



The Society for Protective Coatings

Cover image courtesy of Technology Publishing Co.

## FEATURES



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### MEETING EXPECTATIONS WHEN SELECTING CONCRETE REHABILITATION SYSTEMS

**By Mike Dadik P.E. S.E.,  
Carollo Engineers, Inc.**

Reinforced concrete has become a preferred building material for water storage and conveyance structures, providing great strength and many possible configurations. These advantages, however, bring the challenge of protecting rebar — essential to its long-term durability. With an accurate assessment of the concrete condition, exposure and work constraints, along with a clear understanding of the benefits and limitations of coating systems, a well-written, concise specification will be the basis of a successful concrete rehabilitation project — a project in which everyone's expectations can be met.



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### SELECTING PIPELINE COATINGS: DO CURRENT STANDARDS HELP?

**By Ian Robinson, 3M Company**

The ultimate or universal field-joint coating does not exist, but there are many varied and well-proven technologies currently available, all of which have their strengths and weaknesses. If the long-term, in-service performance of prospective field-joint coatings is to be predicted with an acceptable level of confidence, do currently available standards come to the rescue? This article attempts to answer this question by briefly reviewing some currently published (and generally well-known) standards.



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### THE NEED FOR AN INDEPENDENT THIRD-PARTY COATINGS INSPECTOR

**By Tim Bauman,  
The Sherwin-Williams Company**

The author describes three case scenarios where enlisting an independent, third-party coatings inspector would've reduced cost and time, as well as saving business relationships.

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## SSPC Training Hits the Road

**A**t SSPC 2018 in New Orleans this past January, SSPC unveiled its latest innovation for bringing training and certification opportunities to its members across the country: a new Mobile Training Unit (MTU), a truck-mounted trailer armed with blasting and painting equipment that will be available to travel and provide on-site, hands-on training courses throughout the U.S.

The MTU will allow SSPC to train and certify blasters and sprayers according to the SSPC C-7 Abrasive Blasting Program and C-12 Spray Application Certification Program. For the immediate future, SSPC will conduct classes using the unit at its world headquarters in Pittsburgh, but the MTU will later be available for the industry to use in any location to which it can travel.



SSPC's new Mobile Training Unit (MTU) will be able to travel throughout the U.S. to provide on-site coatings training later this year. Photos courtesy of Technology Publishing Company.





## SSPC ON THE FRONT LINE



The exterior of the MTU is adorned with dynamic illustrations of blasters and painters, created by RL Smith Graphics.

SSPC Executive Director Bill Worms said that the idea of a mobile training unit had been discussed over the past few years among some of the SSPC staff, but no action had been taken until a board discussion brought it to the forefront in May of last year. Design/build proposals were presented at the SSPC Board meeting in September 2017, and ARS Recycling Systems (Lowellville, Ohio) was selected as the vendor. "In a little more than three months, the project evolved from a concept drawing to a finished product at the SSPC 2018 conference," said Worms. He also noted that RL Smith Graphics (Boardman, Ohio) "was very responsive in assisting us with the design and application of the trailer skin which artistically highlights the purpose of the unit – blasting and spraying training and certification."

According to Terry Sowers of SSPC, the MTU is self-contained and the only resources required would be fuel for the compressor and



The MTU is outfitted with all of the necessary blasting and painting equipment, including PPE, required to train protective coatings applicators.



generator, abrasive for the blasting and paint for the application. SSPC estimates that between 8 and 12 individuals can be trained at one time.

While SSPC continues to determine the necessary requirements and permitting for transportation outside of its office area during the first quarter of 2018, the Society will conduct quarterly craft-worker training at the SSPC headquarters and demonstrations for local companies, which Sowers noted "is a great

## SSPC ON THE FRONT LINE



opportunity to work with our chapters, utilize the MTU regionally and hold and promote training in areas that we might not have reached before." The MTU will also potentially be used to introduce craft-worker training for

trade schools and vo-tech programs in the local area, said Sowers.

In addition to the training and certification that will be provided within, SSPC looks to use the travelling unit to further spread the organization's visibility and footprint across the country. "The MTU will also provide SSPC the opportunity to advertise and attract attention to our industry, in the hope of generating the interest of those looking for career opportunities," said Worms. SSPC membership will also be provided an opportunity to advertise their organizations via the display of sponsored logos on the MTU. For information on advertising on the MTU, please contact Michael Kline, SSPC director of technology and communications, at [kline@sspc.org](mailto:kline@sspc.org).

The debut of the MTU at SSPC's exhibit hall booth during the SSPC 2018 conference "was a big hit with the SSPC Board of Governors," said SSPC President Brian Skerry, who highlighted the unit's mobility as its most critical feature. "As new people enter the workplace, and

blasting and painting methods change, this unit provides a highly practical way for people to get the training they want, where and when they need it," said Skerry. "[The MTU] perfectly fits the SSPC Mission, 'To inspire learning, advance knowledge, and elevate performance in the industry through training, certification, and education of the workforce'."

All in all, SSPC Board members and staff alike are eager to see the industry's response once the unit hits the road later this year.

"The MTU generated a great deal of excitement and interest at our conference in January, and we look forward to continuing to generate that interest once we get it on the road," said Worms.

"The SSPC Board is delighted that this program has come to fruition in 2018 and looks forward to hearing back from SSPC members on the value and impact the unit brings to their daily job activities in the protective coatings industry," said Skerry.

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## PaintSquare Debuts Free App at SSPC 2018

A new way to experience PaintSquare made its debut at SSPC 2018: the brand-new PaintSquare app, engineered to be a field coating contractor's best friend and to provide an ideal mobile experience for PaintSquare readers.

Available free of charge for both Apple and Android devices, the PaintSquare app includes news and technical content from PaintSquare.com in three languages alongside tools that are crucial in the field: weather reports and calculations, quick calculators to easily determine figures such as paint consumption and dry film thickness.

When a user logs into the app using his or her PaintSquare.com login credentials (or creates a new account for free), the main menu offers a slew of content choices. The user has the option of viewing app content in English, Spanish or Portuguese.

Choosing "Weather" takes the user to a weather map with current conditions in the area, and to a calculator to determine whether the surface temperature is high enough in relation to the dew point so that coating application can be performed. The app also has an option to quickly calculate dew point using observations from a sling psychrometer in the field.

The app features calculators to help the user quickly determine the rate of paint consumption based on the desired dry film



thickness and percent solids of a given coating; estimate the wet film thickness needed in order to achieve the specified dry film thickness; determine soluble salts concentration based on surface conductivity; and several other important operations used on jobsites.

An RAL color chart is featured as part of the app, and a catalog of suppliers of coatings and equipment, as well as industry contractors, is both searchable and browsable.

And of course, the app features the same up-to-the-minute industry news coverage included in PaintSquare Daily News, as well as technical articles from *JPCL*. Daily coverage of news that affects the protective coatings industry, from mergers and acquisitions to safety and regulatory updates and legal news, is now at the user's fingertips in an easy-to-read, mobile-friendly format.

The PaintSquare app was developed by Technology Publishing Co., publisher of *JPCL* and the PaintSquare publications, under the leadership of app general manager Camilo Zambrano and vice president of operations Andy Folmer.

For advertising opportunities within the app, please contact Marian Welsh ([mwelsh@technologypub.com](mailto:mwelsh@technologypub.com)) or John Lauletta ([jlauletta@paintsquare.com](mailto:jlauletta@paintsquare.com))

Download the app for free now via the App Store for Apple devices or the Google Play store for Android devices.

## Sherwin-Williams Posts Record Sales in 2017

The Sherwin-Williams Company achieved record sales in 2017 on the heels of its blockbuster acquisition of Valspar, according to its fourth-quarter and year-end earnings reports, released Jan. 25.

The Cleveland-headquartered paints and coatings firm reported \$14.98 billion in consolidated net sales in 2017, a record for the company and the highest sales number of any coatings company that has reported its 2017 fiscal year to date. That

represents a year-over-year increase of 26.4 percent, owed largely to the June acquisition of Valspar, which the company says contributed a 20.8 percent increase in net sales on the year.

Without accounting for the Valspar acquisition, net sales from core Sherwin-Williams operations still increased for the company, however, up 5.6 percent on the year.

In the fourth quarter of 2017, Sherwin-Williams reported an increase in net

sales of \$1.2 billion, or about 43 percent, to \$3.98 billion, growth that the company attributes both to the Valspar acquisition and higher paint sales volume in its Americas Group.

On the year as a whole, the record net sales Sherwin-Williams reported translated to a 14.5 percent increase in gross profits, from \$5.92 billion to \$6.78 billion. In 2017, profits as a percentage of net sales were 45.3 percent, down from 50 percent in 2016. The company reported net income

of \$1.77 billion in 2017, up from \$1.13 billion in 2016.

Sherwin-Williams chairman, president and CEO John G. Morikis said 2017 will primarily be remembered at the company as the year the firm welcomed Valspar, in a deal valued at \$11.3 billion that catapulted the company to the top of the global coatings industry in terms of size.

Morikis said in a statement that the company expects further growth in 2018, forecasting mid- to high-single-digit growth in net sales overall for the coming year. The firm also expects financial benefits from the recently passed tax-reform



John G. Morikis

legislation, which should reduce the overall tax rate for the global giant from mid- to high 20 percent range to the low-to-mid 20 percent range.

"The enormous amount of effort and energy invested over the past seven months in bringing these two great companies together, strengthening our customer relationships, defining the right organizational structure and building momentum in every line of business is transforming Sherwin-Williams into a faster growing, financially stronger and more profitable enterprise," Morikis said. "These efforts will continue throughout 2018 with similar effect."

## PPG Reports Net Sales Increase in Q4, Year-End Financials

**P**ittsburgh-based global coatings manufacturer PPG announced its fourth-quarter financial report Jan. 18, as well as its end-of-year report for 2017. Each report indicated an increase in net sales.

For the quarter, the company reported net sales of approximately \$3.7 billion, up about 8 percent over the prior year. Full-year 2017 reported net sales from continuing operations totaled \$14.8 billion, up more than 3 percent from 2016's sales.

PPG also shared its commitment to spend on acquisitions and share repurchases in 2018. "... [We] continue to have strong financial flexibility and are committed to deploy a minimum of \$2.4 billion of cash in 2018 on acquisitions and share repurchases as part of our previously communicated target to deploy \$3.5 billion in 2017 and 2018 combined," said PPG chairman and CEO Michael McGarry.

"In the fourth quarter, we delivered solid and balanced sales growth in each major region, and both reporting segments achieved at least 2 percent sales volume growth," said McGarry.

"Additionally, our aggregate selling prices improved for the third consecutive quarter as we made continued progress on our margin recovery efforts, despite higher than anticipated



Michael McGarry

raw material inflation in the quarter driven by ongoing supply-related issues, including production curtailments from additional environmental enforcement in China."

McGarry also noted that PPG completed its multi-year transformation plan with the sale of the U.S. fiber-glass business, the last of the glass segments for the company.

In addition to the \$14.8 billion in net sales, PPG reported that its full-year net income from 2017 was \$1.4 billion, or \$5.46 per diluted share. Full-

year 2017 adjusted earnings per diluted share from continuing operations was \$5.87 per diluted share, representing an increase of nearly 4 percent year-over-year.

"Looking ahead, we are well positioned to benefit from broadening and more synchronized global economic growth due to our geographic reach, excellent product portfolio, and advanced customer technologies," McGarry said.

"We expect minimal abatement in the first half of the year to the high level of raw material inflation that the coatings industry is experiencing. We will continue to work with our customers to address the inflationary environment and expect to realize additional selling price increases in 2018."

After the Q4 release, the board of directors also declared a regular quarterly dividend of 45 cents per share, payable March 12 to shareholders of record Feb. 16.





## PAINTSQUARE COMMENTS

## In Response to "Forth Road Bridge to Get First Full Paint Job"

*JPCL Special Report, Jan. 30*



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The landmark Forth Road Bridge in east-central Scotland is set to receive a \$91 million repainting, the first since the bridge opened in 1964. The project, which also includes a variety of structural repairs, will begin this year and is expected to take about 10 years to complete.

### Scott Youngs:

"My question is, how did the bridge last that long before needing a repaint? Fifty-four years is a long time."

### Kevin Healey:

"Wasn't it metal sprayed?"

### Tom Schwerdt:

"Different climate, but the old lead painted bridges here in Texas commonly have the paint system last 50-to-60 years."

### Scott Youngs:

"My mistake, it is 53 years old. After a little research, as Kevin had thought, it was coated with thermally sprayed zinc before the topcoat of paint which has provided the long service life."

## In Response to "Blasters Go Rogue, Clean Part of 'Graffiti Bridge'"

*PaintSquare News, Jan. 5*



©iStockphoto.com/sorsillo

In an effort to see how many layers of paint actually cover Pensacola, Florida's locally famous Graffiti Bridge, professional blaster James Romero of Gulf Breeze, Florida blasted spots of coating layers off of the bridge surface, raising conversation as well as safety and legal concerns.

### Michael Halliwell:

"Wow! So the bridge is structural paint with an endoskeleton of steel and concrete? The engineer in me cringes about the loading on the structure (yes, I know...for railway bridges there is a load limit with a factor of safety) and the potential for hidden corrosion and deterioration."

### Scott Youngs:

"It is concerning that CSX is not worried about the thousands of pounds of additional weight. While I am not a bridge inspector, I wonder how you can thoroughly inspect it?"

### Michael Halliwell:

"Scott, I agree 100 percent. There is absolutely no way to adequately inspect a bridge with that much paint on it ... you cannot see the condition of the steel and concrete. If water has worked into any crack, the potential for catastrophic failure is huge and you'd never see it."

### Michael Beitzel:

"It appears there are approximately 25 layers of paint, each one being from 5-to-10 mils thick. Each mil is 1,000th of an inch for total thickness of approximately 1/4-inch. Any major structural crack or issue would be reflected thru the coating layers and observable. Given the milder climate of the area and infrequent freeze/ thaw cycles this is probably the most protected concrete structure on the entire rail line. The additional weight of coatings is insignificant. Rest easy."



# Paint Poll

paintsquare.com/poll

OSHA recently renewed its alliance with the National Association of Women in Construction, aiming to safeguard women in the building trades. In your experience, are women at special risk for workplace injury in the construction industry?

**75% No.**

**17% Yes.**

**8%**

**Other** (please explain in comments section).

**Amber Lounsberry**

"Why would we be at risk? The only risk I would see is sexual harassment. As a woman picking a career in the construction industry, we know what we're in for, just the same as a man."

**Janet Mazeau**

"Only if their vanity gets in the way of using PPE and conducting themselves using good safety practices. Glad to hear that NAWIC is still going strong."

**Regina Montgomery**

"I spent 30-plus years in industry as a marine engineer and haven't met anyone, male or female, who lets vanity get in the way of safety — even the makeup-loving, black-belt, concert pianist oiler."

**Michael Halliwell**

"The only time I see it as being a potential issue is if 'the boys' try to 'burn in' a lady like they do a newbie/greenie. The difference is, I think the ladies get 'burned in' a lot more (longer or on more jobs) than the newbies/greenies do. Otherwise, I don't see it as an issue — if everyone works safe, everyone goes home safe."

