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SSPC The Society for Protective Coatings

FEATURES

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LINING STEEL POTABLE-WATER STORAGE TANKS: BENEFITS OF 100% SOLIDS ELASTOMERIC POLYURETHANES

By Murray Heywood, Sherwin-Williams Protective & Marine Coatings

When lining new steel potable-water storage tanks or rehabilitating existing ones, asset owners, specifiers and applicators in North America most often select epoxy linings as their standard resin of choice. However, in the Canadian potable-water storage market, many specifiers have recognized the performance benefits that 100%-solids elastomeric-polyurethane linings offer, and they have been specifying the systems for more than 25 years with admirable results. This article reviews several performance characteristics that 100%-solids elastomeric polyurethanes offer that make them a timely technology consideration.

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OLD AND GRAY TO NEW AND GREEN: COATINGS TRANSFORM DIGESTERS, TANK AT WATER RECOVERY FACILITY

By JPCL Staff

The City of Lincoln, Nebraska recently required painting services at its Theresa Street Water Resource Recovery Facility, including recoating the exteriors of three 65-foot-diameter anaerobic digesters and one 52-foot-diameter sludge storage tank. The City was looking not only to preserve these important wastewater treatment components so that they could continue to function properly for the community, but also upgrade the way they looked to passers-by. The finished product earned SSPC's William Johnson Award for aesthetic merit in industrial or commercial coatings work, with qualities including color, gloss or texture, or the coating complimenting the environment while enhancing the structure itself.

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LARGE-DIAMETER COOLING WATER PIPE AND PENSTOCKS: SELECTING AND APPLYING LININGS

By Raymond S. Tombaugh, KTA-Tator, Inc.

The installation of linings in large-diameter cooling pipes and penstocks is a major investment for hydroelectric and other power plants. The application should be performed in an expedient manner to minimize outage time and should last for many years—20 or more—without the need for maintenance painting. This is important because many hydroelectric plants are located in remote areas. To achieve these goals, planning must be done long before the start of the lining process. In this article, the author provides a compilation of the necessary tasks to plan for in order to implement a successful application.

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DEPARTMENTS

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STAFF

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Seeking Students: Explore a Growing Trade Industry

Typically, students face pressure to prepare for traditional college through each stage of their education, especially during middle and high school. But is college a one-size-fits-all? What about those students who grew up spending their free time crafting, building treehouses or helping their parents work in the garage? Does a traditional degree make sense on this student's life journey, or does building up communities with their hands and minds, in a different sense, fit better?

Most parents want the best for their children's future, and college can be a great and beneficial option, but family-sustaining wages, passion and rewarding careers can also be found outside of a university's walls—and without all of the debt. SSPC's goal is to educate students and parents on the alternatives to traditional secondary education and open their eyes to the trades, specifically in the protective coatings industry.

There is a plethora of opportunities for high-school graduates, displaced workers and other career-seeking men and women throughout this industry. As many are retiring, students are in demand to learn these trades and fill the shoes in the field, a need that grows daily. Without these jobs, communities would begin to fall apart. Protecting important structures like bridges and pipelines ensures that families can commute safely, water is clean, goods can be transported and so much more. There are millions of other assets worldwide that need to be protected, and the blasters and painters play an integral role in making sure that all runs smoothly and safely. While these matters sit under the radar and are not always heard of, if they were to disappear, the effects would be felt greatly.

Starting as an abrasive blaster or industrial spray painter takes important training to be able to effectively and efficiently carry out the role. These jobs act as a gateway to many different paths for growth, in addition to career pride and full-time (and overtime) earning opportunities. As a craftworker in this industry, one can expect to work in all climates, doing various activities to prepare and coat different substrates to protect against corrosion and reinforce the longevity of structures. These hands-on, industrial-level jobs call for a skilled workforce willing to put in the hard work but in no way require the worker to sacrifice earning potential for picking a skilled trade over a bachelor's degree.

After learning the aforementioned skills, there are a few different routes to be taken. For those who find a passion for painting or blasting, becoming a supervisor or superintendent may alleviate some of the hands-on work, but will give an opportunity to oversee and guide future generations in this field. Other options include becoming an inspector, quality control or quality assistance supervisor, starting your own contracting company or furthering your education and becoming a corrosion engineer. The options are bountiful.

Getting involved and learning about the field is the first step. Reaching out and connecting with a local trade organization, union and nearby contractors is foundational. Applying to a contractor will allow a student to get the hands-on training needed. A non-union contractor will use an internal training program to prepare the future craftworker to adequately carry out job duties. Becoming involved with a union contractor or trade institute will put the student in a four-year long program that is paid, partially lecture-based and primarily structured around on-the-job, safety-focused training, starting the path to becoming a journeyman of the trade. Both paths allow a student to be compensated and trained for the future they are building.

It is necessary for parents to have a conversation with their children and connect with them to learn about their future desires. Having meaningful discussions around what they envision themselves doing, what activities are fulfilling to them and what their strengths and weaknesses are is impactful. These traits hint at the direction that may be best for their future career. Each student is unique, and treating them as such will allow them to blossom in their careers and be nothing short of successful. In the protective coatings industry, there's a path for a myriad of minds and skills, and exploring these options could be life-changing.

Students can access a free membership to SSPC, where they can explore some of the Society's offerings within the protective coatings industry, at www.sspc.org/student.

PeopleImages / Getty Images

SSPC, NACE Continue Merger Talks

SSPC: The Society for Protective Coatings and NACE International leaders are reportedly making headway on investigating combining the organizations into one venture. Both NACE President Terry Greenfield and SSPC President Garry Manous saw the recent meeting as a success.

According to a press release, both organizations hosted an association CEO who has seen the completion of multiple mergers. A teleconference with a potential facilitator, who now works as a program manager, for this process also yielded productive results.

As it stands, both organizations hope to have a membership vote by the second quarter of 2020. In the interim, educational webinars and small-group information sessions will provide guidance for members regarding the discussions.

Governance models and transition plans were also recently discussed. Organization representatives reported feeling optimistic, and that there had been agreement to continue with scheduled phone calls and another face-to-face meeting, to occur later this summer.

Manous and Greenfield said they are most excited about how the integration team is working together and prioritizing what is best for association members and the industry.

The talks between the two organizations were originally announced in March. Both SSPC and NACE serve in the field of corrosion and coatings standards, as well as providing training and certifications.

SSPC, founded in 1950 as the Steel Structures Painting Council, is focused on the use of protective coatings in the industry. SSPC's name was changed in 1997 to mark progress in coatings technology, as well as the addition of new types of construction materials. SSPC is based in Pittsburgh, and has offices in Saudi Arabia, Malaysia and China. Currently, more than 16,000 professionals and 420 companies across the globe carry SSPC certifications.

NACE, founded in 1943 and now with more than 38,000 members in 130 countries, is the world's largest nonprofit of its kind, according to the organization. NACE is based in Houston, with other offices across the U.S., the U.K., China, Malaysia, Brazil and Saudi Arabia, as well as a training center in Dubai. Membership with NACE includes specified technical training and certification programs, industry standards, reports, conferences and publications focused on corrosion prevention and mitigation.

Individuals are welcome to provide their thoughts by emailing cooperation@nace.org and news@sspc.org.

PROVIDE FEEDBACK AT STEEL CITY CHAPTER KICK-OFF

SSPC's recently formed Steel City Chapter is having an inaugural kickoff event on Thursday, October 3 in the Pittsburgh area.

In addition to the celebratory activities, the event will feature an open forum for questions and answers regarding the potential SSPC and NACE merger, hosted by SSPC Executive Director Bill Worms.

The kickoff will take place in Ann's Room at Olivia's Banquet Facility (318 Forest Grove Rd., Coraopolis, PA 15108) and begin at 5:30 p.m. The cost to attend is $35 per person.

For more information, contact Cara Blyzwick (blyzwick@sspc.org) or visit www.sspc.org/chapters.

Q2 FINANCIALS UPDATE

SHERWIN REPORTS SALES INCREASES

Cleveland-based global coatings firm The Sherwin-Williams Company released its second-quarter financial report for 2019 on July 23, announcing an increase in consolidated net sales, diluted net income per share and net sales from stores in the U.S. and Canada.

Consolidated net sales reportedly increased 2.2%, or $104.1 million, to $4.86 billion. Sherwin attributes that increase to higher paint sales volume in North America, and sales from U.S. and Canada stores (open more than 12 months) increased 4.3% in the quarter. Diluted net income per share increased to $5.03 per share compared to $4.25 per share this time last year; and EBITDA increased 8.5% in the quarter to $921.5 million.

"All three of our segments increased profit and margin year-over-year," said John G. Morikis, Chairman and CEO.

For the Americas Group, Sherwin reported an increase of 5%, to $2.76 billion in the quarter and an increase of 4.4% to $4.91 billion in six months. The company also credits this to higher paint sales across all end markets in North American stores. Net sales from stores in the U.S. and Canada increased 4.3% and 4% in the first six months. Although segment profit was negatively impacted by increased raw material costs, it still saw an increase to 22.2% from 21.7%.

Net sales in the Consumer Brands Group increased 3.4% to $804.5 million and 1.7% to $1.46 billion in six months, attributed to a new customer program that was launched in 2018 as well as selling price increases. Sherwin notes that currency translation rate changes led to a decrease in group net sales by 1.6% in both the quarter and six months, however.

In the quarter, segment profit as a percent of net external sales increased to 17.5% from 11.7%, but total segment profit decreased by $1.9 million. In the first six months, however, segment profit increased to $228.6 million from $165.1 million while segment profit as a percent of net external sales increased to 15.7% from 11.5%.

The Performance Coatings Group's net sales decreased 3.8% to $1.32 billion in the quarter and also decreased 1.9% to $2.55 billion in six months. Sherwin says this decrease was primarily due to soft sales outside North America, as well as unfavorable currency translation changes. In this segment, quarterly profit as a percent of net external sales increased to 11.4% from 10.5%, and in the first six months increased to 9.8% from 9%. Segment profit as a whole increased in the quarter to $150.3 million from $144.2 million, which Sherwin says was primarily because of selling price increases and good cost control. Segment profit increased in the first six months to $248 million from $235 million.

"For the third quarter, we anticipate our consolidated net sales will increase by a low single-digit percentage compared to last year's third quarter," Morikis said.

AKZONOBEL FINANCIALS INDICATE FLAT REVENUE

AkzoNobel (Amsterdam) released its second-quarter financial report on July 24, with revenue coming in flat, though there was an increase in return on sales for both the Decorative Paints and Performance Coatings segments. The company also reported an increase in strength in its aerospace coatings offerings with the acquisition of Mapaero, announced earlier this month.

Though revenue was flat for the second quarter at 2.45 billion euros ($2.73 billion), there was a 1% increase in constant currencies. Adjusted operating income was also up 36%, totaling 305 million euros (roughly $339.8 million), over 2018's second-quarter 225 million euros. This growth was largely attributed to ongoing pricing initiatives and cost-saving programs. ROS also clocked in at 13.7%, excluding unallocated costs, up over 2018's 12.1%.

Operating income totaled 308 million euros, including a 3-million-euro positive impact from identified items connected to a gain on disposal following asset network optimization and transformation costs. The company's focus on "value over volume" also resulted in a 5% increased price/mix and 8% lower volumes.

TOP OF THE NEWS

AkzoNobel also reported progress toward its "Winning Together: 15 by 20" initiative, which aims for the company's RDS to hit 15% and its ROI to be greater than 25%.

RDS for the Performance Coatings' second quarter increased to 13.6%, which was attributed to a price/mix of 7% connected to pricing initiatives. Revenue for Marine and Protective Coatings was reportedly flat, and the Powder Coatings segment experienced the same.

Segment revenue decreased 1%. Adjusted operating income increased to 197 million euros, with pricing initiatives and cost control more than compensating for higher cost of raw materials and lower volumes.

Though demands differ per region and segment "in an uncertain macro-economic environment," according to AkzoNobel, raw material inflation is forecasted to stabilize during the second half of this year. The company will be using pricing initiatives and cost saving to address current issues. Currently, AkzoNobel is aiming to deliver the next 200 million euros in cost savings by next year, which will also include incurring one-off costs in both this and next year.

PPG REPORTS NET SALES DECREASE

In its latest earnings report, released July 18, PPG Industries (Pittsburgh) reported a 3% decrease in net sales over this time last year, totaling $4 billion. The company reportedly continued to benefit from growth across several businesses, though, including aerospace and protective and marine coatings.

Net sales in constant currencies were roughly 1% higher than last year's second quarter, which was largely attributed to higher selling prices totaling more than 2%. Volumes were also down 4%, which includes roughly 1.5% U.S. architectural coatings customer-assortment changes. Foreign currency translations negatively impacted net sales by more than 3%, totaling $130 million. Acquisition-related sales, as well as net of divestitures, both contributed to 2% sales growth.

Adjusted net income from continuing operations totaled $441 million. Michael H. McGarry, PPG Chairman and CEO, noted that the company is committed to recovering operating margins, and that the company had also experienced higher gross profit and segment operating margins compared to last year.

PPG's Performance Coatings segment—which includes architectural, protective and marine, auto refinish and aerospace coatings—net sales were down around 3%, or $65 million, totaling $2.4 billion. Sales in constant currencies remained even with last year, and acquisition-related sales amounted to $15 million, which is largely attributed to the SEM acquisition. Segment volumes were also down 3%, which led to a 2% reduction in segment sales—around $60 million. Foreign currency translation also reduced net sales by nearly 3%.

Second-quarter segment income clocked in at $425 million, down $3 million, or roughly 1%, from last year, and foreign currency translation also reduced net sales by nearly 3%. In turn, aerospace coatings sales volumes experienced a high-single-digit percentage uptick, and aggregate organic sales for protective and marine coatings increased by a high-single-digit percentage.

Income for the industrial coatings segment was up 5%, amounting to $235 million, up $12 million from last year. [This total includes unfavorable currency translations amounting to roughly $10 million.] The uptick was thanks to higher selling prices and cost management, but this was offset by lower sales volumes. Net sales volumes for automotive OEM coatings decreased by a high-single-digit percentage, which was consistent with lower global automotive industry production rates.

McGarry said that as the company looks to the third quarter, it expects industry demand to remain "sluggish."

"We expect the momentum of our margin recovery to continue as we work with our customers and suppliers to further offset the multi-year raw material cost inflation we have experienced," he said.

PAINTSQUARE COMMENTS

In Response To "Mountain Valley Pipeline Coating Questioned" (PaintSquare News, July 1)

The Federal Energy Regulatory Commission recently issued a request for "toxicological, environmental and health information" from the Mountain Valley Pipeline's corporate attorney regarding the coatings used on the project's 42-inch-diameter steel pipe. Various sections of pipe have been stored aboveground because of project delays, raising concerns about the possibility of degrading epoxy coatings and the effects they could have on the surrounding air, soil and water.

Tommy Forster:
"That has to be the biggest load of bunk I have ever read in regard to coatings wear."

