Mitchel Named President of Technology Publishing/PaintSquare

Peter Mitchel, a veteran publishing industry executive serving on the Board of Directors of Technology Publishing/PaintSquare, has been appointed president of the company by CEO Harold Hower, who formerly served as both president and CEO. The appointment took effect Jan. 18.

Mitchel recently served as chief operating officer of Boat International USA and publisher of *Boat International USA Magazine* and *Dockwalk Magazine*, both of which serve the megayacht industry. Previously, he was general manager and publisher for Soundings Publications, a major recreational marine news media group with four publications.


Peter Mitchel

In addition to his experience with marine media, Mitchel has held executive positions with *Time* Magazine, Cadmus Consumer Publishing, Diversified Business Communications, and Vanguarde Media. His roles in these companies have included finance manager; chief financial officer; vice president, finance and publishing operations; and general manager.

He holds a BS in mathematics from St. Lawrence University and an MBA from the Amos Tuck School of Business Administration at Dartmouth College.

As president, Mitchel will oversee the day-to-day operations of Technology Publishing/PaintSquare, whose media properties include *Journal of Protective Coatings & Linings* (*JPCL*), the voice of the technical society SSPC; *Painting & Wallcovering Contractor* (*PWC*) magazine; Paint BidTracker, a daily electronic publication featuring project leads on coatings work; and PaintSquare News, a daily e-newsletter for the paint and coatings industry.

"The appointment of Peter Mitchel is a significant step in the leadership succession process for the company," said Hower, who founded the company in 1984 and has been its leader for 26 years. "Peter is a consummate professional with great business judgment and strong leadership skills. And he has a clear vision of how to transition media companies from a primary print orientation to a platform neutral orientation where print and digital media operate together synergistically."

RPM Expands Protective Coatings Portfolio

RPM International Inc. (Medina, OH) announced that it has acquired the Universal Sealants (U.K.) Limited group of companies, a supplier of coatings and construction products and services for bridges and other large infrastructure projects headquartered near Newcastle, England. The announcement was made on January 19.

Universal Sealants, which has sales of approximately $55 million, will operate as a stand-alone industrial business in the RPM Performance Coatings Group.

Universal Sealants manufactures, supplies, and installs construction products, including waterproofing systems, protective coatings, expansion joints, and concrete repair products. Its products are primarily used for the construction, maintenance, and repair of bridges, parking structures, tunnels, railways, and other major structures. The company is a market leader in the United Kingdom and Ireland, and has a growing presence in the Middle East.

RPM International Inc., a holding company, owns subsidiaries that provide specialty coatings, sealants, building materials, and related services for the industrial and consumer markets.

Additional details are available at www.rpminc.com.

Obituary: Carl Milton Jones

Carl Milton Jones, 68, a long-time member of the Coating Society of the Houston Area, passed away on January 19, 2010, at home following a long illness.

Mr. Jones is survived by his wife of 44 years, Judith Hoffman Jones; daughter and son-in-law, Sarah and Joseph Rozelle; grandchildren, Laura and James Rozelle; brothers, Earl Franklin Jones, Jr. and Arthur William Jones; sister-in-law, Rebecca Woodworth; and numerous nieces, nephews, and cousins.

Mr. Jones served as a U.S. Marine and was also a business owner and an avid outdoorsman.

Chase Acquires Protective Tape Line

Chase Corporation (Bridgewater, MA) has acquired the full range of ServiWrap® pipeline protection products from Grace Construction Products, a unit of W.R. Grace & Co.

Chase Corporation is a global manufacturer of coatings, sealants, tapes, and laminates. ServiWrap/ServiShield® is a line of protective tapes for new and refurbished transmission pipeline for oil, gas, and water.

According to Chase, the acquisition will complement the company's existing line of pipeline protection tapes, coatings, and accessories.

Correction to the December 2009 *JPCL*

The phone and fax numbers listed for Waterdown, ON-based Opta Minerals Inc. on p. 108 of the December 2009 *JPCL* are incorrect. The company's phone number is 905-689-7361; the fax number is 905-689-3915.

'Qualifications' Top 'Low Bid' in Study

Public agencies save money and have greater satisfaction when procuring certain subcontractors on a "qualifications" basis, rather than the lowest bid, a new study concludes.

Construction costs are lower, taxpayer dollars are used more efficiently, and construction satisfaction is higher when federal and state agencies procure design and engineering services when contractors are selected for their qualifications, reports *An Analysis of Issues Pertaining to Qualifications-Based Selection*, conducted jointly by the University of Colorado and Georgia Institute of Technology, and co-sponsored by the American Council of Engineering Companies (ACEC) and the American Public Works Association (APWA).

Researchers drew from a database of about 200 public and private construction projects in 23 states. The sample included transportation, water, commercial, and industrial projects, ranging in size from relatively small projects to those costing hundreds of millions dollars.

The study compared various procurement methods, including Qualifications-Based Selection (QBS), Best Value, Low Bid, and Sole Source, with such factors as total project cost, projected life-cycle cost, construction schedule, and project quality outcome.

Results show that using QBS to procure the design component of a construction project consistently meant lower overall construction costs, reduced change orders, better project results, and more satisfied owners than in other procurement methods.

Since 1972, with the passage of the Brooks Act, federal law has required QBS for procuring engineering and design services for federally funded projects. Most states and many municipalities follow the federal model in adopting QBS in their procurement policies.

Under QBS, the public agency evaluates and "short-lists" design firms based on qualifications. Negotiations are held with the top-ranked firm to secure a fair and reasonable price for design and engineering services based on the scope of the project. If the agency and firm cannot agree on a price, the agency opens negotiations with the second-ranked firm.

By using QBS to procure architectural and engineering (A/E) services, agencies were "better able to control construction costs and achieve a consistently high degree of project satisfaction" than those using other procurement methods, researchers said.

To obtain copies of *An Analysis of Issues Pertaining to Qualifications-Based Selection*, contact Mary Jaffe at ACEC at 202-347-7474 or visit www.acec.org.

Coating Society of Houston Plans Trade Show

The Coating Society of the Houston Area has planned its annual trade show for April 23. This year's title is "Corrosion To End in 2010!" The one-day event will take place at Campbell Hall at the Pasadena Convention Center in Pasadena, TX.

In addition to the trade show, there will be a crawfish boil and live music.

For details, visit www.houstoncoatingsociety.org.

ASTM Updates Coatings Field ID Standard

ASTM International updated D5043, Standard Practice for Field Identification of Coatings, on January 13, 2010.

The standard provides a guide for the procedure of identifying the generic type of coating on a surface in order to select a compatible coating for repainting and when evaluating the performance of a coating in an environment. The procedure can be performed in the field by personnel with limited laboratory experience.

To order and download the standard, visit the Standards Center on www.paintsquare.com.

On Measuring Surface Profile in the Field

ASTM standards define four methods for determining the profile of a steel surface: visual comparator, depth micrometer, replica tape, and portable stylus. Which one is best to specify for field use to assure quality compliance with the surface profile specified, and why?

Dave Heyne,
H.I.S. Painting Inc.

In a world full of advancing technology, a lot of old methods can be erased. When it comes to determining the profile of a steel surface however, there is one method that cannot and should not be erased. From my experience, I feel replica tape is this method.

In most any situation, replica tape is the most reliable source because it is the only method that doesn't need a third party's opinion. The tape speaks for itself. When a sample is taken, it can be filed and retained for future reference. The same visual exists well after the completion of the project. The benefit of using the replica tape is that there is a permanent physical marking that leaves no room for interpretation.

