug. 5)*

Chuck Pease: *"Ten dollars to a donut, no one gets any time out of this. Any takers?"*

Car F.: *"I wish the same diligence and penalties would be imposed on the constant strings of employers who willfully disregard safety resulting in the death of workers."*

Suit Demands Overhaul of NYC Pavement *(Aug. 5)*

John Fauth: *"As I see it, the issue isn't whether disabled Americans (differently abled for the PC amongst us) are deserving of public accommodations. They are. Period."*

Mike McCloud: *"Why is a blind person walking in the middle of the street without some sort of escort? She can't take a little self responsibility?"*

Tony Rangus: *"Do we set priorities and do a 'triage' on what is really needed for the USA in total, or pander to the few to satisfy political correctness? Hard choices need to be made."*

M. Halliwell: *"I can understand the purpose of the suit, and it could easily be avoided with a little common sense (which seems grows less and less common these days)."*

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On Removing Thick-Film Elastomeric Floor Coatings

What is the best way to remove thick-film elastomers from floors and ship decks?

Lydia Frenzel
Advisory Council

The best way to remove thick elastomeric coatings is to use ultra-high-pressure waterjetting (UHP WJ) methods. I observed back in 1985 that waterjet cleaning at 20,000 psi could remove thick elastomeric coatings at a production rate up to six times faster than traditional abrasive blasting. The advent of UHP WJ methods make what used to be a time-consuming process to remove thick, elastomeric or abrasive-resistant coatings into an economical solution. Thick elastomeric coatings might serve as abrasive-resistant coatings. After removal of abrasive-resistant coatings that have been degraded (for example, icebreaker coatings) the substrate should be inspected for profile. Generally, if the coating has failed down to the substrate in spots, then the profile of those exposed areas have been mechanically compromised by further abrasion. If that is the case, then the profile in those areas should be renewed with abrasive blast methods back to the original manufacturer's requirements. Depending upon the coating, waterjet methods can be used to cut through the lining and then lift the coating in sheets or chunks. The operator has to optimize flow (for the hydraulic lifting) and pressure (for the cutting). I have photos and slides of a very thick flue gas scrubber coating that has been degraded, along with the observed removal rates where UHP WJ is six times faster than conventional dry abrasive blasting. This goes back to 1983, so 20,000 psi was the top limit and this was a slotted slot (fan) compared to conventional dry abrasive blast.

Jesse Chasteen
Schriener Construction

It would depend on size of area to be cleaned. Needle guns, deck crawlers, grinders, portable centrifugal blast or UHP waterjetting are all ways to remove thick-film elastomers. Accessibility would be the determining factor.

David Zuskin
SAIC/U.S. Naval Research Lab

The best way is to use ultra-high-pressure water jetting at 40,000 psi and above, using a hand lance. The UHP water slices through the thick-film elastomer and can be used to get under the coating and lift it from the substrate.

SSPC PROTECTIVE COATINGS SPECIALIST

Q&A with Duane Hough

by Charles Lange, *JPCL*

Duane Hough is the Chief Operating Officer at Champion Painting Specialty Services Corp. in Fort Lauderdale, Fla. He has been involved in the protective coatings industry since 1999. Hough is an SSPC-certified Level 3 Protective Coatings Inspector (PCI), a Level 2 Bridge Coating Inspector (BCI), a Level 2 Concrete Coating Inspector (CCI), a C-3 Supervisor/Competent Person and recently received his Master Coatings Inspector (MCI) certification. He is also a combat-decorated veteran of the U.S. Marine Corps.

JPCL: How did you get your start in the protective coatings industry?

DH: My first large-scale project was as a journeyman painter out of Local 411 in Harrisburg, Pa., working for Williams Power at the Three Mile Island Nuclear Plant. Prior to that, I had been doing mostly commercial and light industrial work. My brother, Kyle, mentored me in the areas in which I lacked experience, such as rigging, application of short pot life products and the nuclear arena.

JPCL: In addition to your PCS and other industry certifications, you were also recently certified as a Master Coating Inspector (MCI) through SSPC. Can you talk briefly about how these certifications have helped you in your work today?

DH: I was fortunate to be able to pursue certification courses. The additional knowledge I was given each time provided the opportunity to be able to interact with others within our industry (owner's reps, inspectors, engineers, etc.) and to have the opportunity to see how they approach projects. Many disputes can be resolved by taking the time to view an issue from another perspective, and frame a solution that resolves issues from multiple angles. I find that I run into issues when I assume that someone has the same knowledge and perspective as I do about a coating system or surface preparation technique. There are so many systems and techniques; you can spend your entire career without encountering many of them. Transparency and sharing knowledge go a long way in resolving disputes.

JPCL: You served as a Sergeant in the U.S. Marines Corps. First off, can you describe the extent of your military experience? Secondly, what are some of the lessons that you have taken from your military experience and applied to your protective coatings career, or your everyday life in general?

DH: I served a majority of my time as infantry with Golf Company in the 2nd Battalion, 2nd Marines "Warlords." I received my combat action ribbon in 1996 during Operation Assured Response in Monrovia, Liberia, while attached to the 22nd MEU SOC. My company spent three months in Panama in 1997 completing jungle training and serving as a security response unit. I extended my service to complete my second Mediterranean Float in 1998, for which I trained as a coxswain of the Combat Rubber Reconnaissance Crafts, again attached to 22nd MEU SOC, and we secured the embassy housing complex in Tirana, Albania when it was targeted after the embassy bombings in Africa.

There are many lessons I learned in the Corps that I have applied in my career in coatings. Most of my time is spent divided between business growth and systems management. Similar to my time as an infantry sergeant, I am constantly evaluating strengths and weaknesses and structuring plans based upon the results of those analyses. Every project is dynamic and requires detailed pre-planning and a team on the ground that can adjust to conditions and make decisions based upon project goals.

JPCL: You work with your brother, Kyle, at Champion, and have collaborated on papers and presentations together in the past. What's it like working with a family member - especially someone as close as your brother?

Do typical brotherly disagreements that arise in some families ever cross over into your everyday work?
DH: Although Kyle is my younger brother, he is my mentor in this industry. The reason I started in this industry was to be able to work with him, and it is part of the reason I enjoy coming to work every day. We had an atypical childhood and often had only each other to rely on, so we don't have those typical brotherly disagreements.

JPCL: What advice would you give a young person looking to get into the protective coatings industry today?
DH: I had a difficult time adjusting to civilian life when I left the military, and I feel that our industry has a lot of elements that can make that transition less difficult. Our industry is a great fit for anyone who is looking for structure, constant challenges, travel and growth dependent upon personal ability and drive.

JPCL: Is there a project or job that you worked on in the past or are currently working on that is particularly memorable? What makes this project stand out in your mind?
DH: We are currently working on the Miami Ave. Bridge with the Kiewit Infrastructure Group. The initial existing condition assessment determined that a majority of the topcoat has failed, but most of the zinc primer and some of the intermediate is intact. We have access to one leaf of each bridge at a time, so we are able to rig and contain each in the upright position. We are applying a Carboline coating system of Carboguard 635 (cross-linked epoxy polymeric amine) and Carbothane 133 LH (aliphatic acrylic-polyester polyurethane).

JPCL: What has been the highlight or proudest moment of your career thus far?
DH: Kyle and I took and passed the PCS course together. It was the first time that our schedules had allowed us to do any courses or testing together.

JPCL: What is your favorite thing about the work that you do?
DH: Estimating projects. I enjoy breaking everything down to the numbers and working through a project in my mind. It is also the calmest portion of any project, because once the project is awarded, all of the moving parts flurry into motion.

JPCL: How do you like to spend your free time outside of work? What are some of your interests and hobbies?
DH: I love to spend time at the beach or in the Florida Keys with my wife, daughters, nieces, nephews and the rest of my extended family - it's one of the benefits of living in Fort Lauderdale. Most of my free time is late night after all the girls are in bed, so I like to decompress by reading or playing a fantasy or sci-fi computer game after finishing my coursework. I am working to finish my bachelor's degree at Penn State University through their online World Campus.

Hough on the beach in St. Augustine, Fla., with his wife, Julie, and four daughters Brianne, Parker, Avery and Tessa.

Drying ≠ Curing: Topcoating Ethyl Silicate Inorganic Zinc-Rich Primers Too Soon

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

Inorganic zinc (IOZ) primers are one of the leading corrosion-inhibitive primers available today. They prevent corrosion so readily because they are highly filled with zinc powder (usually 85 percent or more by weight), which serves as a sacrificial anode preventing corrosion when in intimate contact with well-prepared steel.

However, the inorganic zinc primers come with their own set of limitations. Specifically, problems can arise with adequate curing prior to overcoating. IOZ's cure uses the following reaction:

$$Si(OC_2H_5)_4 + 4H_2O \rightarrow SiO \text{ compounds} + C_2H_6O$$

Essentially, tetraethyl orthosilicate [$Si(OC_2H_5)_4$] and other alkyl silicates react with airborne moisture/water, releasing ethanol. A silicate-based structure is formed. Problems arise when there is insufficient moisture present in the air to ensure a complete reaction of the silicates.

While some manufacturers require a minimum relative humidity of 40 percent in order to ensure adequate cure, a minimum of 50 percent is often specified when IOZ is applied. In colder climates humidity levels are often below 30 percent, especially when the already dry winter air is heated in the shop. Consider that the moisture capacity of air at 40 F is only about 5 grams per kilogram (g/Kg) of air. A relative humidity of 40 percent contains only about 2 g/Kg. This same quantity of moisture is equivalent to 20 percent relative humidity at about 60 F. IOZ requires a finite amount of water to properly cure and until that quantity is available to the resin, cure will not be complete. (Conversely, excessively high humidity will inhibit evaporation of solvent, leave unreacted water in the porous matrix and inhibit release of the reaction product, ethanol.)

Similarly, shops that are located in the arid west and southwest can also encounter curing issues as a result of dry air. It is not uncommon to see relative humidity conditions in the 10 to 20 percent range in Nevada, Arizona and the surrounding states. While some shops may have humidity-controlled atmospheres, limited interior storage space will often lead to moving partially cured primed components outdoors where humidity may be low. These dry conditions will cause solvents to evaporate rapidly from the film, resulting in a dry but

Fig. 1: Pictured here is a bridge where only one girder had thick, uncured zinc. Note the significant failures. The other girders were cured and had no failures. Photos courtesy of KTA-Tator, Inc.

uncured primer. If the applicator knows that IOZ primers react with moisture to cure and recognizes that arid conditions exist, the primed surfaces can be misted with water an hour or so after application in order to facilitate the curing reaction. Multiple applications of water may be necessary, because the water will also evaporate from the surfaces rapidly under arid conditions. Special fans equipped with water atomizers can also be effective. Misting the primed surfaces with water or saturating the floor with water to increase the relative humidity in the shop must be done reasonably soon after application (i.e., within one to two hours), as the reaction with moisture must occur early in the curing phase.

When uncured IOZ primers are overcoated too soon, the product is essentially sealed off from the available moisture and a complete cure may never be achieved. In steel fabrication and in blast and paint shops, production rates are always a concern and multiple coat systems can present a bottleneck. In the past, only the primer coat was applied and the IOZ had more than ample time to cure during shipping and storage. Today, two- or three-coat systems may all be applied in the shop in order to limit the amount of field painting required. Limited shop floor area often dictates that the steel be fabricated, abrasive blast cleaned, primed and overcoated with one or more finish coats in rapid succession to improve shop throughput. When this occurs, the primer may not be subjected to moisture long enough to fully cure. That is, IOZ primers are not traditionally considered a rapid recoat product, especially under dry conditions. This is counterintuitive for some.

The curing of inorganic zinc primers may also be inhibited by the application of thicker film builds. Traditionally, the standard thickness has been 2 to 3 mils' dry film thickness (DFT). In more recent years some manufacturers have increased the recommended thickness up to 6 or 7 mils, perhaps to avoid rejection of excess thickness in overlap areas such as web or flange interfaces.

When overly thick IOZ films are applied, moisture may have a more difficult time penetrating through the cross-section and curing the film. Although often thought to be "self-policing" via

the presence of micro-cracking or mud-cracking when applied excessively thick, that is not always the case. Micro-cracking may never be discovered until a coating failure occurs.