## PAINTSQUARE NEWS TOP 10

paintsquare.com/news, Jan. 8 to Feb. 4

1. PA Contractor Pleads Guilty to Fraud, Pollution
2. Sherwin-Williams Posts Record Sales in 2017
3. New Bridge Collapses in Colombia
4. New Bay Bridge May Be Under Microbe Attack
5. Report: Border Wall Prototypes Pass Testing
6. PPG Releases Q4, Year-End Financials
7. Oroville Dam Forensic Team: 'Systemic Failure'
8. PennDOT to Fill Plug Welds After Bridge Incident
9. Caltrans Halts Bridge Build Over Movement
10. Forth Road Bridge to get First Full Paint Job

## Problem Solving Forum

paintsquare.com/psf

### What abrasive should be used to prepare stainless steel?

**Lam George, Steelcote Pte Ltd:**

"Aluminium oxide and garnet."

**Trevor Neale, TF Warren Group:**

"Assuming that the preparation is prior to applying a protective coating where a profile is required, aluminum oxide of the correct sieve size is the best candidate."

**Erik Andreassen, CPS:**

"The reason behind the selection of stainless steel in fabrications is its own ability to prevent corrosion with out coatings. If blasting of any media is used on stainless items, it can remove the chrome layer in the stainless composition and therefore reduce its corrosion resistance. I would rather suggest a hand-prepared surface if it's an actual specified requirement. If someone adds blasting to the specification for surface preparation to stainless steel, I would seriously question this decision before proceeding."

**Brad Gooden, Blast-One International:**

"Alluvial almandine garnet which is greater than 97 percent garnet. For best results use a size of 80 mesh or smaller, unless a high surface profile is required."

**Madalaine Elliott, Techno Coatings Inc.:**

"You should always use aluminum oxide or garnet abrasive only."

# Airport Jet Fuel Piping Lining Issues

BY RICK HUNTLEY AND CYNTHIA O'MALLEY, KTA-TATOR, INC.

An international airport was in the midst of an expansion project. As part of the project, 24-inch-diameter jet fuel piping was being installed by a subcontractor hired by the general contractor that was directly hired by the owner to manage the project. The piping manufacturer installed both the interior and exterior linings. According to the specification, the interior of the pipes was required to be abrasive blast-cleaned to an SSPC-SP 10/NACE No. 2 Near-White Blast Cleaning finish. Additionally, according to the specification, "The standard required at the time of lining shall be a minimum of ISO 8501-I grade Sa 2-½, with a surface profile of 70 ± 20 microns peak-to-trough height."

The coating system specified for application to the interior of the piping system was a phenolic lining. According to the product data sheet, the lining material was an amine-cured, modified epoxy-phenolic. The primer's solids content was approximately 65 percent by volume and the finish coat's solids content was approximately 63 percent. Both coats had a recommended dry film thickness of 100-to-150 microns per coat. The specification required that the coating be applied in two coats at a dry film thickness of 125 microns per coat. The first 50 mm of the ends of the pipes were required to be left bare.

The pipes were manufactured by a different company than the contracted company that was responsible for abrasive blast-cleaning and coating. After application of the interior coating, the pipes were transferred to a protected curing area. The interior of the curing area was heated with portable heaters.

The pipes were delivered to the jobsite at the airport in three lots, referred to as Lot 1, Lot 2 and Lot 3. During installation of the pipes, no additional preparation or coating was required to be performed at the welded seams. Sometime after the pipes were shipped to the jobsite, a number of the pipes in Lot 2 had been placed

in trenches and were exposed to flooding conditions that partially or fully exposed the pipes to muddy water. Most of the pipes that were exposed to the floodwater were subsequently cleaned with fresh water to remove sand and other contaminants.

After the pipes had been exposed to the water, a video survey was performed to determine the condition of the interior coatings and to determine whether contaminants had been removed. It was discovered that the coating had blistered and delaminated in several areas. The delamination was most prevalent at the first several centimeters of the coating at the edges of the pipes.

## FIELD INVESTIGATION

A consultant visited the expansion project at the airport approximately 11 months after the coatings were applied. The consultant was accompanied by the facility management representatives and the pipe installation organization. The results of the field investigation, in summary, are as follows.

Some of the pipe that had been installed and was subject to the flooding was subsequently removed and transported to a laydown yard close

to the site office. The pieces of pipe that were examined during the field visit are listed in Table I.

The interior of the 24-inch-diameter pipe sections were coated with a light gray lining. The lining appeared to have been applied in a smooth and consistent manner and there was a minimum of noticeable visible application defects such as runs, sags and missed areas.

Several of the pipes from Lot 2 were examined. The pipes were reportedly flame-cut when they were removed, which in many cases caused visible damage to the coating near the edges, including some visible charring. As a result, the coating was not sampled in these areas since there was no assurance that any visible coating damage was not caused during the removal process.

There were two major concerns with the interior lining. The first concern was the prevalence of rust staining. In several of the pipes that had been flooded and subsequently flushed with water, there was a pattern of pinpoint rusting that was prevalent, typically on one side of the pipe. The areas of pinpoint rusting were closely examined using a field microscope and it was clear that the rusting was the result of deposits of metal on the surface of the lining. The rust staining did not

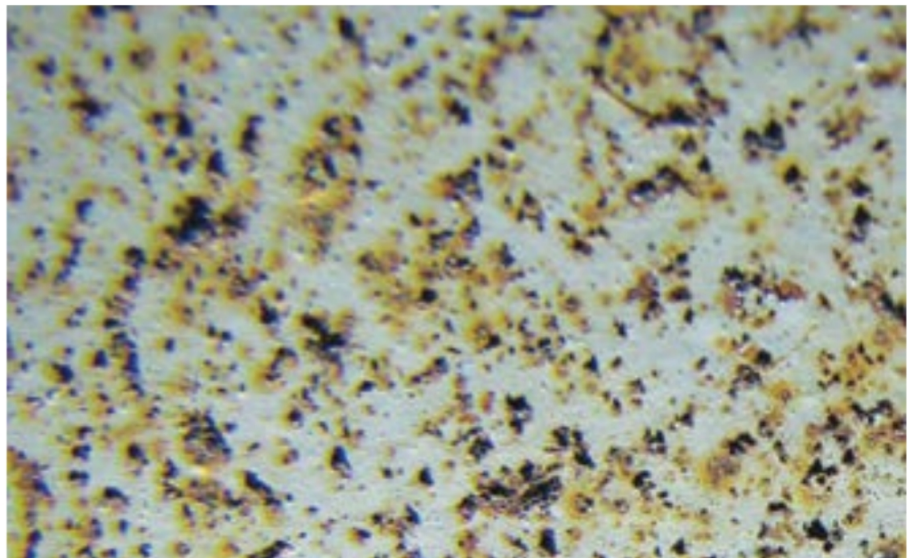


Fig 1: Rust staining on the surface of the lining. All figures courtesy of KTA-Tator, Inc.



**Table 1: Pieces of Pipe Examined During Field Visit.**

Lot Number	Condition
1	New Pipe (at installation location)
2	Flooded and Flushed
2	Flooded and Flushed
2	Flooded and Flushed
2	New Pipe
2	Half Flooded and Not Flushed
3	New Pipe

penetrate through the topcoat, and there was no noticeable associated rust staining on the surface of the pipe when the coating was removed. Typically, small particles of metal were visible on the surface of the lining, and rust stains were visible surrounding the metal particles. The metal particles could be removed by scraping the surface with a knife.

The second concern was the occurrence of

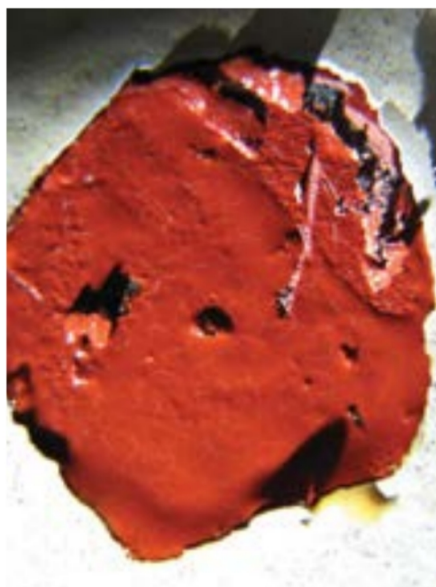


Fig. 2: An exudate is visible on the surface of the primer.

blistering and coating delamination of the interior lining. Blisters in the coating were found in several of the Lot 2 pipes. In all cases, the blisters occurred between the topcoat and the primer. No blistering or delamination of the primer from the substrate was found. The blisters ranged in size from ¼-inch in diameter up to approximately 3 inches in diameter.

When blister caps were removed, an amber

colored translucent viscous liquid was found on the surface of the primer. The blister liquid had a slight unidentifiable odor. In some cases, when the blister was pulled away from the surface, the clear viscous liquid formed a string between the surface and the blister cap.

On two of the pipes that were examined, blistering was prevalent along the longitudinal weld. Typically, the blistering occurred at the boundary between the weld and the surrounding pipe surface. When the blister caps were broken in this area, the translucent viscous liquid was present on the surface of the red primer.

On the Lot 2 pipes that experienced blistering, there was also an unusual surface deformity on the topcoat, which was present on approximately one half of the circumference of the pipe, but extended much of the length of the pipe. The deformity was present as a pattern of furrows or valleys and the surface had the appearance of mud cracking, although there was no actual crack in the topcoat. When blisters were removed, there was often a similar mud cracking pattern on the red primer, although that pattern appeared to be the result of deposits of the gray primer on the surface of the red primer that matched the pattern of the furrows on the topcoat surface.

One of the pipe sections from Lot 2 had been in contact with floodwater on approximately half of the circumference of the entire pipe, but had not been flushed. Dirt was present on approximately half of the circumference, but the other half was clean and similar in appearance to the new pipes. The unusual topcoat surface deformity appeared on half of the circumference of another pipe from the same lot, but the half with the surface deformity did not align with the half that had been flooded. There was some overlap, but there were areas that had been flooded that did not exhibit the surface deformity, and areas that exhibited the service deformity that had not been exposed to floodwater.

The adhesion of the coating was assessed in accordance with ASTM D-3359, Method A, "Measuring Adhesion by Tape Test." This method involves making two intersecting cuts through the coating to the substrate with a sharp blade. The smaller angle of the cuts is between 30 and 45 degrees F. A special pressure sensitive tape is then applied to the X-cut area and rapidly removed. The adhesion of the coating is rated



Fig. 3: Cracking pattern on primer consisting of traces of the gray topcoat.

according to the amount of coating removed by the tape using the following ASTM scale.

5A - No peeling or removal.

4A - Trace peeling or removal along incisions.

3A - Jagged removal along incisions up to 1/16 inch on either side.

2A - Jagged removal along most of incisions up to 1/8 inch on either side.

1A - Removal from most of the area of the X under the tape.

0A - Removal beyond the area of the X.

Generally, the adhesion of the coating was found to be good (3A to 5A) even in areas immediately surrounding the blisters. When the coating was picked and probed with a utility knife, it was found that the topcoat could be separated from the primer, although in very small chips, in areas generally on the same half of the pipe as blisters and in areas where the topcoat surface cracking pattern was present. In areas where cracking was not present and on new pipes from Lot 1 and Lot 3, the topcoat could not be separated from the primer.

The dry film thickness of the coating was measured on all the pipe sections that were examined using a calibrated electronic dry film thickness gage. The dry film thickness of the coating varied from 7.6 mils (193 microns) to 13.0 mils (330 microns) and was generally close to the specified coating thickness. There was no noticeable correlation between the thickness of the coating and the occurrence of coating delamination, blistering, or the unusual surface deformity.

## DISCUSSION

The field investigation and the laboratory analysis revealed the cause of the blistering and



## INVESTIGATING FAILURE

delamination of the epoxy phenolic pipe lining system to be the presence of an exudate on the surface of the primer. The exudate was an amber-colored, translucent viscous liquid that was clearly visible on the surface of the primer when blister caps were removed from pipes



Fig. 4: Good adhesion of the coating on Lot 1 pipe.

during the field visit. The blistering and delamination of the coating always occurred between the topcoat and the primer.

Laboratory infrared analysis indicated that

the exudate was mostly organic material consisting of epoxy and unreacted amine. The composition of the exudate is similar to the composition of the resin materials that are present both in the primer and in the epoxy phenolic topcoat. Because the exudate was present between the



Fig. 5: Cracking pattern on topcoat and primer.

primer and the topcoat, it is believed that it originated in the primer and was present on the surface of the primer when the topcoat was applied. Had the exudate originated in the topcoat,

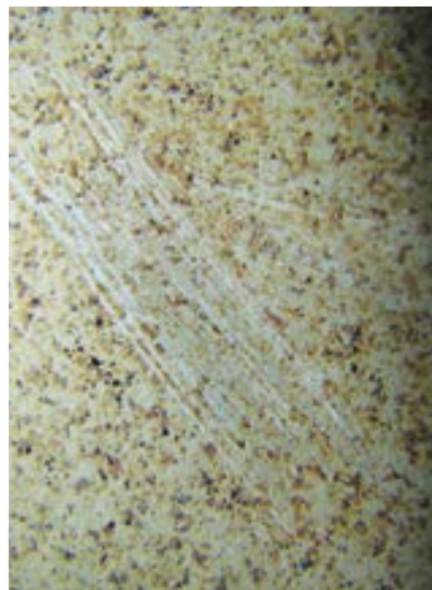


Fig. 6: Rust staining could be scraped away with a knife.

it would simply have appeared on the surface of the topcoat and would not have created blistering or delamination problems.

Along with the blistering and delamination of the topcoat from the primer, there was also the unusual visible pattern on the surface of the epoxy topcoat consisting of furrows or valleys, which resembled something similar to a mud cracking pattern even though the topcoat did not actually crack, but instead formed connected valleys in the coating. The pattern that was formed is most likely a result of the exudate present on the surface of the primer, which was soft, while the topcoat developed considerable hardness and shrinkage stress during the curing process. It is clear that the topcoat shrank during the curing process and while the topcoat was still a semi-liquid, it stretched in certain areas to relieve the shrinkage stress. The areas that stretched were the valleys in the unusual mud cracking pattern. Typically, when a coating develops shrinking stress during the curing process, the coating is unable to move because the underlying surface is hard, and the coating is attached to the surface. In this case, the soft exudate allowed the topcoat to slide over the surface during the curing and shrinking process, eventually leading to the unusual mud cracking pattern.

The flooding of the pipes did not create the delamination or blistering problem, but instead revealed a problem that already existed. The laboratory analysis determined that the exudate was

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## INVESTIGATING FAILURE

water-soluble or at least partially water-soluble. When water was introduced into the pipes, some of the water transferred through the topcoat to the water-soluble exudate in a process known as osmosis, which mostly occurs in a coating system when a water-soluble material is present beneath a coating.

The unusual cracking pattern on the surface of the topcoat was created during the initial curing process. Once the topcoat has cured and hardened, the coating can no longer be deformed to create the valleys that were present in the topcoat. These valleys can only be created while the coating is still in a semi-liquid state. Once a coating has hardened, the curing stresses are relieved only by cracking of the coating, not by stretching or deforming of the coating.

Further evidence of the formation of the unusual surface pattern independent of the flooding was found in one of the Lot 2 pipes. It was clear from the deposits on the surface of the pipe that approximately half the circumference of the pipe had been flooded, but the variability of the cracking pattern on flooded and unflooded areas of the pipe is an additional indication that the cracking pattern was not a result of the flooding.