When using a visual comparator, there is no physical evidence. Any visual record isn't as legitimate as a physical source when two or more parties will be involved. Once paint is applied to a steel surface, there is no proof of the profile. It is as if the profile never existed. Because every person has a different perspective, using the visual comparator can lead to a battle of opinions.

The depth micrometer is a tool that provides no record of the depth of the surface—except at the moment the measurement is taken. Right after the micrometer is removed from the substrate, the reader goes back to zero. Like the visual comparator, it can lead to a battle of opinions and "who saw what." It is desirable to have an undeniable source to look back on.

The portable stylus is another method where a person must be present to monitor the profile of the steel surface. The digital field is more likely to make an accurate number presentation; however, it's only presented to the person holding it at the time. The way the stylus was placed on the surface, how much pressure was added, etc., may also have to be taken into consideration. Furthermore, the risk that the digital display is not working properly is always a factor. Sometimes using replica tape instead of a stylus may relieve the stress of wondering if the stylus was working properly or not. There are a number of variables that can play in the situation. Consistency is necessary for reliability.

All of the above methods are proven to be useful. But replica tape is a constant, leaving a marking that cannot be erased or misjudged. You get a solid answer every time. It has the promising physical factor that our world of advanced technology cannot deny.

Dave Heyne is one of the founders of H.I.S. Painting Inc (Titusville, FL). Throughout his 37 years of agricultural, commercial, and industrial painting experience, he has held positions that include operations manager, estimator, and supervisor. He is currently responsible for overseeing the daily production operations of H.I.S. and all its components.

Lee Wilson,
Coating Consultant

In my experience, the best method for measuring surface profile is surface replica tape; its usefulness is primarily due to the mirror image mold created of the surface profile and the permanent record that it gives of the actual surface profile achieved after abrasive blasting. My answer to this is backed up by the corrosion control industry—surface replica tape is the most widely specified and used field test method for surface profile testing and recording. The use of the dial micrometer and the surface comparator will also be discussed in this PSF response.

Surface replica tape uses a small compressed foam square attached to a noncompressible plastic film known as the Mylar. The foam is forced into the blast-cleaned surface, giving the exact reverse impression—or mirror image—of the surface profile. This is known as the replica. As previously stated, and unlike the other methods used for surface profile testing in the field, the tape gives a permanent record or mold of the actual profile achieved. This record is available to the inspector or other QA/QC representatives after the surface is coated and the profile covered. The mold can then be attached to any quality control documentation for later verification, if required, or used as evidence during any failure analysis or arbitration cases.

A replica tape kit is relatively affordable and is readily available at most inspection outlets across the globe.

There are two commonly used stan-

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dards in the industry for describing the methods for carrying out surface profile readings by surface replica tape: ASTMD 4417 and NACE RPO 287, Field Measurement of Surface Profile of Blast Cleaned Surfaces Using Replica Tape. These documents give the inspector clear instructions for performing surface replica tests.

Digital surface profile needle gauges with built-in memory are a more recent development for measuring surface profile. A surface profile needle gauge, also known as a dial gauge depth micrometer, is quite expensive. It is a very sensitive piece of equipment, with the actual testing requiring a great deal of skill. Although the test can be carried out in the field, it is much more suited and more commonly used in the laboratory. The test works by projecting a spring-loaded tip into the valleys or troughs of the profile. The author has encountered doubts within the industry, however, that the tip actually projects exactly into the valley, which could give a wrong indication of the actual surface profile achieved.

Surface comparators, or coupons, e.g., the Keane-Tator and the ISO 8503 comparators, only show a comparison between the blasted surface roughness and a roughness on the comparators; they do not indicate the exact peak to trough range. These field tests rely heavily upon touch and sight for verification, which has in the past resulted in adhesion-related failures due to a comparison being incorrectly diagnosed. I often see inspectors debating if a profile is fine, or finer than fine, or coarser than coarse—so there is room for debate between different inspectors, which could cost a coating project heavily.

I believe that using comparators creates a potentially huge margin for error that can affect the lifespan of any coating system applied. Remember the importance of surface profile and the ramifications of getting the results wrong: too shallow a surface profile can lead to premature adhesion-related failure; and too deep a profile can result in rouge peaks or incomplete primer coat coverage of the amplitude, which shows as flash spot rusting due to the peaks being exposed to the environment. So it is vital to keep the surface profile within a specified range and to verify that the actual peak-to-trough amplitude is within the range specified. Surface replica tape confirms this in the field. Out of the methods used for surface profile, I would always specify surface replica tape as a field inspection requirement to determine surface profile.

Lee Wilson is a UK-based NACE Certified Coating Inspector, a NACE CIP Instructor and lecturer, and an ICorr Level 3 Approved Painting Inspector.

Reader Response

Jim Deardorff,
Superior Coatings

I am writing to offer another perspective in response to the October 2009 *JPCL* Problem Solving Forum question, “What do you do when the spec calls for SSPC-SP 10, Near-White, but the metal gauge won’t support abrasive blasting at the standard pressure of 100 psi or more at the nozzle?”

The photos show parts that I recently cleaned for a manufacturer of industrial air cleaners. Due to the recent economic slowdown, these parts had been left in storage too long and had developed rust. Because the parts are powder coated, the rust had to be removed before re-application. I used my graded walnut shell-aluminum oxide, low pressure-low impact abrasive cleaning process to

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clean these parts. The specifications, genericized, are listed below.

- Media: an 80/20% mix of garded walnut shell and 80-mesh aluminum oxide
- Equipment: 350-pound closed top blast pot
- Nozzle: a double venturi number 5 blast nozzle
- Working pressure: 30 psi
- Open air blasting using containment to capture used media for recycling

The process provided the following:

- no warpage or metal distoration;
- economic feasibility because the media can be recycled more than 20 times;
- speed, because each part required two minutes of blasting time to remove rust; and
- quality, because the blasting produced cleanliness better than that of an SSPC-SP 10 standard.

Moreover, the minimal profile was suitable because most manufactured products require no surface profile prior to painting, and for such products, surface cleanliness is more important than profile.

Over the past 10 years, I estimate that I have cleaned over 10,000 fabricated steel and aluminum parts, including classic car, tractor, and aircraft parts.