Inorganic zinc primers can be assessed for degree of cure using two relatively simple tests. The first test, described in ASTM D4752, "Standard Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub," involves rubbing the surface of the primer back and forth (double rub) for fifty times with a white cloth saturated in methyl ethyl ketone (MEK). The binder in the uncured film is soluble in MEK and can be removed if it is not completely cured; while a completely cured film is not soluble and will resist the solvent. A relative resistance rating is assigned based on the double-rub test. A rating of 5 indicates that there was no effect on the surface, while a rating of 0 indicates that the film was penetrated to the substrate in 50 double rubs or less. Note that a small amount of discoloration may be present on the cloth (due to burnishing of the zinc) even though the primer is cured. The specifier may invoke a minimum resistance rating based on the ASTM standard prior to over coating the IOZ.

The second test, the coin rub test, has no industry standard to describe it. However, it is widely used to assess cure and is fairly reliable. It is conducted by rubbing the edge of a coin (for example a nickel) across the surface of the primer. The surface of a cured IOZ primer will burnish (become shiny), while an uncured primer will powder.

Fig. 2: This photo shows an area where the IOZ had been exposed for a couple weeks. When the topcoats were pulled away separation occurred within the zinc layer, with zinc on the back of the delamination and left on the bridge.

While impractical in the shop or field, the cure rate of inorganic zinc primers can be monitored using laboratory analytical techniques including Fourier

Transform Infrared Spectroscopy. Samples can be prepared and spectra obtained at various time intervals and under varying curing conditions of temperature and humidity. The cure ratio can be determined based upon the disappearance of organic groups by integration of the areas of absorption spectral bands due to the aliphatic carbon-hydrogen stretching vibration near 2900cm^{-1} relative to the silicate vibrations near 1050cm^{-1}.

Visual evidence of coating system failure due to over coating uncured inorganic zinc may be immediate or may be delayed. If years pass by prior to noticing the problem, the failure may become catastrophic including widespread delamination cohesively within the inorganic zinc primer. Generally, a mil or two of zinc remains behind but in a relatively short time period (a few weeks), the uncured zinc is worn away and rust appears on the surface of the steel.

Fig. 3: Excessive impact damage on a light rail line that occurred during erection is visible in this image.

The delamination typically occurs due to the stresses imparted by the coating layer(s) applied over the primer, causing the weakened primer to cohesively separate. Epoxy mid-coats are often the next coat that is applied after the primer. These coatings contain strong solvents that penetrate the uncured primer and the epoxy resin exerts stress on the underlying layer during the crosslinking process. Naturally, an increased thickness in the zinc primer or overcoats worsens the problem.

A recent "Cases from the F-Files" column ("Can In-Process Quality Control Prevent Premature Coating Failure?" *JPCL*, January 2013) described several case studies of coating failures that were caused in part by a lack of quality control. Case Study No. 3 is repeated on the next page because it clearly illustrates the phenomena described in this column.

Case Study No. 3: You Know What They Say, Dry Heat is More Comfortable

Background:

The project specification required abrasive blast cleaning to achieve a Near-White Metal finish per SSPC-SP 10/NACE No. 2 and the application of an inorganic zinc primer to structural steel components in the fabrication shop. Application of the intermediate coat was also performed in the shop, while the topcoat was scheduled for application in the field after erection and bolting of the steel. The work was done in the winter months and the shop was heated. The fabricator's quality control specialist kept documentation revealing that they had conformed to the thickness and recoat times recommended by the coating manufacturer's technical representative, who visited the shop during coating application activities. The steel was loaded onto trucks and shipped to the site. Upon arrival at the construction site spontaneous cracking of the coating along the fillet weld (where the web and flange are joined) was discovered. That cracking and lifting along the fillet, and the poor adhesion of the coating system on the web was evident. Examination of a disbonded coating chip revealed the presence of zinc primer on the back side of the chip and on the steel surface, indicating that the location of break was cohesive within the zinc primer.

Cause:

Ethyl silicate type inorganic zinc-rich primers require moisture to cure. In this case, an insufficient length of time was allowed before the application of the epoxy mid-coat. Once the epoxy was applied, no more moisture could react with the primer, since it was effectively sealed off by the epoxy. The zinc primer remained in a dry, but uncured (and weakened state). The solvents from the epoxy mid-coat penetrated the uncured primer, and the contractive curing stresses imparted by the epoxy caused the zinc primer to cohesively split. Since the web and flange are adjacent to one another, the thickness of the epoxy was slightly higher along the fillet weld area. The

higher thickness exacerbated the problem and resulted in the cracking and detachment. When other areas were evaluated, it became evident that the entire system was at risk for failure.

Avoidance Through Quality Control Inspection?

Inorganic zinc-rich primers dry very quickly (especially in a heated environment); however they may not cure for many hours or even days if the humidity is too low within the prevailing environment. The key is to verify that the conditions of temperature and humidity (listed on the product data sheets) are present in the shop prior to application and to verify that the cure has been achieved, rather than relying on cure-time tables provided by the coating manufacturer, or assuming that drying and curing are synonymous. Quality control inspection by the fabricator should have included a curing test. In fact there is one specifically designed for the type of coating described by this case study (ASTM D4752, referenced earlier). Once a resistance rating of 4 or 5 is achieved (after 50 double rubs) the zinc-rich primer can be considered cured and ready for recoating. Some manufacturers rely on pencil hardness data instead of solvent resistance to assess cure. Either way, a knowledgeable QC inspector knows how specific coating types cure, the conditions that are necessary for the reactions to occur, and the tests that are available to verify coating film properties prior to overcoating.

While it may take some time for the failure to reveal itself, some telltale signs are often evident during the storage and erection processes. These observations may be disregarded as normal coating defects by construction companies or coating manufacturers. One indication that there is a problem is when there is an excessive amount of impact damage that occurs during erection. The topcoats are exerting stresses on the weakened IOZ primer. When the coating is impacted, the stress is relieved and the coating literally pops off of the surface, typically separating

cohesively within the zinc primer layer. This problem can be exacerbated by the application of thick topcoats as even greater stresses are exerted on the primer.

A second indicator of a problem is when large delaminations occur after one or two winters. The stresses caused by thermal expansion and contraction of the steel members may cause spontaneous delaminations. These failures may be isolated to only a few areas but are indications that the problem may be more widespread. Of course, the wearing away of the remaining IOZ film after it is exposed and the formation of rust on the surface of the steel is another indicator of a problem.

Conclusions

In summary, the key parameters in assuring a sound application of inorganic zinc are to:

1. Apply the primer at the correct thickness;
2. Verify that the primed steel is stored in an area with relative humidity conditions above the coating manufacturer's minimum and ideally in excess of 50 percent;
3. Verify that the primer is allowed to cure for the manufacturer's recommended cure time under conditions of temperature and humidity; and
4. Verify the cure using the solvent rub test or other prescribed procedures.

Never assume the zinc primer has cured just because the prevailing conditions conformed to the manufacturer's product data sheets. Cure times may need to be adjusted if the primed components are stored at locations with varying ambient conditions.

About the Author

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JPCL

Safe Use of Ultra-High-Pressure Waterjetting

Ultra-high-pressure waterjetting (UHP WJ) is defined by SSPC and NACE as cleaning with water pressures above 30,000 psi. While these high pressures can be effective for cleaning, they are also dangerous.

The Basics

UHP WJ systems consist of a high-pressure pump, hoses and various tools. The hydraulic hoses used must have a bursting strength of 2.5 times the maximum-rated operating capacity; a 30,000 psi unit requires hoses with a minimum bursting strength of 75,000 psi. The tools used in field surface preparation consist of a control valve, lance (wand) and nozzle assembly. These tools can be manual or robotic (automated). In manually operated systems, this nozzle is usually referred to as the jetting gun. The control valve is operated by a trigger, which is protected by a trigger guard. The lance is a section of metal pipe that allows the operator to point the nozzle assembly at the surface. Robotic systems use tools such as wall crawlers or articulating arms to direct the high pressure water, and can also include a vacuum system to contain water and debris. The nozzle assembly contains the jets, which are orifices or tips that have very small openings. Tools can have a single jet, a fan-shaped jet or multiple rotating jets. The most common arrangement on UHP WJ equipment for cleaning steel is a rotating multiple-jet assembly. A single jet has a very small blast pattern. Multiple jets on a rotating head increase the size of the blast pattern to increase productivity. Rotation also increases the cutting action.

With UHP WJ, the pressure (i.e., velocity) of the water is the main energy characteristic that performs the cleaning. This is different from high-pressure waterjetting (HP WJ) units that operate between 10,000 and 30,000 psi, where flow rate plays a role equal to water velocity in cleaning. Pressure falls off quickly with distance. Productive cleaning with UHP WJ requires keeping the nozzle .25 to .5 inches from the surface. HP WJ units, where flow rate contributes to cleaning, are normally held 2 to 10 inches from the surface. UHP WJ requires closer stand-off distance, yet is, however, especially dangerous at close distances. The closer you are to the surface, the closer the wand end is to your body and the more you are at risk.

Fig. 1: Personal protective equipment, including head, eye, body, foot, hand, hearing and respiratory protection, should be worn at all times when during UHP waterjetting operations.
Photo courtesy of Jetstream of Houston, LLP

Safety Hazards

Water pressure of 30,000 psi is extremely powerful and dangerous. The main safety hazards associated with UHP WJ are injection and fatigue.

UHP WJ can cut skin and bones at close distances. Air injection equipment used to give vaccinations operates at about 600 psi; UHP WJ units use pressures about 50 to 90 times higher. A waterjet striking you from several centimeters can easily pene-

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trate the skin. If this happens, you may not see the full extent of the injury. The entry wound may be quite small and may not bleed, but there is no telling how much water was injected into the body or if any internal damage was done. Microorganisms can enter through the wound and spread inside the body.

If an accident occurs that penetrates the skin, medical attention should be sought immediately. If it is not possible to have the injury treated immediately, restrict first aid to dressing the wound and observing the person until a medical examination can be performed. The injury should be monitored by a physician for several days to make sure that infection does not occur. Because physicians may not be immediately familiar with the dangers of a high-pressure injection injury and may treat only the superficial wound, it is recommended that operators carry a card detailing dangers and emergency treatment of a waterjet injection injury. These cards are available from the WJTA-IMCA.

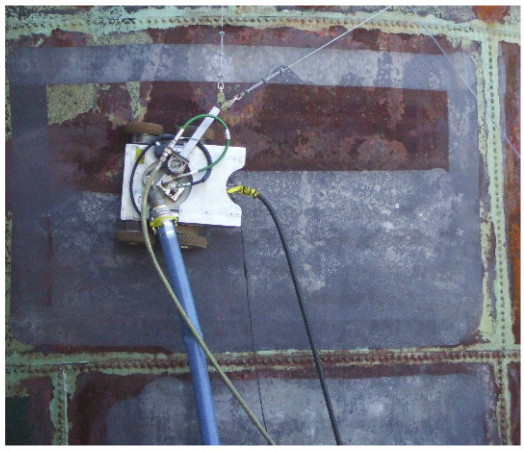

Fig. 2: Automated systems, such as this robotic wall crawler, allow operators to keep a safe distance from the surface being cleaned during UHP waterjetting.
Photo courtesy of NLB Corp.

Another possibility in addition to injection is that skin or flesh can be removed. This takes less than 0.1 seconds if the wand is swept past an unprotected body part.

An associated safety hazard is a hose rupture. Experience has shown that 90 to 95 percent of hose ruptures occur 5 to 10 inches from the connection to the lance. A hit from a waterjet at close distance to the abdomen or neck can be fatal. Special hose protection that is attached to the hose near the lance is available to protect against being hit by these types of hose ruptures.

Fatigue is another problem associated with waterjetting. This results from the back

thrust of the equipment. Back thrust can be calculated from the equation:

Back thrust (lbs.) = 0.052 x Q x $P^{1/2}$

where:

Q = flow rate (U.S. gal./min)

P = jet pressure (psi)

For example, an operator working with a jet at 30,000 psi and using 6 gal./min. will experience a force equal to 54 lbs. It is recommended for a person to be able to withstand a back thrust of up to one-third of his or her body weight. Fatigue can happen in minutes or less, depending on the worker. Therefore, the operator for this example should weigh at least 162 lbs.

Safety Equipment

Proper personal protective equipment (PPE) should be worn when using UHP WJ equipment. This includes head, eye, body, foot, hand, hearing and respiratory protection.

Head and eye protection should be worn at all times. The head protection should include a full face shield and/or eye protection such as goggles for visibility. Water droplets forming on goggles or face shields may be a nuisance, but it is still easier to see through wet goggles than it is when you get water directly in your eyes. In addition, material removed from the surface can get into the eyes if they are not protected.