A video examination of the installed piping system indicated that the coatings were often cracking and delaminating near the circumferential welds. It appeared that often the first 5 or 6 centimeters of coating at the edges cracked, and the cracking and delamination occurred on approximately half of the circumference of the pipe. The video did not have sufficient resolution to determine whether or not the mud cracking pattern was present on the intact coating near the areas of cracking and delamination at the pipe edges. If cracking delamination had been present on the edges of the pipes that were removed for examination, these areas were damaged by the heat of the removal process and no appropriate sample areas exhibiting the edge delamination were found.

It is likely that the cracking and delamination at the edges was also a result of the exudate. Similar to the blistering and the unusual surface pattern, the delamination at the edges occurred between the primer and the topcoat and was found on half the circumference of the pipe. It is most probable that the heat generated during the welding process softened or melted the exudate

to the point where the topcoat cracking released. Because the exudate appeared to be composed mostly of uncured resin, it is reasonable to expect that heat would lower the viscosity of the material. The properly cured epoxy phenolic coating system should not have been adversely affected by the welding process to the degree found in the inspection videos. Typically, if weld heat does affect the lining, the failure mechanisms

are blistering from the steel substrate, and not between coats.

The reason for the formation of the exudate could not be definitively determined, but most likely the primer surface was exposed to moisture before the epoxy phenolic resin and the amine hardener had reacted. Sometime before the resin and cross-linker adequately reacted, the coating was exposed to moisture.

## KNOWLEDGE SHARING

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## INVESTIGATING FAILURE

When the moisture evaporated from the coating, it transferred the partially water-soluble material to the surface. This material was not volatile, and it remained on the surface when the water evaporated.

The source of the moisture could not be determined because the exposure occurred during painting operations and the conditions were consequently not directly observed for the investigation. Photographs taken during painting operations indicated that the pipes were transported to a heated building after coating to facilitate curing. It appeared that the heat was supplied by direct-fired kerosene heaters. Direct-fired fossil fuel heaters should typically be avoided when providing heat for curing of coatings in enclosed areas, as they emit carbon dioxide and water vapor and in some cases can create moisture condensation problems, especially if the substrate is cold. The use of these heaters may have contributed to the formation of the exudate on the surface. Regardless of the exact source of the

moisture, it was clear that the exudate formed on the surface of the primer before application of the topcoat, and the detrimental environmental conditions that precipitated the formation of the exudate occurred during the painting process.

During the field investigation, pipes from Lots 1 and 3 were closely examined. There was no sign of blistering and delamination, and the unusual surface pattern was not present in these pipes. Additionally, the adhesion of the coating in these pipes was excellent and there was no noticeable separation of the topcoat from the primer. There was no evidence that the problem with the exudate that was found in Lot 2 was present in Lot 1 or Lot 3.

It was reported that sections of the pipe will be flushed with jet fuel at a flow rate several times higher than would be expected during normal operation. The effect of the jet fuel on the problematic pipe sections from Lot 2 was unknown. The introduction of jet fuel into these pipes in conjunction with the higher flow

rate should be a good test to determine whether the jet fuel will dislodge additional sections of coating. It is anticipated that coating that can be dislodged by the jet fuel will be dislodged during this flushing process and that coating that is intact after the process should substantially remain intact during operation, although the magnitude of the coating delamination during the jet fuel flush should be considered.

Rusting that was found on the surface of the pipes was a result of metal shavings that had deposited on the surface of the lining. The rusting did not penetrate through the coating system to the surface. The particles could be relatively easily removed by scraping the surface with a knife. The rust staining will not detrimentally affect the performance of the lining system.



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This review lead me to some new conclusions regarding our testing, management and documentation of potentially characteristic waste resulting from abrasive blast-cleaning. All generators and co-generators in the field and in the office need to evaluate their current waste-management practices for compliance with this new information.

BY ALISON B. KAE LIN, CQA, ABKAE LIN, LLC

In 40 CFR 268.9, special rules regarding wastes that exhibit a characteristic require that the hazardous determination includes evaluation of the toxic characteristic thresholds (for example, is lead above 5.0 mg/L?) and "the generator must determine the underlying hazardous constituents (as defined at § 268.2[i]) in the characteristic waste."

UHCs are trace amounts of hazardous chemi-

The existing coatings may contain lead, chromium, cadmium or arsenic. To determine what UHCs may be present, one must review the abrasive safety data sheets and perform and review paint test results to identify any trace UHCs present. Once waste was generated, one must perform TCLP analysis for all eight regulated metals and any trace UHCs (such as beryllium) in the waste. When results are received, one must review them and determine first if the waste is hazardous (above the toxic characteristic threshold); and if not, whether it contains UHCs above the UTS.

For Example Two (Table 2, p. 18), the waste would

In Example One (Table I, p. 18) most of us would conclude this is a non-hazardous waste. We'd be partially right, however, we'd not be complying with the land

If UHCs are present above the universal

Fig. 2: Sample waste profile.

For Example Three (Table 3, p. 18), the waste would need to go

# OFFICE TO FIELD: LOST IN TRANSLATION

**Table 1: Example 1 — Waste Tested for Eight Heavy Metals.**

Regulated Constituent	Hazardous Waste Threshold 261.24 Method 1311 (TCLP mg/L)	Theoretical TCLP Results (mg/L)	Hazardous Waste
D004-Arsenic	5.0	<0.10	N/A
D005 - Barium	100	1.1	N/A
D006 - Cadmium	1	0.5	N/A
D007 - Chromium	5	3	N/A
D008 - Lead	5	2	N/A
D009 - Mercury	0.2	<0.0020	N/A
D010 - Selenium	1	0.5	N/A
D011 - Silver	5	<0.10	N/A

**Table 2: Example 2 — Waste Exhibits a Toxic Characteristic and Has Other UHCs.**

Regulated Constituent	Theoretical Method 1311 TCLP Results (mg/L)	Toxic Characteristic Threshold 261.24 (TCLP mg/L)	Applicable Toxic Characteristic	Universal Treatment Standard 268.48 (TCLP mg/L)	Applicable UHC 268.2(i)
D004 - Arsenic	<0.10	5.0	N/A	1.15	N/A
D005 - Barium	1.1	100	N/A	21	N/A
D006 - Cadmium	<0.10	1	N/A	0.11	N/A
D007 - Chromium	1.1	5	N/A	0.60	✓
D008 - Lead	7.0	5	✓	0.75	N/A <sup>1</sup>
D009 - Mercury	<0.0020	0.2	N/A	0.025	N/A
Nickel	0.05	N/A	N/A	0.025	N/A
D010 - Selenium	<0.10	1	N/A	5.7	N/A
D011 - Silver	<0.10	5	N/A	0.04	N/A
Beryllium	4.0	N/A	N/A	1.22	✓

1: Lead is treated as N/A for UHC since it is being treated as D008 waste.

**Table 3: Example 3 — Waste Does Not Exhibit Toxic characteristic, but does have UHCs.**

Regulated Constituent	Theoretical Method 1311 TCLP Results (mg/L)	Toxic Characteristic Threshold 261.24 (TCLP mg/L)	Applicable Toxic Characteristic	Universal Treatment Standard 268.48 (TCLP mg/L)	Applicable UHC 268.2(i)
D004 - Arsenic	<0.10	5.0	N/A	1.15	N/A
D005 - Barium	1.1	100	N/A	21	N/A
D006 - Cadmium	<0.10	1	N/A	0.11	N/A
D007 - Chromium	1.1	5	N/A	0.60	✓
D008 - Lead	4.0	5	N/A	0.75	✓
D009 - Mercury	<0.0020	0.2	N/A	0.025	N/A
Nickel	0.05	N/A	N/A	0.025	N/A
D010 - Selenium	<0.10	1	N/A	5.7	N/A
D011 - Silver	<0.10	5	N/A	0.04	N/A
Beryllium	4.0	N/A	N/A	1.22	✓

to a Subtitle C facility to be treated for lead, chromium and beryllium to below the UTS levels. It could then be disposed of in either a Subtitle C or Subtitle D non-hazardous waste facility.

## DOCUMENTATION

It is also important to check the documentation being completed in the office and field to make sure it properly addresses both toxic characteristics and UHC, and meets land disposal

restriction (LDR) requirements. In 40 CFR 268.7, testing, tracking and record keeping requirements for generators, treaters and disposal facilities stipulate the following records be maintained.

## Hazardous Waste Determinations

As discussed earlier, one should perform TCLP testing for potential UHC, even when the generator declares the waste to be hazardous (as is frequently done when steel abrasives are used).

The person signing the hazardous waste manifest or the bill of lading or completing forms required by the treatment, storage and disposal facilities (TSDF) should first have knowledge of the test results.

## TSDF Forms/Waste Profile Information

All treatment, storage and disposal facilities (TSDF) have specific forms and documents that they require based on their individual permits and Resource Conservation and Recovery Act (RCRA) requirements for TSDF. They may be referred to as Waste Material Profile Sheets, Waste Analysis Profiles or Waste Characterization Reports. They are required to be signed by the generator.

What is common on all of these forms are questions regarding the hazardous determination of the waste, physical characteristics, heavy metals, VOCs and land disposal restrictions. All require identification of UHCs, and most require completion of a UHC waste profile addendum or similar. Results of TCLP testing is generally attached.

These forms are legally binding and state that the information is complete and an accurate representation of the waste and its known or suspected hazards. Additional notifications or certifications are required if the waste streams change.

## Manifests/Bills of Lading/Non-Hazardous Waste Manifests

Based on the hazard determination, the generator (or approved offerer) completes the appropriate transmittal document to accompany the waste.

Waste manifests have a fixed format (40 CFR 262) and only require identification of hazardous wastes. It requires generator certification regarding the information provided.

Bills of lading generally do not ask about UHC or hazardous wastes. Some states or TSDF have non-hazardous waste manifests that do ask about UHC.

It is important to remember that persons



completing manifests are required to be trained in hazardous waste.

### Land Disposal Notification/ Certification Forms

A notification may be referred to as a land ban form or land ban statement. The land ban form is used when your waste has been sent to a treatment, storage and disposal facility (TSDF), but has not yet been treated to meet the UTS. In other words, the waste still requires treatment before it can go onto "the land" (a landfill or surface impoundment).

On the other hand, a land disposal certification form or "certification" is used when your waste meets UTS upon arrival at the TSDF. This waste can be disposed of without further treatment.

These are one-time responsibilities and sent with the first bill of lading or manifest.

### SO WHAT DOES THIS MEAN FROM OFFICE TO FIELD?

#### In the Office (Generators/Consultants)

Check your specifications. Some of you are using language that has not been revised since the 1990s. In light of this and the recent changes to generator regulations [*JPCL*, January 2017], verify that you are asking for enough testing and a vigorous hazardous-waste-determination process. Verify that you are receiving and reviewing all information on hazard determinations.

Determine which documents you are requesting, reviewing and receiving. Who is signing or reviewing them? Do you have a good

understanding of the entire hazardous waste management process?

Consider requiring testing for potential UHCs. This should include UHCs that may be present in abrasives, existing paint and substrates (stainless steel frequently exhibits chromium). Verify that UHCs are being appropriately identified, disclosed and managed.

#### In the Field

Check the forms you're using with your waste vendors. There are many obsolete or legacy forms out there that do not include current information. Just because your company used this form four years ago does not make it appropriate for all waste streams generated today.

Verify that you understand your responsibilities when performing hazardous waste determinations.

Verify that you are performing hazard determinations on all potential waste containing UHC.

### CONCLUSIONS

I've got to admit, some of the aforementioned information was news to me. I contacted a representative of the NJDEP Bureau of Hazardous Waste Compliance and Enforcement who confirmed the information provided in this article.

### ABOUT THE AUTHOR

Alison B. Kaelin, CQA, has more than 30 years of public health, environmental, transportation and construction management experience in the coatings industry. She is the owner



of ABKaelin, LLC, a provider of EHS, coatings quality assurance, consulting and related services to the protective coatings, construction, fabrication and nuclear

industries. Kaelin is a certified quality auditor and a NACE-certified Coating Inspector. She was a co-recipient of the 2016 Coatings Education Award, a co-recipient of the inaugural SSPC 2014 Women in Coatings Award, a 2012 *JPCL* Top Thinker, a 2012 *JPCL* Editor's Award Winner and an SSPC Technical Achievement Award winner in 2005. Kaelin is also a *JPCL* contributing editor.

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# Meeting Expectations When Selecting Concrete Rehabilitation Systems

BY MIKE DADIK P.E. S.E.,  
CAROLLO ENGINEERS, INC.

**B**y itself, concrete has enormous compressive strength but little tensile capacity. Thus, an unreinforced concrete column can support a large load, but a beam has minimal strength without reinforcing steel. Reinforcing steel, also known as rebar, first came into common use near the end of the nineteenth century. Since then, reinforced concrete has become a preferred building material for water storage and conveyance structures, providing great

strength and many possible configurations. These advantages, however, come with the challenge of protecting rebar, which is essential for long-term durability.

Engineers have learned that maintaining concrete's alkalinity is the key to this protection. With a pH between 11 and 12, concrete's pH is very high, similar to that of lime or lye. This high pH environment surrounds reinforcing steel, forming a passivating layer that prevents corrosion. Concrete longevity depends heavily on maintaining the high pH environment. Exposure to acid breaks down



Fig. 1: This photo shows the site before the project was bid. The best access available was by removing the covers from the full grit basins. Photos courtesy of the author.



this protective mechanism.

Coating concrete can minimize, or even stop damage from aggressive environmental exposures that harm the concrete and lower its pH. Properly applied, a coating can stop concrete deterioration before it progresses to the reinforcing steel and prevent costly structural repairs. This practice is commonly implemented in wastewater treatment plants, collection systems and industrial plants where concrete coatings are commonly used to reduce acid exposure. An acid/base reaction occurs when high-pH concrete is exposed to low-pH acids. There are many sources of low-pH acids. Atmospheric carbon dioxide in water forms a weak acid resulting in concrete carbonation. Extensive, widespread concrete deterioration is more commonly seen as the result of acid byproducts produced by bacteria-consuming hydrogen sulfide from wastewater. Referred to as biogenic sulfide corrosion, this may be the most common form of concrete deterioration remediated with protective coatings. Wastewater processes can also become upset, resulting in unintentional acid exposure<sup>1</sup>.

Applied when concrete is new, coatings can protect it from acid exposure. For a number of reasons, concrete may not be coated

until after damage occurs. Coating deteriorated concrete is considerably more difficult than coating new concrete. Understanding the deterioration process is important when specifying and applying remedial coatings.

### REINFORCED CONCRETE DETERIORATION PROCESS

Damage from acid exposure begins at the concrete surface and progresses in toward the reinforcing steel. When exposed to a low pH environment, acid/base reactions break down the concrete paste, reducing the thickness of the high-pH concrete layer that protects the reinforcing steel. The deterioration advances deeper into the concrete, eventually lowering the pH near the reinforcing steel, allowing corrosion to begin. When rebar corrosion initiates, expanding rust forms larger cracks accelerating the corrosion rate and reinforcing steel wasting, ultimately weakening the structure. Coatings can reduce deterioration by eliminating exposure and restoring the corrosion protection by replacing the lost concrete with an impermeable membrane.