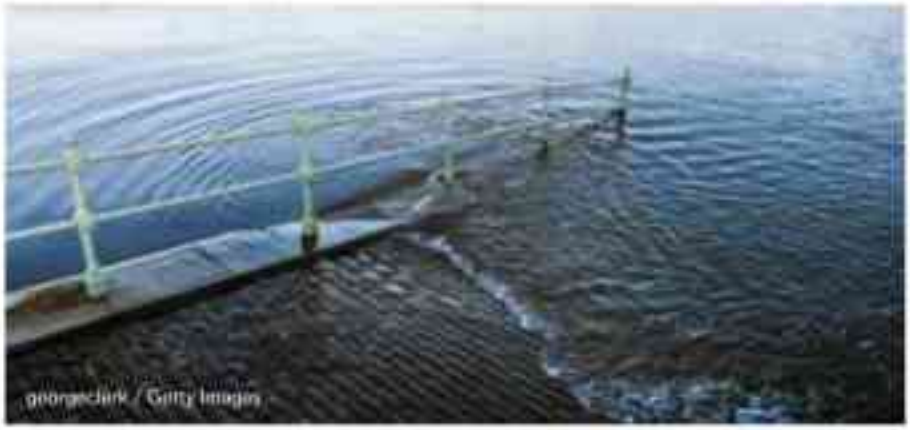
William Gusnard:
"I have a question: Are [we] now going to [be] worried about all the existing FBE-coated pipelines in place? Those coatings also eventually fail and they are already buried and inspection is almost impossible. Is this the beginning of the end of FBE coating use in America?"

Jon Cavallo:
"This is a situation where SSPC and NACE could make its many member subject matter experts available to respond to these concerns."

Luc N. Turenne:
"It seems like every conceivable option or argument, factual or false, is being used to stall, thwart or cancel all energy-related products. Yet the opponents themselves are often not the greatest environmental stewards, still jump on a plane for a weekend getaway, drive their vehicle to the protest site, and like their home perfectly climate controlled."

Eric Pelletier:
"I can't believe what I just read. [The manufacturer] should have at least provided an answer quickly to defuse a potential and unnecessary source of concern among the public. And yes, exposing an epoxy to sunlight for a prolonged period can lead to chalking, but people need to learn once and for all what a toxin is. And a chalking epoxy is far from releasing toxins into the air or the environment."

Ed Thornton:
"Aren't there Safety Data Sheets available, or is this a new ambulance to chase?"


georgeclerk / Getty Images

In Response to "Protective Seawalls Could Cost Coasts $416B" (PaintSquare News, July 10)

In a recent report by the Center for Climate Integrity—a project of the Institute for Governance and Sustainable Development—in partnership with engineering firm Resilient Analytics, various U.S. coastal communities are expected to pay $416 billion in seawall protection services over the next 20 years.

Lou Lyras:
"State-of-the-art MSR nuclear power plants should cost $5 billion each. We need to begin building these while solar and other power generation is developed and the dependency on fossil fuels for electrical power is significantly reduced. If we don't begin serious reduction of CO_2 emissions, the seawalls are just a Band-Aid, not a cure."

Tony Rongus:
"Places are going to look like Los Angeles from the Kurt Russell movie 'Escape From LA.'"

Suppiah Chandrasekaran:
"Society as a whole should commit to a real organic change in its behavior to use less fossil fuel products. Blaming fossil fuel producers is futile even if they pay 100% and we continue our current ways."

PAINT POLL

paintsquare.com/poll

Recently, Louisiana's Sunshine Bridge was struck a second time since its last incident in October. According to reports, the tanker ship involved damaged the fender system that serves to protect the bridge. A DOTD spokesperson noted that the structures themselves are designed to handle this kind of damage. However, with reoccurring instances and increased water traffic, do you think fenders are the best option for bridge protection?

Photo: Bluepoint951, CC BY-SA 2.5 via Wikimedia Commons.

Yes. **79%**

No. **16%**

Other. **5%**

Peter Kenimer:

"Fenders are a whole lot cheaper than raising the bridge out of the way of clueless pilots and/or captains smashing into the bridge."

Michael Halliwell:

"Fenders help avoid far worse consequences, but I'm with Peter: Although accidents can happen, I would expect there to be some form of emergency condition if you're striking a stationary object with a seaworthy vessel. Otherwise, if a pilot or captain cannot control their vessel well enough to avoid a known, stationary hazard, then what are they doing at the helm? That's incompetence. If they are not competent enough to avoid a bridge, then get them out of the wheelhouse. If it is not incompetence or an emergency, then the cause would likely be negligence or impairment. Again, get them out of the wheelhouse."

Problem Solving Forum

paintsquare.com/psf

Some painting specifications call for the use of "Best Effort" in relation to blasting. How does one determine "Best Effort?"

Erik Andreassen, CPS:
"If a painting specification includes that statement, then it has quite obviously been created by someone who has no knowledge of our industry. The painting specification should have been written around the paint material, recommended by the supplier. A standard for surface preparation has to be stipulated in writing. If the person has little understanding of what is required, do not be frightened to consult those who do know."

Simon Hope, Bilfinger Salamis:
"The statement 'best effort' is one that is surely open to absolutely gross misinterpretation and is a clear indicator that the document has been written by a bean-counter or other non-technical [individual] trying to impress and save money. They deserve everything they get if they [can't] seek out proper support, which is on the whole freely available from the coating supplier as the first port-of-call, as well as standards such as NORSOK M-501, which can be downloaded online for no cost and gives clear guidance. Most coating technical data sheets are proscriptive as to the standard of preparation required as a minimum. This is the absolute baseline and not something as woolly and vague as 'best effort.'"

Per Gabrielsson, Free Lance Consultations and Inspections:
"In Korean shipyards, [they] used to say, 'We will try to do our best.' And then, you know, nothing would happen!"

Katheravan Arumugam, ENI:
"Frankly, looking at the statement suggests that there is a possibility you might not be able to achieve the standard required due to the complexity of the structure, so every effort will be required to ensure that a combination of resources is applied in order to achieve the best effort in getting the job as close to the specification requirement as possible."

What causes bubbling or cratering of an epoxy intermediate coat when applied over epoxy zinc-rich primer?

Ricardo Marceles, Pintuco:
"The first layer of anticorrosive paint, rich in zinc, fills the valleys left by abrasive blasting,

however, that first layer does not offer a good leveling since it has metallic pigments and leaves a porous surface, which generates bubbles in the intermediate layer. To avoid this, it is recommended that when applying the intermediate layer, a high dilution is made with solvent, in such a way that a 'fog layer' is applied to fill this porosity. Then, immediately paint the intermediate layer of paint that is needed, with the required elucidation and the wet film thickness that is needed to comply with the specification."

Nourhan Demirdjian, Waterproofing Technologies:
"It is due to the porous nature of the substrate. It is more of an issue over inorganic zinc-rich rather than over organic zinc-rich. To overcome, apply a mist coat first before applying a 'wet' coat or reduce the epoxy 20–25% to fill the pores of the substrate, then apply another coat next day."

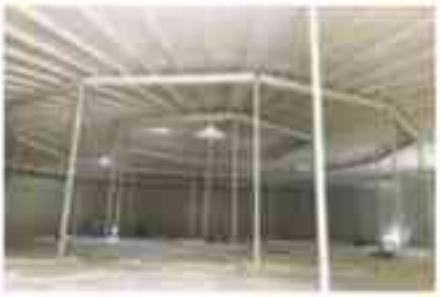
Qaisar Malik, ABC:
"There are three reasons: 1. humidity is greater during application of zinc-rich epoxy and less time for curing; 2. the solvent has not properly evaporated; and 3. surface preparation may be inadequate."

James Prevatt, SPEC-GUARD:
"The chemist for my former industrial coatings company added that zinc was not only porous, but would temporarily hold solvent from the intermediate coat, when the intermediate coat would see bubbling as solvent is released from the zinc. Most data sheets resolve the matter by recommending a 'thin' application be allowed to get beyond tack-free before applying the full thickness of the intermediate coat."

PAINTSQUARE NEWS TOP 10

paintsquare.com/news, July 8–Aug. 4

1. **Report: Improper Coating Likely Used on Pipeline**
2. **Historic ND Bridge Collapses; No Injuries**
3. **Mountain Valley Pipeline Coating Questioned**
4. **PPG Reports Decrease in Q2 Net Sales**
5. **PPG to Acquire Specialty Materials Firm**
6. **AkzoNobel Q2 Financials Indicate Flat Revenue**
7. **SSPC, NACE Continue Merger Talks**
8. **Protective Seawalls Could Cost Coasts $416B**
9. **Aluminum Corrosion, Corrosion Prevention in Seacoast Atmospheric Environments**
10. **PA Contractor Faces Fines for Bridge Collapse**



(Clockwise from top left) Fig. 1: East elevation columns J1–7. Figures courtesy of KTA-Tator, Inc.

Fig. 2: South elevation J1 line, columns G1, G2, G, G1, G2 and 7 (left to right).

Fig. 3: Columns G2 and 7 on line J1 show rust-staining below the apparent active corrosion zone.

Fig. 4: Lower area of active corrosion on Column G; J1 line indicated by a horizontal white chalk line.

Partially Galvanized Steel Columns: What Could Wash-ably Go Wrong?

BY RICH BURGESS, PCS, KTA-TATOR, INC.

The Gulf Coast of the United States has a multitude of petroleum refining and chemical production facilities. Many plants are expanding as demand for raw materials grows. In the Gulf Coast, expansion means structural steel—lots of it. Galvanizing along with application of coating systems is relied upon to protect the steel from corrosion. Over time, protective coatings begin to fail and refurbishment is needed. But one facility experienced corrosion problems while still under construction. Why? Let's find out.

BACKGROUND

A steel fabricator won a contract to supply structural steel and erect a new process unit as part of a PVC production facility expansion near the Gulf Coast. The requirements for the structural-steel columns included galvanizing the upper portion of each column where they would be exposed to the environment. The remaining portions of the columns and other interior structural members did not require galvanizing but were required to be painted (Figs. 1 and 2).

Structural steel painted at this fabricator's facility in the southeast is typically prepared by abrasive blast-cleaning in an automated blast booth. However, since the structural columns were partially galvanized prior to painting, it was decided to prepare all of the ungalvanized surfaces by power wire brush (SSPC-SP 3) followed by spray application of a rust-inhibitive gray alkyd shop primer. The galvanized upper sections were not painted. The product data sheet for the shop primer recommended a dry-film thickness of 2.0–4.0 mils. The data sheet also indicated that the coating performs well over power- or hand-tool-cleaned surfaces (SSPC-SP 2).

Following painting and drying, the columns were shipped to the PVC production facility and erected. Within a few days, it was reported that painted sections of the columns were rusting badly. The fabricator requested assistance to investigate the cause.

FIELD INVESTIGATION

A coatings consultant visited the PVC production facility to examine the coating and corrosion on the partially galvanized columns. The fabricator's field project manager was present during portions of the examination. The investigation steps included a visual examination; determination of coating-failure pattern; coating adhesion and coating-thickness measurements; and collection of field samples for soluble-salts analysis.

- Visual Examination: Viewed from a distance, the light-gray galvanized portions and dark-gray painted portions of the steel columns were clearly distinct. However, a zone of red rust, rust streaks and rust staining was visible over portions of the columns above the clean, dark-gray painted lower ends and immediately below the upper galvanized portions (Fig. 3). Closer inspection revealed that the zone of red rust consisting of crusty, rust-colored spots and patches were corrosion products erupting from beneath the coating. The corrosion caused localized peeling. The rust-colored streaks were rust stains on the surface of the dark-gray coating.
- Pattern of Failure: The zones of red rust and rust stains were visible around the perimeter of the columns (the outside flanges, inside flanges and webs). The active corrosion zones ranged from the painted areas below the galvanizing down to about one-half of the total column height (Fig. 4). Heavy rust staining was present in streaks from where active corrosion ended, becoming somewhat lighter toward the bottom of the columns. The coating condition on laterals and diagonals at the

Table 1: Dry-Film Thickness on Coated Structural Steel (mils).

Steel Item	Surface Type	Avg.	Min.	Max.
Painted Column Sections	Inside Flange	3.7	1.6	7.1
	Outside Flange	4.8	2.4	9.6
	Web	5.5	3.3	8.4
Painted Structural Cross Members	T Shape	4.1	1.3	8.9
	I-Beam	4.3	1.8	7.7

attachment points to the columns was consistent with the coating condition on the columns (rusted, stained or clean).

- Coating Adhesion: Adhesion was assessed by ASTM D6677, "Standard Test Method for Evaluating Adhesion by Knife," and ASTM D3359, "Standard Test Methods for Measuring Adhesion by Tape Test, Method A." The coating was scribed with an "X" and adhesion assessed by probing and picking the coating with the tip of a knife blade (knife test), or by application of tape and then removing the tape and grading adhesion based on the amount of coating that is removed (tape test). The coating on the lower portions of the columns exhibited good adhesion. Coating adhesion in the corroded zone was very poor where active corrosion was present and fair-to-poor on surfaces where coating was unstained and appeared intact. The degraded condition of the coating in areas of active corrosion was demonstrated by use of adhesion test tape applied without scribing the surface. Coating and rust were pulled from the surface with the tape. It should be noted that during removal of the gray coating adjacent to corrosion patches, the steel perimeter appeared to have a moist surface (a coating undercutting environment) that dried very quickly. Additionally, the small coating blisters and crusty surfaces contained liquid, but too little to collect.
- Substrate Condition: The coating was removed from locations on the lower half of columns revealing a cleaned surface with light, tight corrosion and scale. The appearance was consistent with a surface prepared in accordance with SSPC-SP 3. Intact coating removed from the steel in the active corrosion zone revealed a dark gray/black surface. The coating in the active corrosion area (upper half of the column below the galvanized sections) was very rust-colored, blistered and crusty. When this coating was removed, the substrate exhibited corrosion and undercutting. However, within the active corrosion area, there were some spots of intact coating and clean substrate. The observations are illustrated in Figures 5–7. Figure 5 shows the corrosion zone of column 7 (column line J), Figure 6 depicts an area with active corrosion with a portion of the surface scraped and staining, and Figure 7 shows an area of intact coating (fair-to-poor adhesion) and a clean substrate where the coating was scraped away.
- Soluble-Salt Sampling: Soluble-salt sampling was performed in the field using latex patches, a syringe and deionized water. A patch is shown in place in Figure 5 and partially removed in Figures 6 and 7. Deionized water (2 ml) was introduced

In order to understand how only a portion of the columns came to be contaminated, it is necessary to understand how the steel was processed from receipt to field delivery.

Fig. 5: Visual example of a corrosion zone on one of the supplied columns (Column J-7).

Fig. 6: This example shows a crust-like material, stained coating, blisters and substrate corrosion.

Fig. 7: This example exhibits pickling.

Table 2: Samples Collected from Partially Galvanized Columns.

Sample Identification	Sample Description and Location
Sample 1	Coating from non-failing area, Column H–II.
Sample 2	Bresle cell liquid (2 ml) from corroded "T" brace, column H–2.
Sample 3	Surface corrosion scraped from surface below galvanizing column H–7.
Sample 4	Poorly adhered between galvanizing line and corrosion (Location of Sample 3).
Sample 5	Bresle cell liquid (2 ml) from substrate exposed at location of Sample 4.
Sample 6	Bresle cell liquid (2 ml) from substrate exposed at location of Sample 3.
Sample 7	Adhesion test tape with coating removed from area of active corrosion.

using a clean disposable syringe and agitated to aid in dissolving water-soluble chemicals (salts) from the surface. The resultant solutions were extracted with the same syringes. The collected solution was tested for pH using indicator strips. The solution from the area in Figure 6 had a pH of 4 (acidic) while the solution from the area in Figure 7 had a pH of 6 (slightly acidic). The solutions collected from the latex patches were placed in separate septum vials and sent to the laboratory for testing.