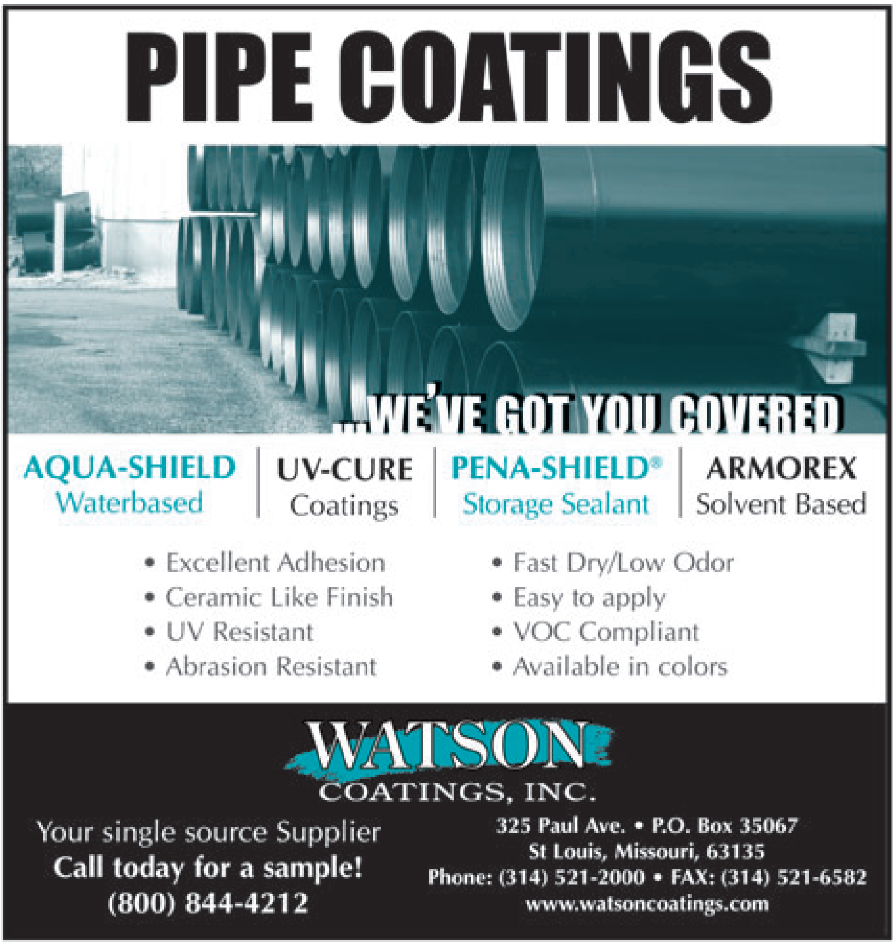
In my opinion, virtually any type of coated or uncoated metal surface can be cleaned by abrasive blasting using the correct media and equipment combinations.

SSPC and NACE member Jim Deardorff is the president of Superior Coatings, a contract painting and abrasive blasting company located in Chillicothe, MO. He has over 25 years experience in his field, and over 50 of his articles have been published in a variety of coating industry magazines.

Two industrial air cleaner parts, each before and after walnut shell/aluminum oxide/low pressure/low impact abrasive cleaning process. Photos courtesy of Jim Deardorff.

Next Month's Question:

Some concrete structures, e.g., concrete bridges, are metallized to provide sacrificial protection of the rebar and therefore reduce the corrosion risk. What surface preparation is needed for metallizing the concrete?



The Case of... A Failure To Communicate

By Thomas Neal, KTA-Tator, Inc.
Richard Burgess, KTA-Tator, Inc., Series Editor

Fig 1: Monolithic Airform Dome Construction was used for this school in the Midwest U.S. Photos courtesy of Thomas Neal

Monolithic Airform dome construction, simply described, is a process that uses an inflatable fabric—a polyvinyl chloride- (PVC-) coated nylon or polyester fabric—manufactured in the size and shape required for a job. The construction process includes building a foundation footing at the building site with attachment rings for the dome. For insulated structures, air is used to inflate the dome and hold it in place while construction takes place inside the inflated dome. Construction consists of applying a layer of insulating polyurethane foam beneath the inflated PVC airform and then installing a reinforcing steel fabric lath beneath the foam layer. Shotcrete is then applied to create the reinforced concrete domed structure. The outer PVC fabric skin is left in place to protect the insulation from the elements.

This month's F-File considers the fading and peeling of paint bands applied to the exterior of the domes. The specified coating system was from a sole source supplier. However, the supplier could not provide the desired finish coat color and a product substitution was necessary. The failure investigation identified the coating system substitution, as well as plasticizer migration from the dome fabric substrate into the primer as potential causes of the failure. This article concludes with a discussion of the ramifications of the failure for the contractor based on his handling of the substitution.

Background

A school complex using the Monolithic Airform dome construction technique was built in the northern Midwest (Fig. 1). The complex consists of five ground-mounted domes with interconnecting, conventional corridors, entrances, and two block walls at the rear of the complex. The painting requirements for the domes' exteriors were primarily aesthetic and consisted mainly of two horizontal bands of paint, in the school's dark purple color, encircling the domes. The block walls, as well as some of the interconnecting areas, were also painted the same purple.

The contract required the use of a primer and elastomeric acrylic topcoat made by a specific coatings manufacturer for the exterior PVC surface bands. When the industrial painting contractor tried to purchase the products specified, he learned that the topcoat was not manufactured in the color specified. Subsequently, the contractor contacted his local paint supplier, who proposed a substitute coating system (primer and topcoat) to the contractor. The specified coating system was basically an acrylic elastomeric roof coating, whereas the proposed system substitute was an acrylic most commonly used for CMU/stucco coating. The proposed paint was applied to a section of fabric, and adhesion tests were then conducted on the painted fabric and the results were deemed acceptable. No other testing was conducted. Without contacting the owner/designer, the contractor made the substitution. Two years later, the school lodged complaints with the contractor about the fading and peeling of the painted purple bands (Fig. 2). The contractor requested assistance in determining possible causes of the reported problems. Because dark colors are known to have chalking/fading problems, the contractor also wanted to determine if the fading was due to the topcoat formulation used. His paint supplier had proposed an alternate repair product for correcting the problem and claimed it was more lightfast. The contractor did not wish to propose to the school a coating repair that was not capable of performing satisfactorily.

Investigation

A site visit was performed. Visual inspection revealed bare areas within

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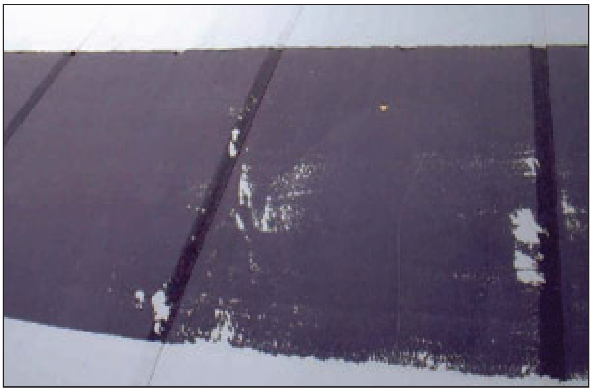

Fig 2: Fading and peeling color bands on dome, two years after application

the painted bands as well as some peeling paint at the edges of the bands and bare areas. No significantly large areas of disbondment were visible. Because standard adhesion tests would have involved cutting and, therefore, potential for damage to the fabric, it was not possible to perform the tests. The "infamous" dull putty knife was used to scrape intact painted surfaces (Fig. 3). Moderate scraping did not remove the coating. Heavy scraping could scrape off small, rubbery pieces. Knife-tip probing was performed in general accordance with ASTM D6677, "Standard Test Method for Evaluating Adhesion by Knife." However, because of fear of damaging the fabric, rather than scribing the coating film, already peeling areas were scraped and the intact edge was carefully probed with the tip of the knife at the edges of the bands and bare areas. The adhesion was given a rating of 8 (out of 10).

Areas on the front of the north face of the domes were scrubbed with a wet sponge and wiped with water to reveal a purple color only slightly faded (Fig. 4). Areas that were washed and scrubbed on the south face of the domes revealed that the color was very faded compared to the original dark purple color.

Samples were taken and sent to the laboratory for a microscopic examination and an infrared spectroscopic analysis. Field measurement of the coating thickness was not possible due to the nature and texture of the substrate. The laboratory analysis revealed that two different colored coats of paint had been applied and that the resins in the samples of both colors were consistent with a styrenated acrylic.

Wet samples of the type of paint applied to the domes and wet samples of the paint supplier's proposed repair system were obtained for accelerated laboratory testing to compare the proposed repair system's color fading with the fading of the applied system (Table 1). (Although the specified paint system was not available in the required color, a wet sample of a similarly dark color was obtained from the company for comparison purposes.) The school provided a fabric sample for testing purposes. Application of the specified, applied, and proposed repair primers to the fabric revealed that, unlike the other two primers, the specified primer did not wet into the fabric.