Chemicals such as sulfates and chlorides also lead to concrete deterioration. Chlorides from chemicals used for wastewater disinfection will penetrate the concrete. The

chlorides break down the passivating layer around the rebar. Without this protective layer, rebar can corrode. Coatings can be used after chloride contamination begins to reduce moisture in the concrete and the rate of corrosion. It is best to remove all of the chloride-contaminated concrete before a coating is applied.

Sulfates present in groundwater or in concrete can react within the cement paste. Expansive byproducts in the cement paste form microcracks. Chemical changes within the concrete matrix then weaken the cement paste, leaving it susceptible to water intrusion and accelerated corrosion. Sulfates are also a byproduct of biogenic sulfide deterioration, where concrete is exposed to sulfuric acid from  $H_2S$  reducing bacteria. This is why biogenic sulfide corrosion is so damaging.

Sulfate exposure is best mitigated with a properly designed concrete mix before the concrete is placed. As with chloride contamination, coating to reduce moisture in the concrete after the sulfate contamination has taken place can help. This approach can be used in specific circumstances, but because most external sources of sulfate are in the ground and below-grade, coating is usually not a cost-effective approach.



Fig. 2: The contractor begins work removing the lining system to uncover extensive  $H_2S$  damage.



Fig. 3: The finished project used calcium aluminate cement.

## SELECTING CONCRETE REHAB SYSTEMS

### EVALUATING CONCRETE DETERIORATION

Selection of cost-effective coating and concrete repair systems should consider the extent of deterioration and substrate condition. Assessment tools range from easy-to-perform visual and nominally destructive techniques to removing core-drilled samples for laboratory analysis. The test findings provide the specifier and estimator with an idea of how much concrete should be removed during surface preparation and if structural repairs are required.

#### Visual Assessment

Damage from acid exposure begins with softening of the concrete surface followed by loss of the weakened paste. At the start of the process, when the deterioration is a fraction of an inch deep, the concrete may look nearly new. However, striking the surface with a sharp tool will expose the softened paste. While undamaged concrete is hard to

chip, deteriorated concrete can be chipped back without much difficulty. A widespread area must be surveyed to assess the variation on the walls below, near and above the waterline, as well as the underside of overhead slabs. Floor surfaces should also be assessed though floor coatings are not typically used in water containment structures.

In wastewater and petrochemical facilities, biogenic sulfide corrosion starts with acid attack then continues with the formation of sulfates which weaken the cement paste in a two-phase process — a soluble salt byproduct forms during the second phase. The resulting loosely adhered, powdery white deposits are easy to spot and are typically the first visible damage observed after significant deterioration has occurred. The loosely adhered powder can be easily removed exposing aggregate.

As the deterioration continues, lowering the pH of concrete surrounding the reinforcing steel, rusting and spalling occurs,

exposing the rebar. Exposed reinforcing steel, rust staining and spalled or cracked concrete usually indicates loss of structural strength. Hammer sounding can identify rebar corrosion below the surface. Concrete that sounds hollow when struck indicates a void possibly caused by rebar corrosion.

Removing damaged concrete and rust to expose the remaining reinforcing steel helps assess the structural repairs required. At a minimum, all reinforcing steel corrosion must be cleaned to near-white condition before repair mortar is applied prior to coating. Depending on the location, adding new reinforcing steel may be required.

Visual assessment benefits from a standardized scale to rate deterioration (Table 1, p. 24). Though non-proprietary standard scales are not currently available, ICRI 310.2R concrete surface preparation replicas provide a standard to compare surface roughness<sup>2</sup>. The replica surfaces are produced by abrasive blasting or more

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# SELECTING CONCRETE REHAB SYSTEMS

**Table 1: Visual Concrete Deterioration Assessment Scale Example.**

<p><b>1. Smooth, hard surface – nearly new</b></p> <p>a. Quality: sound when struck with a pick, freshly exposed pH &gt;10.  b. Texture: smoothness.  c. Cracking: drying or plastic shrinkage cracks.  d. Spalls: none.</p>	
<p><b>2. Initial surface deterioration</b></p> <p>a. Quality: 1/8 to 1/4 inch easily removed with a pick, freshly exposed concrete pH &gt;10.  b. Texture: some exposed aggregate.  c. Cracking: cracks greater than 15 mils, localized or widespread.  d. Spalls: none.</p>	
<p><b>3. Advanced surface deterioration</b></p> <p>a. Quality: 1/4 to 1/2 inch easily removed with a pick, freshly exposed pH &lt;10.  b. Texture: widespread exposed aggregate.  c. Cracking: 1/16 inch to 1/8 inch cracks, moderate frequency.  d. Spalls: localized, infrequent if any.</p>	
<p><b>4. Advanced surface deterioration with initial reinforcing deterioration</b></p> <p>a. Quality: 1/4 to 1/2 inch easily removed with a pick, freshly exposed pH &lt;10.  b. Texture: widespread exposed aggregate.  c. Cracking: Widespread cracks, some greater than 1/8 inch.  d. Spalls: spalls or rust staining.</p>	
<p><b>5. Advanced surface deterioration with reinforcing deterioration</b></p> <p>a. Quality: 1/4 to 1/2 inch easily removed with a pick, freshly exposed pH &lt;10.  b. Texture: widespread exposed aggregate.  c. Cracking: Widespread cracks, some greater than 1/8 inch.  d. Spalls: widespread or localized easily removed spalls, exposed reinforcing, widespread rust staining.</p>	

## SELECTING CONCRETE REHAB SYSTEMS

aggressive surface preparation techniques and may not be directly applicable to corrosion-damaged concrete. ACI 201.1 is another resource providing guidance for visual assessment<sup>3</sup>.

### pH Measurement

Visual observation and hammer-sounding can help assess the surface physical appearance and condition, indirectly providing insight into concrete pH. Measuring concrete pH at and below the surface affords a better estimation for the rate of deterioration and the work required to restore reinforcing steel protection.

Indicator pencils, litmus paper, phenolphthalein and pH meters all measure in-situ concrete alkalinity. Measurements must be taken as soon as possible after the concrete is exposed. Concrete in contact with the atmosphere will begin to carbonate lowering the pH measurement. When concrete pH is below 10 to 11, the passivating benefits are reduced and corrosion can begin<sup>4</sup>.

**Table 2: Repair Mortar and Lining Systems.**

Grout and Mortar Surfacers	Coatings and Lining Systems
Portland Cement Mortar	Epoxy mastic
Calcium Aluminate Cement Mortar	Thick-film coatings
Epoxy Mortar	Elastomeric polyurethane and polyurea hybrids
	Ultra-high solids amine-cured epoxy
	Novolac Epoxy
	Liners
	PVC sheets
	Sulfur cement precast panels
	Stainless steel plates

To measure concrete pH, first chip or grind to expose a fresh concrete surface, then wet the concrete with neutral pH (distilled or deionized) water and wait approximately a minute to solubilize the concrete compounds. Expose indicator pencils or litmus paper to the wetted surface and compare the color change against a reference

standard. When using PH meters, place the electronic probe on the wetted concrete to measure the surface pH. ASTM F710, though written for concrete evaluation prior to installation of flooring, provides additional guidance<sup>5</sup>.

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**Table 3: Grout and Mortar Surfacers Comparison.**

System	Benefits	Limitations
Portland Cement Mortar	Simple, most crews have experience. Versatile – Trowel- or machine-applied. Versatile – Wide range of application thickness. Least expensive material.	Cure time between application and coating. Abrasive blast required before coating.
Calcium Aluminate Cement Mortar	Coating not required. Surface-tolerant. Versatile - Trowel- or machine-applied.	Cannot be coated. Effective in vapor spaces.
Epoxy Mortar	May be used as structural repair. Rapid cure and time to coating. Corrosion resistant.	High material cost. Limited application thickness. Abrasive blast before coating not required.

### Destructive Testing

If removing a core sample is an option, petrographic evaluation of concrete core samples provides the best assessment of concrete condition. Phenolphthalein solution is sprayed onto a fresh core for a rapid assessment of the carbonation depth. Microscopic, petrographic examination of the concrete structure will identify other types of deterioration in addition to acid attack.

These test findings will inform the specifier and estimator about the approximate amount of concrete that must be removed during surface preparation, which is useful information when evaluating potential coating and concrete repair systems.

### PRODUCT SELECTION

After assessing the concrete condition, coating selection is the next step in developing a repair approach. Rehabilitation has two components: restoring the concrete surface and enhancing the corrosion protection provided by the remaining concrete. Typically, cementitious or epoxy/polymer mortars rebuild the concrete surface. Calcium aluminate cement has inherent resistance to biogenic sulfide corrosion and does not need a coating. Factors influencing the selection of cementitious or epoxy mortars

include depth of repair, cost, curing time and surface preparation for coating.

High-build coating systems are commonly

used in wastewater exposures. These coatings are solvent-free, epoxy or elastomeric polyurethanes/polyureas. Thin-film coatings are generally not considered suitable for these environments; however, for less aggressive environments, an epoxy mastic or coal tar may be appropriate.

Factors influencing the selection of the coating include concrete moisture content, potential for cracking after coating installation and exposure. Table 2 presents repair mortars and coating and lining systems sorted in a commonly perceived order of increasing chemical resistance. The advantages and disadvantages of the each technology are summarized in Tables 3 and 4 (p. 28) and discussed in the following paragraphs.

### Grout and Mortar Surfacers

#### Portland Cement Mortar

These general-purpose mortars are trowel- or machine-applied at thicknesses ranging from a ¼ of an inch to over 4 inches.

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## SELECTING CONCRETE REHAB SYSTEMS

**Table 4: Coating Systems Comparison.**

System	Benefits	Limitations
Epoxy Mastic	Easy to apply with conventional equipment.	Thin film does not cover substrate defects well e.g., exposed aggregate, cracks and blowholes.  Osmotic blistering from entrapped solvents may occur.  Longer cure time before return to service.
Elastomeric Polyurethane/ Polyurea	Good for bridging cracks. Chemical resistant.	Low moisture concrete is critical for application.  Hydrostatic pressure may cause blisters or widespread failure.  Plural component equipment required.
Ultra-High Solids Amine-Cured Epoxy	Tolerates cracking. Chemical resistant. Moisture tolerant. Conventional equipment may be used in some applications.	Plural component equipment required except in limited applications.
Novolac Epoxy	Tolerates cracking. Best chemical resistance. Moisture tolerant.	Plural component equipment required. Most costly.

**Table 5: Specification Topics.**

Repair Mortar and Surfacers	Coating
Depth of repair	Exposure
Groundwater/moisture tolerance	Cracks after coating
Time to recoat	Substrate moisture content
Surface pH	Groundwater/hydrostatic pressure
Access	Access
Repair mortar surface prep	Return to service

Sometimes thick placements require multiple lifts. When the substrate is saturated surface-dry and neat grout is scrubbed in, the bonding strength improves.

Usually, cement mortar requires at least a week of cure time, sometimes up to 28 days before the coating can be applied. It is also a recommended practice to use abrasive blasting to remove laitance and loose material prior to coating.

### *Calcium Aluminate (CaAl) Cement Mortar*

This specialty mortar has similar properties to cementitious mortars with the added benefit of being resistant to hydrogen-sulfide-induced corrosion. Because of this, it does not need to be coated before return to service.

These systems are commonly used in collection systems to repair manholes and vaults, since high-quality surface preparation is difficult for these confined, hard to access and isolated locations. Performance history indicates that CaAl cement mortars perform well and can also restore structural capacity, essentially building a new manhole inside the existing manhole.

### *Epoxy Mortar*

There are a wide variety of epoxy mortars. Some have significant structural capacity to rebuild small vaults and manholes similar to CaAl cement mortars and are also corrosion resistant.

Epoxy grouts, which are used in coating applications to restore a concrete surface, are made by mixing epoxy paste with fine sand or silica fume. Trowel- or spray-applied, these mortars are typically no more than 1-inch thick, since application thickness is limited by the material's cost and heat generated from the epoxy curing. As with cement mortar, the bond strength is improved by scrubbing into the substrate. A dry surface will improve bond. Epoxy mortar surfacers are easy to apply and usually require a short cure time before coating. Abrasive blasting the repaired mortar surface may not be required.



## Coating and Lining Systems

Coating systems can protect concrete in vapor spaces and below the water surface in tanks. Lining systems installed as sheets, are effective only in the vapor space above the water surface.

### *Epoxy Mastic*

Epoxy mastic and coal tar epoxies were industry workhorses in the mid-to-late twentieth century. With tighter VOC limits, concern for worker safety and development of new technologies, these coatings are now applied less frequently. Nonetheless, these products are surface tolerant and can be applied at 10-to-20 mils thick, providing a good membrane to protect the concrete.

Even with these benefits, entirely covering surface defects and blowholes is difficult with this type of coating. In immersion service, entrapped solvents can lead to osmotic blistering that compromises the film's integrity and cracks can reflect through the thin coating film leaving concrete exposed at the crack edges. When biogenic sulfide corrosion begins at these very fine cracks, widespread damage occurs as expansive byproduct peels off the coating, progressively exposing more concrete.

### *Thick-Film Coatings*

Elastomeric polyurethane and polyurea, amine-cured epoxy and novolac epoxy are often 100-percent/ultra-high-solids formulations that do not contain solvents. Prior to application, these two-component coating systems (resin and catalyst) are mixed to begin the curing process. Depending on the formulation and temperature, the curing reaction can last less than a minute to almost an hour. The rapid cure time reduces working time.

Some coatings can be premixed (hot-pot) and applied with airless spray equipment. All of these coatings can be applied using plural-component systems with metering pumps that mix the components immediately before application. The curing process requires accurate component ratios. The pumps and application equipment must be well maintained to ensure proper mixing. Operating the metering pumps and mixing the coatings requires specialized training;

additional inspection and quality-control measures are highly recommended.

The solvent-free coatings allow for thicker-film application from 40-to-125 mils or more. The thick film provides a less permeable and more durable membrane to protect the concrete than thin-film coatings.

These coatings can address reflexive cracking concerns. Elastomeric coatings' tensile strain capacity allows them to stretch, bridging shrinkage cracks. The epoxy coatings have less tensile capacity but are recognized as having enough capacity to bridge most common concrete cracks.

Concrete age must be considered when evaluating a coating's ability to bridge cracks. Newly installed concrete is more prone to drying shrinkage cracking than concrete that has been in service. Existing cracks in aged concrete should be evaluated because they will continue to open and close with temperature cycles. To a lesser extent, varying loads will cycle existing cracks. Given this

information, crack width, condition and temperature variation are important factors to assess when selecting a coating.

In addition to these three factors, substrate surface texture must also be taken into consideration for coating selection. Plural-component coatings tend to be viscous and require heating to pump and apply. On an irregular surface, air can be trapped behind the uncured film. The trapped air then heats and expands causing pinholes in the coating film. Some products address this problem with fillers or by expanding the film with an inert gas: the fillers or bubbles intercept the pinhole before it can penetrate the film. Elastomeric polyurethane/polyurea coatings and epoxy coatings use this approach.

### *Ultra-High-Solids Elastomeric Polyurethane, Polyurea and Hybrids*

This subset of thick-film coatings uses polyurethane, polyurea or polyurethane-polyurea-hybrid chemistry to provide good

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Here are a few things to consider. No winter is predictable and the weather can change quickly and often does. Also even in the dead of winter, even at temperatures in the single digits, the dewpoint can still be achieved causing frost to form on areas cooler than the dewpoint. Finally even if you are utilizing heat, the significant amount of heat and the ability to not keep up with quick changing temperatures might leave you out in the cold per se.