- Coating Thickness: DFT was measured on the painted sections of structural members using an electronic gauge. This included non-galvanized pieces of the partially galvanized columns.. A summary of the measurements is provided in Table I (p. 17). The average thickness for most surfaces exceeded the manufacturer's recommended thickness of 2–4 mils. Also, there were a few defects such as runs and sags typically associated with overly thick alkyd coatings, but these were not associated with the corrosion.
- Coating Samples: Samples were removed from representative failing and non-failing areas, corrosion products were collected, and soluble-salt extractions were performed on surfaces with and without active corrosion. Coating sample locations are listed in Table 2. A white residue was observed on the backs of some coating samples from areas of corrosion.

LABORATORY INVESTIGATION

The coating samples were submitted to compare the coating on the lower portion of a column and the upper (failing) area. The liquid extraction samples were tested for soluble salt anions, and to identify the white residue on the back of coating. The laboratory investigation consisted of infrared spectroscopy, ion chromatography and scanning electron microscopy-energy dispersive X-ray spectroscopy (SEM-EDS).

Infrared-spectroscopic analysis revealed that the coating from the non-failing area (Column II-6) and poorly adhered coating between the galvanizing line and area of corrosion (Column II-7) were consistent with an alkyd resin containing calcium carbonate. No resin degradation was evident in either of the two spectra.

Ion chromatography was performed on the surface corrosion sample (Sample 3, Fig. 5) and two liquid samples from the latex patch extractions. One sample (Sample 6) was collected on the surface after surface corrosion was removed and collected as Sample 3 (Fig. 6). The second sample (Sample 5) was collected where the coating was removed to expose the substrate (Fig. 7). The sample of surface corrosion was boiled in deionized water, then cooled. The resultant liquid and samples from the latex cell extractions were filtered and tested; the results are shown in Table 3 (p. 20).

An SEM-EDS analysis was performed on a sample of the white residue that adhered to the back of adhesion test tape (Sample 7) (Fig. 8). The white residue was composed primarily of carbon, oxygen, sodium, sulfur and calcium, with trace amounts of titanium and iron. The white color was thought to be from either zinc salts or coating deterioration. No zinc was detected ruling out deposits from zinc kettle fumes. The calcium, carbon, and oxygen could have been from the calcium carbonate in the coating pigment; titanium was most likely from pigments and sulfate from pickling the steel prior to galvanizing.

CONCLUSIONS

The corrosion that developed on the columns supplied to the PVC production facility by the steel fabricator was the result of residual soluble salts from the galvanizing process on the surface of the steel that were painted over in the shop. Not all sections of the columns were affected. The lower halves of the columns exhibit heavy rust-staining, but the coating was well-adhered and the substrate was free of active corrosion. The upper halves of the columns were only partially painted, with the upper end galvanized. There were patches and spots of active corrosion that developed in the painted sections of the upper halves of the columns. The galvanized sections did not exhibit visual defects. In order to understand how only a portion of the columns came to be contaminated, it is necessary to understand how the steel was processed from receipt to field delivery.

New hot-rolled steel generally arrives at the shop with a full or partial layer of mill scale on the surface. Steel can be painted with intact mill scale present when surface-tolerant coatings (such as alkyds) are applied, but the mill scale must be removed when the steel is painted with high-performance coating systems or when the steel is galvanized. Mill scale removal for painting is normally accomplished by abrasive blast-cleaning by an automated process in fabrication shops (centrifugal blast-cleaning booths) and/or by open-nozzle abrasive blast-cleaning. However, when fabricated steel is to be galvanized, the surface is typically cleaned and prepared by using chemicals aggressive to mill scale, dirt, grease, oil and the steel itself.

Fig. 8: Adhesion test tape was applied per ASTM D3359, but without scribing. The back of the tape and underlying surface are shown as the tape was being removed.

Table 3: Results of IC Analysis (µg/ml).

Analyte[1]	Sample 3: Extraction From Corrosion Product on Surface	Sample 5: Bresle Liquid From Area of Poor Coating Adhesion	Sample 6: Bresle Liquid From Corroded Surface
Chloride	628	5,335	613
Sulfate	246	806	360
Common Units	Sample, % by Weight (ppm)	µg/cm²	µg/cm²
Chloride	2.58% (25,865 µg/g)	5,335	613
Sulfate	1.01% (10,132 µg/g)	806	360

1. The IC analysis did not reveal nitrite, bromide, nitrate or phosphate in any of the samples.

The fabricated columns sent for galvanizing were required to have only the upper ends galvanized. Although the galvanized surface was not painted, the portions of the columns below the galvanizing were shop-painted by the fabricator after galvanizing. The upper ends of the columns were cleaned and prepared, then dipped into the galvanizing kettle.

Thorough rinsing and cleaning of steel not to be galvanized was incomplete. Thus, some portion of the upper section of each column was dip-cleaned and prepared for galvanizing, but only the upper-end section was galvanized. Upon return of the columns from the galvanizer, the paint shop prepared the surfaces to be painted using power tools (wire brushes) to remove loose rust and scale. However, this cleaning process would not remove the non-visible chemical salt anions from the surface, nor would it neutralize dry salts and dried anion residues that would recreate an acidic solution when wetted. The alkyd primer was applied, and the steel shipped and erected. Upon exposure to the humid environment and condensation in the Gulf Coast, moisture collected around the salts remaining on the surface recreating a slightly acidic solution and conditions for development of osmotic blisters. This solution attacked the steel causing corrosion and formation of blisters and cracks, thereby increasing moisture passage and corrosion rates. Water rundown from condensation and rain resulted in heavy rust-staining of the paint below the areas of active corrosion.

SUMMARY

The steel columns of a PVC-production-facility expansion were galvanized on their upper portions and painted from the end of the galvanizing to the base. Spots and patches of active corrosion and corrosion product (rust) were found beginning about halfway up the column height and ending at the bottom of the galvanizing. The coating on the columns below the areas of corrosion were rust stained from rundown of the corrosion product. No ferrous corrosion was observed on the galvanized portions of the columns, which were not painted. The cause of the rusting was attributed to residue from the galvanizing preparation processes (cleaning, pickling and fluxing) that occurred prior to power-tool cleaning and painting. Laboratory testing revealed high levels of chloride and sulfate in the corrosion product and on surfaces near the galvanizing with and without corrosion present. When corrosion was present, the substrate was more acidic (pH 4) than when corrosion was not present (pH 6).

It was recommended that the existing coating and corrosion product on the contaminated sections of the columns be removed and replaced. Wet abrasive blast-cleaning was recommended to remove coating and rust scale, including the use of a fine abrasive in the mix to scour small pits that had begun to form in the steel surface. The use of fresh, potable water to thoroughly rinse the surfaces was recommended, as well as testing to verify that the surface was chemically neutral (pH 7) and that chloride and sulfate salt concentrations were under 20 µg/cm² prior to applying a replacement coating. Finally, the use of a surface-tolerant coating, such as an aluminum-filled epoxy mastic or moisture-cured urethane containing micaceous iron oxide was recommended.

The cause of the rusting was attributed to residue from the galvanizing preparation processes that occurred prior to power-tool cleaning and painting.

ABOUT THE AUTHOR

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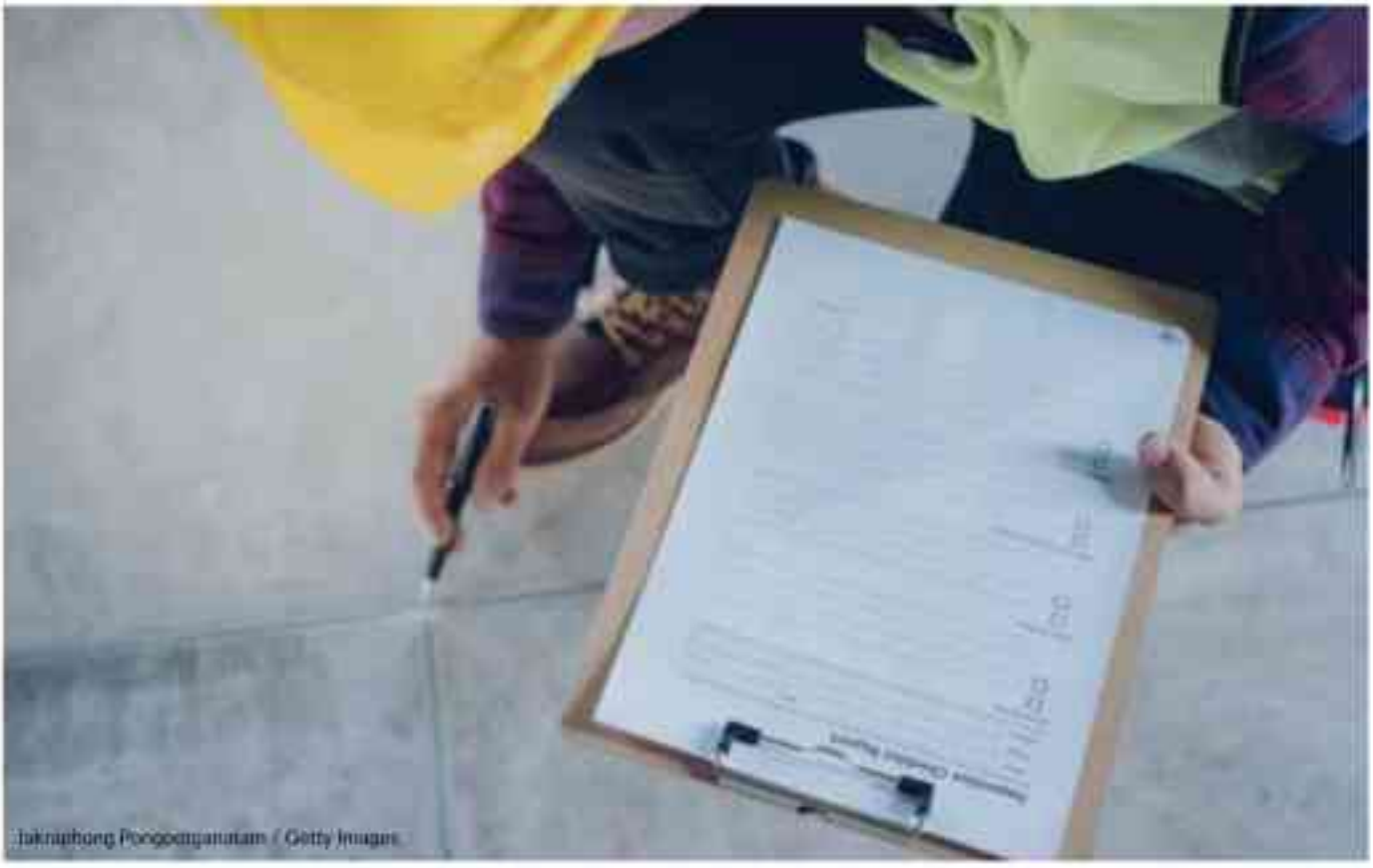
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ARE YOU A QUALITY CONTROL INSPECTOR—AND BY WHOSE DEFINITION?

BY TROY FRAEBEL, ABKAELIN, LLC

Previous versions of this column have stressed the importance of inspection on protective coatings and linings projects, and explained the quality assurance and quality control approach to quality management in the protective coatings industry. Many specifications now require QC inspection by the contractor, but do the individuals assigned to this task meet the requirements? This article will review the SSPC requirements for inspectors cited in many specifications.

The following standards include qualification and training requirements for QC inspectors:

- SSPC-QP 1, "Standard Procedure for Evaluating the Qualifications of Industrial/Machine Painting Contractors" (Field application to Complex industrial and Machine Steel Structures) (January 1, 2019);
- AISC 420/ SSPC QP-3, "Certification Standard for Shop Application of Complex Protective Coating Systems" (September 2010);
- SSPC-QP 5, "Standard Procedure for Evaluating the Qualifications of Coating and Lining Inspection Companies" (July 2012);
- SSPC-QP 6, "Standard Procedure for Evaluating the Qualifications of Contractors Who Apply Thermal Spray (Metallizing) for Corrosion Protection of Steel and Concrete Structures" (July 2004);
- SSPC-QP 8, "Standard Procedure for Evaluating the Qualifications of Contracting Firms that Install Polymer Coatings and Surfacings on Concrete and Other Cementitious Substrates" (March 2015);
- SSPC-QP 9, "Standard for Evaluating Qualifications of Painting Contractors Who Apply Architectural Paints and Coatings" (January 2014); and
- SSPC-QS 1, "Standard Procedure for evaluating a Contractor's Advanced Quality Management System" (March 2015).

By reference, ASTM International D3276, "Standard Guide for Painting Inspectors (Metal Substrates)" and ASTM D6237, "Standard Guide for Painting Inspectors (Concrete and Masonry Substrates)" come into play, as well inspector training programs from SSPC and NACE International, among others.

SPECIFICATIONS

The primary qualification and training requirements for inspectors may be defined in the project specification. If so, these requirements must be met by the contractor. SSPC Protective Coatings

Table 1: Inspector Experience and Training Requirements.

Certification	Experience	Training
QP 1	3 years	BCI Level 2 or PCI Level 2, NACE CIP Level 2, FROSIO Level II, ICorr Level 2, BGAS-CSWIP Grade 3
QP 8	3 years	CCI Level 2
QP 9	2 years	MPI Level One Online

Inspector, Bridge Coatings Inspector, Concrete Coating Inspector and NAVSEA Basic Paint Inspector, or NACE Coating Inspector Program-certified inspectors of a particular level (1, 2 or 3) are often specified. Internationally, we also see FROSIO, ICorr and BGAS-CSWIP inspectors specified at various levels.

Unfortunately, some specifications are silent concerning inspection. Some may only mention that "the contractor shall inspect the work" or provide "an inspector," but even this mention leads to an industry definition in the SSPC Protective Coatings Glossary from 2011:

"An individual or group of individuals whose job it is to witness and document the coating work in a formal fashion."

While this definition does not touch on qualifications or training, it does include a key requirement: documentation. If inspection is required in a specification, an owner should require formal inspection documentation regardless of the qualifications of the inspector, prior to payment.

Another industry standard that is often mentioned in coating specifications is SSPC-PA 1, "Shop, Field and Maintenance Painting of Steel" (June 2016). While the specifier may have never read PA 1, he or she may have accidentally specified contractor QC inspection, without reference to inspector qualification or training:

"13. INSPECTION REQUIREMENTS

The contractor's work plan (or the inspector's inspection plan) shall include hold points prior to each step of the application as described in the SSPC Guide for Planning Coating Inspection (2008). These include:

- Pre-surface preparation;
- Post-surface preparation;
- Coating conditions for application;
- Coating application;
- Post-application of coating; and
- Post-curing."

While not obvious by title of the standard (except for QP 5), a specification that requires a contractor be QP certified invokes specific inspector qualifications and training.

SSPC QP STANDARDS

SSPC-QP 1 requires the following.

"Quality Control Inspectors: Unless more stringent requirements are specified by the project specification or stated in the Contractor's quality manual, persons designated by the Contractor to perform quality control inspections in the field shall have at least two years field experience in protective coatings and have successfully completed a training course approved by the Qualifying Agency. The course shall require 24 hours minimum contact time, including hands-on training and an assessment that covers subjects for coating inspection described in ASTM D3276 applicable to the Contractor's scope of work. Prior to assigning a Quality Control Inspector to a project, the Contractor shall verify that the inspector has the physical (including visual) capability to perform required inspections."