Waterproof clothing must be worn to protect the body. The garment should completely cover the operator, including the arms and legs. Regular work clothes will quickly become saturated with water. The protective clothing should have an outer layer that repels rebounding water and provides protection from rebounding debris. Most typical wet suits worn by operators will not stop penetration of the waterjet into the skin if the nozzle gets too close to the body.

PPE designed and certified specifically for UHP WJ is recommended for the operator. This special UHP WJ protective clothing is made from high-strength materials that can take the sweep of the jet at a distance of 3 inches and up to 43,500 psi without penetration. The type of nozzle and time duration that the nozzle is directed at the material is also important. Rotary nozzles disperse water over a larger area, and a single-orifice nozzle is a more concentrated force on a smaller area. The faster that the nozzle is swept over the surface, the lower the chance for injury.

Feet are especially susceptible to inadvertent exposure to the waterjets at close distance if the operator should point the lance down without shutting off the equipment. Waterproof boots with steel toe caps should

be worn by everyone on the job. The operator should also wear a metatarsal guard atop the boots and hands should be protected with plastic-coated or rubber gloves.

Hearing protection is also needed because UHP WJ can generate over 90 decibels in the operator's hearing zone.

Respiratory protection may be required, depending on the hazards associated with the materials being removed. The selection of respirator type depends on the severity of the hazard. Water does suppress dust, so the need for respiratory protection is reduced compared to using dry methods of surface preparation. A qualified safety or health professional should be involved in risk assessment and selection of respirator type. Be aware that filter cartridge respirators can become saturated with water for anyone close to the waterjetting, especially the operator, which can lead to difficulty breathing. Because of this, supplied-air respirators are recommended for UHP WJ if respiratory protection is needed. Note also that other aspects of a worker protection program may be required if a hazardous material is being removed.

Equipment Operation

Safety in UHP WJ includes proper care and operation of equipment. The equipment should be inspected before use. Hoses should be checked for evidence of damage, wear or imperfections. This can include compromised wire braids, mechanical damage such as flat spots, crimping or damage to the threads on the hose end. All hoses and hose connections should be checked to make sure they are rated for use at the pressures to be used. WJTA-IMCA has recommended a color coding scheme for pressure hoses to help identify their maximum allowable working pressure. Hoses should also be marked with their maximum working pressure. Hoses should be laid out to avoid creating tripping hazards, and they should be protected from being run over and crushed by forklifts or other vehicles and to avoid or minimize abrasive wear. The fittings should be cleaned before installing them into the system.

Once installed, the fittings should be checked to make sure the connections are leak free. The point where the hose connects to the gun should be fitted with a hose shroud that will protect the operator from high-pressure water if the hose, pipe or fitting breaks open. A hose shroud consists of a length of heavy-duty hose or a shoulder guard, generally 6 feet, but sometimes longer. The shroud should be inspect-

ed before each use and removed from service if a hose burst occurs within it.

The system should be flushed with clean water before use to remove any contaminants that may clog the nozzles. The orifices in the nozzles should be checked for blockage, damage or imperfections. The orifices do wear out and need to be replaced regularly. After the system has been checked, it should be slowly pressurized to make sure the nozzle openings are open and clear. A clogged orifice, especially on a set-up with multiple nozzles or a self-rotating nozzle assembly, can be very dangerous. When a nozzle assembly contains multiple offset nozzles, clogging of one nozzle puts the sideways forces off-balance, causing the tool to suddenly be thrust to one side and the worker to lose his or her balance.

In addition to the hoses, the unit should be visually checked. All fittings should be tight and leak free. UHP WJ units are equipped with a bursting or rupture disc located on the pump. This is normally a metal disc in a specially designed holder. The disc is similar in purpose to a relief valve on a hot water heater. The disc is meant to fail (burst or rupture) if the pressure applied to it exceeds a set level. A properly sized disc must be used for a given operating pressure.

While the system is under pressure, no nut, hose connection, fitting or other component of the equipment should be tightened or otherwise adjusted apart from the normal adjusting of valves and other components required for proper equipment operation. The pumps must be stopped, and any pressure in the lines must be discharged before adjustments or repairs are made.

Waterjetting requires at least two people. One operates the pump, and the other operates the gun. There are no controls on the gun except the trigger and a dump valve. The dump valve is a safety device similar to a deadman switch on a dry abrasive blast setup that controls a dump system that will shut down the pump, idle it to low speed, bypass the water flow or reduce the discharge pressure to a low level. This is a very important safety device for the personal protection of the gun operator. It should be on every gun, and it should be operational.

There needs to be good coordination between the pump and gun operators. The pump operator should bring the pressure up slowly, and only after the gun operator has signaled that he or she is ready. The gun operator needs firm footing and should hold the gun in the operating position. Some

guns have a shoulder stock that needs to be in position before pressurizing begins. The operator must be prepared for the back thrust that will develop as the pressure increases. Preparation usually consists of leaning forward and letting the back thrust straighten you up. The pump operator should not change the operating pressure unless the nozzle operator is aware that an adjustment is going to occur. The pressure should be slowly reduced at shutdown so the gun operator does not lose his or her balance.

The gun operator needs to be aware of the change in thrust if the system fails or if the dump valve is activated. This awareness comes from experience, i.e., activate the dump valve a few times until you are familiar with how to position yourself to withstand the change in thrust.

The work area should have a warning barrier such as a barricade or tape when UHP WJ is in operation. Warning signs should be posted to tell others to stay out of this hazardous area. No unauthorized person should be allowed in the work area. If two or more gun operators are working in an area, a physical barrier should be installed or the workers should be adequately spaced to prevent one worker from accidentally injuring another.

The pump operator should be in visual contact with the gun operator at all times. If this is not possible due to layout of the site, another worker should be positioned where both operators are in sight to relay signals, such as the gun operator signaling the pump operator to shut down the system. The pump and gun operators should establish hand signals to use because the equipment and operation are so noisy.

Whenever work stops, the system should be depressurized. Even though there is a trigger guard to protect against accidental operation of the system, there is a small possibility of accidental actuation if the gun were to fall or move. If the system is not depressurized, there is a greater possibility of a hose rupture or leak that cannot be reacted to immediately if workers are on break.

Conclusion

UHP WJ has inherent dangers because of the high pressures involved. Serious bodily harm can occur if the equipment is not used properly or proper personal protective equipment is not worn. A good source of information is "Recommended Practices for the Use of High Pressure Water Jetting Equipment," published by the WJTA-IMCA (www.wjta.org).

Maintenance Painting Practices for Offshore Oil & Gas Structures

Part One

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All other photos courtesy of the author

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Offshore oil and gas structures, typically floating production, storage and offloading vessels (FPSOs) and the more conventional fixed platforms, are usually very complex assemblies of fabricated steelwork, metalwork, pressure vessels, structural members, tanks, pressure equipment, valves, pumps, screens and pipework crammed into a very tight and congested deck footprint. The most widely used material of construction for these assets is carbon steel, with lesser amounts of stainless steel (in a variety of grades), galvanized steel and some nonferrous metals.

Operating around the clock in a marine environment with the ever-present influences of heat, moisture, marine salts, guano (bird droppings), ultra violet (UV) light, well fluids, vibration, pressure, abrasion and impacts mean that these materials of construction are extremely vulnerable to corrosion. The most common method of limiting corrosion and metal loss is the use of liquid-applied protective coatings.

While not ignoring the prospects of internal corrosion of vessels, pipelines and tankage, the major risk to offshore structures arises from external corrosion, principally atmospheric corrosion. In atmospheric corrosion, the corrodent of concern is oxygen. In this context, the corrodent is defined as the cathodic reductant, i.e., the material that steals electrons from the steel substrate.

The chemical reaction depicting oxygen as the corrodent is:

$$O_2 + 2H_2O + 2e^- \longrightarrow 4OH^-$$

This reaction shows that oxygen dissolved in water plus the negatively-charged electrons it takes from the steel will form hydroxyl ions. The corresponding reaction with the steel losing electrons then allows the formation of ferrous hydroxide and other hydrated iron/oxygen compounds we know as rust.

Acids and alkalis can also be corrodents, and there are some of these materials present on most offshore structures, but the reactions resulting would be more accurately described as chemical corrosion rather than atmospheric corrosion, which is the form that would be most widespread. The important point is that chloride, sodium or other ions, for example from marine salt, might be influential in atmospheric corrosion, but they are more correctly defined as corrosive agents not corrodents.

Protective coatings have a long and effective history of providing protection to carbon steel and other corrodible metals by minimizing the ability of the corrodent and the electrolyte (typically moisture) from accessing the substrate. The operating environment on an FPSO or an oil and/or gas production platform would probably rate as one of the more corrosive that coatings engineers might face.

The Adoption of FPSOs

An FPSO is a floating oil and/or gas production facility with all production equipment and crew accommodation mounted on a ship hull instead of a conventional rectangular platform. It is held on station by an automated mooring system and hooked up to nearby subsea or surface-completed wells.

Over the past couple of decades, the popularity of FPSOs has grown markedly as offshore field operators have realized that they potentially offer a faster way to get a facility into production after the wells have been drilled and connected using flexible flow lines to a floating buoy or riser assembly that is picked up by the turret usually on the bow of the vessel. The floating riser might have a dozen or more individual high-pressure flow lines, and when connected to the turret, each flow line connects uniquely to a matching line on the facility. The turret or swivel allows the vessel to weathervane around the floating riser in response to the wind or sea currents ensuring that each flow line retains its unique hydraulic connection.

Using an FPSO often means that the wells are in production much quicker than if a conventional fixed platform were to be employed because the construction or conversion of the FPSO, the drilling/subsea work and the construction of the floating buoy can be done concurrently and then quite quickly connected and commissioned. FPSOs have also become popular as petroleum production has moved into marginal fields and remote offshore locations without nearby refineries or pipeline infrastructure. An FPSO has integral storage for a large

Editor's Note: This article is the first in a two-part series. Look for Part Two in early 2015.

quantity of crude oil within the ship hull, so it need not be connected to a pipeline network. Moreover, an FPSO can operate in a wide variety of water depths, has a large deck for processing equipment and can be simply transported to the oilfield, disconnected and relocated.

Design Aspects

It is unquestionably true that the best way to combat corrosion and minimize metal loss — whatever the service environment, but particularly offshore — is by sound and professional design. This does not just mean structural design and detailing; it also involves intelligent material selection, avoiding dissimilar metals, using bolts and fasteners that match the metals and items being joined, avoiding ponding and poor drainage zones, ensuring access for surfaces to dry out to reduce the time-of-wetness, aiding physical access for inspection and maintenance, as well as careful design of coating systems and corrosion mitigation measures for each and all of the substrates and service environments expected.

When any of these details is not performed well, in the highly corrosive offshore marine environment, the most common outcome is the commencement of coating breakdown or corrosion.

Good design of coating systems not only involves nominating the surface preparation, quality and appropriate coating products for each layer and system and specifying dry film thicknesses (DFTs), but also selecting skilled contractors and experienced inspectors; sequencing work so that it is performed correctly under the right conditions; ensuring that coated items and surfaces are handled and stored properly after coating; considering how connections or assemblies are to be made and joined; how adjacent surfaces are to be protected if hotwork or similar is unavoidable; and how proper cleaning, surface preparation and coating application can and will be performed for touch-up when damage does occur. The long-term payback for careful attention to these issues and the other implied design-related aspects cannot be overstated.

Building FPSOs and Platforms

As an aid to the reader, we will provide a brief description of the process that is often involved in constructing an FPSO — specifically the steps involved with the conversion of an existing tanker — because many of the subsequent corrosion and coatings problems that occur over the next couple of decades will stem from this stage of the work.

FPSOs are either built as a dedicated new-build vessel or facility; or more usually, they are conversions of a traditional ocean-going tanker — of which there are thousands afloat all over the world — and are converted by adding the topsides production and processing equipment and other hardware to the upper tank deck of the donor tanker. An extensive industry has developed worldwide to convert tankers to FPSOs.

Tankers have a series of internal, large-capacity, double-hulled storage tanks below the upper deck (typically called the tank deck), plus an aft-mounted superstructure with accommodation rooms and the bridge. The on-board tankage capacity is an important component of an FPSO because this extends the time that a production unit can store produced crude before it has to be offloaded to a tanker. The expanse of the tank deck in front of the accommodation block might have some piping and a crane or two, but on most tankers is usually otherwise mostly open. It is this open deck where the majority of the processing and production equipment and structures are fitted during the conversion, plus a riser or turret to connect to the floating buoy, and a flare tower (if needed) to vent off the unusable gases. A helipad is usually fitted to one side of the accommodation module or bridge, in addition to safety provisions such as lifeboat, raft and emergency evacuation facilities. A large conical opening called a moon pool is often fabricated into the hull just to the rear of the bow for the riser buoy to dock into when connected over the field(s).