Table 1: Color Evaluation Results

Panel #	Baseline Color Values			Color Difference (ΔE) After 500 Hours Exposure	Color Difference (ΔE) After 1000 Hours Exposure
	L*	A*	B*		
1	48.73	7.17	-19.96	1.66	0.36
2	49.07	7.13	-19.98	1.67	0.21
3	47.43	8.80	-20.03	3.31	2.83
4	47.64	8.84	-20.14	2.89	2.61
5	49.61	-3.88	-9.55	1.14	2.24
6	49.41	-3.83	-9.50	0.66	1.86

Panels 1, 2: Substitute Paint
Panels 3, 4: Proposed Repair Paint
Panels 5, 6: Specified Paint

Accelerated weathering tests to assess color fade were performed on metal panels. The color shift after 1,000 hours of accelerated weathering exposure showed that the substituted paint applied to the domes had somewhat better color change

Fig 3: Scraping colored band with dull putty knife

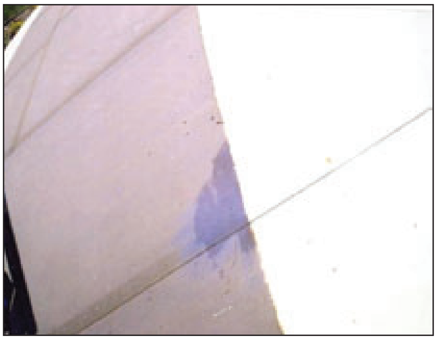

Fig 4: Area after washing on north face of dome

resistance than either the proposed repair paint or the specified paint.

Concurrent to the weathering tests, the school obtained the services of another consultant (and laboratory) to evaluate the applied (substitute) paint for its resistance to plasticizer migration. It was determined by analysis that plasticizers had migrated from the PVC coated fabric into the applied paint. Contact with the fabric manufacturer verified that plasticizer migration was a known phenomenon and that a primer able to resist this migration was necessary to prevent disbondment. Contact with the specified paint manufacturer indicated that its (specified) primer product had been tested for resistance to plasticizer migration. The substitute primer had not been evaluated for this resistance.

Analysis and Conclusions

There was no field evidence that the contractor had improperly applied the products. At the time of the site visit, the paint was moderately adhered, and thus, after scraping, washing, and scrubbing, should have been capable of supporting an overcoat of paint.

The effect that sliding ice/snow may have had on the coating remained unknown. It may have caused the peeling and loss of adhesion. The location of the circular bands on the domes and the textured nature of the fabric meant that ice and snow could collect and remain for the winter. Any pack ice would slide over the bands during a melt cycle. Damaged/bare areas were not visually inconsistent with that expected of sliding ice, but evidence that sliding ice caused the coating failure was not con-

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clusive because no shear testing had been performed on the applied coating. It was also not known if the inability of the specified primer to wet the surface would have created any adhesion problems or issues due to ice pack slide.

The accelerated weathering tests indicated that the paint that was originally applied to the domes would likely retain its color better than either the proposed repair paint or the specified paint. Thus, the proposed repair paint system was not a viable solution. It is generally accepted that changes in color less than a DE (Delta E) value of 3 are not visible to the naked eye. The fading of the paint on the front (northern) side of the domes was less severe than on the rear (southern) side. This indicated that there were potentially different site conditions for the fabric on the north side versus the south side. However, color change on the vertical surfaces, such as the block walls, was significantly less than that on the fabric. Dark colors are particularly susceptible to fading when exposed to solar radiation. Although there were differences in fading, there did not appear to be any difference in adhesion between the northern and southern faces. No laboratory weathering tests were conducted to evaluate if the migrating plasticizer would have contributed to or accelerated a color change. It also remained unknown if the specified product (in the color specified) would have weathered successfully or resisted ice pack slide because the laboratory data indicated that the primer did not wet into the fabric. Although, from an academic standpoint, it would have been informative to know how the different systems would perform, the contractor was not interested in spending more funds on investigating the flawed system that had already been applied.

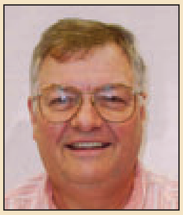
After plasticizer migration was determined to be a contributing factor to the failure, it was concluded that overcoating of the applied paint was not an option. Overcoating would not stop the plasticizer migration. Thus, total removal of the existing (substituted) paint would be necessary.

Removing the failing coating was problematic because aggressive methods, such as abrasive blast cleaning or high-pressure water jetting, could not be used for fear of damage to the fabric. Tears and holes would allow moisture to enter and damage the insulation. Thus, other methods of removal would need to be investigated. Another concern was if stain residues remained after coating removal, would they impede the performance of any newly applied paint?

Lessons Learned

Applying coatings to unique or unusual substrates clearly requires some investigation and planning. In-situ testing for adhesion may not always provide sufficient information regarding long-term performance, and the behavior of the substrate—in this case, plasticizer migration—cannot always be anticipated.

But there is also an additional and important economic lesson that came from this case from the F-Files. Whether one is coating steel, concrete, or, as in this case, fabric, whenever there is a problem or flaw in the contract, it is incumbent upon the contractor to bring the issue to the attention of the owner/designer and seek concurrence for any change in conditions. The contractor did not contact the school to seek their approval for the change of supplier/coating system. When the contractor learned that the specified product was not available in color specified, this should have been communicated to the designer for a resolution. Indeed, the after-the-fact laboratory data indicated that there might have been a problem with the adhesion and color retention of the specified system. By acting unilaterally, the contractor transferred the responsibility for the material flaw from the owner/designer to himself, and thus took responsibility for the consequences. While there was an absence of malice on his part, this "failure to communicate" created a performance issue and an additional financial burden to him. The contractor decided to settle out of court.



Tom Neal is a Senior Coatings Consultant with KTA-Tator Inc. (Pittsburgh, PA). Before joining KTA in 1995, he was Chief Chemist with the Virginia Department of Transportation. He is a NACE Certified Coating Inspector (#378) and is a Certified Welding Inspector(08100651).

Passive Fire Protection Application with Plural-Component Equipment

By Murphy Mahaffey, WIWA Wilhelm Wagner GmbH & Co. KG

Passive Fire Protection, or PFP, is a term that is frequently used in our industry today for describing technologies that delay or mitigate damage by fire to allow more time for protecting human life. PFP technologies operate without human intervention, focus on compartmentalization (preventing the spread of fire), and maintain the structural integrity of the vessel or building for a longer period of time—as opposed to Active Protection, which focuses on detection and suppression, including alarms and sprinkler systems. PFP systems include intumescents, cementitious materials, and proprietary boards or sheets. Each of these systems is engineered to protect the substrate.

This article will discuss aspects of intumescent plural-component PFP material application, including proper training, equipment required, and job profiles.

Fig. 2: A training class in Lahnau, Germany, conducted by an equipment manufacturer and a paint manufacturer, for an application company being certified. Photo courtesy of WIWA GmbH and International Paint

Intumescent PFP

Intumescent PFP materials are comprised of a resin matrix that contains a blend of thermally active chemicals formulated for fireproofing. An intumescent coating will expand (intumesce) 5 to 10 times its original thickness when exposed to fire, producing a carbonaceous char layer that insulates the substrate from the heat source by producing a char layer that protects it, and emitting gases that cool the surface area (Fig. 1).