(At 14 pages in length, ASTM D3276 is a comprehensive and very useful document for explaining and teaching the inspection process.)

SSPC-QP 8 requirements are similar to QP 1 (two years of experience and 24 hours of training) with the exception that the substrate is concrete:

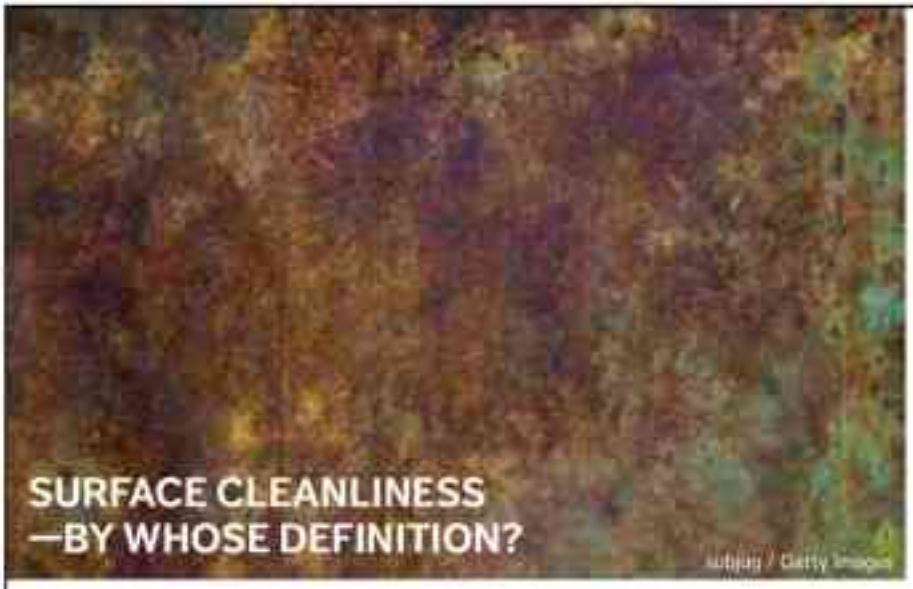
"Quality Control Inspectors: Unless more stringent requirements are specified by the owner's project specification or stated in the contractor's Quality Manual, persons designated by the contractor to perform quality control inspections in the field must have at least two years field experience in protective coatings including at least one year of field experience applicable to the scope of this standard in installation of polymer coatings and surfacings to concrete, and have successfully completed a training course approved by the Qualifying Agency. The course shall require 24 hours minimum contact time, including hands-on training and assessment (test) that covers subjects for coating inspection described in ASTM D6237 applicable to the contractor's scope of work. Bonded repair and retrofit of concrete structures using FRP composites shall require an SSPC Concrete Coatings Inspector (CCI) Level I working under an SSPC Certified CCI Level 2. Prior to assigning an inspector to a project, the contractor shall verify that the inspector has the physical (including visual) capability to perform required inspections."

As would be expected, the requirements for an SSPC-QP 9 architectural paint inspector are less (one year of experience and six-module online course):

"Paint Inspector: Unless third-party inspection is required for a specific project, the architectural paint inspector is typically provided by the painting contractor. The painting contractor shall employ the services of a Paint Inspector(s) who has (have) satisfactorily completed MPI [Master Painters Institute,] Level One—Essentials of Paint and Painting Technology or equivalent training. In addition, inspectors shall have a minimum of one year of architectural painting experience. The

painting contractor shall ensure that a qualified inspector performs all inspections and results are reported as required by contract documents. It is possible for an appropriately qualified employee to perform the duties of both the Quality Control Supervisor and the Paint Inspector."

QP 1 and QP 8 also require a Quality Control Supervisor with SSPC QCS training or equivalent. However, the QP1 or QP 8 QCS is typically a manager supervising field inspectors and not a field inspector. In all cases, the QCS is required to have a higher level of experience and training (Table I).



SURFACE CLEANLINESS —BY WHOSE DEFINITION?

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One of the most contentious inspection hold-points that a QC inspector can have when working with QA oversight is surface cleanliness after abrasive blast-cleaning. Not only are there different standards (SSPC/NACE joint standards vs. ISO 8501-1, "the Swedish Standard") with different definitions, but the inspection of cleanliness ultimately hinges on a visual estimation of how much staining is present. This inspection is very subjective, but there is a solution.

Table 1: Permitted Levels of Contamination for Blasting Standards.

Cleanliness Level	Class	Loose Contamination	Adherent	Staining
Highest Standard	SSPC-SP 5/NACE No.1	None	None	None
	ISO Sa 3	None	None	None
	SSPC-SP 10/NACE No.2	None	None	<5%
	ISO Sa 2½	None	None	"Slight"
	SSPC-SP 6/NACE No.3	None	None	<33%
Lowest Standard	SSPC-SP 14/NACE No.8	None	<10%*	Remainder
	ISO Sa 2	None	Most removed*	Not given
	SSPC-SP 7/NACE No.4	None	None	Not applicable
	ISO Sa 1	None	None	Not applicable

A February 2015 JPCL article[1] compares and contrasts the SSPC/NACE joint standards and ISO 8501-1. Table I from that article summarizes the differences, and the author astutely points out that, "It is important to always adhere to the surface preparation standard that is written in the specification."

In North America, most abrasive blast-cleaning specifications for new painting or complete removal of old coatings reference one of the SSPC NACE joint standards:

- SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning";
- SSPC-SP 10/NACE No. 2, "Near-White Metal Blast Cleaning"; and
- SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

All the definitions contain the same requirement: "When viewed without magnification, [surface] shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter." The only is difference is the allowable degree of staining. White Metal does not allow staining, while Near-White and Commercial standards allow 5% and 33%, respectively.

To help with this subjective inspection, SSPC developed SSPC VIS-1, "Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast-Cleaning." While the pictures are helpful, they cannot be enforced on a project unless explicitly required by the specification. Also, one must know the initial condition of the steel in order to select the right picture. The QA inspector may not have observed the initial condition.

What is the solution? Create a site standard on the structure. Abrasive blast-clean a typical area (maybe 10 square feet). Jointly inspect the area with the abrasive blaster, QC inspector, QA inspector, owner and paint manufacturer and have all agree that the level of cleanliness meets the written standard. Then, clear-coat and preserve the area for future reference. Multiple standards may need to be created based on the structure (for example, flat webs versus riveted pack-rusted areas).

REFERENCES

1. Francis, R.A. "Basic Training: Visual Surface Preparation Standards." JPCL, February 2015.

QP 1, 8 and 9 do not address whether QC inspectors (or the QCS) can also perform field production activities. The higher-level QS-1 Certification defines the separation of production and quality.

JOINT STANDARDS

Being a joint standard with the American Institute of Steel Construction, AISC 420/SSPC QP-3 is a little different from the rest. While ASTM D3276 is referenced, no experience or training duration is required:

"Qualification and Training of Inspection Personnel. Personnel involved in inspection of surface preparation and coating application and curing shall be qualified by training and experience as defined by the Firm. Experience shall include the inspection of complex coating systems applied on a variety of projects ... The competency of inspectors without experience or inspectors at new Firms shall be documented. Qualification standards and certifications granted by recognized industry organizations can be used to establish the basis for qualification. Training for inspectors may be provided and documented by qualified in-house instructors or by external sources. At a minimum, the training shall include these 'body of knowledge' items as described in ASTM D3276."

AISC 420/ SSPC QP-3 includes a detailed list of ASTM D3276 topics, including Surface Preparation; Coating Storage and Handling; Weather Considerations; Coating Application; Additional Considerations; Inspection Equipment; Comparison of Surface Preparation; and Inspection Checklist.

AISC 420/ SSPC QP-3 does not require a QCS, but a top individual is required:

"Executive management identifies and records the top individual at the facility with technical knowledge of the coating process. This individual shall have a minimum of one year experience in surface preparation and application of complex coating systems or their components."

AISC 420/ SSPC QP-3 also explicitly allows production personnel to perform inspections:

"Inspectors shall be assigned on the basis of their qualifications to perform inspection of coating systems. Production personnel can be assigned to inspection duties under the following conditions:

- They are trained
- They are aware of and have adequate time to perform their inspection responsibilities.
- Production personnel shall be capable of inspecting their own work as an in-process inspection, however, that inspection cannot be accepted as the final inspection for product conformity.
- Their inspections are monitored by qualified personnel. Production personnel can perform final inspection of the work of others, provided they are properly trained, and their work is monitored by QC (another QC qualified inspector or QC management.)"

While QP 6 is an SSPC standard, it is based on a joint standard with NACE and the American Welding Society, and is markedly different from QP 1, 8, and 9. Per QP 6, "Thermal Spray Inspector (TSI): A person who has training and experience to conduct inspections in accordance with SSPC-CS 23.00/AWS 2.23M/C2.23/NACE No. 12 and the applicable inspections of ASTM D 3276." Interestingly, no duration of experience is specified. Like ASTM D3276, SSPC-CS 23.00/AWS C.2.23/NACE No. 12, "Specification for the Application of Thermal Spray (Metalized) Coatings of Aluminum, Zinc, and their Alloys and Composites for the Corrosion Protection of Steel" (May 2016) is a comprehensive document. If one is inspecting thermal spray (metallizing), intimate knowledge of this standard is required.

SSPC QS-1: A HIGHER STANDARD

Per the scope statement, "SSPC-QS 1 requires a coating contractor to implement and document advanced quality control and record-keeping procedures. As such, the requirements of this standard are intended to supplement the requirements of SSPC-QP 1, SSPC-QP 3, SSPC-QP 6, and SSPC-QP 8. Owners and specifiers who require a higher level of quality control for their projects have the option to require that a contractor qualified to QP 1, 3, 6, or 8 also present evidence that its quality system meets the requirements of QS 1 on projects where an SSPC-QS 1 certification or an equivalent advanced quality management system is required."

As mentioned above, QS 1 requires a clear and documented separate between quality and production:

"Be organized in such a way that demonstrates sufficient independence to ensure that quality considerations are independent of production. Provide written evidence that verification of the inspection result is administered independently of the inspection and production operation." Further QS 1 required the contractor to "[e]mploy a full-time Quality Manager (QM) with executive responsibility, who reports directly to executive management of the company or facility and is independent of production, to ensure compliance with all company quality procedures and to monitor their implementation."

A step above a QCS, "The QM shall [] hold current SSPC or NACE PCS [Protective Coating Specialist] certification, or 2) (for QP-1, QP-3, or QP-6 certified firms) be an SSPC PCI Level II or NACE CIP Level II certified coating inspector or, (for QP-8 certified firms) be an SSPC CCI Certified Coating inspector, or 3) hold a B.S. degree in materials science or corrosion engineering or equivalent engineering degree acceptable to the qualifying agency. ... The QM shall have successfully completed the SSPC QCS training or equivalent ..."

For QC inspectors, two years field experience is required for all including QP 3 and QP 6 inspectors. QS 1 is also explicit that QP 6 inspectors must have at least 24 hours of ASTM D3276 training, and QP 8 inspector must have more: "Inspection personnel for QP 8 shall have successfully completed SSPC CCI Level I coating inspector."

Also, QS 1 is explicit about documenting the physical qualifications of inspectors including physical ability, natural or corrected near-distance visual acuity, and color perception.

SSPC-QP 5: THIRD-PARTY INSPECTION

While typically specified and retained by an owner to perform QA inspections, contractors sometime supplement their QC staff by hiring third-party inspectors. Just because the firm is certified at this high QP 5 level does not mean that each individual inspector meets the QP 1, 3, 6, 8 or QS 1 requirements.

The physical inspector requirements are identical to those in QS 1, but QP 5 allows for several levels of inspectors. For example, QP 5 Level I inspectors only require a high school diploma plus minimum of 6 months' general coating inspection experience, not the two years required by QP 1, QP 8, and QS 1. Even a QP 5 Level 2 inspector qualifies with an Associate's or Bachelor's degree plus a minimum 1 year as QP 5 Level I inspector with the applicant inspection company. QP 6 and QP 8 require specific training base on the system (metallizing) or substrate (concrete). Contractors retaining third-party inspectors need to make sure that they meet the qualifications.

CONCLUSION

This author has stated it before and is saying it again: Inspection must be done and documented. Even if the specification is silent on inspection, a quality contractor should inspect and document their own work. If the owner is or is not providing third-party QA oversight, a quality contractor should review its own QC documentation or hire a qualified consultant to do so. Such attention to detail improves not only the quality of a particular project but the overall quality, productivity and profitability of the firm. When QP 1, 3, 6, 8 and especially QS 1 are specified, QCS, QC management and/or QM review is required.

As with all projects, read the specifications and referenced standards, and make sure that submitted inspection personnel meet the requirements and perform and document the inspections. On a small project with a small crew, maybe the painting supervisor or superintendent gets tagged to do the QC inspection—which is OK, as long as he or she is properly equipped, supervised and documents the work.

ABOUT THE AUTHOR

Troy Fraebel is the Vice President of Protective Coating Services for ABKaelin, LLC. He has 30 years of experience in the protective coatings industry and is an SSPC Protective Coatings Specialist, a NACE-certified Coating Inspector (Level III) and an instructor for several SSPC training courses. He holds a B.A. from Western Kentucky University and a Master's degree in education from William Paterson College.

THIS MONTH IN ...

1985

JPCL staff compiled an article, "Testing and Specifying Slag Abrasives for U.S. Navy Shipyards," which examined some of the key issues raised at SSPC's 1985 annual symposium regarding abrasives on the market and the Navy's actions using them in shipyards.

1999

Dan Adley and Ken Trimber of KTA-Tator, Inc., authored, "Evaluation of Substitute Materials for Silica Sand in Abrasive Blasting," which summarized findings from a NIOSH field and lab study evaluating alternative blasting media for surface preparation.

2002

After the first publication of SSPC-VIS I, "Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning" in 1989, SSPC issued a revised and expanded edition of VIS I, containing updated photos depicting different levels of surface cleanliness.

2014

The Applicator Training Bulletin article, "Setting Up Air Abrasive Blast Equipment," originally published in JPCL in 1989, was updated by Bill Corbett and Stanford T. Liang to reflect changes in blasting equipment and best practices.

Visit www.paintsquare.com/archive to read more.