One would hope – optimistically perhaps — that given the criticality and vulnerability of the operating environment that will result after commissioning, that all surface preparation and coating work on the separately manufactured

The tank deck of the donor tanker might have to be strengthened underneath the deck plates (i.e., inside the crude oil tanks) before the heavy multi-level process decks are added on top. It is quite common that the process equipment for the various parts of the production operation – including separator vessels, knockout drums, chemical dosing stations, compressors, gas turbine generators, etc., as well as workshops, cranes, the flare tower, helipad and so on – are fabricated and finished (including painting) as modules which are then sub-assembled or consolidated, craned into place and welded or affixed to the hull.

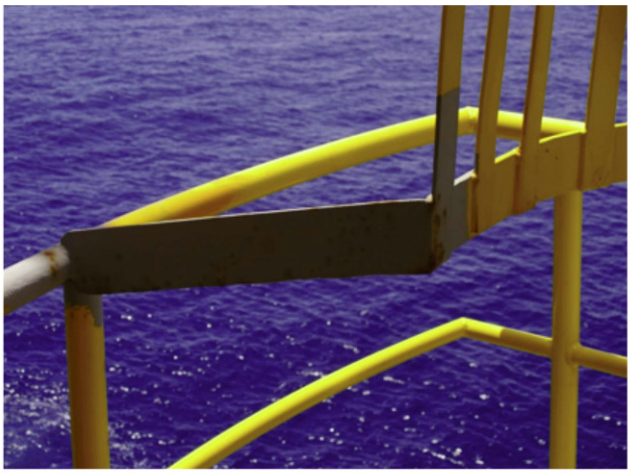
These two prints show examples of prodigious amounts of grinder dust on an offshore gas platform resulting from hotwork after the paint system was applied.

modules and structures would be performed to a very high quality so as to provide the longest possible time to first maintenance. Alas, this is all too often not the case. Depending on where and by whom these modules are made and assembled, the original coating quality can sometimes be quite good, but not always. It is what happens after assembly and during the consolidation that seems to matter the most.

The condition of the coatings on the donor tanker hull is also a factor. For the most part, the recognized tanker construction shipyards in most parts of the world have developed reasonably effective and reliable processes to carry out the surface preparation and apply generic coating systems to the internal and external surfaces of their product. Predictable life spans for the coating systems usually result with these tankers, which, in effect, come off a production line, so most shortfalls that might result from clean newbuilds are rare. However, while some FPSO conversions are performed on new or fairly new tankers, older vessels have also been used particularly where their size and/or configuration has meant that their cost efficiency as tankers has been overtaken by larger, faster or more productive tanker designs, hence lowering their purchase price and raising their attractiveness to be FPSO conversion candidates.

So, even if the coating systems on the donor tanker are reasonable, there is an enormous amount of work to be undertaken to complete the conversion, and much of this can be quite damaging to the existing coating systems primarily because much of it, inevitably, is hotwork.

The tasks of strengthening the tanker, welding on the process deck support structures and affixing and then connecting the modules and other equipment together almost always involves a tremendous amount of hotwork damage to the adjacent coating, be it on the original hull or on the coated surfaces of the modules and their equipment. This is not only welding, but there always seems to be a need to do



These photographs show examples of where black steel sections or members were incorporated as make-up sections.

Here is an example of the inadequate preparation and painting of hotwork zones around circular hollow section columns where they were welded to the tank deck.

large amounts of gas cutting and extensive grinding, both of which spray metallic dust all over adjacent coated surfaces as well as over and into stainless steel items such as pipelines, control cabinets, fluid (chemical) storage tanks and even other hydrocarbon containment-critical hardware.

It appears that the demand to get the facility into production at the oilfield prevails over exercising a modicum of housekeeping efficacy, which has the potential to create a situation that seriously foreshortens the coating's life and adds massively to the task and cost of trying to undertake coating and fabric maintenance once the facility is commissioned. It would seem that no one takes the initiative to put drop sheets, welding blankets or plywood covers around and over the adjacent painted surfaces to stop grinder dust or molten globules of gas-cut steel or weld metal impacting on the vulnerable coating systems; or to vacuum or sweep up the metallic dust before it gets wet and then rusts.

The items that seem to get reworked or adjusted often include handrails, staircases and support brackets for cable trays, control boards; and all manner of conflicts that arise when piping or equipment doesn't fit where or how intended, irrespective of how many CAD drawings and schematics are done. It is also not uncommon to find black steel (i.e., unprepared and uncoated) that has been incorporated, for example, as a brace, a support or as a make-up piece because it was missed in the design stage and had to be site-added. It would seem that the provision of a few lengths of stock steel sections that have been blast cleaned and primed with a zinc-rich coating, has not been considered as a good idea in case extra steel is needed.

Too often, the level of diligence in performing the surface preparation of welded or hotwork areas and the reinstatement of the coating systems after the consolidation, is atrocious. It is not unusual to see evidence of epoxy coatings being poured out onto an uncleaned deck and spread out with a yard broom. The indelible proof, including the tread pattern from the worker's boots, was still visible months or years later. Stories are in circulation of a hardhat being used as a bucket to carry paint that was then just poured onto weld joints on deck plates. Another example would be breakdown in the coatings on the underside of a helideck assembly that coincide exactly with where water would pond in the structural pockets if the helideck were inverted, suggesting that the freshly-applied, atmospheric-grade coatings were subject to sustained immersion in rainwater before the helideck was fitted to the hull.

What this all means, sadly, is that what is supposed to be a new, well-protected and productive asset ready to start its life with a high order of reliability and a long window of low maintenance requirements, all too often commences with an already-compromised corrosion protection capacity and poor aesthetics. These tribulations are not confined, of course, to FPSOs; regular production platforms are also assembled and consolidated in much the same way with identical consequences. One of the largest (by dollar value) legal disputes that I have ever been involved with as an expert witness, concerned a newbuild gas platform that had suffered from an unbelievable amount of hotwork and installation damage before it was even commissioned, to the degree that it looked like it was at least the decade old and had been totally neglected. An offshore asset in this condition doesn't enjoy the luxury of a maintenance-free honeymoon until the inevitable breakdown of robust coating systems starts to become apparent.

Out to the High Seas

As the FPSO or platform is being installed and commissioned, the chance that further damage will occur to the coating systems is quite high. Commissioning involves lots of people, tools, equipment and hardware being dragged around; too many holes being drilled to run cables and control lines; spilled fluids; mechanical adjustments and so on. None of these tasks are kind to coating systems and proper repairs seem impossible to schedule, organize and perform, again to the detriment of the future performance of the stressed protective coatings. Proper coating protection, touch-ups and repairs all too often seem to be ignored or neglected, giving rise to the conclusion that the consequences and future costs that will inevitably occur, were not considered by the decision makers.

Once the facility is commissioned and operational, most owners, logically, want to start pumping oil and/or gas and earning some income. As a business activity, maintenance does not have a good profit forecast – that is to say, it is a discretionary, and therefore avoidable, expense." The expectation of most owners and operators

is that the facility is new and won't need any coating attention for some years. As well-engineered and properly-applied coating systems in a marine environment should not require a first round of maintenance for about five to seven years given predictable operating conditions, this is not, therefore, an unrealistic expectation.

Aesthetics

With a new, freshly-coated asset there can be a psychological driver for the facility personnel (not necessarily those with coatings-related responsibilities) to observe and pay attention to small areas of corrosion or coating breakdown that appear, and to be encouraged to action or support efforts to address these with coating maintenance, perhaps because they stand out or because the task of tackling a few localized spots is not seen as insurmountable. It is perhaps also true that a good-looking asset gets treated better, for example, with more diligence in cleaning up after maintenance or spills and workers being more careful with tools that could get dropped. However, if faced with a facility-wide condition (even on a near-new structure) where there are hundreds of repair zones, I have observed that many facility personnel actually do nothing at all. Perhaps it's because it is too hard to know where to start or how to determine where any effort might best be expended. As a result, the facility looks shabby all over and no one does anything. This tends to build on itself where less care is taken in avoiding damage to coated structures, decks or equipment. Thus, the degradation cycle becomes self-perpetuating.

Notice how the good paintwork on a late-model car not only gets prompt attention if a single scratch occurs, but the vehicle also gets washed and polished much more frequently. Items kept in good condition get looked after better and last longer for a lower cost.

Lessons from the Construction Phase

As can be interpreted from this discussion, there is a real danger that if care and attention is not paid to design and all stages of the construction, consolidation, installation and commissioning, the coating's start to life will be endangered. This is where the huge costs, large-scale disruptions, deteriorating hardware, loss of integrity, dropped objects, spills and releases, and poor facility life have their origins.

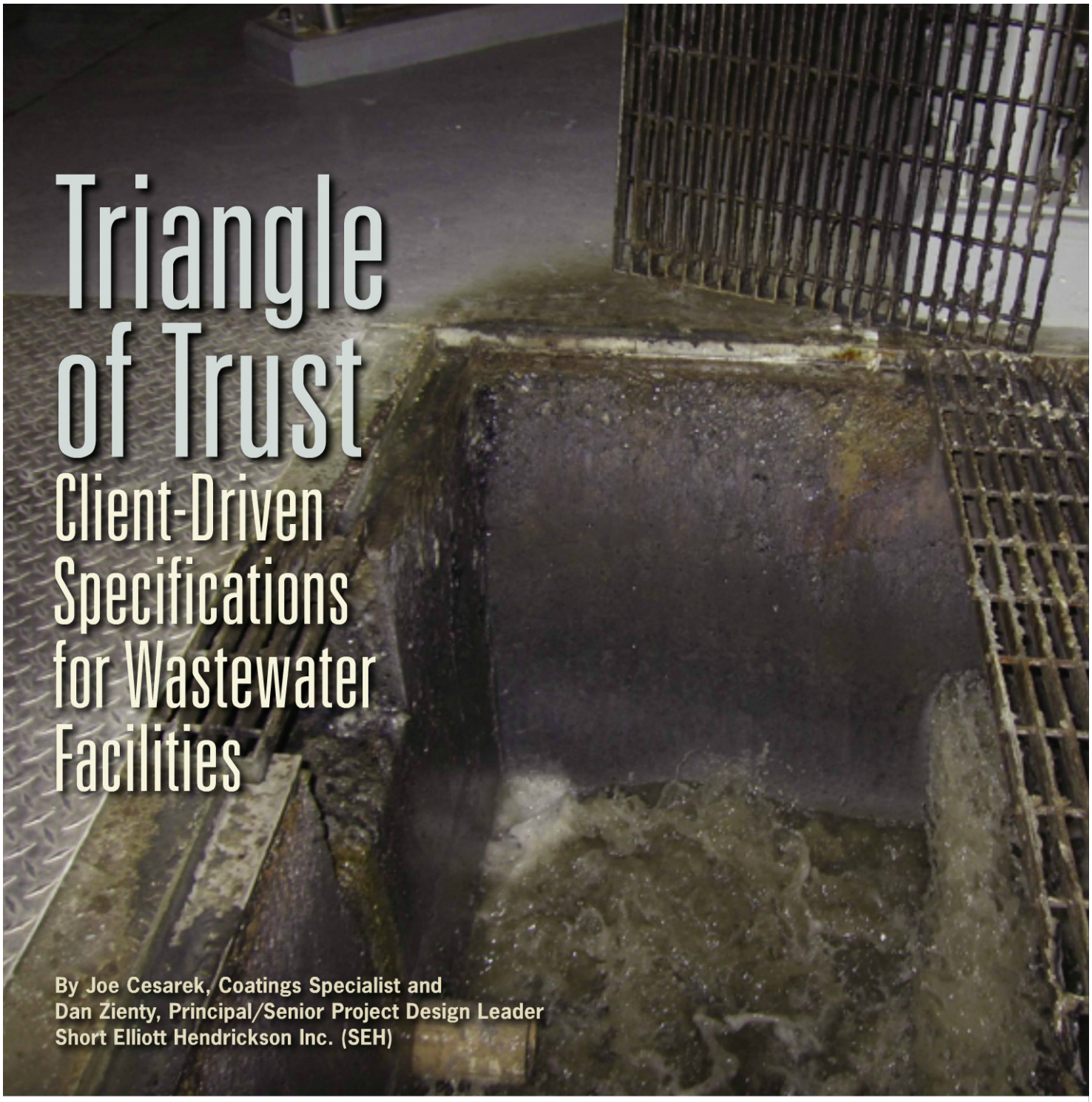
About the Author

Mark Dromgool is the managing director of KTA-Tator Australia Pty Ltd, based in Melbourne, Australia. He has been active in the protective coatings industry for 37 years. Dromgool's

experience includes 10 years as a coating application contractor and about seven working for two of the largest protective coating suppliers in Australia and New Zealand. In 1994, Dromgool formed KTA-Tator Australia as a protective coating engineering, inspection and consulting company.