Intumescents are applied in a variety of industries. PFP materials are used in onshore and offshore applications, including gas/petroleum storage and distribution; petrochemical plants; storage tanks/vessels; refineries; power stations; steel structural beams and elements; valves; offshore platforms; and tanker vessels. The effects of heat on steel are significant, with steel losing half of its load bearing strength at 588 C (1000 F)—the failure point for steel. The dangers associated with this damage are structural collapse, explosion of vessel contents, pipe fractures causing jet fires, and lack of containment that allows fire to spread.

Fig 1: Intumescent coating applied to steel beam (left) and after the coating has been exposed to heat/fire and has expanded (right). Photo courtesy of International Paint

Why specify intumescent PFP systems? In addition to their passive fire protection properties, they are robust and have good adhesion, high tensile and compressive strengths, and good resistance to impact and vibration. They have excellent weatherability and often do not require topcoats. PFP materials also have good chemical resistance and protect the substrate against corrosion due to extremely low water absorption. These systems often have a lower installed weight than other systems with similar properties, thus adding less weight to the final structure while providing maximum protection. PFP systems can be 40%–60% lighter than "lightweight" cementitious products.

Training and certification to apply these materials is of utmost importance to achieve consistent properties and the correct functioning of PFP systems. Normally a company's employees must be trained to apply PFP materials. Most material suppliers provide qualified applicator certification to ensure the correct application of PFP materials. For example, one global paint manufacturer provides a two-day training course with hands-on application, including theory and practical training, sample preparation, and certification. The course trains and takes input from the applicator, fabricator, client, and material and equipment suppliers (Fig. 2).

Fig. 3: Carbon fiber hybrid mesh on structural steel piece. Photo courtesy of WIWA GmbH

In the training course, applicators

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learn different application techniques. For example, one technique is to use carbon fiber hybrid mesh to allow higher thickness build and give anchorage and structural reinforcement to the intumescent material (Fig. 3, p. 19).

Fig. 4: Units for plural-component application of intumescents. Photo courtesy of WIWA GmbH

Surface Preparation for Intumescents

Even the best chemical system will not perform if the proper preparation steps are not followed. Important general preparation includes cleaning surfaces of dirt, oil, and grease to required standard SSPC-SP 1; blast cleaning to required standard Sa 2.5, with 50–75 microns blast profile; checking ambient conditions to ensure they conform to primer manufacturer's specifications (Qualified Primer List); and priming surface with approved primer, ensuring thickness is between 50 and 75 microns, and less than 100 microns at overlaps.[1] Doing things correctly the first time always pays off and this is just one example of surface preparation. All of the steps recommended by the material manufacturer must be followed for a successful application.

Applying Intumescents

PFP materials can be applied with a trowel, a single-leg pump (hotpot), or with a plural-component system. Plural-component equipment allows the fastest production and gives the most control over application. Plural-component application also produces the least amount of waste of the three methods and allows solvent-free application. The material suppliers must certify the equipment for the application. The components are made from materials that will provide the longest life during operation and help resist material abrasiveness while generating and maintaining the temperature and pressure required.

Figs. 5 and 6: Intumescent applied to an offshore platform under construction. Photos courtesy of Disnamair S.A.; WIWA GmbH; and Dragados Off Shore S.A.

Plural-component equipment must be configured with the material supplier and certified for application of the specific material. Components designed and specified for use with these materials are 'configured' or put together in an optimum way to allow the desired output. Components include pumps, heating systems, motors, tanks, hoses, and spray guns. The equipment system must be able to heat the material to the proper temperature, maintain the temperature to the gun, proportion the material to give proper ratio, and generate the correct pressure for mixing and spray pattern. The specialized chemistry in PFP systems requires a machine that is designed with these considerations in mind (Fig. 4).

Intumescent Applications

Where are PFP materials being applied? All over the world. Many structures that can benefit from having PFP, including offshore rigs. Figures 5 and 6 show the application of an intumescent on the offshore platform "Hammerfest."

In the U.S., PFP is being used on the steel structure for the new interchange station servicing subways, buses, and trains in New York City. The architect of the project specified intumescent PFP, and a steel structure workshop was conducted in La Coruña, Spain. Structural members have the PFP applied (Figs. 7

Continued


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and 8), and are then installed.

Large storage vessels in the petroleum industry are a target application area for PFP materials because they benefit from the fire protection and anti-corrosion properties of PFP materials. The adhesion to substrate and moisture-resistant nature of intumescents minimize the possibility of corrosion occurring due to moisture between the material and substrate. Figure 9 shows a gas sphere in Tenerife, Spain, on which a proprietary PFP has been applied. This was an on-site application, as can be seen by the plural-component unit set up on the scaffold below (Fig. 10). Figure 11 shows a sphere on which a cementitious PFP material was applied.

Conclusion

Passive Fire Protection is a very specialized niche application that is growing worldwide due to the need for fire and corrosion protection that is low in


Figs 7 and 8: For the New York interchange station project, a certified painting contractor applied the PFP with technical support from a distributor for the equipment manufacturer. Photos Courtesy of Disnamair S.A.; WIWA GmbH; and Julio Crespo S.A.

Fig. 9: Coating application on a gas sphere in Tenerife, Spain. Photo courtesy of Disnamair S.A. and Compañía Española de Petróles S.A.

Fig. 10: Plural-component unit staged on scaffolding for on-site application. Photo courtesy of Disnamair S.A.

Fig. 11: A sphere collapsed due to undetected corrosion under cementitious PFP. Photo courtesy of International Paint

installation weight. Companies who are certified to apply these materials have an advantage today because they have a lead in specialized markets and competition is currently limited. The only way to get involved is to become certified by one of the material suppliers and work to develop the market together. Proper training and technical support from the material and equipment suppliers are important components of a successful and on-time installation of PFP because PFP requires the combined expertise of the applicator, technical advisor, material supplier, and equipment supplier.

Acknowledgements

This article, an example of the combined expertise that is required for PFP training and installation, would not have been possible without the contributions of Herbert Mann, Rob Jansen, Werner Goetz, Uwe Tinz and Dirk Scherer of WIWA GmbH; Carlos Aguirre of Disnamair S.A.; and Jack Tay, John Yeoh, and Markus Federico of International Paint. The author thanks all for their contribution and support.

Reference

1. International Paint, "Pre-Application Key Points to Note," on steps before applying PFP.

Odor and Corrosion Problems in Wastewater Collection Systems and Treatment Plants:

Two Related Issues Requiring Separate Control Strategies

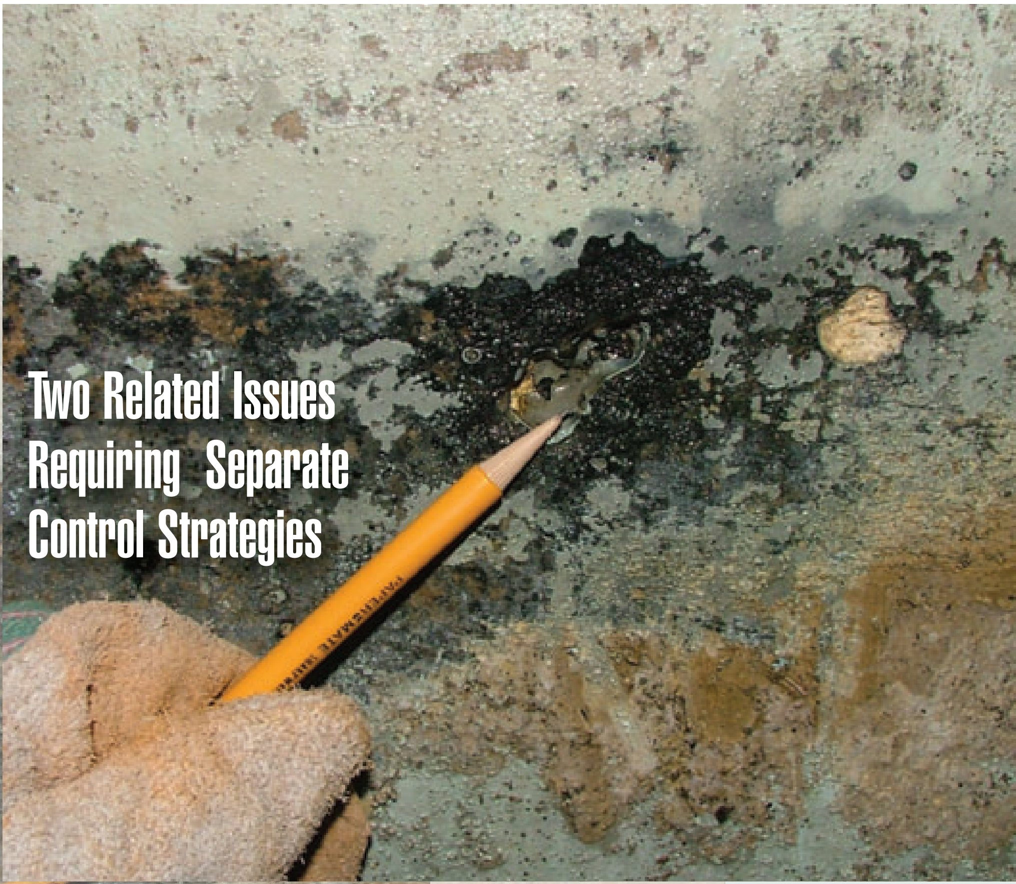


Fig. 1: Primary clarifier headspace with ordor control. Photos courtesy of the author

By Randy Nixon, Corrosion Probe, Inc., Centerbrook, CT

Editor's Note: This article is based on a paper presented at PACE 2008, the joint conference and exhibition of SSPC and PDCA, held January 27–30, 2008, in Los Angeles, CA.

Odor control systems are critical to handling and treating foul air in wastewater collection systems and treatment plants. However, odor control systems do not stop corrosion related to biogenic sulfide formation of sulfuric acid, as some engineers would have you believe. Conversely, if you have an odor problem, you also typically have a corrosion problem, and each problem requires separate control strategies.

This article explains why odor control ventilation does not mitigate biogenic sulfide corrosion in wastewater treatment plants or pump stations and why corrosion protection is also required. In fact, as the article will illustrate, odor control ventilation merely reduces the severity of corrosion related to the biogenic sulfide formation of sulfuric acid that damages wastewater system infrastructure. Research by others has shown this to be true and is discussed later in this article.

Odor Control Ventilation: Reducing the Severity of Headspace Corrosion

Odor control systems generally extract the air from the enclosed headspaces of tanks and other structures and collect it in one of the many types of odor treatment systems. These treatment types include activated carbon adsorbers, biofilters,

Fig. 2: Pump station wet well headspace with operable odor control

fine-mist wet scrubbers, packed-tower wet scrubbers, and thermal oxidizers. There is no doubt that collecting this foul air for treatment is an essential control strategy.

Extracting and collecting the foul air can reduce the concentration of H_2S gas in the headspace atmosphere. Fresh air is brought into the headspace with multiple air changes per hour, so that a negative pressure environment is maintained within the headspace. And while this air movement does lower the hydrogen sulfide gas levels within the headspaces of tanks, wet wells, and channels, the H_2S gas can still contact the concrete and metal surfaces upon which condensation of water is generally constant. As such, the gas is dissolved or absorbed into the layers or sheets of moisture where sulfur-oxidizing bacteria reside. Therefore, sulfuric acid formation can still occur, and corrosion continues, although to a lesser degree.

The design of airflow patterns for odor control systems is quite involved. Care is taken to sweep the air over all of the water surfaces with greater flow over areas where wastewater turbulence occurs. Also, the design process is focused on preventing dead spots within the headspaces where air changes could be obstructed or slowed due to the geometry of the structure. In doing this, an ample supply of oxygen passes over the surfaces where the sulfur oxidizing bacteria have colonized. Remember that these bacteria, mostly of the Thiobacillus genus, are aerobic and thrive in an oxygen-rich environment. If the number of air changes provided does not remove the gaseous hydrogen sulfide as quickly as it comes out of solution, the amount of H_2S gas dissolved into the wetted surfaces will increase, as will the formation of the sulfuric acid responsible for corrosion. If dead spaces are allowed to exist, more rapid corrosion rates will occur at the locations where the higher H_2S gas levels remain for longer periods of time.

Further important points about corrosion must be considered in relation to odor control systems. The construction materials for these systems are also subjected to biogenic sulfide corrosion. Ductwork, fans, damper valves, and treatment equipment routinely degrade due to acidic exposure and associated corrosion, and as such, are typically constructed using FRP, stainless steel, or other corrosion-resistant materials. These odor control components are not constructed from unprotected concrete or carbon steel because the corrosion rates would be too high. Therefore, would it not be prudent also to continue to protect the concrete and metallic substrates found in the headspaces of the wetwells, tanks, and channels at treatment plants or pump stations? These surfaces can be considered as an extension of the air collection and conveyance components (the ductwork if you will) of the odor control system. Thus, they must still be properly coated or lined to prevent rapid deterioration.

Hydrogen Sulfide Gas and the Dynamic Chemical Equilibrium

Hydrogen sulfide generation in wastewater is mostly controlled by a chemical equilibrium in which the sulfide ion $S^=$ is first produced and introduced into the liquid wastewater from the anaerobic slime layer. The sulfide ion reacts with hydrogen in the wastewater to form bisulfide or hydrosulfide (HS^-). It, HS in turn, further reacts with hydrogen to form dissolved H_2S [or H_2S (aq)]. At areas of turbulence, the dissolved H_2S is released as gas into the headspaces of tanks or structures. As this occurs, more bisulfide ions are transformed into more dissolved H_2S to

Fig. 3: Pump station wet well headspace with operable control

replace the molecules that are lost to the headspace. More sulfide ions then react with hydrogen in the wastewater to form more bisulfide ions to replace those lost to form aqueous H_2S. Through this dynamic equilibrium (Fig. 5 on p. 28; also, an explanation of chemical equilibrium reactions is given in sidebar below), the quantitative relationship between the four species of sulfides is mainly controlled by the pH of the wastewater.

The sulfide ion does not exist at a pH much below 12.0. So we know that once released into the wastewater at near neutral pH, the dominant species will be bisulfide. At the normal pH of municipal wastewater (6.8 to 7.2), this means that in a 50/50 proportional relationship, nearly half of the sulfide present will be bisulfide ions, while the other half will exist as dissolved hydrogen sulfide ($H_2S(aq)$). And because the concentration of dissolved gases tends to be directly proportional to the partial pressure of the same gas above the liquid surface, the $H_2S(aq)$ can be released to exist in its free gas form. The concentration of dissolved H_2S gas in solution is controlled by the specific Henry's Law coefficient for H_2S. When subjected to turbulence, the wastewater releases the dissolved H_2S as free $H_2S(g)$, and more bisulfide ions are transformed into the dissolved gas form to replace the H_2S lost to the headspace environment. The main thrust here is to

Chemical Equilibrium Reactions

In a simple chemical reaction,

$$A + B \longrightarrow C,$$

A reacts with B to form C, and the reaction continues until all of A and/or B have been used up.