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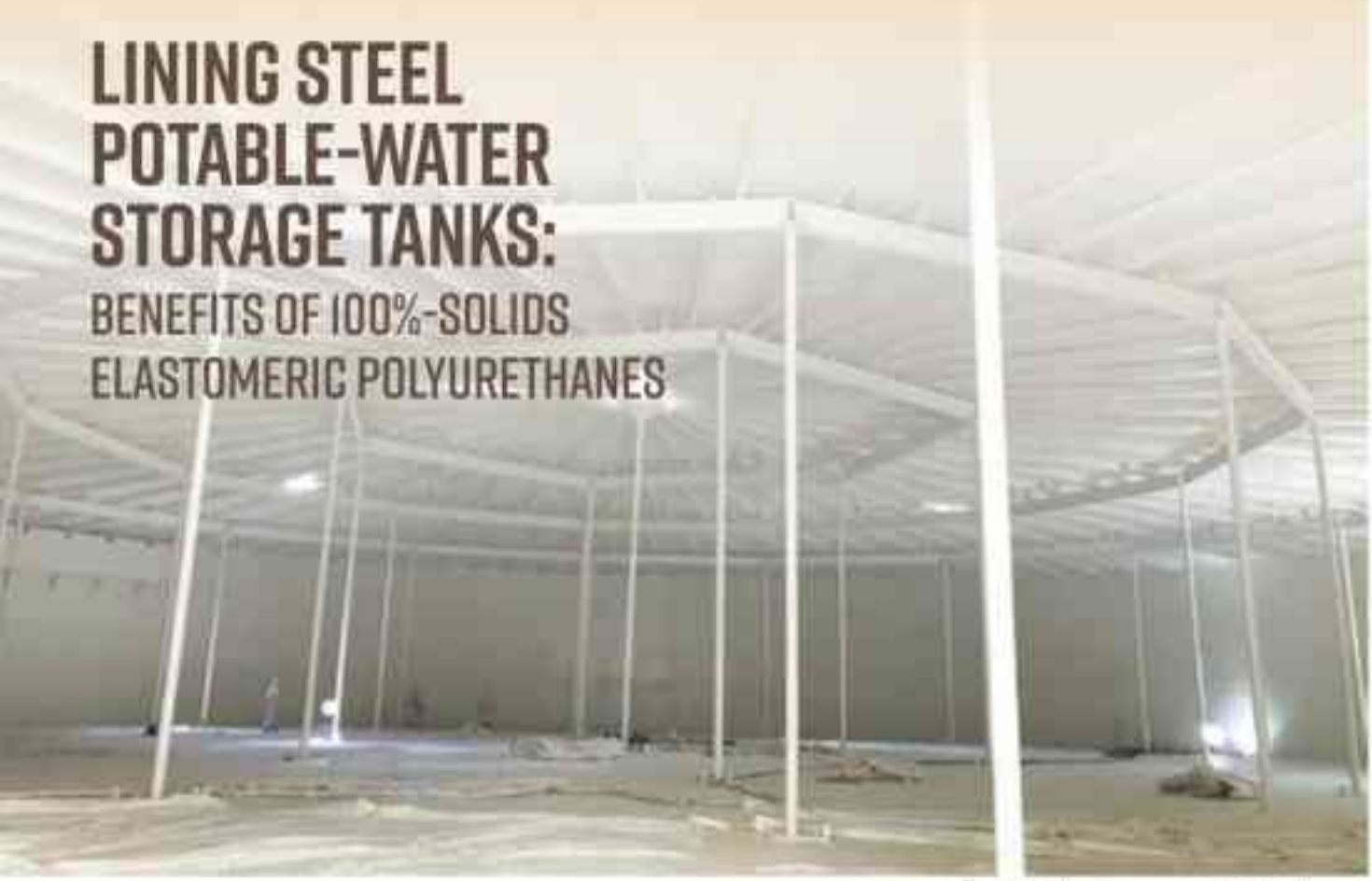
BENEFITS OF 100%-SOLIDS ELASTOMERIC POLYURETHANES



BY MURRAY HEYWOOD, SHERWIN-WILLIAMS PROTECTIVE & MARINE COATINGS

Fig. 1: With elongation properties of 35–45%, 100%-solids elastomeric polyurethanes are designed to withstand the thermal expansion and contraction of tanks and their contents. Photos courtesy of Alpine Painting & Sandblasting Contractors.

When lining new steel potable-water storage tanks or rehabilitating existing ones, asset owners, specifiers and applicators in North America most often select epoxy linings as their standard resin of choice. However, the Canadian potable-water storage market is an exception. There, many specifiers have recognized the performance benefits that 100%-solids elastomeric polyurethane linings offer and they have been specifying these systems for more than 25 years with admirable results.

Compared to elongation properties of just 3–4.9% for 100%-solids epoxies, 100%-solids elastomeric polyurethanes offer much greater elongation properties of 35–45%. This flexibility enables polyurethane linings to better withstand the thermal expansion and contraction of tanks and their contents (Fig. 1). Their excellent abrasion resistance also helps the coatings remain intact if ice that can form inside tanks rubs against the lining's surface. In addition, elastomeric polyurethanes deliver application efficiencies compared to epoxies by enabling significantly higher film builds in one coat and reducing material heating needs due to their lower viscosity. Elastomeric polyurethanes also give contractors greater application timing flexibility compared to epoxies by offering low-temperature curing down to roughly 25 F (-4 C).

The performance benefits that 100%-solids elastomeric polyurethanes offer are more pronounced in northern climates due to the extreme weather fluctuations steel water storage tanks must endure. However, these benefits offer viability in southern climates as well and have the potential to influence specification adjustments that will enable more projects to realize the benefits of polyurethane linings. This article will review several performance characteristics 100%-solids elastomeric polyurethanes offer that make them a timely technology consideration as 100%-solids coatings continue to gain widespread acceptance.

SUPERIOR ELONGATION PROPERTIES

In a water tank, two varied thermal dynamics take place. As temperatures fluctuate, the water inside the tank may freeze and thaw,

while the steel itself contracts and expands. The temperature variance can be quite drastic within a 24-hour period—from freezing to very warm—especially in northern climates.

An applied liner must withstand potentially drastic thermal cycling to remain intact for optimal performance and corrosion protection. Consider how much the structure of a water storage tank will change as it heats from 0 F to 75 F. Based on steel's expansion coefficient of 7.2 x 10^{-6} and the 75-degree temperature differential, the steel will expand by a factor of 0.00054 (0.0000072 x 75). If the tank is 360 inches tall at 0 F, the steel will be 0.194 inches taller (360 x 0.00054) when it reaches 75 F. The applied liner will need to accommodate that expansion and similar expansion in all directions.

As previously stated, typical 100%-solids-epoxy coatings used for potable-water-tank linings feature elongation properties of between 3 and 4%, while 100%-solids elastomeric polyurethanes offer elongation properties of more than 40%. Either option is better than using two- or three-coat solvent-based, low-solids epoxies, which typically have 60–80% volume solids. However, the significantly higher elongation properties of polyurethanes make them a better choice over 100%-solids epoxies for many applications. This is particularly true for tank roof structures that feature leading edges, support bracing and other nooks and crannies—all areas that tend to fail early with epoxies due to the effects of thermal cycling.

EFFECTIVE ABRASION RESISTANCE

Ice formation is closely coupled with thermal cycling. As tank temperatures drop, 2–3 feet of ice may form inside the tank. This thick, heavy mass of ice floats freely, scraping and hitting the top and walls of the tank with significant impact. The elastomeric properties inherent within polyurethanes provide enough give to allow the ice to move without damaging the coating.

LOWER-TEMPERATURE CURING

The 100%-solids epoxy products that are widely specified today cure down to temperatures in the 35 F (2 C) range and typically take approximately 48 hours to fully cure at these temperatures. This threshold accommodates many locations across North America in the early and late fall and later spring. However, many contractors and asset owners can benefit by extending their coating seasons to avoid taking tanks out of service during higher-usage times. Elastomeric polyurethanes enable that extension because they cure down to 25 F, giving applicators greater scheduling

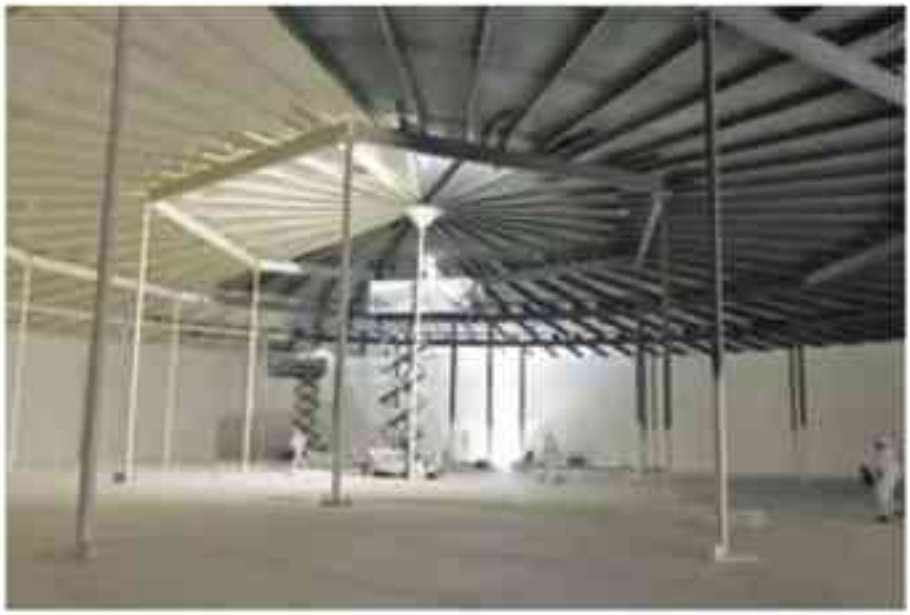


Fig. 2: Applicators can achieve film builds of up to 250 mils' (¼ inch) DFT when spraying elastomeric polyurethane linings.

THE CONTINUED SHIFT TO 100%-SOLIDS MATERIALS

The switch from traditional solvent-based epoxy linings to 100%-solids epoxy linings has become standard in many areas of North America to reduce the release of volatile organic compounds and eliminate taste and odor concerns for potable water-storage tanks. As 100%-solids materials only contain about 1.5–2% tail solvents to aid in their application, no solvents evaporate during curing and therefore do not become trapped in the film or tank. In addition, 100%-solids materials can be applied in one coat (not counting an optional holding primer) rather than two-to-three coats like standard solvent-based epoxy materials. This represents a major labor savings for tank owners.

Still, some specifiers are reluctant to make the change to 100%-solids materials based on concerns that they'll limit the number of applicators who can bid projects. Most 100%-solids epoxies and all 100%-solids elastomeric polyurethanes must be applied using plural-component equipment, and not all applicators have this specialized equipment and/or training. Such equipment draws both the resin and curing agent separately down a heated line to a mixing manifold where the materials are combined through a series of static mixers. The mixed material then flows out to the spray gun via an integrated 10–25-foot spray hose.

Among its advantages, plural-component-spray application allows for quick-setting materials to be applied. It also greatly reduces the amount of wasted material on projects, as the only mixed material is in the shorter integrated lines.

As more specifiers recognize the environmental and taste and odor benefits that 100%-solids materials offer for potable-water-storage tanks and more applicators invest in plural-component equipment and training, the continued paradigm shift to using 100%-solids materials will likely eventually span North America.

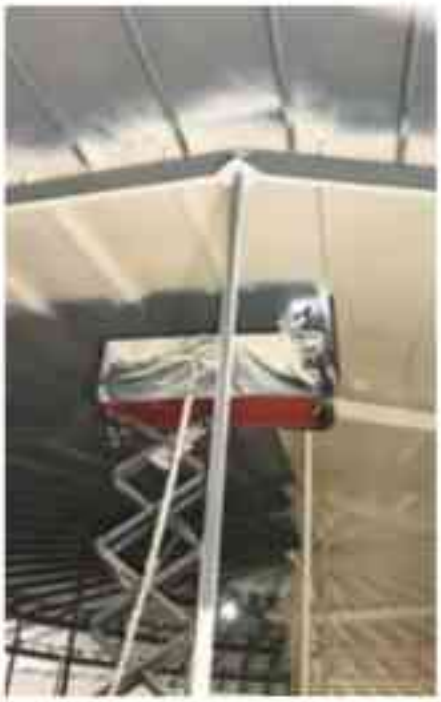


Fig. 3: Elastomeric polyurethanes serve well on lap seams on tank ceilings due to their excellent elongation properties, often allowing applicators to skip caulking seams.

flexibility. In addition, the lower-temperature cure reduces heating requirements for projects, which can reduce application costs.

HIGHER FILM BUILDS IN ONE COAT

Epoxy resins are capable of film builds of 16–50 mils' dry-film thickness in single applications, meeting AWWA D102 standards for Inside Coating System No. 3 (ICS-3). This is acceptable for most steel applications unless the steel is pitted, in which case the applicator will need to use a separate pit filler. Adding significant thickness in one pass, many elastomeric polyurethane linings can be applied up to 250 mils (¼ inch) per NSF International (Fig. 2, p. 31). Applicators can therefore prefill pits using the same resin system and then topcoat them after the initial pit application sets (usually within 15–30 minutes). In addition, when applying epoxy linings in tight areas, applicators may inadvertently exceed the 50-mil NSF International limits. When using polyurethanes, they won't be nearly as limited.

The higher film-build capabilities of elastomeric polyurethanes also offer additional benefits. The coatings serve well on lap seams on tank ceilings due to their excellent elongation properties and often displace the need for caulking seams (Fig. 3). In addition, the coatings perform extremely well on riveted and bolted tanks featuring multiple seams, bolts and other difficult-to-coat areas.

LOWER VISCOSITY

With a lower initial viscosity than some 100%-solids epoxies, 100%-solids elastomeric polyurethanes require less heat at the pump to condition the material to achieve the desired spray pattern at the gun. Typical 100%-solids epoxies require heating the material to 110–130 F (43–54 C) to gain a suitable spray pattern, while 100%-solids elastomeric polyurethanes achieve an optimal spray pattern at 80–100 F (27–37 C). The

reduced temperature requirement makes it easier to pump long distances, allowing applicators to stage spray equipment 200–300 feet away from the application site. Some 100%-solids elastomeric-polyurethane formulations also have slower initial gel times, which allows them to be used as a stripe-coat material. Stripe coating with 100%-solids epoxies is difficult, if not impossible when using plural-component spray because the set time for epoxies is simply too short; a separate stripe-coating material with a lower solids volume of approximately 75% or less is necessary so the stripe coat will remain tacky for the 100%-solids epoxy application.

EXCELLENT BOND TO BLASTED STEEL

Both elastomeric polyurethanes and epoxies can be applied to holding primers. However, they achieve maximum adhesion when they're applied directly to clean blasted steel with a suitable surface profile. Adhesion values of greater than 1,500 psi are expected for both elastomeric polyurethanes and epoxies based on the ASTM D4541 standard test for pull-off strength of coatings. As a best practice, it is recommended to use dehumidification equipment and apply elastomeric polyurethanes direct to blasted steel whenever feasible to optimize adhesion values. One exception is when lining large ground-storage tanks with greater than two-million-gallon capacities, as the necessary dehumidification equipment would be too large to be practical.

QUICK RETURN TO SERVICE

Scheduling is often a factor on projects and returning the tank to service in a timely manner is typically required or desired. Elastomeric polyurethanes offer similar return-to-service times as 100%-solids epoxies for immersion per NSF International. Return-to-service times of 24–72 hours is typical for either formulation, which is significantly better than the minimum immersion-service curing time of seven days at 75 F (24 C) for standard solvated epoxies. Such epoxies may take as long as two to three weeks to cure under adverse conditions.

COST AND LIFE-CYCLE CONSIDERATIONS

The total cost of ownership for a tank lining is based on its material cost and applied thickness coupled with its life-cycle maintenance costs. When comparing 100%-solids epoxies with 100%-solids elastomeric polyurethanes, both initial costs and life-cycle costs are comparable.

The AWWA D102 Inside Coating System No. 3 (ICS-3) standard covers high-solids epoxy linings with the option of using a zinc or epoxy holding primer as part of the system. AWWA D102 ICS-4 covers the use of elastomeric polyurethane and polyurea linings and also allows for the use of a holding primer. AWWA D102 requires a minimum DFT of 20 mils for high-solids epoxies (ICS-3) and a minimum of 25 mils' DFT

BENEFITS OF 100%-SOLIDS ELASTOMERIC POLYURETHANES

for thermosetting polyurethanes (ICS-4). The additional 5-mil requirement for polyurethanes is likely based on older polyurethane technologies that required this additional thickness to obtain a solid film. That is no longer true, but AWWA's published ICS-4 minimum currently remains at 25 mils. Because polyurethane materials are typically slightly less expensive than epoxies, the cost of materials is essentially equal on most projects despite the additional required 5 mils of polyurethane material.