Dromgool is a long-standing member of SSPC and NACE, and is former president of the Blast Cleaning and Coating Association (BCCA) of New South Wales (NSW). He has written and published many papers on coatings and linings and has lectured widely at local and international conferences. In 1996 and again in 2007, Dromgool was the recipient of the *JPCL* Editor's Award for papers entitled "Maximizing the Life of Tank Linings," and "Epoxy Linings – Solvent-Free But Not Problem-Free," respectively. In 2006, he was awarded the John Hartley Award for Excellence by the BCCA of NSW.

Dromgool has qualifications as a mechanical engineer, is an Australasian Corrosion Association (ACA)-certified Coatings Inspector, a NACE-accredited Protective Coating Specialist, an SSPC-accredited Protective Coatings Specialist and a NACE-certified Coating Inspector – Level 3. JPCL



Triangle of Trust

Client-Driven Specifications for Wastewater Facilities

By Joe Cesarek, Coatings Specialist and
Dan Zienty, Principal/Senior Project Design Leader
Short Elliott Hendrickson Inc. (SEH)

Through the course of any project, communication is the key element for success. In the coatings industry, a lack of communication by project stakeholders can show up in a very short time after project completion, appearing in the form of premature failures and shorter equipment service life. Every project starts with an owner whose vision is to achieve an identified level of asset protection for the life cycle of his or her wastewater plant and its infrastructure.

Owner-Driven Specifications

The owner invests time and money to achieve the best possible service from the infrastructure and equipment. The choice of design engineers, materials such as protective coatings and lin-

Fig. 1: It is a good idea to review asset components, such as this grit chamber in a life station, prior to writing a specification.

Photos courtesy of the authors

firm with coatings experience and the additional competency of a coating specialist can give an owner peace of mind. An owner-driven specification identifies coating systems that meet the owner's expressed criteria based on environment and process or operation, long-term protection or maintenance cycle, wear and aesthetics where applicable, and a balance between cost and performance.

As the project progresses through design and construction, each stakeholder, from the material manufacturer to the general and/or painting contractor, influences the final product, but unfortunately miscues, miscommunications and sometimes personal agendas between the involved participants can impede a project's success. One method of prevention is the addition of a qualified coating specialist as part of the design team, acting as a liaison between the parties to close the communication gap, thereby creating a "triangle of trust" between the engineer, coating supplier and contractors.

Understanding the Evolution

In 1977, an amendment to the Clean Water Act mandated pretreatment of industrial wastewater to remove heavy metals which in turn created a more fertile environment for the production of hydrogen sulfide (H_2S). H_2S gas is converted to sulfuric acid (H_2SO_4) which is highly corrosive. Furthermore, as cities grew, dwell times increased

Fig. 2: Understanding each stakeholder's role in a project is key to effective communication.

ings, and perhaps most importantly, the contractor, plays an essential role in the longevity and preservation of those assets. Planned management of the entire process will promote a successful outcome. Planning that considers and compensates for life-cycle maintenance is an important part of the initial phase of a project. A proficient engineering

and the addition of covers squelched the wastewater smell. These actions, although good for the environment, resulted in increased microbially induced corrosion or MIC, accelerating the degradation of our wastewater infrastructure. The use of thin-film coatings such as coal-tar epoxies gave way to new chemical-resistant coatings such as polyurethane elastomers, glass-flake-reinforced epoxies, polyurea elastomers, 100%-solids epoxy linings, cementitious repair mortars, polysulfide caulks and other coatings with increased service life and offering better protection of facility assets.

This knowledge is necessary in order to understand the properties, proper use and implementation, and application of these more advanced coatings. In many cases, not all of the stakeholders involved with high-performance coating projects and specifications for wastewater facilities have achieved this level of understanding.

Potential Wastewater Specification Pitfalls

Economic Motivation

The owner, due to increased economic challenges, may require a repair or maintenance specification based on present need in lieu of a long-term approach. Though economy may be the driving force, a secondary approach might be based on cost savings through lower life-cycle maintenance. If the project engineer is not well-versed in issues related to coating selection, the approach in either case may not match the desired result.

The project engineer or specification writer typically possesses a general knowledge of standards, equipment and plant process methods, but commonly lacks expertise in writing high-performance coating specifications. These specification sections would include product selection based on the environment, location and daily use; containment needs for surface preparation and application techniques. Further, the engineer may not fully understand that though the product may work, a better product selection may better suit the owner's need. A lack of thorough, detailed knowledge may result in a specification which does not consider recoat and in-service times and may limit the pursuit of design or materials that would enhance the equipment's service life. Finally, though the engineer may identify the correct coating system for each situation, the provisions identified for workmanship may be weak, ambiguous, nonexistent, or at times, placed on the supplier.

Multiple Agendas

If the supplier or paint manufacturer does not have an established relationship with either the owner or the engineer, the initial focus or emphasis might be on qualifying a particular product line rather than developing a relationship. Not having a relationship to start with can inhibit the supplier's ability to offer a good specification, as a clear understanding of client and project needs often comes from the identification of owner tendencies and the relationship itself.

Quite often the coating contractor is hired by the general contractor (GC) who typically does not have enough specific knowledge to judge the intricacies necessary to properly perform the coatings work as indicated in the specification. Standard practice by the GC is to put the coating section of the contract out to bid to multiple painting contractors, awarding the painting portion of the contract to the

Fig. 3: Pipe penetrations that are not filled and sealed properly prior to immersion can be more vulnerable to corrosion.

low bidder. For this reason it is essential that contractor qualifications are included within the coatings section of the specification. At a minimum they need to include language that outlines required years of experience and project references for work representative of similar size and scope. If qualifications specific to the selected coatings (as applicable) are lacking, this can lead to workmanship problems in the field. Specifications that are ambiguous on qualifications or unclear on scope can strain the contractor's ability to plan for and execute the work properly.

Many asset failures can be attributed to miscommunication. One example is a lift station in a food-processing facility. The specification writer failed to investigate pH levels in this severe wastewater tank; the pH had swings of 1 to 10. The concrete was severally damaged due to use of an inadequate chemical-resistant coating.

Another example demonstrates that pipe penetrations are especially vulnerable if not sealed and detailed properly (Fig. 3, p. 45). In this case the owner had to invest in a temporary holding tank for bypass storage because there was insufficient time available for shutdown of the plant in order to perform repairs.

Project Stakeholder Roles and Responsibilities

The Specifier or Engineer

The specifier or project engineer must be familiar with the budget and use parameters, and discuss with the owner the best coating system options that will provide the longest uninterrupted service and still meet that budget. He or she must develop specification language to ensure that the most qualified coating contractor is selected to do the

Fig. 4: In order to write a coating specification properly, the specifier must first be able to recognize microbially induced corrosion (MIC), such as on these lift station components.

job by the most efficient and safest means possible. The specifier relies on the expertise of the coating specialist for material selection advice and for recommended systems that are equipment-specific, such as for the digester where H_2S concentration is very high. Whenever possible, the specifier should request a pre-job conference to establish that all parties are aware of the nuances that make each project different.

The Coating Supplier

The supplier assists the specifier as a trusted advisor before, during and after the project to ensure a satisfied owner at project completion. The supplier or coatings manufacturer must provide a quality product that will meet the intended service life based on standard set criteria for conditions and for process and use. Further, he or she must work with the owner and project engineer to deliver service consistent with the capital plan and budgetary constraints, being cautious not to overstate product performance.

The Contractor

It is important that the contractor furnish proper documentation as defined in the specification, certifying that key staff has been adequately trained or is sufficiently qualified to mix and apply the specified product. Though the contractor may have previously used products manufactured by the selected supplier, systems may have been selected that the contractor has little or no experience with. Requiring documentation and its review contributes to project success.

Even when products are well-formulated, they will not perform properly if applied incorrectly. Initial training for a new product or annual training by the supplier is essential, but within the specification responsibility for overall training rests with the qualified contractor. The reasoning here lies with crew rotation.

At all times, the painting contractor must have competent supervision onsite who can inspect the coating process and product and work with the site inspector, general contractor and project engineer to ensure through the reporting process that the products are applied properly. The painting contractor must fulfill the contractual obligation as safely and as timely as possible to meet the project schedule, while satisfying all coating quality requirements.

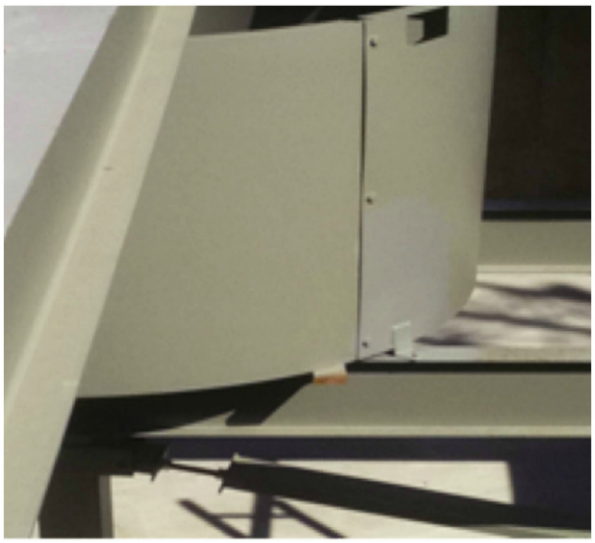


Fig. 5: This seam in a clarifier mechanism drum should be sealed with H_2S-resistant caulk in order to prevent moisture intrusion which will create corrosion in the seam and rust bleed on adjacent surfaces.

Even after pre-job and preconstruction conferences, it must be understood that issues might arise necessitating further communication. For example, the specification may require a non-chemically resistant floor but the owner decides to put in a tank that may have secondary containment needs, and therefore a different coating requirement. When trust is established from the beginning, a give-and-take situation that is beneficial to all is the result.

In many cases the GC will be bidding the project due to their understanding of the overall project scope, whether it is new construction or rehabilitation. The contractor must read, understand and possess a general knowledge of all phases and of all trades involved. This includes being aware of specification distinctions such as a need for prequalified coatings applicators depending on the types of products used for the project, special applications, or provisions for equipment or containment.

The Qualified Coating Specialist

The coating specialist can be an essential part of the design team. His or her expertise comes from specialized training through organizations such as the Society for Protective Coatings (SSPC) and the National Association of Corrosion Engineers (NACE International). This training is coupled with real industry experience as a coating supplier or a contractor, making the individual well-rounded. With respect to protective coatings, they are responsible for investigating the needs of the overall project, based on the scope identified by the project engineer. The coating specialist will know what products to use to fit the intended environment in order to maximize the service life of the coating. The coating specialist can provide the technical expertise to ensure that the specification includes language that is clear and concise in regard to scope, materials, application testing and quality control. Equally important is language addressing contractor qualifications, requiring the awarded contractor to have the necessary experience, staff and equipment to apply the specified systems in a manner that will meet the intended service.

An experienced coating specialist can identify situations where painting may not be the best course of action. Aluminum handrails and catwalk structures, for instance, have proven to be very resistant to H_2S and are aesthetically pleasing without coatings. The coating specialist can assist the project engineer by pointing out instances where dissimilar metals could create a corrosion issue — for example, the use of structural carbon steel stringers paired with galvanized stairs. The coating specialist will know that galvanized steel has certain surface preparation requirements prior to coating application to keep it from rusting prematurely.

As stated earlier, the coating specialist can identify instances in a design that could be revised to reduce or minimize potential corrosion issues, such as using a continuous weld in lieu of a skip weld along the rim angle at the top of the cen-

Fig. 6: Prior to writing a specification, visiting and reviewing all asset components, such as this wastewater clarifier, can ensure a more thorough understanding of condition and potential courses of action.

Fig. 7: This concrete joint in a wastewater holding tank should have been filled and sealed prior to coating application.

ter barrel (drum) in a wastewater clarifier. The void left between the steel drum and the attached rim angle is a location that normally exhibits early rust.