A best practice here might be to utilize a smaller dehumidifier to provide some protection for your tank. This will allow you a bit of insurance from those quickly changing weather conditions that could result in costly re-blasting. Note that you can reduce the size of the dehumidifier due to the fact that the air is fairly dry (low dew point) due to the colder weather.

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## SELECTING CONCRETE REHAB SYSTEMS

chemical resistance and tensile elongation capacity. The resulting elastomeric film is well-suited to bridging cracks.

These compounds are hydrophobic while curing. Moisture will repel the uncured coating. The primary mechanism for bonding to concrete is wetting into small pores exposed at the concrete surface. Moisture near the surface of the concrete pore structure reduces the coating bond. This can be problematic when the moisture source is groundwater or an adjacent tank. Water on the opposite side of the wall being coated reduces the coating bond, then exerts a hydrostatic pressure through the porous concrete on the cured impermeable film potentially delaminating the coating. The failure can be localized blisters or widespread. Some manufacturers recommend a thin-film epoxy primer to hold back moisture and improve coating adhesion.

### *Ultra-High-Solids Amine-Cured Epoxies*

These thick-film coatings have very good chemical resistance. Additives and fillers modify the properties to bridge cracks. They do not have the crack-bridging properties of elastomeric coatings; however, in-service performance demonstrates that they are effective at protecting concrete, especially after early-age cracking has occurred. Epoxy coatings are moisture tolerant, providing a good bond when small amounts of moisture are present. This makes them a good choice when groundwater or adjacent tanks may apply hydrostatic pressure.

### *Novolac Epoxy*

Novolac epoxy is similar to amine-cured epoxy but has better chemical resistance. It is the most chemical resistant of the three types of ultra-high solids coatings.

### *Plastic Sheet Liners*

PVC or HDPE sheet lining is commonly used in the U.S. for new concrete construction. The sheet liner is installed on the inside face of concrete forms before new concrete is placed. During retrofit application, a thick layer of epoxy mastic is applied and the sheets are pressed into the surface. After the sheets

are installed, the seams are sealed using heat-welded closure strips.

Properly installed plastic sheet lining systems provide long-lasting protection from H<sub>2</sub>S exposure in the vapor space. This system is not as effective for submerged applications.

### *Other Sheet Liners*

Sulfur cement and stainless-steel plates are similar to plastic sheets except that they are attached to the concrete with anchor rods. These systems are rarely used in the U.S. Stainless steel can also be used with structural repair materials to rebuild heavily damaged concrete that has lost structural capacity.

## CONCRETE REPAIR AND COATING SPECIFICATIONS

After a repair and coating system is selected, the next step prior to application is to specify the repair and coating system. For competitively bid or sole-source projects, the specifications must include necessary information for bidders. A well-defined scope of work reduces the risk of misunderstandings and costly changes. Table 5 (p. 28) lists important topics to consider when writing a scope of work or specification.

## SUMMARY

Concrete deterioration can be arrested and repaired to extend a structure's useful life with a properly selected and specified repair and coating system. Perhaps the biggest problem that arises during this work is misaligned expectations: it is the specifier's responsibility to clearly spell out what the applicator can expect to encounter. During concrete repair and coating projects, the engineer, estimator and applicator all benefit from a good understanding of the damage, appropriate repair methods and conditions or expectations that will require special effort. Applicator input will also be useful when uncertainties arise.

With an accurate assessment of the concrete condition, exposure, and work constraints, along with a clear understanding of the benefits and limitations of coating

systems, a well-written, concise specification will be the basis of a successful concrete rehabilitation project — a project in which everyone's expectations can be met.

## ABOUT THE AUTHOR

Mike Dadik is a structural engineer with more than 20 years of experience specializing in wastewater and water construction.



He has worked on concrete rehabilitation and coating projects throughout his career, through which he has earned an in-depth understanding of

the unique challenges presented by this type of work.

Dadik has been a member of the SSPC Northern California-Nevada Chapter steering committee since 2012.

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# SELECTING PIPELINE COATINGS: DO CURRENT STANDARDS HELP?

BY IAN ROBINSON, 3M COMPANY

Pipeline operators and coating specifiers are often faced with an almost bewildering array of products and technologies when selecting the most appropriate solution for their field-joint coating needs. Before looking at the role that current standards might play in the decision-making process, it is perhaps useful to explore the fundamental purpose(s) of a field-joint coating and consider some related requirements that can all too easily be overlooked within the decision-making process.

While a field-joint coating may need to exhibit a considerable number of different performance attributes (for example, adhesion, damage resistance, impermeability to oxygen and water/electrolytes, temperature/chemical resistance and compatibility with the mainline coating) an appropriate suite of performance attributes is simply a way of ensuring that the desired long-term protection can be provided within the operating environment over the lifetime of the pipeline. The overarching requirement is that the field-joint coating, once installed, should provide reliable corrosion protection for the design life of the pipeline. The key phrase here is “once installed,” in that for many projects, the field-joint coating may have to be installed in widely differing topographic and climatic regions, and/or be subjected to seasonal climatic variations during the construction phase of the project. Clearly,

these factors must be taken into consideration when selecting a field-joint coating system and that performance attributes in isolation cannot provide an entirely reliable basis for selection.

An ideology increasingly agreed upon by many suppliers within the industry, is that the field-joint coatings should replicate as closely as possible the factory-applied parent coating, thus providing equivalent performance from both the factory- and field-applied systems. This may seem a plausible argument, but does it really stand up to close scrutiny? If it is accepted that the purpose of the installed field-joint coating is to afford reliable corrosion protection for the design life of the pipeline, then there is no logical reason as to why the factory-applied mainline coating and the field-applied coating must be the same. To understand this, it is essential to consider the external influences the factory-applied coating may potentially be exposed to prior to and during the construction phase of the project, none of which the field-joint coating will ever be subjected to (for example, mechanical handling and storage at the pipe-coating plant, mechanical handling and transportation to the construction site, and mechanical handling and welding at the construction site, to name just a few). In fact, it has been reported that the factory-coated pipe could be moved as many as 39 times, from leaving the factory until the trenches have been filled at the construction site<sup>1</sup>. Embodying performance characteristics within the field-joint coating to accommodate these factors would essentially be an unnecessary over-design which ultimately does not add value and may preclude the use of alternative systems potentially more suited to the specifics of the pipeline construction site while still being capable of delivering the desired long-term performance outcome(s).

From the foregoing comments, it is perhaps not unreasonable to conclude that the existence of a “universal” field-joint coating is probably very unlikely, so how can appropriately informed decisions be made? Firstly, the practicalities of application at the construction site must be considered. Pipelines may pass through regions of widely differing climates and topographies and construction

may have to take place during extremes of summer and winter conditions. This immediately places considerable constraints on the field jointing and may go some way to narrowing down any list of candidate solutions.

Secondly, the ease or simplicity of installation of candidate systems must be considered. Will a specialist field-joint coating contractor be employed or will the selected system need to be forgiving enough to be reliably installed by a local direct labor force? Finally, the anticipated in-service operational conditions must obviously be carefully considered, particularly with regard to pipeline operating temperature(s) and the anticipated external soil loadings during both construction and long-term operation.

If the long-term in-service performance of prospective field joint coatings is to be predicted with an acceptable level of confidence, do currently available standards come to the rescue? This article will try to answer this question by briefly reviewing some currently published (and generally well-known) standards.

#### ISO 21809-3: 2016

- Specifies requirements for field-joint coating of seamless or welded steel pipes for buried and submerged sections of pipeline transportation systems used in the petroleum, petrochemical and natural gas industries.
- Classifies field-joint coatings into eight generic groups (Codes) with up to five subgroups within each.
- Specifies minimum performance requirements for each group and subgroup.

Interestingly, the stated minimum requirements are different for virtually every Code. For example, in the case of liquid epoxy and liquid polyurethane (PU) coatings (Codes 4A/4B) we see a cathodic disbonding requirement of less than or equal to 15mm at maximum operating temperature for liquid epoxy coatings but a requirement of less than or equal to 20mm for liquid PU coatings. If we look at flame-sprayed polyethylene (PE) and polypropylene (PP) or PE/PP tapes or sheets utilized in conjunction with liquid or fusion-bonded epoxy primers (Codes 5A/5B/5D/5E), a disbonding requirement of less than or equal to 10mm is called out. However, in the case of single- or dual-layer fusion-bonded epoxy systems (Cases 3A/3B), no disbonding requirement at maximum operating temperature is stipulated at all, just a requirement of less than or equal to 15mm at 65 C (149 F). Systems satisfying the aforementioned performance criteria could therefore all justifiably claim to be in compliance with the standard, yet could clearly exhibit very different levels of performance.

As a further example, consider the requirements that are called out for the impact resistance of liquid epoxy and PU coatings (Codes 4A/4B): less than or equal to 3 Joules/mm for liquid epoxy but less than or equal to 5 Joules/mm for liquid PU. Assuming the minimum acceptable values pertain, an epoxy system applied at a 0.5 mm thickness would afford an impact resistance of 1.5 Joules, whereas a PU system applied at a 1.5 mm thickness would afford an impact resistance of 7.5 Joules. It seems illogical that one system could provide five times the impact strength of the other, yet both systems

**Table 1: EN 12068 — Functional Performance Requirements for Mechanical Resistance.**

Property	Test Temp. (C)	Mechanical Resistance Class		
		A	B	C
Impact resistance (Joules)	23	≥ 4	≥ 8	≥ 15
Indentation resistance (N/mm <sup>2</sup> )	50	0.1	1.0	10.0
Peel strength to pipe (N/mm)	23	≥ 0.40	≥ 0.40	≥ 0.50
	50	≥ 0.04	≥ 0.04	≥ 0.05
Peel strength to factory coating (N/mm)	23	≥ 0.20	≥ 0.20	≥ 0.40
	50	≥ 0.02	≥ 0.02	≥ 0.04
Specific electrical insulation resistance (Ω.m <sup>2</sup> )	23	≥ 10 <sup>6</sup>	≥ 10 <sup>8</sup>	≥ 10 <sup>8</sup>



## PIPELINE COATING STANDARDS

could be claimed to be in compliance with the standard.

While being admirable in terms of capturing the plethora of product types currently on the market, as can be seen from these examples, the standard does not readily lend itself to making meaningful comparisons across different product categories — rather it tends to reflect the inherent or

anticipated performance characteristics of generic product groups, thus providing little assistance in selecting a system that will be suited to the project-specific requirements. Fundamentally, compliance with the standard, for any class of coating, does not provide confirmation that the system will actually fulfill the specific requirements of the project. As another example, a liquid epoxy

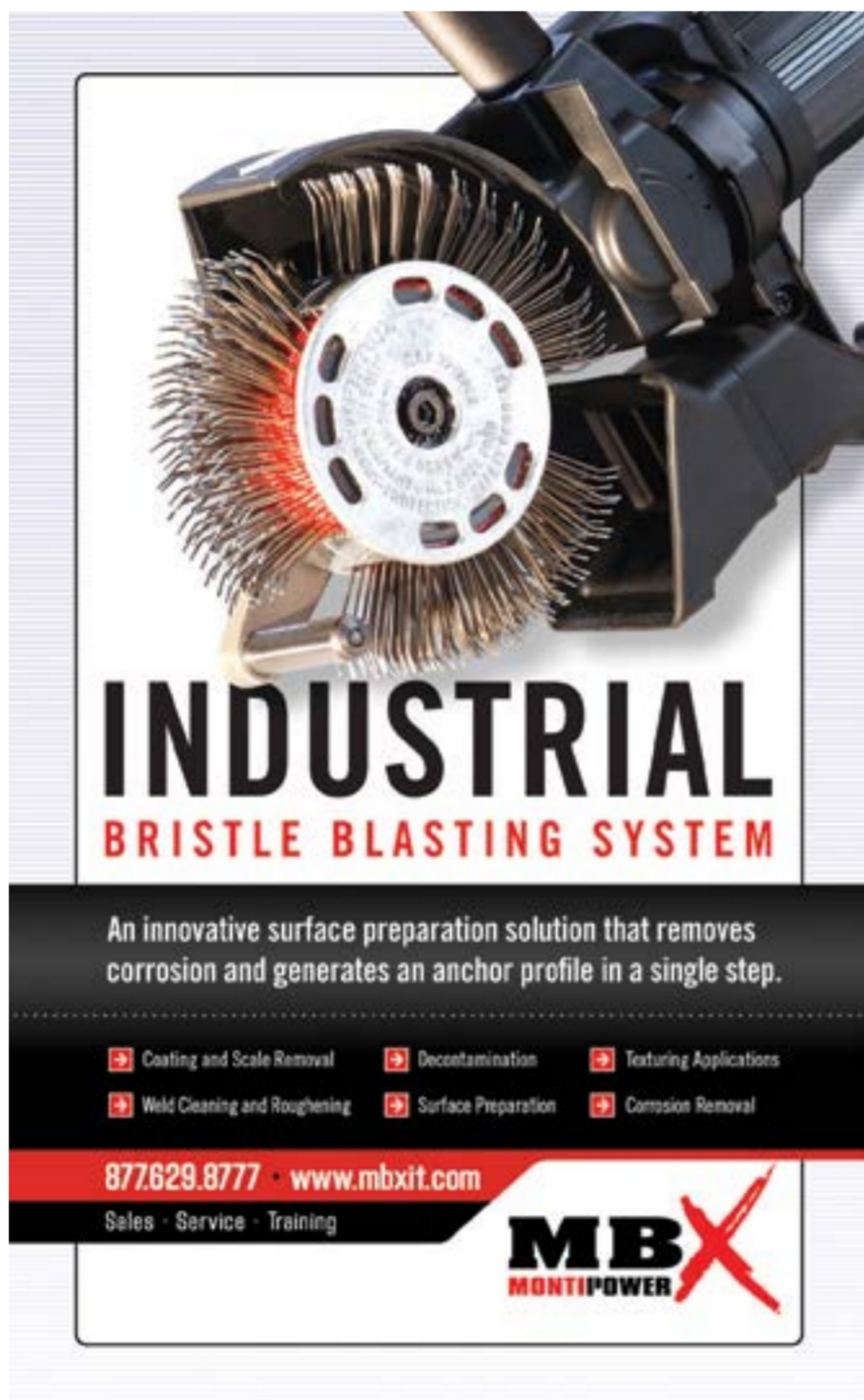
coating conforming to ISO 21809-3 (Code 4A), with a maximum operating temperature of 60 C (140 F), could provide a very good solution for a given project, yet it could equally provide an entirely inappropriate outcome.

### CSA Z245.30-14 (CANADIAN STANDARDS ASSOCIATION)

- Specifies requirements for field-applied external coatings for steel pipeline systems intended primarily for buried or submerged service in oil or gas pipeline systems.
- Covers 7 classes of coating systems (FC1 – FC7), primarily fusion-bonded epoxy, plus tapes and heat-shrinkable systems.
- Specifies minimum performance requirements for each class of coating.