When comparing life-cycle costs, both epoxy and polyurethane linings offer minimum 20–30-year life spans. Coating inspectors and owners must make the final decision on when to reline a tank, but it is recommended that the assessment be based on the inspection and not on an arbitrary schedule. For example, if a tank that is scheduled to be relined only shows minor corrosion on 5–10% of its surfaces, those areas should be repaired, and the parties involved should settle on the next suitable inspection interval—which could be in more than 10 years. This approach would be much more cost-effective than removing the relatively intact liner and relining the tank simply because the maintenance calendar said it was time.

SUMMARY

As an alternative to 100%-solids epoxies, 100%-solids elastomeric polyurethane linings offer a host of benefits for tank owners and applicators. Their enhanced elongation properties help coatings better withstand the effects of thermal cycling. Their application characteristics enable higher film builds and more efficient and lower-temperature applications. In addition, they offer excellent adhesion and abrasion resistance, as well as fast returns-to-service. These benefits are especially true in northern climates but are also valid further south. Based on these advantages, it would behoove owners, specifiers and engineers in all geographic areas to take a closer look at elastomeric polyurethanes when planning their potable-water storage-tank rehabilitations or new installations.

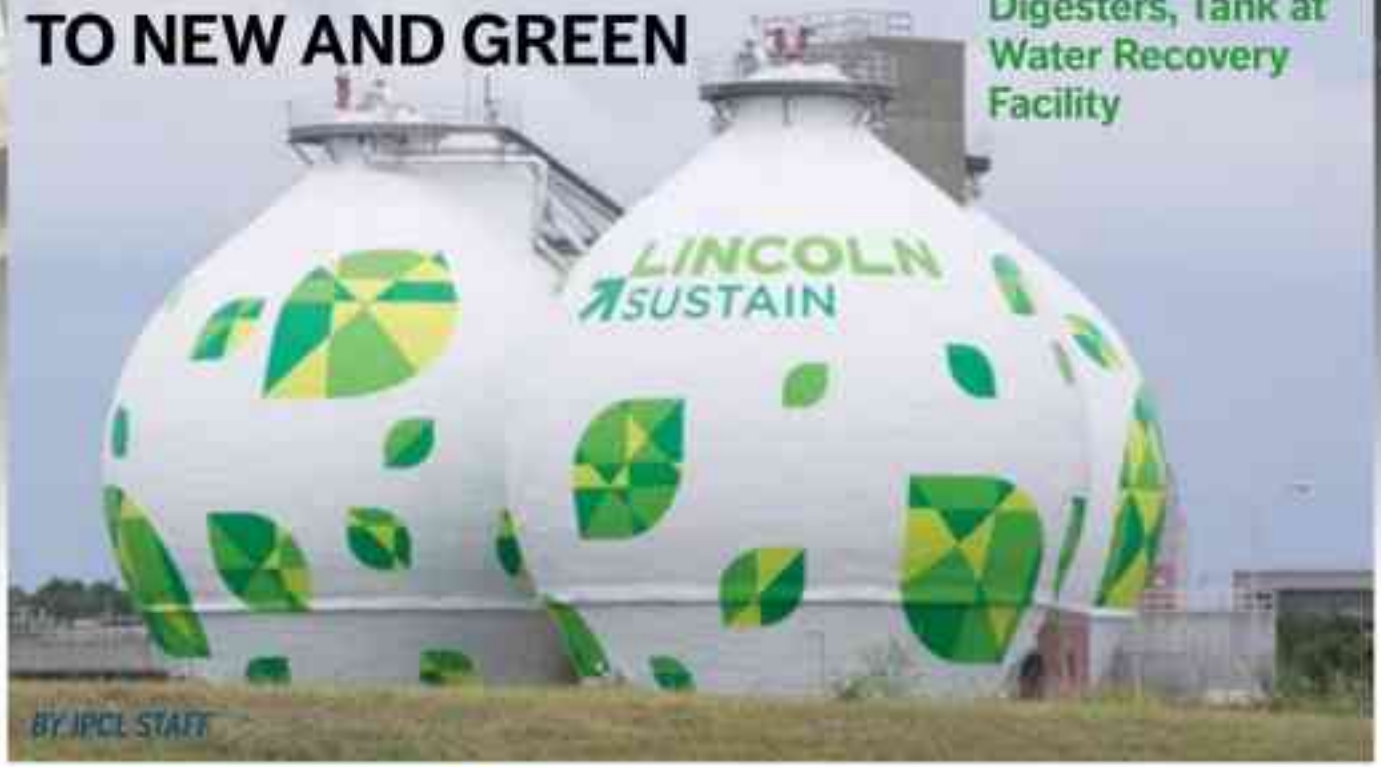
ABOUT THE AUTHOR

Murray Heywood is the North America Market Manager, Water & Wastewater for Sherwin-Williams Protective & Marine Coatings.

He has served the coatings industry for more than 36 years, beginning as an applicator for his father's coating business. Heywood is an SSPC-certified Master Coatings Inspector (MCI) and Protective Coatings Inspector (PCI), as well as a NACE International Level III-certified Coating Inspector. He teaches coating-inspection courses for both organizations. Heywood also holds certifications as an SSPC Protective Coating Specialist (PCS), an SSPC Concrete Coating Inspector (CCI) and a Master Painters Institute (MPI) Architectural Coating Specialist (ACS). He currently sits on several SSPC and American Water Works Association (AWWA) technical committees and is the current chair of SSPC's Ontario, Canada chapter. ***JPCL***

OLD AND GRAY TO NEW AND GREEN

Coatings Transform Digesters, Tank at Water Recovery Facility



BY JPCL STAFF

Editor's Note
SSPC's annual Structure Awards recognize the work of teams of contractors, designers, end users and coating manufacturers for excellence on protective coatings projects. The 2019 Structure Awards were presented at SSPC Coatings+ 2019 in Orlando, Feb. 11.

The City of Lincoln, Nebraska recently required painting services at its Theresa Street Water Resource Recovery Facility, which recovers about 20 million gallons of water on an average day and has a maximum capacity of 38 million gallons per day. The project scope included recoating the exteriors of three 65-foot-diameter anaerobic digesters and one 52-foot-diameter sludge storage tank.

At the time, the digesters and tank resembled many typical industrial structures that one might pass by any day: aging, faded and dull. The City was looking not only to preserve these important wastewater treatment components so that they could continue to function properly for the community, but also upgrade the way they looked to passers-by.

Three anaerobic digesters and one sludge storage tank at the City of Lincoln's Water Resource Recovery Facility were transformed from nondescript industrial structures to attractive local landmarks. Photos courtesy of TMI Coatings unless otherwise specified.

PROJECT AT A GLANCE
Start Date: October 2017
Completion Date: November 2017
Facility Owner: City of Lincoln (NE), Lincoln Wastewater System
Contractor: TMI Coatings (Eagan, MN)
Coating Manufacturer: Tnemec Company, Inc.
Engineer: Olsson Associates (Lincoln, NE)

(Clockwise from top left): Before the project, the digesters and tanks were painted a gray color that did not stand out from the surrounding environment. After pressure-washing the exteriors and making insulation repairs, contractors applied a new white topcoat.
The newly painted digesters and tank display a sustainability-themed design scheme that is not only an aesthetic improvement, but represents the city's commitment to sustainability.

The finished product earned SSPC's William Johnson Award for aesthetic merit in industrial or commercial coatings work, with qualities including color, gloss or texture, or the coating complimenting the environment while enhancing the structure itself.

A few factors complicated the project planning and staging from the get-go. To start, the project was bid in the fall and needed to be complete before the Midwestern winter shut down operations, leaving a tight window for completion.

In addition, the digesters and tank were insulated with a spray-foam material, which made abrasive blast-cleaning a less-than-ideal option, as it would not only necessitate full coating removal and replacement, but complete insulation replacement as well.

The City was also uncertain about the initial substrate condition, and if anything less than abrasive blasting and removal of the existing topcoat would provide an adequately prepared surface for further coatings application.

At the pre-bid meeting, it was decided that the contractor would pressure wash the digester and tank exteriors at 5,000 psi to remove any dirt and debris, cut out any failing insulation areas and apply new spray-foam insulation to the surrounding plane, and overcoat the entirety of the exteriors with a waterborne acrylic system designed to "bite" into the remaining topcoat. Because conventional solvent-based coatings are not compatible with spray-foam insulation, this coating was selected to form an impact-resistant elastomeric film that would tightly adhere to the previous coatings and foam-insulation system.

This overcoating provided a fresh, clean white finish to the tank—but work wasn't yet complete. The contractors finished the exteriors with a 360-degree graphic layout, including city logos and green and yellow leaf designs. The graphics, including the LINCOLN SUSTAIN logo, represent an overall theme of sustainability, which the WRRF plays an important part in achieving. The new coatings also exhibit improved weathering characteristics, and gloss and color retention.

The final result is not only an enhanced facility, but an added central feature to the community. City of Lincoln WRRF Superintendent Steve Crisler commented, "We have received numerous compliments from visitors and the general public as they pass by our facilities."

Pictured, from left: Garry Mancus, President, SSPC; Vaughn O'Dea, Tnemec Company, Inc.; and Scott Salmon, TMI Coatings. Photo courtesy of SSPC.

remelo / Getty Images

LARGE-DIAMETER COOLING WATER PIPE AND PENSTOCKS:

Selecting and Applying Linings

BY RAYMOND S. TOMBAUGH, KTA-TATOR, INC.

The installation of linings in large-diameter cooling pipes and penstocks is a major investment for hydroelectric and other power plants. The application should be performed in an expedient manner to minimize outage time and should last for many years—20 or more—without the need for maintenance painting. The latter is significantly important because many hydroelectric plants are located in remote areas. To achieve these goals, planning must be done long before the start of the lining process.

This article provides a compilation of the necessary tasks to plan for in order to implement a successful application. Factors that must be considered when selecting a lining, the types of linings that are available and are typically used, important requirements that must be included in a specification and safety considerations are all discussed.

PLANNING

Planning for penstock relining work must begin months or years before the actual project start date. Major items to consider at the beginning of the project include gaining an understanding of the condition of the existing lining system, if present, and the condition of the piping itself. This is determined by performing inspections of the penstock interior. The outcome of these assessments will then be used to prepare a concise, detailed project specification. When informative specifications are developed for a relining project, overall costs are reduced, proposed schedules are more likely to be followed and change orders are minimized, or in many cases eliminated. This is because the contractors have the information necessary to prepare responsive, accurate bids, and costs are not factored into the proposals because of unknown conditions.

INSPECTING THE EXISTING LINING AND GATHERING INFORMATION FOR THE SPECIFICATION

The scope of the inspections should include a determination of what type of lining system is present as well as its condition. The condition assessment should include lining

remelo / Getty Images

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The scope of the inspections should include a determination of what type of lining system is present as well as its condition. The condition assessment should include lining

thickness measurements, degree of rusting, adhesion and the identification of other types of lining defects.

The existing lining should also be inspected to determine whether there is any erosion or abrasion occurring. Silt, sand and gravel can be carried through the pipe via the flow of water and abrade the surface of the pipe lining. This is usually observed on the invert of the pipe between the 4:00 and 8:00 positions. The coating can appear to be scoured or may be worn away in more severe cases. In some instances, the steel itself can be eroded. The knowledge of whether this is occurring is useful in determining what type of replacement lining to use, as some are formulated to have a greater resistance to abrasion.

If repair of the existing lining system is being considered (or even when total removal of the existing lining is necessary), samples of the lining should be removed for laboratory analysis to determine its generic type—such as epoxy, coal-tar enamel or coal-tar epoxy—to help ensure compatibility (if repair is possible) or to provide bidders with an indication of the level of difficulty they may anticipate during removal due to thickness and elasticity. Analyzing toxic metal content such as lead, cadmium and chromium is also important in determining worker- and environmental-protection requirements, as well as waste-management processes. This information is particularly important for potential bidders in preparing responsive bids that include the costs associated with controlling these hazards. That is, the contractor will be able to better estimate the means and methods necessary to safely and effectively remove an existing lining, prepare the surface of the pipe and install the new lining system. The more pertinent information that is provided to the contractor, the more accurate and complete the bids will be.

For example, if a coal-tar enamel is present in the pipe, special requirements for removal are often required. Coal-tar-enamel removal requires additional steps beyond typical pressure-washing and abrasive blast-cleaning. Ultra-high-pressure waterjetting or hand/power tool chipping is often necessary to remove the bulk of the enamel prior to the final step of abrasive blast-cleaning. Contractors will almost certainly submit a change order for performing the additional coating removal work if they are not informed up-front that a coal-tar enamel is present. Experience has shown that costs associated with the tasks included in a change order are always greater than if those costs had been included in the original bid.

Further, knowledge of toxic-metal concentrations is essential for developing a responsive bid. When lead and/or other toxic metals are present in an existing coating, special precautions must be taken to safely remove the coating without overexposing workers and/or contaminating the surrounding environment. The costs associated with managing these hazards are not incidental.

Toxic-metal concentrations should be included in the specification to inform the contractor that the metals are present in order to select appropriate controls. Requirements should direct the contractor to perform his or her own testing and base the toxic-metals-compliance plan on those results. Without this wording, change orders can be anticipated if the contractor's test results reveal higher concentrations than those referenced in the specification. Nevertheless, it is important that the contractor be informed that toxic metals are present prior to the start of the project.

In addition to information about the existing lining system, the condition of the substrate is also essential. The presence and characterization of pitting, more severe corrosion and erosion should be included in the specification. This information is important because some pits and rough surfaces caused by corrosion and erosion should be repaired prior to abrasive blast-cleaning and filling. Pits and corroded or eroded areas that have sharp edges should be smoothed to facilitate acceptable coverage of the lining. Many liquid coatings do not have edge-retentive properties. Similarly, pits that have wider bases than mouths will have to be widened to permit lining material to fully cover the surface. Deep pits and degraded areas are likely to require the application of a paste-grade surfacer (pit filler) to smooth out the surface prior to lining installation. If the

Table 1: Recommended Testing and Acceptance Criteria for Epoxies.

Property	Minimum Requirement	Test Method
Tensile Strength	>2,400 psi	ASTM D2370
Abrasion Resistance	≤70-mg loss per 1,000 revolutions, 1,000 grams CS-17	ASTM D4060
Impact Resistance	>100 inch lbs.	ASTM D2794
Dielectric Strength	≥300 V/mil	ASTM D149
Cathodic Disbondment	Upon completion of a 90-day test, the area of the resulting flaw shall not exceed 150% of the intentional flaw.	ASTM G8
Atlas Cell	No blistering or other degradation. The average of the Barcol hardness tests (ASTM D2538) performed on the specimens following completion of the Atlas cell test shall not be less than 80% of the average measured across the control specimen.	NACE TM0174, Procedure A using demineralized water for 180 days. Three test specimens shall be tested and one specimen shall be used as a control.
Water-Vapor Permeability	Less than 0.15 perms average of three specimens. No single specimen shall exceed 0.20 perms.	ASTM E96
Water Absorption	<2%	ASTM D570-Long Term
Adhesion to Steel	≥1,800 psi	ASTM D4541

**Acceptance criteria for elongation was not included as epoxies are not known for that characteristic.*

Table 2: Recommended Testing and Acceptance Criteria for Urethanes.