In a chemical equilibrium reaction

$$A + B \longleftrightarrow C,$$

A and B react to form C, and at the same time, C dissociates into A and B. In other words, A, B, and C all exist together at fixed concentrations. If product C is removed from the environment, then A and B will react to form more B to re-establish the equilibrium concentrations. Similarly if either A or B are removed, the reaction switches to the left, and C will dissociate to replace the lost ingredient.

Fig. 4: Grit tank headspace with non-operable odor control system

point out that, despite odor control ventilation, H_2S gas will continue to be released into the headspace atmosphere unless chemical treatment is applied upstream to reduce sulfides in the wastewater.[1]

$$\begin{array}{l} \text{pH} < 12 \\ 2\,S^{2-}\ \_\ 2\,HS^{-} + H_2\ \_\ 2\,H_2S\,(aq)\ \_\ 2\,H_2S\,(g) \\ \text{pH} < 12 \end{array}$$

Fig 5: Dynamic Chemical Equilibrium of H_2S

Ideal Conditions for Mitigating Biogenic Sulfide Corrosion

Studies based on laboratory work by the County Sanitation Districts of Los Angeles and others have shown that biogenic sulfide corrosion does not occur when H_2S gas concentrations are less than 2 parts per million volume (ppmv) because the growth of sulfur oxidizing bacteria (SOB) is not possible.[2] It would also be nearly impossible for biogenic sulfide corrosion to occur if headspace surfaces were completely dry. If no moisture from condensation was present, then H_2S has could not be dissolved and be made available to the bacteria.

So for corrosion to be mitigated by odor control ventilation, the H_2S gas concentrations would have to be kept below 2 ppmv and/or the headspace surfaces would have to be kept dry. Such ideal conditions cannot possibly be sustained in wastewater treatment plant or collection system tanks or structures. Just the difference in temperature between the concrete structures and the liquid wastewater will generally produce moisture condensation in the headspaces of these environments. Additionally, odor control ventilation exacerbates this situation by introducing air that is either warmer or cooler than the wastewater or the concrete surfaces, depending on the time of year. Keeping such headspaces completely dry using dehumidification equipment is simply not an economical alternative. Creating conditions in the wastewater collection system to ensure that H_2S gas concentrations remain below 2 ppmv is also both impractical and uneconomical. The National Fire Protection Association (NFPA) recommends that a minimum of 12 air changes per hour be provided at a minimum negative pressure of 0.1 inch of water column to maintain H_2S gas concentrations below 10 ppm.[3] This is a typical air change rate used for odor control systems in wastewater treatment plants. Typically, even air change rates up to 20 per hour are not able to reduce H_2S concentrations much below 10 ppm. Much larger motors, fans, and ductwork would be necessary to achieve such high volume air flow requirements. And such equipment costs would be much

higher than the costs for proven linings for corrosion protection of the headspaces.

Real World Experience

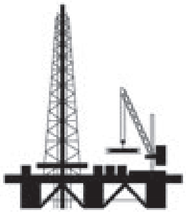
Inspections of wastewater treatment plant covered tanks that have odor control systems consistently show corrosion losses and active (ongoing) corrosion of concrete and metallic substrates. See Figs. 1, 2, and 3 (p. 24-26), which show headspace concrete corrosion problems in treatment plant and pump station tanks and structures where odor control ventilation has operated routinely for several years. By contrast, Fig. 4 shows corrosion damage that has developed in a structure's headspace where an odor control air flow system did not operate properly for several years.

Summary

Odor control systems do not magically make H_2S gas disappear from the headspaces of wastewater tanks and structures. Rather, odor control ventilation systems pull foul air over headspace surfaces, which are wet and inhabited by sulfur oxidizing bacteria. Additionally, fresh air supply to these headspaces brings an ample supply of oxygen to the aerobic bacteria, ensuring their health and the proliferation of corrosion. Dead spaces in the airflow patterns have been shown to create zones of higher corrosion in headspaces with operating odor control systems, as well.

The ductwork and the other air handling and treatment equipment used for odor control systems suffer from biogenic sulfide corrosion when not constructed from corrosion resistant materials. The headspaces of the covered tanks and other wastewater treatment structures are an extension of the odor control air collection system. Hence, concrete and many metal surfaces in these headspaces must also be protected from corrosion

Because the sulfide species are in chemical equilibrium in wastewater environments, the free H_2S gas removed by ventilation will invariably be replaced by



more dissolved H_2S. The dissolved H_2S gas will, in turn, be replaced by the conversion of bisulfide (HS^-) to aqueous H_2S. This means that, despite ventilation, H_2S gas will continue to be released into the headspace atmospheres and pulled across the surfaces upon which it will condense and/or be absorbed and be transformed by the ever-present sulfur-oxidizing bacteria to sulfuric acid.

Two conditions would mitigate biogenic sulfide corrosion. The H_2S gas concentrations would have to be below 2 ppmv, and the surfaces over which the headspace air was pulled would have to be dry. Neither condition typically occurs in the subject headspaces. If these two conditions exist, they would be extremely short-lived. Creating these conditions through more air changes or better air sweeping is not pragmatic or economical.

The end result, thus, is consistent with what we see in real-world field applications. Ventilation associated with odor control cannot mitigate corrosion related to biogenic sulfide production of sulfuric acid. Rather, it simply reduces the severity of sulfide corrosion to our infrastructure. Corrosion protection is therefore required for headspace substrates despite the presence of odor control air treatment systems. In short, corrosion and odor are related issues in wastewater applications and require separate control measures.

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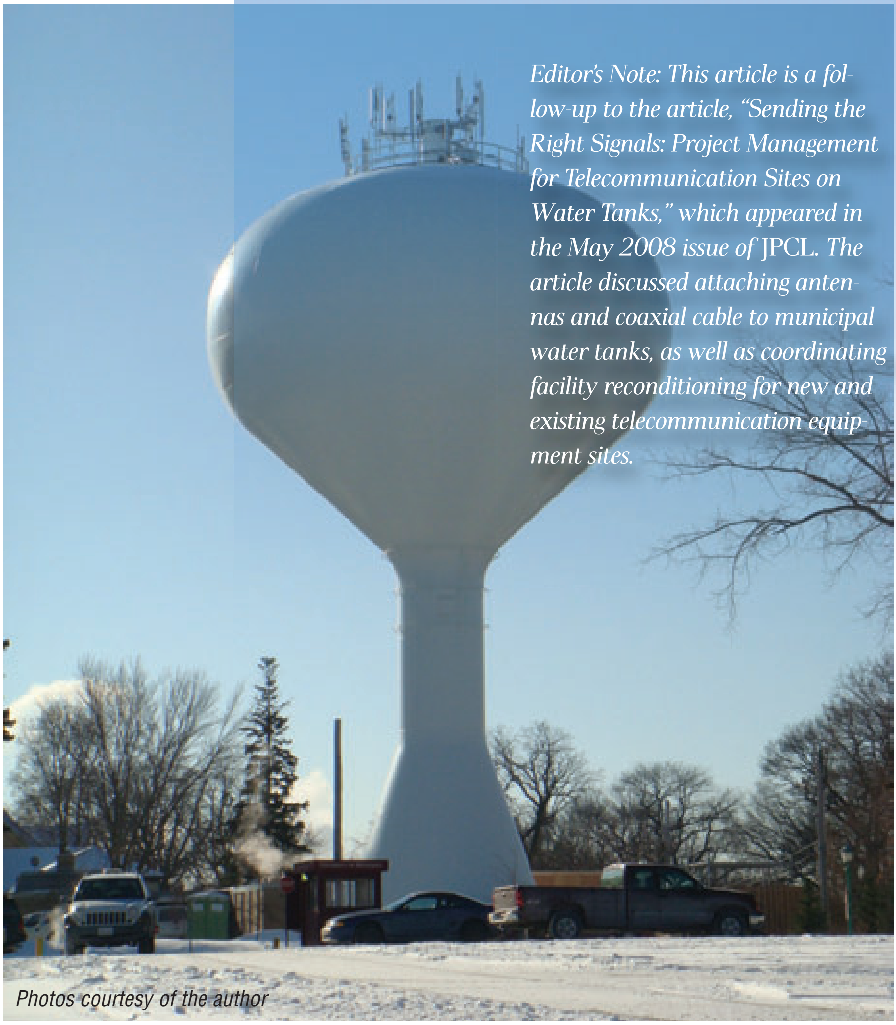
JPCL