In many respects this standard exhibits similarities to the general format and style of ISO 21809-3, albeit with a reduced number of product categories. While there is a consistency of requirements across generically similar product classes — for example in the case of the three classes of fusion-bonded epoxy (FBE) coatings — once again there are widely differing minimum requirements called out for generically different systems such as FBE coatings, tapes, heat-shrinkable systems and viscoelastic materials. As an example, the stipulated cathodic disbonding requirement for all three classes of FBE coatings (standard, high-temperature and dual-layer) is less than or equal to 8.5 mm at 20 C (68 F), whereas the requirement is less than or equal to 12 mm for tapes and heat shrinkable systems and less than or equal to 20 mm for viscoelastic materials. At maximum design (operating) temperature, a requirement of less than or equal to 10 mm is called out for all three FBE systems, yet no requirement is stipulated for tapes, heat shrinkable systems and viscoelastic materials other than “meets manufacturer’s specification.”

As is the case with ISO 21809-3, the standard documents some useful minimum requirements for a number of classes of field-joint coating but doesn’t readily lend itself to drawing comparisons across generically different classes of material.



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## NACE RP0105-2015 (NACE INTERNATIONAL)

- Provides guidance on coating qualification, surface preparation, application/repair and inspection and testing of liquid epoxy coatings applied to external pipe surfaces.
- Specifies minimum performance requirements for coating qualification with respect to adhesion, cathodic disbonding, impact resistance and penetration resistance.

This standard could be considered as effectively equivalent to a subset of ISO 21809-3 or CSA Z245.30 in that it specifies the minimum performance requirements for one particular class of coating, namely, liquid epoxy. The acceptance criteria called out generally differ from those in the corresponding CSA/ISO classes and codes, in some cases being more onerous. For example, the stipulated cathodic disbonding requirement is less than 10 mm at maximum operating temperature, compared to less than 15 mm called out in Code 4A of ISO 21809-3. By virtue of its narrow scope, the standard is obviously of limited utility in terms of aiding selection of an appropriate class of field-joint coating for a specific project. However, the standard does specify useful baseline properties for liquid epoxy coatings which are widely used as field-joint coatings in North America where single-layer FBE coatings are the predominant form of factory-applied corrosion protection coating, thereby providing a frame of reference for the use of such coatings.

## EN 12068

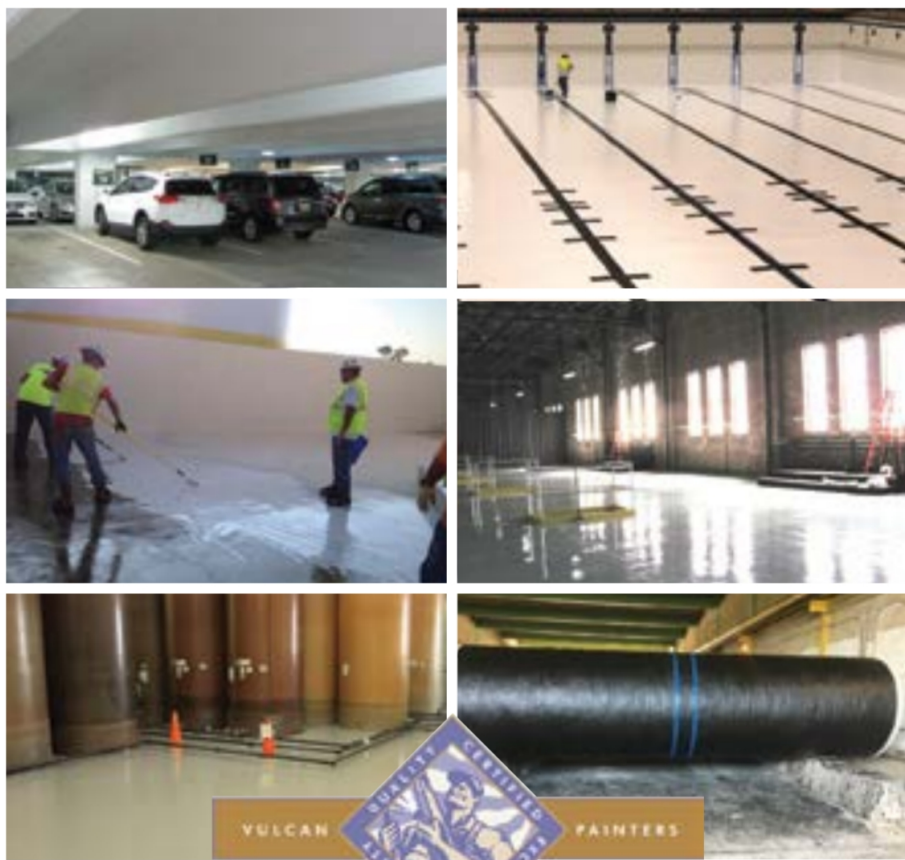
- Specifies the functional requirements and test methods for external organic coatings based on tapes or shrinkable materials to be used for corrosion protection of buried and immersed steel pipelines in conjunction with cathodic protection.
- Defines the functional performance requirements for three classes of mechanical resistance — low (Class A), medium (Class B) and high (Class C) — and three classes of maximum operating temperature — up to 30 C (86 F) (Class 30), up to 50 C (122 F) (Class 50) and greater than 50 C (Class HT).

- Classifies coating systems according to both mechanical resistance and maximum continuous operating temperature, for example EN 12068-B 30, EN 12068-C 50 and EN 12068-C 60 (HT). Unlike the two aforementioned standards, EN 12068 clearly defines the minimum performance requirements that must be satisfied in order for a coating system to attain a

particular classification. Thus, for any classification, the minimum functional performance requirements are constant, irrespective of the coating type, thereby providing a means of directly comparing one coating system against another with respect to defined performance criteria.

Table 1 (p. 33) illustrates a selection of the functional performance requirements called

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## PIPELINE COATING STANDARDS

out for mechanical resistance Classes A, B and C, respectively, assuming a Class 50 operating temperature classification.

While it is not the purpose of this article to review the appropriateness of the acceptance criteria cited in the standard, this style of classification would appear most helpful to any decision maker tasked with selecting the right field-joint coating for his or her project. If the requisite performance levels for the project are defined, then the decision maker is able to potentially consider multiple technologies or products meeting those requirements and make an informed decision based on other pertinent criteria, such as ease and speed of installation and cost. It should be noted, however, that the scope of EN 12068 is limited to tapes and heat-shrinkable materials. It therefore excludes a number of other highly useful technologies, for example FBE, two-component liquid-applied coatings and flame-sprayed polyolefins.

### CONCLUSIONS

The ultimate or universal field-joint coating does not exist, but there are many varied and well-proven technologies currently available, all of which have their strengths and weaknesses. However, specifying or selecting the most appropriate solution for any given project is not necessarily straightforward. In such situations, reference to standards is often the first port of call, but in the case of field-joint coatings this presents some challenges. ISO 21809-3: 2016 and CSA Z245.30-14 are both commonly quoted in the industry but suffer from the same shortcomings in that they specify minimum performance requirements for a wide variety of generic classes of coating system, yet the requirements are quite different from one class to the next. Thus, as previously noted, compliance with the requirements of the standard provides no confirmation that the system in question will fulfill the specific needs

of the project. Rather, that will depend upon whether an appropriate generic system has been specified in the first instance.

In the author's opinion, EN 12068 adopts a more logical approach, defining mechanical classes of performance that are universal and not specific to any generic technology, thereby enabling multiple technologies to be assessed against a common set of requirements. The downside of the standard is that its scope is confined to tapes and heat-shrinkable materials, so it cannot be considered universally applicable. The ideal industry standard would therefore seem to be one which mirrors the approach utilized in EN 12068, combined with the breadth of scope associated with ISO 21809-3.

### ABOUT THE AUTHOR



Ian Robinson currently holds the position of Division Scientist within 3M Electrical Markets Division. He graduated from the University of Nottingham in 1980

with a Bachelor of Science Honors degree in chemistry holding research and development positions of increasing responsibility with Dunlop and Belzona before joining E.Wood Ltd. in 1987, where he was Technical Director for 10 years prior to its acquisition by 3M in 2007.

Robinson has more than 30 years of experience in the pipe-coating industry and is recognized as a subject matter expert in the field of liquid-applied pipe coatings for both factory and field application. He is the author of numerous internationally published papers and is responsible for an extensive patent portfolio.

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Photo courtesy of The Sherwin-Williams Company.

## THE NEED FOR AN INDEPENDENT THIRD-PARTY COATINGS INSPECTOR

BY TIM BAUMAN,  
THE SHERWIN-WILLIAMS  
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**D**uring my career in the coatings world, I grew from a green sales rep into an SSPC- and NACE-certified inspector, who later became a trainer in the protective coatings industry. I believe that no matter what your training or what college or graduate school you went to, the world of heavy-duty protective coatings is so expansive that sooner or later you will need to enlist a coatings specialist, expert or consultant to understand why things are done the way they are and to take steps to make certain that the specification is enforced.

For example, a good engineer knows that for coatings or linings to do what they intend to do, abrasive blasting is almost always required. A good engineer may know that concrete needs to be



blasted but may not know some of the finer points (i.e., the ICRI Standards that call out specific concrete surface preparation results based on the total film thickness of the system that is specified) that are critical to a successful linings project.

Over my 30-year tenure in this field, I have seen many coating failures. I remember in my certification courses listening to the grizzled vets tell their "old war stories." Now I have my own, three of which I am going to share with you. The point of this article is that an independent third-party coatings inspector, while not always required, is a very good idea and certainly worth the money involved. The three stories I'm going to tell you are true, but the names are changed to protect the innocent as well as the guilty.

#### SCENARIO NO. 1

I got a call from a major refinery located in the northern part of the U.S. requesting consultation on a wastewater tank-lining failure.

My associate and I visited the refinery in order to inspect the lining, which had thousands of small blisters all over the walls and the bottom of the tank. With the owner's representative's permission, I removed some of those blisters and examined the chips under a 30-times magnification microscope. Each chip showed a shiny amber substance that appeared to lie on the underside of the chip (i.e., the side in contact with the steel tank). It should be noted that we also removed blisters from areas that appeared to be sufficiently adhered and saw no signs of adhesion failure or the amber substance on the underside of these chips. The lining was a vinyl-ester product from a well-known major coatings manufacturer.

Dry-film samples ranged in thickness from 20.0-to-40.0 mils. We did not have the luxury of viewing the lining specification, so our only recourse was to ask many questions of the owner's representative. From

our experience in the industry and comparable products that we had seen perform adequately, we determined that the low end of 20.0-mil-dry-film thickness (DFT) was probably a bit light.

The internet helped us to determine that when the tank was blasted and coated, the average temperature that January was 25 F. Vinyl-ester coatings typically need air and surface temperatures of about 50 F. We also discovered that heaters had been used to aid the tank lining in its final cure.

The owner's representative eventually gave us a piece of info we could chew on.

He explained that the contractors had completed the tank late Friday afternoon, set the heaters in place and found on Monday morning that the heaters were not working. No one knew how long the heaters had been inoperable. "So what did you decide to do?" we asked. We were told that the schedule was so tight that the tank was to be put back into operation even though no one could really say if the lining had cured sufficiently. "Git 'er done" had presided over this case and the tank was put back into operation.

Inspectors discovered the blisters during the tank's first inspection seven years later



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and the major refinery wanted answers. We kicked these facts around a bit with our technical department and felt confident that the amber substance on the blistered areas of the tank was probably the uncured vinyl-ester lining material. No one really knows for sure because very little, if any, records were available seven years later. The decision was made to reblast the tank and reapply the lining — this time during the summer months.

### SO, WHY HIRE AN INDEPENDENT THIRD-PARTY COATINGS INSPECTOR?

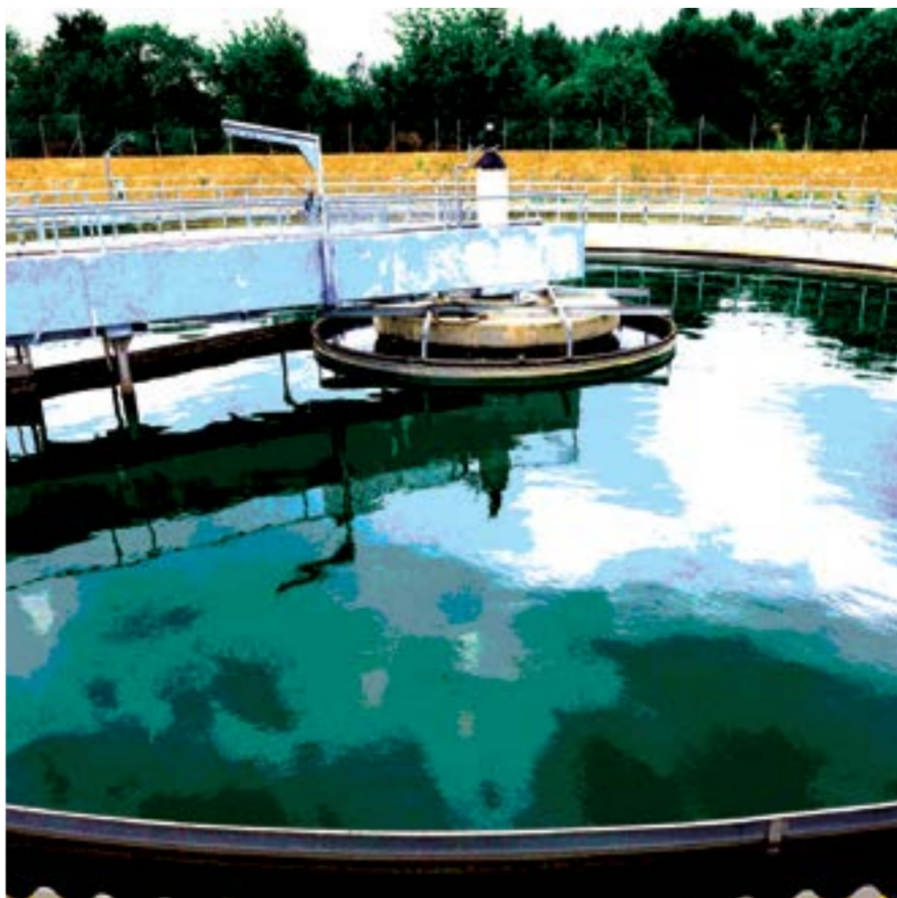
While we could beat this scenario to death by picking out various aspects of typical inspection services that might have prevented this total failure, I would like to point out one thing clearly. The lack of adequate supervision during the baking or curing cycle most likely was one of the biggest issues affecting this project's success or failure. Heating should be monitored constantly during the curing of a vinyl-ester lining. The monitoring should not just verify that the heater is working but should be recording the temperature in the tank over the entire curing period. Data loggers are available to do this kind of monitoring, but of course, this costs money. In the end, what do you think was more costly: the cost of an independent third-party coatings inspector or reblasting and relining the gigantic carbon steel wastewater storage tank?

### SCENARIO NO. 2

Scenario 2 took place at a water treatment plant and involved a polyamide epoxy that attained poor adhesion to the concrete walls. I was called to the site to investigate why "our paint" had failed.

I first requested a copy of the spec, which showed that the concrete was supposed to be prepared in accordance with SSPC-SP 13/NACE No. 6, "Surface Preparation of Concrete."

Next, I visited the site, pried off some of the loose coating and found that there was concrete on the back of the chip. The concrete



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underneath the failed coating did not appear to have a surface profile that one would expect after an abrasive blast. All the chips I inspected had concrete on the backs of them. I gathered some that had poor adhesion as well as some chips that had marginal adhesion. By marginal I mean that they appeared to have better adhesion than the loose chips — not much better adhesion except to say that they had not popped off the concrete yet.