Property	Minimum Requirement	Test Method
Tensile Strength	≥2,800 psi	ASTM D412
Elongation	≥40%	ASTM D412 or D638
Abrasion Resistance	≤80-mg loss per 1,000 revolutions, 1,000g CS-17	ASTM D4060
Impact Resistance	≥120 inch lbs	ASTM D2794
Dielectric Strength	≥250 V/mil	ASTM D149
Cathodic Disbondment	≤0.38-inch average	ASTM G8 or G95
Atlas Cell	No blistering or other degradation. The average of the Barcol hardness tests (ASTM D2538) performed on the specimens following completion of the Atlas cell test shall not be less than 80% of the average measured across the control specimen.	NACE TM0174, Procedure A using demineralized water for 180 days. Three test specimens shall be tested and one specimen shall be used as a control.
Water-Vapor Permeability	≤0.088 perms	ASTM E96
Water Absorption	≤0.5%	ASTM D570-Long Term
Adhesion to Steel	≥1,500 psi	ASTM D4541

pits are deeper, it may be necessary to fill them with weld material.

Details regarding the design of the penstock should also be included in the specification, including the dimensions (length and diameter) of the portions of the penstock to be lined, the slopes that are encountered and available access points. Penstock dimensions are used by the contractor to calculate the area to be lined and the volume of material required. Some penstocks are located on the side of a mountain with steep slopes, so special access will be required to prepare and line the surfaces. On steep slopes, movable platforms on pulleys are frequently used to access all pipe elevations. When slopes vary, platforms are often movable to create a level surface on which to place equipment and personnel as it moves from one slope to the other.

Information on the location and size of the current access points is essential to the contractor to plan his or her work. High-solids (100%) materials, the common type of lining used in penstocks today, can only be pumped about 1,000 feet. The specification should require the contractor to identify whether additional access points are necessary and where they should to be located. The responsibility of establishing additional access-point locations (and sizes) is placed on the contractor so that the owner is not responsible if difficulties are encountered during the surface-preparation and lining processes.

Also, the method by which the individual pipe spools are joined—welded, bolted, riveted or by Dresser couplings—must be identified so that appropriate measures can be taken to coat these areas properly. Welds may need to be ground smooth and coated with paste-grade material, while bolted connections and Dresser couplings may need to be caulked or sealed in some other way. Because these are time-consuming operations and require special materials, full knowledge of the scope is essential to assuring that the project proceeds on time and on budget.

Other information that is useful to include in a specification are details about the penstock isolation. Isolation valves are usually located at the top of the penstock so that it can be isolated from the water source. These valves

inherently leak. Dams usually constructed using plastic sheeting and sand bags are used to collect the water and isolate the leakage from the rest of the pipe. Submersible pumps are placed in the collected water and pumped out of the penstock so that it doesn't flow down prepared surfaces, requiring the contractor to perform rework. The specification should include language that places the responsibility of rework resulting from water intrusion on the contractor unless there is a major failure of the valve. The author has seen more than one project where the contractor inadvertently shut off the submersible pump, causing the dam to overflow and ruin entire sections of pipe that had just been abrasive blast-cleaned or coated.

Finally, a specification should address logistics including available utilities such as power, water and area access; areas for equipment and material storage; and in some cases, even locations for personnel housing. Many penstocks are remotely located and a clear indication of what roadways, utilities and housing are available is important information. Schedules can be drastically impacted if the necessary utilities and work areas are not available.

PREPARING THE SPECIFICATION

Once this information is gathered, the preparation of a technical specification can be initiated. In addition to the general information described earlier, the items that should be included in the specification encompass contractor qualifications, safety requirements, surface-preparation requirements, lining materials and installation requirements and quality control/assurance-inspection requirements.

On major projects such as penstock relining, it is essential to hire a qualified contractor. A convenient way to achieve this is to require bidders to be certified to the applicable quality procedure (QP) of the SSPC Painting Contractor Certification Program (PCCP). For penstock relining work, contractors should hold SSPC-QP 1 certification and if toxic metals are present in the existing coatings, then QP 2 certification should be required in addition to QP 1. These certifications provide reasonable assurance that the contractor has established the necessary work practices and quality-control procedures to perform field painting and to safely remove coatings containing toxic metals. If modifications are included in the project that require the installation of new shop-coated piping or components, then the shop should hold SSPC-QP 3 certification as well. While these certifications do not guarantee project success, they provide the owner with peace of mind that the contractor has the appropriate procedures in place to safely perform quality work.

The selected contractor should not only be qualified but should also have experience in penstock lining. These requirements typically include having experience on at least three similar projects in the past five years. This provides reasonable assurance that the contractor is able to deal with the challenges of preparing and lining several thousand feet of steel in a confined space.

Safety requirements are equally important. Because many penstocks are located on the sides of mountains and are steeply sloped, care must be taken to assure that workers do not cascade down the pipe. Fall protection should be mandatory when working in these configurations. Also, penstocks are considered to be confined spaces and pose a unique set of safety concerns. Perhaps one of the worst coating-industry-related accidents was the Cabin Creek tragedy that occurred in a penstock in Colorado in 2007. Five workers were killed, and three others injured as a result of a fire that started when flammable solvent was introduced to a plural-component spray rig fitted with an electric heater. The fire was fed by numerous open five-gallon drums of solvent. It occurred between the workers and the egress point of the penstock and consumed the oxygen in the pipe, causing suffocation.

Once the general and safety information is assembled, the technical requirements associated with surface preparation and lining installation can be established. As with many surface-preparation activities, one of the

first operations is to pressure-wash the pipe. Pressure-washing at 5,000–10,000 psi is typically done to remove the silt and sediment that may have accumulated in the pipe, as well as loose lining materials. The specification may also include the option to perform high-pressure waterjetting at pressures between 10,000 psi and 30,000 psi. In addition to the silt, sediment and loose paint, high-pressure waterjetting (at the 30,000-psi level) will typically remove all existing lining and corrosion products.

Waterjetting and pressure-washing operations must be followed by abrasive blast-cleaning. Most lining manufacturers will require a minimum of SSPC-SP 10/NACE No. 2, "Near White Blast Cleaning," yielding a nominal surface profile of 3.0–5.0 mils (75–125 µm). Also, testing for non-visible surface contaminants such as chlorides, sulfates and nitrates should be performed on the blast-cleaned steel. If permitted to remain on the surface, these ions can shorten the service life of the lining by drawing water through the coating via osmosis, resulting in blistering and/or premature rusting.

Some specifications have included more restrictive surface-preparation requirements to extend the service life of the lining by increasing the cleanliness requirement to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning." In addition, a final blast may be performed with #20 aluminum oxide to create a very dense, sharp anchor pattern in the steel. The aluminum oxide is only used in the final blast since it is typically more expensive than the other abrasives. However, the contractor may elect to perform all abrasive blast-cleaning with the aluminum-oxide abrasive.

It is important to note that if new pipe spools are installed, the joints will need to be prepared and coated after the spools are joined. While it is easiest to power-tool clean the joints prior to coating, experience has shown that when power-tool cleaning is performed, these areas are frequently the first to fail. Therefore, it is highly recommended that the joints be abrasive blast-cleaned.

The most commonly specified lining materials for penstocks include 100%-solids epoxies and elastomeric urethanes or urethane hybrids. The epoxy linings have over 40 years of history of successful use and some of the first applications in the United States in the early 1980s are still in service today with little need for maintenance. These early epoxy lining installations consisted of two to three coats to achieve a total dry-film thickness of 25–30 mils (625–750 µm). In more recent times, high-build coatings have been developed where 50 mils (1,250 µm), and in some cases more, can be applied in a single coat. The epoxy linings have low permeability, enabling them to perform longer; however, the standard 100%-solids epoxy linings are not known for their abrasion resistance. There are special epoxy coatings that can be used that will resist the abrasion caused by sand and sediment, or in high-flow areas. Pitted areas and other rough surfaces and sharp edges will require the use of a paste-grade material to prevent pinholes or thin spots, and the epoxy linings often take several days to cure prior to putting them back into immersion service, so cure time must be factored into the schedule.

Urethane lining materials have a slightly shorter historical track record than the epoxy linings. Urethane linings were first used in the late 1980s and like the epoxy materials, some of the original applications are still in service. These linings have the advantage of a relatively quick cure; generally, polyurethanes can be put back into service 24 hours after installation. The urethanes are usually applied in one coat with multiple passes. The typical specified dry-film thickness is 60–80 mils (1,500–2,000 µm). The thickness of the elastomeric urethanes is higher because in many cases, they have higher permeance than the epoxy linings. The increase in thickness makes them very useful over pitted and rough surfaces, in some cases eliminating the need for additional surfacers.

One elastomeric urethane manufacturer has developed a process where carbon dioxide is injected into the liquid coating, causing it to expand. This enables very pitted and rough surfaces to be coated uniformly. The system is finished with the application of a layer of unexpanded material.

No matter which lining system is used, it should have a proven track record. It is the author's opinion that no lining should be used that does not have a proven service life of at least 15 years. A record of successful use in a similar environment is one of the most important pieces of information an owner can use to select a lining. If the owner has established a qualified products list (QPL), the contractor should be required to provide references for at least three applications where the lining they plan to use (from the QPL) has been in service for at least 15 years.

Candidate lining materials should also be subjected to a number of tests in order to provide reasonable evidence of successful performance. Recommended tests and acceptance criteria are shown in Table 1 (p. 39) for epoxy linings and Table 2 (p. 40) for urethane linings.

While the tests in these tables are important, the performance of the lining in the Atlas cell test and the cathodic-disbondment test are the most critical. For the Atlas cell test, coated test panels are exposed to warm, demineralized water in the presence of a temperature gradient across the test panel. The Atlas cell test is intended to simulate the conditions in an uninsulated steel tank or vessel that has an internal lining and handles hot process fluids. The temperature gradient that occurs across the coating produces a cold-wall effect that tends to draw water into the coating, thereby promoting blistering and disbonding. While the temperature gradient is relatively small between the penstock contents and the wall of the pipe, the test is still very useful for assessing how well the coating will perform in service.

Even though cathodic protection is not usually installed on the interior of a penstock, the cathodic-disbondment test is useful for evaluating a coating's inherent ability to resist undercutting. This test is conducted by creating a defect in the coating applied to a test panel. The coated panel is immersed and subjected to electrical current. The coating's resistance to undercutting is evaluated based on the increase in the size of the affected area surrounding the defect after exposure.

THE BIDDING PROCESS

Once the specification is prepared and the project is advertised, the bidding process can begin. The request for proposals should include owner-specific requirements for preparing the cost proposals. Lump-sum costs are acceptable for performing the routine work associated with the project, such as initial pressure-washing, abrasive blast-cleaning, worker and environmental protection, and the lining installation. However, the unique nonquantifiable operations should be bid on a unit basis. For example, additional pressure-washing to reduce nonvisible surface contamination should be bid on a square-foot basis. Similarly, operations such as pit filling and caulking should also be bid on a unit basis (cost per square foot or cost per linear foot).

It is highly recommended that a pre-bid meeting be held, which may or may not be

mandatory depending on owner preference, and that bidders be given the opportunity to visit the site and walk down the penstock and power plant prior to preparing their bid. In addition, the bidders can consider material- and equipment-storage areas. Responses to questions that arise during the pre-bid meeting should be distributed to all plan holders. The questions are usually very useful as they often originate from a contractor perspective, specifically focusing on the means and methods of performing the work. Conducting a pre-bid meeting is another step that will assist in minimizing change orders.

IN-PROCESS TECHNICAL SUPPORT AND QA INSPECTION

Finally, in-process quality assurance (QA) and technical support is essential for achieving project success. If third-party QA inspection is desired (versus using owner staff), the QA personnel should be hired under a separate contract from the coating work; however, it is important that the QA inspectors work in cooperation with the contractor's QC inspector. Technical support should come from the coating manufacturer and in some cases a coatings engineering firm. No matter what the source, technical support should have broad-base knowledge of the application of linings to large-diameter pipes.

SUMMARY

When the installation of linings to large-diameter cooling pipes and penstocks is performed in an expedient manner, outage time is minimized. When the application is performed correctly it should last at least 20 years without the need for significant maintenance. Several key elements must be considered in achieving a successful lining installation such as proper planning, inspection of the existing lining condition, gathering detailed information about the structure, preparing a project specification, selecting an appropriate lining material, and verifying that surfaces are prepared properly and that the lining system is properly installed.

ABOUT THE AUTHOR

Ray Tombaugh is a Senior Consultant for KTA-Tator, Inc. He is an SSPC-certified Protective Coatings Specialist, a NACE-certified Coating Inspector (Level III) and an ASTM D4537 Level III Inspector with almost 30 years of experience in the protective coatings industry. He holds a B.S. degree in chemical engineering from Lehigh University. ***JPCL***

Photos courtesy of SSPC.

COURSE SPOTLIGHT:
Concrete Coating Inspector

Concrete is one of the most widely used materials in the world, forming the foundation for much of the industrial realm, and the need to protect it from deterioration is critical. Moisture and moisture-vapor transmission are huge concerns in the industry. The use of coatings to protect structural concrete, water and wastewater facilities and other assets has been increasing every year.

Inspection standards, practices and instrument use for coatings applied to concrete surfaces differ in many ways from inspecting coatings on steel surfaces. While the surface of concrete may appear dry, below the surface, hidden moisture could ruin a coating application.

SSPC offers courses specific to the concrete industry, developed with a focus on protecting these surfaces. One of these offerings is the Concrete Coating Inspector course, which SSPC will bring to Elcometer's headquarters in Manchester, England from September 9–13.

The CCI program sets out to certify individuals who possess in-depth knowledge of the protective coatings industry in relation to concrete. Inspectors have a crucial job on any site and a thoroughly trained individual is an asset to any project. Being certified in concrete in addition to steel, inspectors can contribute to a large range of jobs. Industrial sites are looking for a certification to match the task at hand and this growing demand in the industry. Earning and maintaining a CCI certification means that an inspector will have the qualifications that are vital to the concrete industry.

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For more information about the SSPC's Concrete Coating Inspector program or to find a location hosting training near you, please visit sspc.org/concrete-coating-inspector-program-cci or call 412-281-2331.