A qualified coating specialist has the aptitude to know when history, rather than marketing, makes a particular coating a good choice for a given environment. This individual can serve the project engineer well in field dispute resolution between third-party inspectors and painting contractors when it comes to interpretation of standards and knowledge of instruments needed to ensure a quality paint job or when the technical information and the actual application may differ. A qualified coating specialist can also provide necessary onsite inspection affording a level of comfort to the owner.

Conclusion

The "triangle of trust" works when qualified people communicate before, during and after the start of a project, always focusing on the goal of providing the owner with a value-engineered asset. The specification for wastewater projects should not be "cut and paste," but rather a clear, concise instruction based on sound planning with regard to each facility and environment, and including qualification requirements for general contractors and all subcontractors.

Involving a qualified coating specialist is a sound consideration for the project from design through construction. The coating specialist's knowledge and training can assist the engineer and other project stakeholders in bridging any communication gap that may occur due to lack of trust, interpretation and the understanding of industry terminology. This professional's experience can identify a qualified applicator and ensure that the painting contractor knows and understands the intent of the specification from start to finish ensuring that the owner is satisfied.

When attention is paid to each of these issues and answers are clearly conveyed to the owner, all parties in the "triangle of trust" have a greater probability of achieving the goal. The design team's effective communication of the requirements and their solutions can enable the owner to better understand the different levels of service depending on the products recommended, and the cost of proper and safe application of the coating system that has been selected. Better planning and communication results in fewer change orders and a project that is within the budget.

About the Authors

Joseph Cesarek joined the Protective Coatings Management Group at SEH in 2011, bringing with him more than 38 years of coatings and linings experience, including 25 years with Sherwin-Williams Protective and Marine Division as their senior global coatings specification specialist. He is certified as both an SSPC Protective Coatings Specialist and a NACE Coating Inspector. Cesarek is a former chairman of the North Central Region Chapter of SSPC and remains active in the chapter.

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

Passive Fire Protection: Intumescent Coatings

JPCL Staff

Today most buildings and structures have some degree of fire protection in order to protect lives, delay possible structural collapse allowing for evacuation, provide areas of temporary refuge in the case of fire, and ensure the integrity of escape routes by preventing or delaying the escalation of a fire and protect high-value assets.

There are two basic types of fire protection: active and passive. Active fire protection includes alarms and detection systems, sprinklers and water deluge systems, firefighting equipment and foam and powder extinguishers. Passive fire protection involves components of structural methods and materials such as concrete, mineral fiber boards, vermiculite cements and intumescent coatings. This article will describe how intumescent coatings can achieve passive fire protection in many structure types including offshore constructions, ships and commercial buildings.

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All other images courtesy of The Sherwin-Williams Company

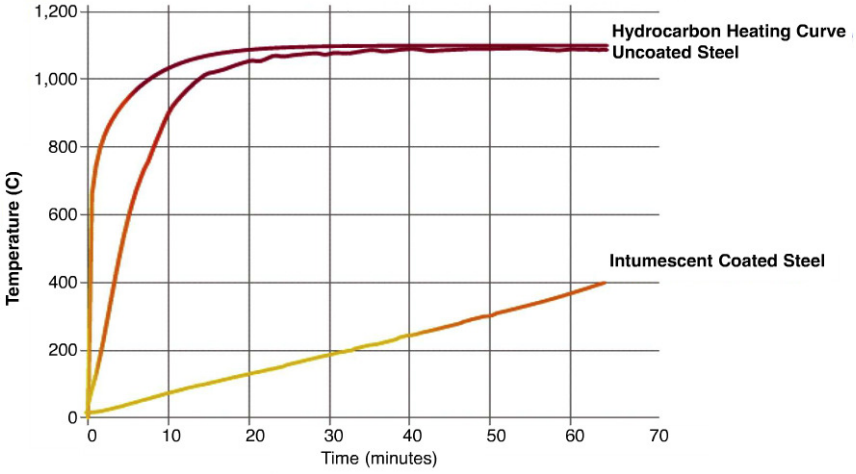

Fig. 1: This graph illustrates the effect of intumescent coating on steel temperature in a hydrocarbon fire.

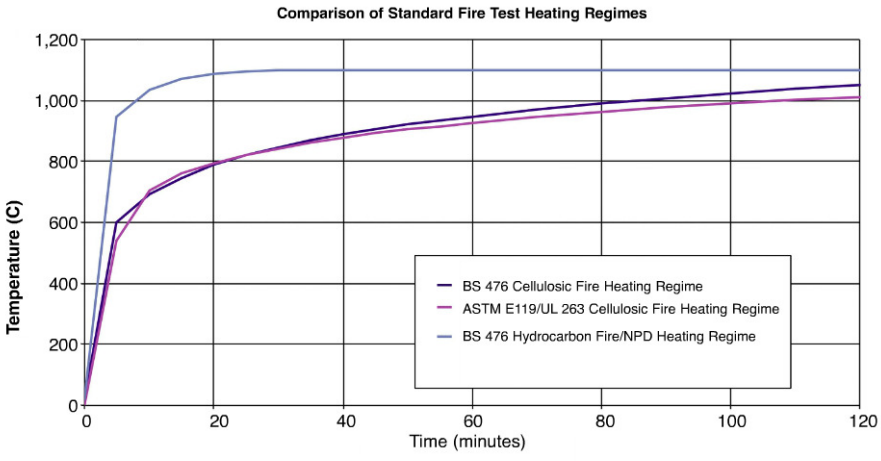

Fig. 2: This graph compares the heat-up rate of cellulosic and hydrocarbon fires.

Intumescent coatings have been used to protect the steelwork in buildings and other structures from fire for approximately 40 years. These coatings work by swelling up in the event of fire and physically creating a barrier between the steel and the fire for up three hours. Steel loses its structural strength at about 500 C and these coatings can delay the time it takes to reach this temperature (Fig. 1). Intumescents are often referred

Fig. 3: These images show the progression of a typical jet fire test using ISO 22899-1.

to as thin-film or thick-film coatings. Thin-film intumescents can be solvent- or water-based products and have dry film thicknesses (DFTs) of less than 5 millimeters. Thick-film coatings are typically solvent-free, epoxy-based with DFTs of up to 25 millimeters. Thick-film epoxies can also be used to form castings, typically in two half-shells to protect narrow diameter pipework where spraying would create large volumes of overspray.

The acceptance and use of intumescent coatings increased dramatically in Europe in the 1970s as the major oil companies learned of their ability to protect structural steel from the extreme heat caused by hydrocarbon fires, including jet fires caused by leaking hydrocarbons.

In 1988 an explosion and subsequent oil and gas fires at the Piper Alpha, a North Sea oil production platform, resulted in the deaths of 167 people and £1.7 billion ($3.4 billion) in damage. The severity of this disaster, considered the worst offshore oil disaster at the time, prompted increased development and use of intumescent coatings for protection against hydrocarbon fires. The coatings developed tended to be thick-film coatings, often with mesh reinforcement.

Also, in the 1980s, exposed steel was used more prevalently in the design of commercial structures and high-rise build-ings, increasing the use of thin-film intumescents which looked more like con-ventional paint and therefore could meet the aesthetic requirements of architects.

How Do Intumescent Coatings Work?

Intumescent coatings react to fire by expanding to form a carbon "char" with low thermal conductivity, which essentially forms an insulating layer reducing the rate of heat transfer and extending the time necessary to reach the critical failure temperature of the underlying steel.

It's a complex chemistry incorporating the organic (coating) binder resin — typically an epoxy — and an acid catalyst, for example ammonium polyphosphate, which decomposes to yield a mineral acid. This acid reacts with a carbonific source, for example, pentaerythritol, to produce a carbon char. A spumific (foam-producing) agent, such as melamine, reacts with the acid source and decomposes, evolving into an inert gas which then expands the char. These are the basic reactions taking place, although more complex interactions also occur. For example, filler particles are incorporated into the formulation to act as nucleating sites or "bubble growth" sites and the resin binder plays a large part in softening and charring. Reinforcing mesh can be used to support the formed char.

Cellulosic vs. Hydrocarbon Fires

A cellulosic fire has a fuel source composed mainly of cellulose — for example, wood, cardboard or paper. Hydrocarbon fires are fueled by hydrocarbon compounds and ignite and grow exceedingly fast, achieving high temperature almost immediately after ignition, greater than 1,000 C in less than five minutes (fig. 2, p. 53). Cellulosic fires are slower to reach maximum temperature but may eventually reach or surpass the temperature of a hydrocarbon fire.

Hydrocarbon fires can reach temperatures higher than 1,000 C in less than five minutes (Fig. 2, p. 53). A pool (hydrocarbon) fire is defined as a turbulent diffusion fire burning above a horizontal pool of vaporizing hydrocarbon fuel where the fuel has zero or low initial momentum. A jet fire is a turbulent diffusion fire resulting from the combustion of a fuel continuously released with high pressure.

Testing Intumescent Coatings

No two fires are the same. The conditions depend on the type and quantity of fuel, the availability of oxygen and ambient conditions. For reproducible product testing in the U.K. "standard" fires have been defined. British Standards BS 476 (parts 20 and 21) "Fire tests on building materials and structures" and EN 13381 (part 8), "Test methods for determining the contribution to the fire resistance of structural members" describe how intumescent coatings are tested with cellulosic fire exposure. Performance depends on coating thicknesses, the types of steel section, I sections, hollow sections and the section orientation, i.e., beam or column.

Thermocouples are used to measure furnace temperature and core steel temperature. Other test standards include UL 1709, "Rapid Rise Fire Tests of Protection Materials for Structural Steel" for hydrocarbon fire exposure, ISO 22899-1, "Determination of the resistance to jet fires of passive fire protection materials" and IMO Resolution A.754 (18), "Recommendation on Fire Resistance Tests for 'A,' 'B' and 'F' Class Divisions" for fire protection of decks, bulkheads and doors on marine vessels. It is not possible to test every variation, so the test results are analyzed to produce an assessment of performance.

Table 1: Ratio of Surface Exposed to Fire and "Heat Sink"

$Hp/A\ (m^{-1})$	$A/V\ (m^{-1})$
$\frac{\text{Heated perimeter}}{\text{Cross section Area}}$	$\frac{\text{Surface Area}}{\text{Volume}}$
Perimeter in m Cross section area in m^2	Surface Area in m^2 Volume in m^3 (per linear meter)

Ensuring Durability

To protect steel in a fire a coating must be resistant to the environment and be intact at the time of the fire. Poor durability can lead to ineffective fire protection resulting in structural failure during a fire and expensive restoration afterwards. Poor durability can also lead to corrosion of the substrate, compromising structural integrity. To ensure durability of intumescent coatings the key ingredients — ammonium polyphosphate, melamine and pentaerythritol — are all sensitive to moisture and must be formulated carefully.

Different resins are used to formulate intumescent coatings for different applications. Water-based acrylic materials are formulated for use in mainly dry, internal locations. Solvent-based acrylic materials are used to formulate intumescent coatings for use in internal or sheltered external locations. Solvent-based or solvent-free epoxy materials are used to formulate intumescents that can be used in any location. These resins have different weathering performance, and therefore, protection capabilities.

To test the durability of an intumescent coating, standard coating test procedures are used such as NORSOK M 501, "Surface preparation and protective coating," Underwriters Laboratory, UL 1709, "Rapid Rise Fire Tests of Protection Materials for Structural Steel" and European Technical Approval Guidance, ETAG 18-2, "Reactive Coatings for Fire Protection of Steel Elements."

In addition, the intumescent coating should not spall or crack in use, be resistant to atmospheric and chemical attack and be recoatable with itself — even after prolonged curing. There should also be excellent bonding between substrate, primers and the intumescent to combat the problems of under-film corrosion.

Specifying Fire Protection

Firstly, the item to be protected must be identified, whether it is structural steel, vessels or divisions such as fire-resistant bulkheads or decks on ships. The general

rule is, the thicker the coating, the longer the protection – up to a limit. The thickness of the intumescent used will depend on the weight and type of the steel member being protected. As the weight of steel decreases, the thickness of the intumescent should increase. Lightweight steel sections will heat up faster than heavier sections and will therefore need more protection for a given time.

Rather than just figuring the weight of the steel, specific calculations must be made in order to determine the appropriate thickness of the coating, taking into consideration the shape or shapes of the steel and accounting for any cutouts or irregularities in the beams.

The critical steel temperature which must be protected against should be defined — for example, structural steel between 200 and 750 C, vessels between 200 and 350 C, or a 140 C temperature rise for divisions where the critical temperature requirement is much lower to protect personnel on the other side of the division or in a safety refuge.