These chips were then submitted to our technical department for analysis to determine whether the product had been manufactured in accordance with our stringent standards. Analysis confirmed that the material was not defective and that the product had cured thoroughly.

Next, I requested a meeting with the painting contractor, the owner and the specifying engineer. While waiting in the

parking lot for the players to arrive, the contractor and I chatted. I pointed out that the surface was supposed to have been abrasive blasted. He pointed out to me that the standard, SSPC-SP 13/NACE No. 6, could also be achieved by pressure washing. This could have been the term that turned this project into a complaint. You see, there are a few ways one can meet this standard. Let's visit the document for clarification:

*1.1 This standard gives requirements for surface preparation of concrete by mechanical, chemical or thermal methods prior to the application of bonded protective coating or lining systems.*

And let's look to the standard for the definition of surface preparation: *The method or combination of methods used to clean a concrete surface, remove loose and weak materials and contaminants from the surface, repair*



the surface, and roughen the surface to promote adhesion of a protective coating or lining system.

Therefore, there are officially three ways an applicator can consider achieving this objective: mechanical, chemical or thermal.

The bottom line is that once this concrete substrate is effectively prepared per SSPC-SP 13/NACE No. 6, the surface is sound with no loose concrete (including powder) remaining.

This standard goes on to define laitance as a thin, weak, brittle layer of cement and aggregate fines on a concrete surface. This was the aggregate and loose, powdery concrete that was evident on the backs of the samples I collected.

I instructed the painter to put on a few other products that we knew had good adhesion characteristics and once they were fully cured, additional tape tests resulted in the same poor adhesion that we had experienced with the originally specified product.

Regarding the paint applicator who said he had achieved the SSPC-SP 13/NACE No. 6 by pressure washing — actual pressure washing may have been necessary to remove any contaminants prior to removing the laitance by mechanical methods. Pressure washing, however, is a vague term. It should not be used when it is in conjunction with achieving an SSPC-SP 13/NACE No. 6 surface preparation because the standard requires a much higher pressure, calling out *High-Pressure Water Cleaning (HP WC): Water cleaning performed at pressures from 34 to 70 MPa (5,000 to 10,000 psig).*

In the wonderful world of protective coatings and linings, there is a huge difference between pressure washing and high-pressure water cleaning. Pressure washing can occur as low as 1,500 psi and is generally considered to be approximately in the 2,500-to-3,000-psi range, but effectively removing laitance from a concrete substrate requires a minimum of 5,000 psi. Not every industrial contractor has a pressure washer that goes up to 5,000 psi. They are pieces of specialty equipment that are purchased for precise reasons, sometimes

to achieve only one specific purpose.

Our painting applicator did just that. He used a 3,000-psi pressure washer to achieve something it was not designed to do. It did not achieve the objective, and the result was a

surface that was not sound, meaning it did not remove the loose concrete or the laitance.

To achieve this level of surface preparation, the entire surface would need to be prepared again in strict accordance with

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the standard set forth in SSPC-SP 13/NACE No.6 prior to applying the coating again.

### SO, WHY HIRE AN INDEPENDENT THIRD-PARTY COATINGS INSPECTOR?

This scenario gave the owner a black eye, as the concrete wall was not a pretty thing to be observed. It cost the applicator dearly, as he was required to remove the failed coating and then reapply the product. It shows again why an independent, third-party inspector should be employed on all industrial painting projects. Did the contractor know he was using the wrong piece of equipment? Or was he deliberately trying to achieve the standard without abrasive blasting? We will never know, but one thing is certain: the cost of an independent, third-party coatings inspector would have



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saved money, time and the reputation of the painting applicator on this project.

### SCENARIO NO. 3

The third scenario involved a small bridge that was to be blasted to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" and then receive a zinc/epoxy/urethane system similar to the ones that were used on typical DOT bridges in the early 2000s.

Our story begins like this: a young sales rep who received some technical training in coatings inspection had arranged to specify a system at a facility where locomotives were being built. A fire many years ago had closed a railroad bridge that was soon to be reopened. Therefore, the bridge would need to be rebuilt, to a certain degree, with the structural steel members blasted and recoated.

The spec read "prepare in accordance with Commercial Blast Cleaning SSPC-SP6/NACE No. 3." The system that followed was 2.0 to 3.0 mils DFT of an organic zinc-rich primer, 4.0 to 6.0 mils DFT of a high-solids polyamide epoxy and a topcoat of aliphatic polyurethane at 2.0 to 3.0 mils DFT.

Our young rep prepared the specification with the assistance of his sales manager, who was involved to ensure the spec was sound and without flaws. The specification was presented to the locomotive manufacturer who then asked our young rep for names of applicators who could do the project. Three names with the appropriate contact info were provided to the client, the locomotive manufacturer. After the bidding process was completed, XYZ Company was chosen to do the project.

This is where the fun begins. Our young sales rep was also to be the inspector on the project, which means he was expected to sign off on the surface preparation blast profile as well as make certain the DFTs were in accordance with SSPC-PA 2, "Procedure for Determining Conformance to Dry Coating Thickness Requirements." He received a phone call from the painting sub who informed him that blasting would begin on

Tuesday morning and that they would like him to check the blast profile, or anchor pattern, of the blasted steel on Tuesday afternoon.

At around 2:00 p.m. our young rep arrived at the railway site. He was armed with replica

tape and his trusty swizzle stick, which is used to apply pressure to the compressible pad on the replica tape so that the thickness could be read using a micrometer to measure the depth in mils.

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After taking about a dozen readings, our young rep approached the painting foreman and explained that the specification called for a 1.5-to-2.0-mil anchor pattern or blast profile. The foreman said that was what the crew

did, but the young rep showed the foreman the sample reading that indicated the blast profile was averaging about 0.7 mils. The foreman insisted that the rep take the reading with him present, and the spot measurement,

consisting of three readings that were then averaged, came out to about 0.8 mils.

The painter's rep told the young rep that it didn't matter and that the coating system would work fine. That explanation didn't sit well with our hero, who told the foreman that he could not allow the zinc primer coat to be applied until the blast profile met the specification. The foreman explained that they had done tons of bridges before and that the crew was very experienced. "This is the way we have always blasted," was the comment that sent our rep toward his car with a warning not to start applying the zinc until the foreman's crew had met the specification.

The foreman stopped the rep from walking away by saying that he would have to call Angelo, who was the owner of the contracting company. Looking straight into the eyes of the young rep, the foreman said, "Angelo ain't gonna like this!"

About 30 minutes later, Angelo appeared holding the biggest, longest, most expensive flashlight our young hero had ever seen. A long conversation followed with lively verbiage and bodily movements which were meant to intensify Angelo's emotions. "There is no way we can reblast that bridge," he passionately stated. "We already did it once."

The flashlight was being moved very quickly in multiple directions at the same time ... or at least that's how it seemed to our young hero, the paint sales rep. While he was focused on what Angelo was saying, he was also focused on the path that the flashlight traveled while noticing at the same time that it was traveling very fast, sometimes from one hand to the other.

Our hero was being muscled by the imposing owner but finally found the guts to say, "I cannot let you apply any primer until the blast pattern meets the specification you were given." All of a sudden, WHACK! BAM! BOOM! The flashlight hit the pavement. Then Angelo began cussing even more than he had been cussing before, jumping on the flashlight, repeatedly smashing the metal tube with batteries

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rolling along the pavement and tiny bits of glass heading in all directions. At this point, Angelo, who was a large man, was huffing and puffing and was down on his knees looking up at our hero.

The young rep, who up to this time had been the model of composure, slipped and said, "I think you're going to need a new flashlight." This comment set off somewhat of an explosion: Angelo leaped from

the ground pointing and as loud as he could screamed, "I WANT A NEW SALES REP!" Our hero, who had played his cards almost perfectly, said in reply, "You will get one as soon as this project is complete." He then turned toward his car and said to Angelo, "Call me when you have a 1.5-to-2.0-mil average blast profile."

The next day the rep returned, checked the blast profile – which now met the spec – and proceeded to approve the application of the zinc primer. The rest of the project went very smoothly and our young rep lost a customer who was eventually assigned to another rep.

### SO, WHY HIRE AN INDEPENDENT THIRD-PARTY COATINGS INSPECTOR?

Because there was no independent, third-party inspector on the project, a very uncomfortable and expensive scene unfolded at this small bridge project. Sadly, our hero lost a not-so-good customer, and the reputation of the paint company was compromised along with a \$200 flashlight being brutally assaulted by the pavement. All of these occurrences could have been avoided had an independent third-party inspector been chosen at the onset of the project.

### ABOUT THE AUTHOR

Tim Bauman has been involved in the coatings world for nearly 30 years. He is currently employed by The Sherwin-Williams



Company but has also worked for Glidden, PPG and Carboline. Bauman is an SSPC Protective Coatings Specialist and a NACE-Certified Coating Inspector and has taught the

NACE International CIP Level 1 Course. He holds an undergraduate degree in communications with a concentration in business from John Carroll University and an MBA from the University of Indianapolis. **JPCL**



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Core Industrial LLC	Edeco Peru S.A.C	GMA Industries	Insulating Coatings Corporation
Corporacion Mara S.A.	Elcometer	Goldenwest Painting Inc.	Intech Contracting LLC.
Corporacion Peruana de Productos	Elektro-Physik Usa, Inc.	Goodwest Linings and Coatings	Inter-City Contracting, Inc.
Quimicos SA.	Elite Contractors, Inc.	Gordon Contracting Inc.	International Flooring & Protective
Cortec Corporation	Elite Industrial Painting, Inc.	GOS Pte. Ltd.	Coatings, Inc.
Cosmos Comprehensive Construction,	EMI International LLC	Gracie Painting LLC	International Rigging Group, LLC.
Inc.	Endisys	Graco Inc.	Interpaints SAC
Crescent Coatings & Services, Inc.	Entech Industries, LLC	Green Diamond Sand Products	Intertek Industry Services
Crown Painting, Inc.	Environmental Planning &	Greener Blast Technologies	Ionion Painting
CRP Industrial	Management, Inc.	Greenfield Fence Inc.	IPAC Services Corporation
Crystal Coast Industrial Coatings	Envirosafe Stripping Inc.	Greer Steel	Iron Bridge Constructors, Inc.
CSI Services, Inc.	EPAcoat, Inc.	Groome Industrial Service Group	ISTI Plant Services
CTL Group	Era Valdivia Contractors, Inc.	GS Engineering & Construction Corp.	IUPAT
CTS Substrate and Flooring	Erie Painting and Maintenance, Inc.	Gulf Coast Contracting, LLC	IUPAT, District Council #5
Custom Abrasives, LLC	Ervin Industries, Inc.	H D Water Jetting	J. Goodison Company, Inc.
CV Associates NY	ESC Al Sharafi Group (Middle East)	H-I-S Coatings	J. Mori Painting Inc.
Cypress Bayou Industrial Painting, Inc.	ESCA Blast	H.I.S. Painting, Inc.	J.S. Held LLC
D & B Engineers and Architects	ESMETAL SAC	Hancock Sandblast & Paint LLC	JAD Equipment Co. Inc.
D & M Painting Corp	Euro Paint LLC	Hardesty & Hanover Construction	Jade Painting
D.H. Charles Engineering, Inc.	Euro Style Management, Inc.	Services LLC	Jag'd Construction, Inc
DACA Specialty Services	Excel Engineering & Contracting Co.	Harrison Muir, Inc.	Jal Engineers Pvt. Ltd.
Dampney Company, Inc.	Exceletech Coating & Applications, LLC	Hartman-Walsh Painting Company	Jamac Painting & Sandblasting Ltd.
Danos	Extreme Coatings, Inc.	HCI Chemtec Inc.	The JD Russell Company
Darran Green Sandblasting & Painting	Extreme Sandblasting and Painting	HCI Industrial & Marine Coatings Inc.	Jeffco Painting & Coating, Inc.
Daubert Chemical Company	FT.I. District Council 57 J.A.T.F.	HDM Spiral Kaynakli Celik Boru A.S. /	Jerry Thompson & Sons, Inc.
Daubner Advanced Coating Solutions	Farr Construction Corporation	HDM Steel Pipe	Jet De Sable Houle Sandblasting Ltd.
(formerly NTB SOUTH INC)	Farwest Corrosion Control Company	HDR	JK Industries, Inc.
Davis Boat Works, Inc.	FCS Group LLC	Henkels & McCoy	John B. Conomos, Inc.
Dawson-Macdonald Company, Inc.	Fedco Paints and Contracts	Herc Rentals	John W. Egan Company, Inc.
De Koning Groep	FeO	Hercules Painting Company	Johnson, Mirmiran & Thompson, Inc.
DECO Coatings, Inc.	FGA Ingenieros S.A.	Highland International, Inc.	Jollyflex
Defelsko Corporation	Fine Painting and Allied Services, LLC.	HIPPO Multipower	Jos. Ward Painting Co.
Dehumidification Technologies, LP	Finishing Systems of Florida, Inc.	Hippwrap Containment	JSC Sewon Vertex Heavy Industry
Delta Coatings, Inc.	Fischer Technology, Inc.	HITECH PROJECTS TRADING &	Jupiter Painting Contracting Co. Inc.
Demaco Corporation	Fish & Associates	CONTRACTING W.L.L.	Kaloutas + Co., Inc.