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Kern Steel Fabrication, Inc.
Kimery Painting, Inc.
Kiska Construction, Inc. (KCI)
Kiscos Painting Company, Inc.
KMK Painting, Inc.
Knowles Industrial Service Corporation
Kodin Testing Instrument Co. Ltd.
Kolonia Painting & General Construction, Inc.
Kordata
KS Fabrication & Machine
KVK Contracting Inc.
L & L Painting Company Inc.
L Z Painting Co.
LaM Fabrication & Machine, Inc.
L. Calvin Jones
L. F. Clavin & Company, Inc.
Lambton Metal Service
Langley Blast Technologies Inc.
Ledwood Protective Coatings Ltd
Legend Painting, Inc.
Lesson Equipment Pte Ltd
Level 3 Coating Inspection, LLC
Liberty Maintenance, Inc.
LifeLast
Limmex Corp.
Lindner Painting, Inc.
Luna Canadian Tri-Fund
Llamas Coatings
Lopes Ltd.
Luoyang Hongfeng Abrasives Co., Ltd
M & O Coatings Inc.
M & J Construction Company of Pinellas County
M. Pallonji & Company Pvt. Ltd.
MacDonald Applicators Ltd.
Magnum Drywall Inc.
Manda Corporation
Manolis Painting Company, Inc.
Mansfield Industrial
Manus Abrasive Systems, Inc.
Marathon Industrial Finishing LLC
Marcom Services, LLC
Marine Equipment Supply (MES), LLC
Marine Metal Coatings, Inc.
Marine Publications International (MPI Group)
Marine Specialty Painting
Marinette Marine Corporation
Marins Bros., Inc.
Marlso Corporation
Marlin Specialty Coatings, Inc.
Marunda Utama Engineering Pte Ltd
Mass Coating Corp
Master Powder Coating, Inc.
Matheson Painting
Maxworth Minerals India Pvt Ltd
MB Safety Consulting
McCormick Industrial Abatement Services, Inc.
McCormick Painting Company
McKay Lodge Conservation Laboratory
McLoughlin Industrial Flooring Limited
Mericka Group LLC
Merrill Steel, Inc.
Metallizing Technical Services
Metspray
Michigan Specialty Coatings, Inc.
MK Industrial LLC
Miller Fabrications Ltd.
Mineral Tech, LLC
Minerals Research, Inc.
Minnesota Limited
MMLJ, Inc.
Mobile Pipe Lining and Coating Inc.
Modern Protective Coatings, Inc.
Monarflex by Soplast
Monoko, LLC
Monti Tools Inc.
Monmatsu (Jiangsu) Heavy Industry Co., Ltd. (JMH)
Monn Industrial Coatings Ltd.
Muerthan Cyprus Ltd
Murphy Industrial Coatings
N A Logan, Inc.
N. I. Spanos Painting, Inc.
Napier Sandblasting (NSB Insfrastructure)
National Coating and Linings Co.
National Coatings, Inc.
Natrium Products, Inc.
Naval and Industrial Solutions S.A.S.
NCP Coatings Inc.
Negocios Metalurgicos SAC
Nelson Industrial Services, Inc.
New England Sandblasting and Painting
New Kent Coatings Inc.
NexTec Inc./ProTox
Niagara Coatings Services, Inc.
Nelson, Woltowicz, Neu & Associates
Nisku Industrial Coatings Ltd.
NMI Industrial Holdings
Norfolk Coating Services, LLC
NOR-LAG Coatings Ltd.
Northwest Sandblast & Paint LLC
Norton Sandblasting Equipment
Novatek Corporation
Nu Way Industrial Waste Management LLC
NUCO Painting Corporation
NuSteel Fabricators, Inc.
Nut Communication & Marketing Strategies
Nyhus Enterprises, LLC
O.T. Negholt & Sons, Inc.
Odle, Inc.
Olimag Sand, Inc.
Olympus And Associates, Inc.
Olympus Painting Contractors, Inc.
Olympus Painting, LLC
Omega Coatings & Construction, LLC
Ontario Painting Contractors Association
Opti-Blast Inc.
Optimiza Protective & Consulting, Sl
P & L Metalcrafts LLC
P & W Painting Contractors Inc.
P S Bruckel Inc.
P&P Contracting, Inc.
Pacific Dust Collectors and Equipment
Pacific High Technology Engineering Services
Pacific Painting Co. Inc.

SSPC ORGANIZATIONAL MEMBERS

PAE
Paige Decking
Paige Floor Covering Specialists
Paint and Coatings Manufacturers
Nigeria PLC
Paint Platoon USA & Coatings Inspectors
Paint Supply Company
Painters & Allied Trades - LMCI
Painters USA, Inc.
Panther Industrial Painting, LLC
Park Derochie Coatings (Saskatchewan) Inc.
Park Derochie, Inc.
Partner Industrial LLP
Paul N. Gardner Company, Inc.
Peabody & Associates, Inc.
Pelco Structural, LLC
Pennington Painting Company
Performance Blasting & Coating
Performance Industrial
Phoenix Fabricators & Erectors LLC
Piasecki Steel Construction Corp
Pinnacle Central Company
Planet Inc.
Polyset
Pop's Painting, Inc.
Poseidon Construction
Preferred, Inc.-Fort Wayne
Prezioso Nigeria (Insulation Painting & Engineering Services Ltd)
Prime Coatings, Inc.
Prime Time Coatings, Inc.
Principle Industrial Services, LLC
Pro Tank - Professional Tank Cleaning & Sandblasting
Prospectrum Coatings Bvba
Public Utilities Maintenance, Inc.
Purcell P & C, LLC
Pyeny
Q.E.D. Systems, Inc.
Qualicoat Inc.
Quality Coatings of Virginia, Inc.
Quality Linings & Painting, Inc.
Quanhum Chemical
Quincy Industrial Painting Co
Quinn Consulting Services, Inc.
R & B Protective Coatings, Inc.
R & S Steel, LLC
R. J. Forbes Painting Contractor Inc.
Rader Coating Technology (Shanghai) Co., Ltd.
Rainbow, Inc.
Randell Industrial Services Ltd
Rapid-Prep, LLC
Ravi Engineering & Land Surveying, PC
RBG Trinidad and Tobago Limited
RBW Enterprises
RD Coatings - Dothée S.A.
Recal Recubrimientos, SA De CV
Redi-Strip Metal Cleaning Canada Ltd
Regal Industrial Corporation
Reglas Painting Company, Inc.
Reichle Incorporated
Reliable Coatings LLC
Remington & Vernick Engineers
Revolution Industrial Coatings
Rhino Linings Corporation
Rhinoceros Ltd
Riley Industrial Services, Inc.
Ring Power Corporation
Rizzo Brothers Painting Contractors Inc.
Robroy Industries
Rogers Industries, LLC
Ross Rex Industrial Painters Ltd
Rotha Contracting Company, Inc.
Rover Contracting Inc.
Royal Bridge Inc.
S & D Industrial Painting Inc.
S & S Bridge Painting, Inc.
S & S Coatings, Inc.
S. David & Company, LLC
Sabelhaus West, Inc.
SAFE Systems, Inc.
Safespan Platform Systems, Inc.
Saffo Contractors, Inc.
Sahara Sandblasting and Painting Ltd
Saint-Gobain Specialty Grains & Powders
Samac Painting
Sand Express
SARL ESR-CA
Sasyma Coatings SL
Saxon Enterprises
SBAS Training Services
Scicon Worldwide BVBA
Seaway Painting LLC
Secondary Services, Inc.
See Hup Seng Cp Pte. Ltd
Seminole Equipment, Inc.
SES Infrastructure Services LLC
Shanghai Genesis Chemical Industry Co. Ltd.
Shanghai Sunrowchem Technology Co
Shanghai Zenhua Heavy Industries Co. Ltd
Shenhua United Construction Co. Ltd.
Shenzhen Asiarway Corrosion Protection Engineering Co., Ltd.
Sherwin-Williams Industrial & Marine Coating China
Shimmick Construction
Sil Industrial Minerals, Inc.
Silverline Finishing, Inc.
Simpson Sandblasting and Special Coatings, Inc.
Sky Climber Access Solutions
Skyline Steel LLC
SME Steel Contractors
Soil & Materials Engineers, Inc.
Solient Protective Coatings Ltd.
Somay Q Technologies (CBC America)
South Staffs Industries
Southeast Bridge FL Corp.
Southern Paint & Waterproofing Co.
Southern Painting & Blasting, LLC
Southern Road & Bridge, LLC
Southland Painting Corporation
Spartan Contracting, LLC
Special Equipment Safety Supervision Inspection Institute of Jiangsu Province
Specialist Painting Group
Specialty Application Services, Inc.
Specialty Groups, Inc.
Specialty Polymer Coatings, Inc.
Specialty Products, Inc.
Spider
Spiegel Industrial
Sponge-Jet, Inc.
Spray Foam Systems
SRT Sales and Service, LLC
Stantec
Steel Fabricators of Monroe, LLC
Steel Management Systems, LLC
Steel Service
SteelwVid Industries, Inc.
STM COATECH
Sto Corp
Stork Technical Services
Structural Coatings, Inc.
Subsea Coating Technologies LLC
Sullivan-Palatek, Inc.
Sulzer Mixpac USA, Inc.
Superior Industrial Maintenance Co
Superior Painting Company, Inc.
Surface Prep Supply
Surface Preparation & Coatings, LLC
Swanson & Youngdale, Inc.
Symmetric Painting, LLC
T & W Industrial Services LLC
T Bailey, Inc.
Tank Services Inc.
Tarps Manufacturing, Inc.
Taylor Devices, Inc.
Taylor's Industrial Coatings, Inc.
TDJ Group, Inc.
Team Industries, Inc.
TECHNIA II
Techno-Coatings, Inc.
Technofink
Tecnico Corporation
Termotécnampuilla S.A. E.S.P.
Testex, Inc.
Texan Stone LLC
Thomanos
Thomas Industrial Coatings, Inc.
Thompson Pipe Group Pressure
TIB Chemicals AG
Tidal Corrosion Services LLC
Tidewater Staffing, Inc.
Titan Industrial Services
Titan Tool
TJC Painting Contractors, Inc.
TMI Coatings, Inc.
Tower Inspection Inc.
Tower Maintenance Corp.
TQC Sheen
The Tradesmen Group, Inc.
Travis Industries, LLC
Trelawny SPT Ltd
Triple H Construction, Inc.
Tri-State Painting, LLC
True Grit Inc.
True Inspection Services
TRUOC LLC
T-Tex Equipment L.P.
Turman Commercial Painters
Turner Coatings LLC
Turner Industries Group, LLC
Twilight S.A. De C.V.
U.S. Tank Painting, Inc.
UHP Projects, Inc.
Uniteam Training
United Painters Inc
University of Akron / NCERCAMP
US Coatings, Inc.
US Minerals
Utility Service Company, Inc.
Valentus Specialty Chemicals
Valor Defense Solutions, Inc.
Van Air Systems
Vastas Valf Armatur Sanayi Ticaret A.S
Vector Technologies Ltd
Veritas Steel LLC
VersaFlex Incorporated
Ville Platte Iron Works, Inc.
Vima Construction Corp.
Vimas Painting Co., Inc.
Vision Painting & Decorating Services
Vision Point Systems
Vulcan Painters, Inc.
W G Beaumont & Son Ltd
W Q Walters Company
W S Bunch Company
W W Enroughty & Son, Inc.
WWW-AFCO Steel, LLC
The Warehouse Rentals and Supplies
Wartsila Defense, Inc.
Wasser High-Tech Coatings, Inc.
Waterblasting Technologies
Watson Coatings Inc.
Weir Valves and Controls UK Ltd
Wenrich Painting, Inc.
West Coast Industrial Coatings
Western Industrial Services, Ltd
Western Technology, Inc.
Wheelblast, Inc.
Winco USA
WIWA LLC
Wm. B. Saleh Co.
Worldwide Industries, Inc.
Worth Contracting, Inc.
Worthington Industries
Woyt Industries, LLC
Wyatt Compressor
Yankee Fiber Control, Inc.
Yellow Creek Coating Services
YYK Enterprises, Inc.
Zack Painting Company, Inc.
Zebron Corporation
Zibo Tax Metal Technology Co., Ltd.
Ziegler Industries Inc.
Zingametall BVBA
Zingametall Marine & Offshore (Malaysia) Sdn Bhd
Zintec Industria & Comercio LTDA
ZRC Worldwide

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CALENDAR

SEPTEMBER 2019

SSPC COURSES

Course information available at sspc.org

Sept. 6	Nav Std Item 009-32, Seattle, WA
Sept. 7–8	C7 Abrasive Blast, Norfolk, VA
Sept. 9–10	C7 Abrasive Blast, Theodore, AL
Sept. 9–11	Aerospace Maintainer Ctg App, Newington, NH; Pittsburgh, PA
Sept. 9–13	BCI Bridge Ctgs Insp, Frankfort, KY
Sept. 9–13	Coast Guard Basic Pt Insp, National City, CA
Sept. 9–13	CCI Concrete Ctgs Insp, Manchester, UK
Sept. 9–13	NBPI NAVSEA Basic Pt Insp, Seattle, WA
Sept. 9–13	C2 Plan/Spec, Hammond, IN
Sept. 10–12	Safety, Daytona Beach, FL
Sept. 10–12	Plural Comp App, Irondale, AL
Sept. 11–12	C12 Spray App, Theodore, AL
Sept. 12–13	ACAS Aerospace Ctg App Spclst, Newington, NH; Pittsburgh, PA
Sept. 14	PCS Prot Ctgs Spclst, Hammond, IN
Sept. 16–17	C7 Abrasive Blast, Portland, OR
Sept. 16–18	C3 Lead Pt Removal, Warren, MI
Sept. 16–20	C1 Fundamentals, Grand Rapids, MI
Sept. 16–22	PCI Prot Ctgs Insp, Commerce, CA; Portland, OR; Singapore; Batam, Indonesia
Sept. 17–20	Aerospace Engineer Ctg App, Pittsburgh, PA
Sept. 18–19	C12 Spray App, Portland, OR
Sept. 18–20	CAS Ctg App Spclst, Jacksonville, FL; Chesapeake, VA
Sept. 20	C5 Lead Pt Refresher, Warren, MI
Sept. 20	Nav Std Item 009-32, Pearl Harbor, HI
Sept. 23–24	C7 Abrasive Blast, Pittsburgh, PA; La Porte, TX
Sept. 23–25	CAS Ctg App Spclst, La Porte, TX
Sept. 23–27	NBPI NAVSEA Basic Pt Insp, Pearl Harbor, HI
Sept. 24–25	C12 Spray App Pittsburgh, PA
Sept. 25–26	C12 Spray App, La Porte, TX
Sept. 25–27	CAS Ctg App Spclst, Pittsburgh, PA
Sept. 27–28	C8 Power Tool, Pittsburgh, PA
Sept. 30–Oct. 2	CAS Ctg App Spclst, Commerce, CA

CONFERENCES & MEETINGS

Sept. 9–13	EUROCORR 2019, Seville, Spain, eurocorr.org
Sept. 15–19	NACE Corrosion Technology Week, St. Louis, MO, nace.org
Sept. 15–17	IBTTA Annual Mtg/Expo, Halifax, Novia Scotia, ibtta.org
Sept. 21–25	WEFTEC 2019, Chicago, IL, weftec.org
Sept. 30–Oct. 3	SPE Annual Tech Conf/Exhibition, Calgary, Alberta, atce.org

20 or more

The number of years that a penstock lining should last before requiring maintenance painting.
See page 38.

2

Levels of certification available in SSPC's Concrete Coating Inspector program, which trains attendees on the standards, practices and equipment necessary for inspecting protective coatings on industrial concrete structures.
See page 47.

28 million gallons

The maximum daily capacity of water recovered at a water resource recovery facility in Lincoln, Nebraska, where three sludge storage tanks and an anaerobic digester were recently recoated.
See page 38.

2.0–4.0 mils

The manufacturer's recommended dry-film thickness range for a shop primer applied to partially galvanized structural-steel columns during construction of a new PVC production plant; most DFT averages from samples taken exceeded this range.
See page 16.

SSPC QS-1

SSPC's advanced quality-management program for coating contractors, which requires two years of field experience, 24 hours of training, and physical and visual capabilities.
See page 21.

80–100 F

The temperature range that 100%-solids elastomeric polyurethanes are heated in order to achieve an optimal spray pattern.
See page 30.