Next the section factor must be considered, as well as the fire protection period of between 30 minutes and four hours. The section factor (Hp/A) is the ratio of the fire exposed perimeter to the cross sectional area of the steel (Table 1, p. 56).

Most intumescent coating suppliers provide guidance in calculating the thickness of the coating required for a specific use and some have dedicated departments staffed with trained fire engineers who will do the calculations for you.

Consideration must also be given to the service environment the structure or vessel will be exposed to as well as any special requirements such as blast resistance, high or low substrate temperature or cryogenic spill protection.

Conclusion

In addition to offering fire protection for up to four hours, intumescent coatings offer speed of application, shop or field application, aesthetic appearance and ease of inspection and maintenance. Intumescents can protect a variety of steel surfaces from structural columns and cellular beams, to building components, vessels and complex shapes. They can be formulated to protect against cellulosic and hydrocarbon fires including jet fires and fires resulting from explosions. JPCL

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Technical Program for SSPC 2015 Released

SSPC's annual conference and exhibition, SSPC 2015 featuring GreenCOAT, will take place from February 3 to 6, 2015, at the Westgate Las Vegas Resort. This yearly event is the only conference and exhibition dedicated 100 percent to protective, marine, industrial and commercial coatings.

Attendees at SSPC 2015 will be able to take in a full schedule of training courses, workshops, technical programs, peer forums, committee meetings, panel discussions, exhibitors, special events, awards ceremonies and networking opportunities. This year's conference will also feature the first-ever Poster Session from February 4 to 6, which will be comprised of research presentations given mostly by students or young professionals.

The following is a list of the technical presentations and workshops that will make up SSPC 2015's technical program. For updates, visit sspc2015.com. Upcoming issues of *JPCL* will continue to preview the conference and exhibition.

TUESDAY, FEB. 3

Afternoon — 1:30 to 4:30 p.m.

Session 1: Workshop

• "Protective Coatings — An Overview," by Chris Farschon, PCS, Tony Serdenes, Ron Quesenberry and Charles Brown; Greenman-Pedersen, Inc.

Session 2: Workshop

• "An In-Depth Look at Standards Most Frequently Used by Industrial Painters," by Michael Damiano, PCS, SSPC; and L. Skip Vernon, PCS, MCI, Coating and Lining Technologies, Inc.

Session 3: Hot-Dip Galvanizing

• "Painting/Powder Coatings Over Hot-Dip Galvanized Steel," by Dr. Thomas J. Langill, American Galvanizers Association

• "Real World Application of Coatings Over Hot-Dipped Galvanizing," by Kevin Irving, AZZ Galvanizing Services; and Todd Williams and Ahren Olson, Bayer MaterialScience LLC

• "Common Causes of Premature Coating Failures on Hot-Dip Galvanizing," by Michael O'Brien, Mark 10 Resource Group, Inc.

Session 4: Business

• "Root Cause and Forward Thinking," by Doug Sawyer, CDS Custom, LLC

• "Managing a Multi-Generational Coatings Business," by Jon Goldman, Brand Launcher

• "How to Reduce Human Error through Safety Self-Awareness," by Greg Ford, TalentClick Workforce Solutions

WEDNESDAY, FEB. 4

Morning — 8:30 to 10:00 a.m.

Session 1: Workshop

• "Coating Failure Investigations in Action," by Cynthia L. O'Malley, PCS, KTA-Tator, Inc.

Session 2: Environmental, Health, Safety and Regulations

• "Breathing Fresh Air of Compliance: Establishing an OSHA Compliant Respiratory Protection Program," by Nick Bozzuto, Bullard

• "Regulatory Update: Current and Emerging Trends in Occupational and Environmental Health," by Alison B. Kaelin, ABKaelin, LLC

• "Minimizing Dust in Open Air Environments with Vapor Abrasive Blasting," by Bill Eliason, EcoQuip / AFTD / Graco Inc.

Session 3: Panel Discussion

• "SSPC 2015 Coating Inspectors Forum," moderated by Earl Bowry, PCS, Jotun Paints, Inc.; and J. Peter Ault, PCS, Elzly Technology Corporation; with panelists William Corbett, KTA-Tator, Inc.; and Malcolm McNeil, McNeil Coatings Consultants, Inc.

Session 4: Understanding Building Enclosure Coatings — Project Design and Inspection Workshops, Part I
Sponsored by *Durability + Design*

• "New Construction Coating Design/ Specification Workshop," by Davis Kyle, Master Painters Institute; and Kevin Knight, Retro-Specs, Ltd.

Mid-Morning — 10:30 a.m. to 12:30 p.m.

Session 1: Panel Discussion

• "Agree to Disagree: Exploring Differing Views on Causes of Coating Failures," moderated by Dwight Weldon, PCS, Weldon Laboratories, Inc.; with panelists Gunnar Ackx, PCS, Scicon Worldwide; Gordon Kuljian, PCS, GK Consulting, LLC; and Michael O'Brien, Mark 10 Resource Group, Inc.

Session 2: Bridge Painting and Protection

• "Paint System Performance Warranty," by Shameem A. Khan, Maryland State Highway Administration

• "Bridge Maintenance Painting in the Land of 10,000 Lakes: MNDOT's Novel Approach to Improving Bridge Maintenance Painting Operations," by Richard A. Burgess, PCS, KTA-Tator, Inc.; and Sarah K. Sondag, P.E., Minnesota Department of Transportation

• "Into the Future: Advanced Thick-Film Spray Applied Liquid Waterproofing Membrane Systems for Bridge Deck Applications," by Dudley J. Primeaux, PCS, VersaFlex Inc.; and Joe Haydu, Bridge Preservation LLC
• "The Color of History: When the Brooklyn Bridge is Your Canvas," by Guerman Vainblat, P.E., Greenman-Pedersen, Inc.; and Timur Kolchinskiy, E.I.T., Hirani Group

Session 3: Marine Coatings
• "Translational Corrosion Science," by Daniel J. Dunmire, DoD Office of Corrosion Policy and Oversight/LMI
• "Corrosion: The Destructive Stowaway on Marine Vessels — Determining the Cost-Benefit of Protective Marine Coating Systems," by E. Bud Senkowski, PCS, P.E., KTA-Tator, Inc.

• "A Study on the Improvement of Weatherability of Epoxy Coatings for Marine Exposure Structures," by SangMoon Shin, Hyundai Heavy Industries Co.
• "Low Solar Absorbing Epoxy Marine Decking," by Jing Zeng, PCS, Ph.D., and David Robinson, ITW Engineered Polymers

Session 4: Understanding Building Enclosure Coatings — Project Design and Inspection Workshops, Part II
Sponsored by *Durability + Design*
• "QA During Installation Workshop," by Ken Trimber, KTA-Tator, Inc.

Afternoon — 1:30 to 4:30 p.m.

Session 1: Workshop
• "Preventing Premature Coating Failures," by Michael O'Brien, Mark 10 Resource Group, Inc.

Session 2: Coating Types, Part I
• "Penetrating Sealer Over Latex Acrylic — Good or Bad?" by Greg Richards, KTA-Tator, Inc.; and Beth Steimle, TY Lin International
• "Improving Performance of Epoxy-Polysiloxane Coatings," by Constantine Kondos, Momentive Performance Materials
• "Coal Tar Enamel Service Life Extension," by Allen Skaja, Ph.D., PCS, U.S. Bureau of Reclamation
• "Isocyanate Free Polyurethane Coatings for Industrial Metal Applications," by Paul Popa, The Dow Chemical Company
• "Old, New and Forgotten Wisdom for Tank and Vessel Linings," by Mike O'Donoghue, Ph.D., and Vijay Datta, MS, International Paint LLC

Session 3: Concrete Protection Solutions
• "Resurrecting a Concrete Landmark," by Todd Gomez, PCS, VersaFlex Inc.
• "Surface Applied Organofunctional Silane Corrosion Inhibitors for Reinforced Concrete Structures," by Peter K. DeNicola, Evonik Corporation
• "Bio Based Waterborne Floor Coatings with Enhanced Flow and Appearance," by Stephen Hellems, Nuplex Resins LLC
• "Properties of Epoxy Mortars and Best Practices for Application," by Stacy Womack, Belzona Mountain States
• "Measuring Vertical Concrete Surface pH: Viable Test Method for Severe Service Exposures," by Vaughn O'Dea, PCS, Tnemec Company, Inc.; and Robert Maley, PCS, Corrosion Probe, Inc.

• "'All Fouled Up' — An Innovative Solution," by Kevin Morris, The Sherwin-Williams Company

Session 4: Understanding Building Enclosure Coatings — Project Design and Inspection Workshops, Part III Sponsored by *Durability + Design*

• "Building Science/WUFI Workshop," by David de Sola, 3ive, LLC; and Kevin Brown, KTA-Tator, Inc.

THURSDAY, FEB. 5

Morning — 8:30 to 10:30 a.m.

Mini Session 1: Failure Analysis

• "Failure Analysis of Paints and Coatings for Wind Towers, T & D Pipeline and Utility Structures," by Mehrooz Zamanzadeh, Ph.D., MATCO Services, Inc.

Mini Session 2: Industry Training and Certification Programs

• "What are SSPC-ACS 1, CAS, and ATT?" by Earl Bowry, PCS, Jotun Paints, Inc.

Mini Session 3: Corrosion in Concrete

"Selecting Protective Coatings for Corrosion Protection of Anaerobic Digesters: How, When and Why," by Randy Nixon, Corrosion Probe, Inc.

• "Basics of Corrosion in Reinforced Concrete," by Fred Goodwin, BASF Construction

Mini Session 4: Green Industrial Coatings

• "Creating More Sustainable Industrial Coatings: Driving VOCs of High Performance Waterborne Direct-to-Metal Coatings Below 50 g/l," by Leo Procopio, Ph.D., The Dow Chemical Company

• "Green Paints: From 'Paint is a Part of the Problem' To 'Paint is a Part of the Solution'" by Nawras Rimawi, Al-Jazeera Paints, Inc.

International Spotlight Session

• "Global Environmental Regulations Drive New Technologies in Epoxy Coatings," by Marcelo Rufo, Air Products and Chemicals Brazil (followed by Q & A session)

Mid-Morning — 10:30 a.m.

Session 1: Panel Discussion

• "Women's Leadership Forum," moderated by Julie Hough, Trace Industrial Supply, LLC

Session 2: Workshop

• "Proper Use of Coatings Inspection Instruments," by Matthew Fajt, KTA-Tator, Inc.

Session 3: Panel Discussion

• "SSPC-SP 13/NACE No. 6, Surface Preparation of Concrete: Industry Standard or Industry Guideline?" moderated by Heather Stiner, PCS, SSPC; with panelists Vaughn O'Dea PCS, Tnemec Company, Inc.; Randy Nixon, Corrosion Probe, Inc.; Fred Gelfant, Stonhard, Inc.; and Fred Goodwin, BASF Construction Chemicals, Inc.

Session 4: Green Evolution Coatings

• "Methodology for Measuring Energy Savings by the Use of Highly Reflective Coatings," by Francisco Cortes, DuPont Titanium Technologies Mexico

• "Why Green Solvents are Good for Your Business and Not Just the Environment," by Dave Pasin, TBF Environmental Technology

• "In Zinc We Trust? The Path to Novel Environmentally Friendly Corrosion Inhibitors," by Dr. Lars Kirmaier, Heubach GmbH
• "Novel Waterborne Technology Paves a New Roadway for Alkyds," by Jamie Dziczkowski, Ph.D., Reichhold, Inc.
• "'Construction Drying' — The Economic and Environmental Benefits," by Mark D. Lebeck and Bruce Funderburgh, Sunbelt Rentals Industrial Climate Control

Afternoon — 3:00 to 5:00 p.m.