## SSPC ORGANIZATIONAL MEMBERS

Kane, Inc.	McKay Lodge Conservation Laboratory	Opti-Blast Inc.	R.B. Hilton Limited
Keene Coatings Corp.	McLoughlin Industrial Flooring Limited	Optimiza Protective & Consulting, SI	Rainbow, Inc.
Kennametal Inc.	MCSA (Mantenimiento & Construcciones, S.A.)	Orfanos Contractors, Inc.	RAK Paints LLC
Kern Steel Fabrication, Inc.	Merrill Steel, Inc.	P & L Metalcrafts LLC	Rapid-Prep, LLC
Kimery Painting, Inc.	Metallisation Ltd.	P S Bruckel Inc.	Raven Lining Systems
Kiska Construction, Inc. (KCI)	Michigan Specialty Coatings, Inc.	P.C.I. International, Inc.	Ravi Engineering & Land Surveying, P.C.
Klicos Painting Company, Inc.	Midsun Specialty Products Inc.	Pacific High Technology Engineering Services	RBW Enterprises
KMX Painting, Inc.	MIK Industrial LLC	Pacific Painting Co Inc.	Recal Recubrimientos, SA De CV
Knowles Industrial Service Corporation	Mineral Tech, LLC	Pacific Titan, Inc.	Redi-Strip Metal Cleaning Canada Ltd
Kordata	Minerals Research, Inc.	Paige Decking	Regal Industrial Corporation
Koster American Corp.	Mistras Group Inc.	Paige Floor Covering Specialists	Reglas Painting Company, Inc.
KS Fabrication & Machine	MMIJ, Inc.	Paint and Coatings Manufacturers Nigeria PLC	Reichle Incorporated
KVK Contracting Inc.	Mobile Pipe Lining and Coating Inc.	Paint Platoon USA & Coatings Inspectors.com	Revolution Industrial Coatings
L & L Painting Company Inc.	Modern Protective Coatings, Inc.	Paint Supply Company	Rhino Linings Corporation
L Z Painting Co.	Monarflex by Siplast	Painters & Allied Trades - LMCI	Righter Group, Inc.
L. Calvin Jones	Monoko, LLC	Painters USA, Inc.	Ring Power Corporation
L. F. Clavin & Company, Inc.	MONTI - Werkzeuge GmbH	Panco Resources And Engineering Consultancy Services	Rizzo Brothers Painting Contractors Inc.
L&M Fabrication & Machine, Inc.	Monti Tools Inc.	Panther Industrial Painting, LLC	Robroy Industries
Lambton Metal Service	Montipower Inc.	Park Derochie (Seaside) Coatings Inc.	Rogers Industries, LLC
Langtry Blast Technologies Inc.	Morimatsu (Jiangsu) Heavy Industry Co.,Ltd. (JMH)	Park Derochie Coatings (Saskatchewan) Inc.	Rotha Contracting Company, Inc.
Lanza Paint Works, LLC.	Morin Industrial Coatings Ltd.	Park Derochie, Inc.	Rover Contracting Inc.
Ledcor Fabrication Inc.	MSB Marine Surveyors Bureau S.A.	Paul N. Gardner Company, Inc.	Royal Bridge Inc.
Legend Painting, Inc.	MST Inc. (Modern Safety Techniques)	PCI - Performance Contracting Inc.	Rpn Recubrimientos Polimericos Del Noroeste Sa De Cv
Level 3 Coating Inspection, LLC	Municipal Tank Coatings	PCIROADS, LLC	S & D Industrial Painting Inc.
Liberty Maintenance, Inc.	Murphy Industrial Coatings	Peabody & Associates, Inc.	S & S Bridge Painting, Inc.
LifeLast	N A Logan, Inc.	Peak Industrial Coatings & Linings, Inc.	S & S Coatings, Inc.
Limnes Corp.	N. I. Spanos Painting, Inc.	Pelco Structural, LLC	S. David & Company, LLC
Lindner Painting, Inc.	The Nacher Corporation	Penington Painting Company	Sabelhaus West, Inc.
Liuna Canadian Tri-Fund	Nantong Fuchen Tank Co., Ltd	Performance Blasting & Coating	Safe Systems, Inc.
Llamas Coatings	National Coating and Linings Co.	Performance Coatings Inc.	Safespan Platform Systems, Inc.
Loonglobal Engineering Pte Ltd	National Coatings, Inc.	Performance Industrial	Safety Lamp of Houston
Luoyang Hongfeng Abrasives Co., Ltd.	National Equipment Corporation	Perupaint SAC	Saffo Contractors, Inc.
M & D Coatings Inc.	Natrium Products, Inc.	Phillips Industrial Services Corp.	Safway Services LLC
M & J Construction Company	Negocios Metalurgicos SAC	Phoenix Fabricators & Erectors LLC	Sahara Sandblasting and Painting Ltd
M. Painting Company, Inc.	Nelson Industrial Services, Inc.	Piasecki Steel Construction Corp	Samac Painting
M. Pallonji & Company Pvt. Ltd.	New England Sandblasting and Painting	Pinnacle Central Company	San-Blast-Ture
MacDonald Applicators Ltd.	New Kent Coatings Inc.	Planet Inc.	Sand Express
Magnum Drywall Inc.	Newport Industrial Fabrication, Inc.	Platypus Marine, Inc.	Sauereisen
Mandros Painting, Inc.	NexTec Inc.	Pond & Company	Saxon Enterprises
Manolis Painting Company, Inc.	Niagara Coatings Services, Inc.	Pop's Painting, Inc.	SBAS Training Services
Manta Industrial, Inc.	Nielson, Wojtowicz, Neu & Associates	Poseidon Construction	Scicon Worldwide BVBA
Manta Industrial, Inc.: Mansfield Industrial	Nisku Industrial Coatings Ltd.	PRA Coatings Technology Centre	SDB Engineers & Constructors Inc.
Manus Abrasive Systems, Inc.	NOR-LAG Coatings Ltd.	Precision Welding & Fabrication	Seal For Life Industries LLC.
Manz Contracting Services Inc.	Nordstrong Equipment Limited	Preferred, Inc.-Fort Wayne	Seaway Painting LLC
Marathon Industrial Finishing LLC	Norfolk Coating Services, LLC	Prime Coatings, Inc.	Secondary Services, Inc.
Marcom Services, LLC	Northwest Sandblast & Paint LLC	Principle Industrial Services, LLC	See Hup Seng Cp Pte. Ltd.
Marine Equipment Supply (MES), LLC	Norton Sandblasting Equipment	Pro-Tect Plastic & Supply, Inc.	Seifert Construction Inc.
Marine Group Boat Works	Novatek Corporation	Prospectum Coatings Bvba	Seminole Equipment, Inc.
Marine Metal Coatings, Inc.	Nu Way Industrial Waste Management LLC	Pt Berger Batam	SES Infrastructure Services LLC
Marine Publications International (MPI Group)	NUCO Painting Corporation	Public Utilities Maintenance, Inc.	Shanghai Genesis Chemical Industry Co. Ltd.
Marine Specialty Painting	Nusteel Fabricators, Inc.	Puget Sound Coatings Inc.	Shanghai Sezhe Trading Co., Ltd
Marine Tech Services LLC	O.T. Neighoff & Sons, Inc.	Purcell P & C, LLC	Shanghai Zenhua Heavy Industries Co. Ltd
Marinis Bros., Inc.	Odle, Inc.	QED Systems, Inc.	Shenzhen Asianway Corrosion Protection Engineering Co., Ltd.
Marunda Utama Engineering Pte Ltd	Offshore Painting Services Ltd	Qualicoat Inc.	Sherwin-Williams Industrial & Marine Coating China
Mass Coating Corp	Oil Patch Sandblast & Paint Ltd.	Quality Linings & Painting, Inc.	Shimmick Construction
Massy Energy Fabric Maintenance Limited	Olimag Sand, Inc.	Quantum Technical Services	Sil Industrial Minerals, Inc.
Matheson Painting	Olympus And Associates, Inc.	Quincy Industrial Painting Co	Simpson Sandblasting and Special Coatings, Inc.
Maxon Technologies LLC	Olympus Painting Contractors, Inc.	Quinn Consulting Services, Inc.	Sky Climber Access Solutions
Maxworth Minerals India Pvt Ltd	Olympus Painting, LLC	R & B Protective Coatings, Inc.	Skyline Painting, Inc.
MB Environmental Consulting	Omega Coatings & Construction, LLC	R & S Steel, LLC	Skyline Steel LLC
McCormick Industrial Abatement Services, Inc.	Ontario Painting Contractors Association	R. J. Forbes Painting Contractor Inc.	
McCormick Painting Company	OPTA Minerals, Inc.		



# SSPC ORGANIZATIONAL MEMBERS


Slay Steel, Inc.  
SME Steel Contractors  
Soil & Materials Engineers, Inc.  
Southeast Bridge FL Corp.  
Southern Paint & Waterproofing Co.  
Southern Painting & Blasting, LLC  
Southern Road & Bridge, LLC  
Southland Painting Corporation  
Spartan Contracting, LLC  
Specialty Application Services, Inc.  
Specialty Finishes, LLC  
Specialty Groups, Inc.  
Specialty Polymer Coatings, Inc.  
Specialty Products, Inc.  
Spider  
Spiegel Industrial  
Sponge-Jet, Inc.  
SRI Construction LLC  
SRT Sales And Service, LLC  
Stantec  
Steel Fabricators of Monroe, LLC  
Steel Management Systems, LLC  
Sto Corp  
Stork Technical Services  
Structural Coatings, Inc.  
Sulzer Mixpac USA, Inc.  
Superior Industrial Maintenance Co.  
Superior Painting Company, Inc.  
SuperVac Truck & More, Inc.  
Surface Preparation & Coatings, LLC  
Swanson & Youngdale, Inc.  
Symmetric Painting, LLC  
T & W Industrial Services LLC  
T BAILEY, Inc.  
T-TEX Equipment L.P.  
Tank Services Inc.  
Tarps Manufacturing, Inc.  
Taylor's Industrial Coatings, Inc.  
TCI Powder Coatings  
TDJ Group, Inc.  
Team Industries, Inc.  
TECHNIA II  
Techno Coatings, Inc.  
Technofink  
Tecnica Metalicas Ingenieros S.A.C.  
Tecnico Corporation  
Temp-Coat Brand Products, LLC  
Terry Mccall Inc.  
Tesla Nanocoatings, Inc.  
Testex, Inc.  
Textured Coatings of America, Inc.  
Thomarios  
Thomas Industrial Coatings, Inc.  
Thompson Pipe Group - Pressure  
TIB Chemicals AG  
Tidal Corrosion Services LLC  
Tidewater Staffing, Inc.  
Tinker & Rasor  
Tioga Air Heaters, LLC  
Titan Industrial Services  
Titan Tool  
TJC Painting Contractors, Inc.  
TMI Coatings, Inc.  
TMS Metalizing Systems, Ltd.  
Tower Inspection Inc.  
Tower Maintenance Corp.

Tower Power Group Painting Co. Ltd.  
TQC B.V.  
Tractel Inc. Griphoist Division  
Transportation Training Institute, LLC  
Travis Industries, LLC  
Tri-State Painting, LLC  
Trinity Industrias de Mexico S. de R. L. de C.V.  
Triple H Construction, Inc.  
True Inspection Services  
TRUQC LLC  
Turman Commercial Painters  
Turn Key Solutions  
Turner Coatings LLC  
Turner Industries Group, LLC  
Twilight S.A. De C.V.  
U.S. Tank Painting, Inc.  
UHP Projects, Inc.  
Ultimate Linings (formerly Ameraguard Protective Coatings)  
Uni-Ram Corporation  
University of Akron / NCERCAMP  
US Coatings, Inc.  
US Minerals/Stan Blast  
Utility Service Company, Inc.  
Valentus Specialty Chemicals  
Van Air Systems  
Vanwin Coatings of VA, LLC  
Vector Technologies Ltd.  
Venus Painting Co.  
VersaFlex Incorporated  
Ville Platte Iron Works, Inc.  
Vima Construction Corp.  
Vimas Painting Co., Inc.  
Vision Point Systems  
Vulcan Painters, Inc.  
W Abrasives  
W Q Watters Company  
W S Bunch Company  
W W Enroughty & Son, Inc.  
The Warehouse Rentals and Supplies  
Wartsila Defense, Inc.  
Wasser High-Tech Coatings, Inc.  
Waterblasting Technologies  
Wenrich Painting, Inc.  
West Coast Industrial Coatings  
Western Industrial Services, Ltd  
Western Partitions, Inc. DBA, WPI  
Western Technology, Inc.  
Wheelblast, Inc.  
WIWA LP  
Worldwide Industries, Inc.  
Worth Contracting  
Woyt Industries, LLC  
Xi'An Jing-Jian Paint & Coatings Group  
Yankee Fiber Control, Inc.  
Yellow Creek Coating Services  
YYK Enterprises, Inc.  
Zachry Industrial, Inc.  
Zebron Corporation  
Ziegler Industries Inc.  
Zingametall BVBA  
ZRC Worldwide

## Sustaining Members

I 1625820 Alberta Ltd. O/A Propaint  
Abhe & Svoboda, Inc.  
Allen Blasting & Coating, Inc.  
Alpine Painting & Sandblasting Contractors  
American Institute of Steel Construction (AISC)  
Argus Contracting, LP  
Arkansas Painting & Specialties, Inc.  
ASCO - American Stripping Company  
Atsalis Brothers Painting Co.  
Avalotis Corporation  
Brand Industrial Services  
Brock Services, LLC  
C.A. Hull  
Cannon Sline Industrial  
Certified Coatings Company  
Champion Painting Specialty Services Corp.  
Clemco Industries Corp.  
Cloverdale Paint, Inc.  
Consolidated Pipe And Supply, Inc.  
Cor-Ray Painting Co.  
Corrosion Resistance  
DBM Services, Inc.  
Delta Sandblasting Co, Inc.  
Deltak Environmental Coating Services, Inc.  
Demilec USA  
Dex-O-Tex Division Crossfield Products Corp.  
Dow Chemical Company  
DSI, a Safway Company  
Dunkin & Bush, Inc.  
Dunn-Edwards Corporation  
Eagle Industries  
Endura Manufacturing Company Ltd.  
Ergonarmor  
Evonik Corporation (ECA)  
F.D. Thomas, Inc.  
FCA International  
Fletch's Sandblasting & Painting, Inc.  
G.C. Zarnas & Company, Inc.  
General Dynamics NASSCO- Norfolk  
Graham Industrial Coatings LLC  
Harsco Metals & Minerals  
Hempel USA, Inc.  
High Steel Structures, Inc.  
Industrial Coatings Contractors, Inc.  
International Marine and Industrial Applicators LLC  
ITPTS Technical Institute of Preparation and Surface Treatment  
Jotun Paints, Inc.  
King Industries, Inc.  
Landmark Structures  
Line-X Corp.  
Long Painting Company  
Magnum Energy Services Ltd.  
Main Industries Inc.  
Marco  
Mid-Atlantic Coatings, Inc.  
MOBLEYSAFWAY Solutions, LLC  
Mohawk Northeast, Inc.  
National Bridge LLC

Naval and Industrial Solutions S.A.  
Naval Coating, Inc.  
North American Coatings CI Coatings Division  
North Star Painting Co., Inc.  
Northwest Sandblasting & Painting, Inc.  
Odyssey Contracting Corporation  
Olympic Enterprises Inc.  
Olympos Painting Inc.  
Ostrom Painting & Sandblasting, Inc.  
Polygon  
Precon Marine Inc.  
Pro Blast Technology Inc.  
Pro Tank - Professional Tank Cleaning & Sandblasting  
Profile Finishing Systems, Inc.  
Quality Coatings of Virginia, Inc.  
Quillopo Painting Inc.  
Redwood Painting Company, Inc.  
Regional Coating Solutions Inc.  
Rust-Oleum Corporation  
San Diego Protective Coatings Inc.  
Scott Derr Painting Co. LLC  
Shinko Company Ltd.  
Shopwerks Inc.  
SK Commercial Construction, Inc.  
South Bay Sand Blasting & Tank Cleaning  
Sprayroq Inc.  
Stebbins Engineering & Mfg. Co.  
StonCor Group/Carboline Canada  
Surface Technologies Corporation  
T. F. Warren Group  
Tank Industry Consultants, Inc.  
Termarust Technologies  
TRB Industrial Coatings Inc.  
TruAbrasives by Strategic Materials  
TSC Training Academy  
Unified Field Services Corporation  
Williams Specialty Services, LLC



## 11-to-12 pH

The alkalinity of concrete.  
See page 20.



## 1998

The year that the EPA Land Disposal Restrictions were added to the Resource Conservation and Recovery Act in a series of phases throughout the year.  
See page 17.

## 3

The number of storage lots that newly coated jet fuel piping was delivered to prior to installation at an airport, some of which exhibited coating failure.  
See page 12.

## CSA Z245.30-14

The Canadian standard used frequently with field-joint coatings for buried pipelines.  
See page 32.

## \$200

The cost of a flash-light lost along with the reputation of a paint company and a good customer of the rep, all which could've been avoided with the employment of a third-party inspector.  
See page 38.



## 8 to 12

The number of students that will be able to receive simultaneous training via SSPC's new mobile training unit (MTU), which debuted at the SSPC 2018 conference and hits the road later this year.  
See page 4.