Session 1: Inspection
• "Methodology for Coated Infrastructure Inspection by Mobile Potentiostat," by Bobbi Jo Merten, Ph.D., U.S. Bureau of Reclamation
• "Pull-Off Adhesion Testing OG Coatings — Improve Your Technique," by John Fletcher, Elcometer Limited
• "Paint Inspection from the Coating Manufacturer's Perspective," by Troy Fraebel, PCS, The Sherwin-Williams Company
• "Replica Tape — Relating Three Surface Profile Parameters to Pull-Off Adhesion," by David Beamish, DeFelsko Corporation

Session 2: Coating Types, Part II
• "Close Encounters of the Third 'Crude-Oil' Kind," by Mike O'Donoghue, Ph.D. and Vijay Datta, MS, International Paint LLC
• "Use of Penetrating Primers," by Duane Hough, PCS, MCI, Champion Painting Specialty
• "Time, Money and Tank Linings," by Miles Buckhurst, Jotun A/S

Session 3: Concrete Floor Protection
• "Using Forensic Science to Determine Causes of Failure of Polymeric Coatings," by Jon Asselanis, Applied Materials & Engineering, Inc.
• "Moisture Test Methods, Comparisons, Commonalities and Dissimilarities," by Steve Schroeder, Crossfield Products Corp.
• "Understanding Concrete Coatings Adhesion Testing Standards and Procedures/Testing in Accordance with ASTM 7234," by Fred Gelfant, Stonhard, Inc.
• "The Definition and Cause of Osmotic Blistering in Resinous Floor Coatings," by Marcus Gray, Dur-A-Flex

Session 4: Corrosion Prevention in the Military
• "Corrosion — It's a Matter of Choices," by Dr. Roger D. Hamerlinck, Office of the Assistant Secretary of the Army - Acquisition, Logistics and Technology
• "Single-Component Polysiloxane: An Advanced Coating for Navy and Surface Ships Topsides," by Erick B. Iezzi, Ph.D., Naval Research Laboratory
• "NSRP SP&C Panel Update," by Arcino Quiero, Jr., Newport News Shipbuilding
• "Use of Pre-Construction Primers in Marine Construction," by J. Peter Ault, PCS, Elzly Technology Corporation

FRIDAY, FEB. 6

Morning — 8:30 to 9:30 a.m.

Mini Session 1: Safety
• "Understanding the Breathing Air System in Abrasive Blasting," by Thomas Enger, MS, CSP, CHMM, Clemco Industries Corp.

Mini Session 2: Dehumidifcation
"Getting to $0: Strategies for Reducing Climate Control Costs through New Technologies," by Russ Brown, Polygon US Corporation

Mini Session 3: Food Grade Paints
• "Enhancing the Effectiveness of Food Grade Paint: Maximizing Safety & Reducing Corrosion," by Raza Baghpatee, Alwan Paints & Coatings

Mini Session 4: Soluble Salts
• "The Effect of Four Commercially Available Steel Decontamination Processes on the Performance of Internal Tank Coatings," by Michael Melancon, Chevron ETC Coatings SME

Mid-Morning — 10:00 a.m. to 12:00 noon

Session 1: Coating Testing for the Marine Industry
• "Development of an ASTM Standard for Erosion Testing of Protective Coatings Systems," by David Tordonato, Ph.D., P.E., U.S. Bureau of Reclamation
• "Evaluating Coatings for Immersion Service via Electrochemical Activity," by James A. Ellor, P.E., Elzly Technology Corporation
• "The Problem with Meeting Dry Film Thickness Specifications," by John Fletcher, Elcometer Limited
• "The Erosion Resistance Test of the Abrasion- and Cavitation-Resistant Coatings," by Heebaek Lee, Hyundai Heavy Industries Co.

Session 2: Formulating Coatings
• "The Futility and Folly of Seeking the Accelerated Corrosion Testing Holy Grail," by Carl Reed, International Paint LLC
• "Is the Heat and Pressure of Formulating Coatings for the Oil and Gas Market Getting to You?" by Andrew Recker, BASF Building Systems
• "Formulating High Performance Coatings with Novel Adhesion Test Methods," by Yutao Yang, Ph.D., The Lubrizol Corporation
• "BPA Epoxide Inorganic/Organic Coatings," by Mark D. Soucek, University of Akron

Afternoon — 3:00 to 5:00 p.m.

Session 1: Workshop
• "Fall Protection Training," by Charlie Brown, Greenman-Pedersen, Inc.

Session 2: Corrosion Under Insulation
• "Duct Tape Won't Do: Repair Options for Dealing with Corrosion Under Insulation," by David A. Hunter, PCS, Neptune Research, Inc. (NRI)
• "Composite Coatings: Basics of Fiber Reinforced Polymers for Pipe Repairs," by David A. Hunter, PCS, Neptune Research, Inc. (NRI)
• "What Happens to Zinc Under Hot Insulation?" by BangYih Chen, PCS, Formosa Petrochemical

Next month, *JPCL* will preview the training and certification courses that will be offered at SSPC 2015. For more information, visit www.sspc2015.com.

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Photo courtesy of the New Orleans Ernest N. Morial Convention Center

New Orleans Welcomes WEFTEC, Waterjet Conferences

In the upcoming months, the New Orleans Ernest N. Morial Convention Center will play host to two conferences that may be of interest to industrial protective coatings professionals.

The 87th annual Water Environment Federation Technical Exhibition and Conference (WEFTEC) will take place from September 27 through October 1. The largest water quality event in the world, according to the Water Environment Federation (WEF), this year's event will be comprised of more than 30 workshops, over 150 technical sessions, an exhibition with almost 1,000 exhibitors and more.

Focus areas for the workshops and technical sessions include: Collection Systems and Distribution; Disinfection and Public Health; Energy/Residuals and Biosolids Management; Industrial Issues and Treatment Technologies; Facility Operations and Maintenance; Future Insights and Global Issues; Municipal Wastewater Treatment Process and Design; Research and Innovation; Stormwater Management; Utility Management and Leadership; Water Reclamation and Reuse; and Watershed Resources Management and Sustainability.

WEFTEC will also offer several facility tours, where attendees can observe active projects, construction and operations at local facilities including the New Orleans East Bank Wastewater Treatment Plant, the Sewerage and Water Board of New Orleans' pumping stations and the Baton Rouge South Wastewater Treatment Plant. Attendees can also participate in a tour of the Abita Brewing Company's brewery and

take a sustainable design tour of New Orleans' Lower 9th Ward neighborhood hosted by Make It Right, an organization that builds homes and other buildings for in-need communities.

For more information on WEFTEC, visit the official conference website, weftec.org.

Exhibitors at WEFTEC

The following is a list of exhibitors at WEFTEC 2014 that may be of interest to protective coatings professionals. This list is current as of press time.

Exhibit Hours:

Monday, Sept. 29
8:30 a.m. to 5:00 p.m.

Tuesday, Sept. 30
8:30 a.m. to 5:00 p.m.

Wednesday, Oct. 1
8:30 a.m. to 5:00 p.m.

American Water Works Association 3953
AP/M Permaform / ConShield Technologies.....1518
Arizona Instrument 1229
Arkema Inc.....6742
Ashland 8709
Atlas Copco Compressors LLC 7615
AW Chesterton Company ...4363
BASF – The Chemical Company 5551
C.I.M. Industries Inc. 8320
Caldwell Tanks Inc. 7207
Carboline Company 4052
CIPP Corporation.....6537
CIPP Services, LLC 8640
Containment Solutions, Inc.....1230

The WaterJet Technology Association (WJTA) and the Industrial & Municipal Cleaning Association (IMCA) will host the annual WJTA-IMCA Expo from October 14 to 15. This show is dedicated to high-pressure waterjet/hydroblast tools, equipment, and services; industrial vacuum trucks and hydroexcavators; and related industrial cleaning and safety equipment. It is the largest trade show/educational program of its kind, comprised of research paper presentations, educational "Boot Camp" seminars, live equipment demonstrations, an exhibit hall, networking receptions and more.

Technical "Boot Camp" sessions of interest include the following.

- "Busting Waterblast Myths," presented by Bill Shires of StoneAge, Inc.; Tuesday,

Oct. 14, 10:40 a.m. to 11:25 a.m.

- "Nozzle Selection," presented by Bill Shires of StoneAge, Inc.; Tuesday, Oct. 14, 11:30 a.m. to 12:15 p.m.
- "Hose Fabrication, Inspection and Documentation," by Jeff Davis, GHX Industrial, LLC; Tuesday, Oct. 14, 12:20 p.m. to 1:05 p.m.
- "Hands Free Hydroblasting" panel discussion, featuring panelists from BASF Corporation, Dow Chemical, DuPont, HydroChem, PSC Industrial Services and Veolia Environmental Services; moderated by Kathy Krupp, The Dow Chemical Company; Tuesday, Oct. 14, 1:45 p.m. to 3:00 p.m.

For more information, visit the Conference/Expo page at wjta.org.

Exhibitors at WJTA-IMCA

The following is a list of exhibitors at the 2014 WJTA-IMCA Expo that may be of interest to protective coatings professionals. This list is current as of press time.

Exhibit Hours:

Tuesday, Oct. 14
10:30 a.m. to 5:00 p.m.

Wednesday, Oct. 15
10:30 a.m. to 1:00 p.m.

24 Hr Safety LLC.....207
Advance Pressure Systems..717
Autoclave Engineers / Parker Hannifin 600
BIC Alliance.....218
The Blast Bag Company, Inc.209
Blast Environmental & Industrial Services, Inc. 700
Blasters, Inc.....619
Cat Pumps.....318
CESCO / Aquamiser 406

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COMING UP

Courses

**Course information can be found at sspc.org*

Oct. 1–2 C13 Water Jetting, Newington, N.H.
Oct. 2–3 C12 Airless Spray, Portland, Ore.
Oct. 3 Nav Std Item 009-32, Norfolk, Va.
Oct. 3–4 ATT Train-the-Trainer, Newington, N.H.
Oct. 6–7 Bridge Ctg Assessments, Frankfort, Ky.
Oct. 6–7 CCB Conc Ctg Basics, Pittsburgh, Pa.
Oct. 6–10 NBPI, Norfolk, Va.
Oct. 6–10 C1 Fundamentals, Cleveland, Ohio
Oct. 6–10 C2 Planning & Spec, Houston, Texas
Oct. 6–11 CCI Conc Ctg Insp Levels 1/2, Pittsburgh, Pa.
Oct. 7–9 Plural Comp App, Lakewood, Wash.
Oct. 9–10 Weathering, Portland, Ore.
Oct. 11 PCS Prot Ctgs Spclst, Houston, Texas
Oct. 11–12 C12 Airless Spray, Norfolk, Va.
Oct. 12 CCI Supplement, Pittsburgh, Pa.
Oct. 13–14 C7 Abrasive Blast, Zephyrhills, Fla.
Oct. 14–15 ATT Train-the-Trainer, Seattle, Wash.
Oct. 15–16 C10 Floor Ctg Basics, Rowlett, Texas
Oct. 15–16 C12 Airless Spray, Zephyrhills, Fla.
Oct. 16–17 QCS Qual Cntrl Spvr, Seattle, Wash.
Oct. 18–19 C7 Abrasive Blast, Norfolk, Va.
Oct. 20 Estimating, Honolulu, Hawaii
Oct. 20–24 NBPI, Seattle, Wash.
Oct. 20–25 PCI Levels 1/2, Surabaya, Indonesia
Oct. 20–25 PCI Levels 1/2, Portland, Ore.
Oct. 20-25 PCI Levels 1/2, Norfolk, Va.
Oct. 20–25 BCI Bridge Ctg Insp Levels 1/2, Houston, Texas
Oct. 21 Contract, Honolulu, Hawaii
Oct. 21 PCI Workshop, Pittsburgh, Pa.
Oct. 22 Thermal Spray, Irving, Texas
Oct. 22–23 Project Mgmnt, Honolulu, Hawaii
Oct. 23–24 Weathering, Irving, Texas
Oct. 26 PCI Level 3, Surabaya, Indonesia
Oct. 26 PCI Level 3, Portland, Ore.
Oct. 26 PCI Level 3, Norfolk, Va.
Oct. 27 CAS Refresher, Newington, N.H.
Oct. 27 Estimating, Phoenix, Ariz.
Oct. 28 Contract, Phoenix, Ariz.
Oct. 28 CAS Level 1, Newington, N.H.
Oct. 28–29 CAS Level 2, Newington, N.H.
Oct. 29–30 Project Mgmnt, Phoenix, Ariz.
Oct. 31 Nav Std Item 009-32, Portland, Ore.

Conferences and Meetings

Oct. 6–8 NACE Eastern Area Conf, Myrtle Beach, S.C., nace.org
Oct. 8–9 ASM Aerospace Ctgs Conf/Expo, Hartford, Conn., asminternational.org
Oct. 14–15 WJTA-IMCA Conf & Expo, New Orleans, La., wjta.org
Oct. 18–22 AIHA 2014 Fall Conv, Washington, D.C., aiha.org
Oct. 27–30 ASNT Annual Conf, Charleston, S.C., asnt.org

FOR A LIST OF MORE EVENTS, VISIT WWW.PAINTSQUARE.COM