ANTENNA AND CABLE ATTACHMENT METHODS FOR WATER TANKS: A COMPARATIVE STUDY

By Dan Zienty, SEH



Photos courtesy of the author

Editor's Note: This article is a follow-up to the article, "Sending the Right Signals: Project Management for Telecommunication Sites on Water Tanks," which appeared in the May 2008 issue of JPCL. *The article discussed attaching antennas and coaxial cable to municipal water tanks, as well as coordinating facility reconditioning for new and existing telecommunication equipment sites.*

The appropriate method for attaching telecommunications antenna and coaxial cable support brackets to water towers is based on factors such as the function/purpose of the bracket, the water tank design, and the tank's structural integrity requirements. Attaching antenna and cable brackets to existing water towers can damage the tower's metal structure and existing coating system. Connection fatigue due to wind vibration at the base metal of the tower is a concern, as is preserving the connected component. Though attachment by seal welding is the method most widely used, other methods can be used. Water tower owners and the tenants' engineers may not always agree on the most appropriate method for an installation. This article reviews three common attachment methods, specific concerns of owners and tenants about the methods, and a study to help owners and tenants decide on the appropriate method.

METHODS OF ATTACHMENT

- Stud-welding: Welds bolts to the base metal of the tower (tank) using a capacitor discharge or drawn-arc where a small spot of the protective coating has been removed. After welding, the surface directly around the stud should be cleaned and the coating re-applied at the affected area. This method does not damage the coating on the reverse side of the tank surface. Therefore, it is typically used on standpipes and ground storage reservoirs, where there is a need to avoid excessive damage to a coating system. Stud-welding has a high tendency for fatigue failure. Torque testing per the stud manufacturer's specification is recommended to verify the weld strength.
- Bolting: Involves fastening a shop-fabricated attachment (base plate) to the tower using through-bolts, with holes drilled through the tower's metal surface. Bolting can be applied to water towers with support columns, e.g., pedestal and fluted designs. The method results in the lowest structural fatigue concerns for the base metal of the tower and the attached component.
- Seal Welding: Involves direct fillet welding of the attachment base plate to the tower. It requires removal of the surface coating from the heat-affected

area of both the attached component and tower prior to placing a full fillet weld around the perimeter of the base metal. Typically, this method requires cleaning and repainting of the mounting surface and the backside of the surface due to the heat damage caused by welding. Water on the backside of the tower (immersion surface) can dissipate the welding heat and prevent coating damage. Welding is also a low fatigue prone method for the base metal of the tower and the attachment. NACE RPO-178 (www.nace.org) recommends that corners on the attached plate are radiused to reduce stress concentration.

TANK OWNER AND TENANT CONCERNS

The tenant's engineer usually selects the attachment method, based on the integrity of the tower attachment after it is installed. However, the engineer's decision does not take into account how the attachment method affects the owner's tank, with regard to coating integrity, nor does it take into account installation scheduling and costs to the tenant. The tower owner's concerns rest in maintaining the structural integrity of the facility and assuring the long-term serviceability of its protective coating. For instance, winter construction inherently limits the repairs that can be made to surfaces damaged by welding, which leaves surface areas unfinished and exposed. Exposed surfaces can lead to coating damage outside the initial area. For the contractor, returning in better weather to repair coating damage requires additional time and costs.

Owners and tenants may disagree on the merits of bolting and stud welding. But if structural considerations are not at issue, these methods can benefit the owner by minimizing initial damage to the tower, and they benefit the contractor (and tenant) by saving time and money. Many of these issues can be addressed through comprehensive specifications that contain thorough repair and inspection processes.

STUDY OF EFFECTS OF ATTACHMENT METHODS

Given the above issues, a study was conducted to determine whether stud welding or bolting can be used without compromise to the owner's facility and still meet the tenant's project scheduling and cost effectiveness goals. The study incorporated variations to the stud welding and bolting fastening sequence and tested five sample bracket attachment methods in a controlled environment that simulated typical exposure for telecommunications gear on water tank exteriors.

- Stud welding (copper studs) a painted bracket to the tank, with a rubber gasket between components
- Stud welding (copper studs) a painted bracket to the tank; seal around edges with silicone caulk
- Bolting a painted bracket to the tank, with a rubber gasket between components
- Bolting a painted bracket to the tank, with a silicone caulk seal around edges
- Seal welding a painted bracket to the tank

Study Prep

The study team used five panels of 12 in. x 20 in. x ¼ in. steel plates to simulate the tank surface and 6 in. x 8 in. x ¼ in. steel attachment plates to simulate the attachment bracket. Panel plates (Fig. 1) were prepared in a shop following standard AWWA (www.awwa.org) specifications OCS-5, DIO2-06, "Coating Steel Water-Storage Tanks," (two coats of a two-component epoxy followed by one coat of a two-component aliphatic polyurethane).

In addition, the study team incorporated its shop and field surface coating specifications, including surface preparation of the bare metal to an SSPC-SP 6, "Commercial Blast Cleaning" (www.sspc.org) with a 2- to 3-mil profile,

Fig. 1: 12 x 20 in. panels ready for accelerated laboratory testing

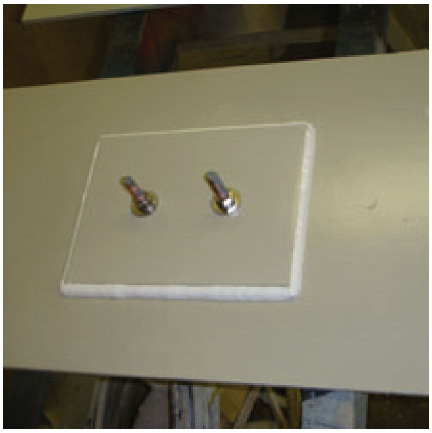


Fig. 2: Stud-welded panel complete (with neoprene gasket silicon caulk around edges)

followed by the application of prime and intermediate coats of epoxy (4 to 6 mils' dft), and a finish coat of polyurethane (2 to 3 mils dft) based on compatibility with the existing tank coating system. Inspections were conducted by a NACE-certified coating inspector during each phase of the process.

Stud-Weld Attachment Prep

For assembly of two panels using copper studs, the 12 in. x 20 in. plates were marked for stud location, and spot areas were ground down to expose bare metal. Studs were shot in two locations, and bare areas were touched up with a spray-on cold galvanizing product. Attachment plates were then fastened using nylon washers, followed by a stainless steel washer and lock washer, and stainless nuts (Grade F593C). Panel 1 had a neoprene gasket placed between the two plates before fastening (Fig. 2). Panel 2 had the two plates in direct contact with a bead of silicone caulking around the edges for a seal.

Bolt Attachment Prep

Assembly of panels 3 and 4 required drilling holes in the base metal plates in two locations each. Each hole was mechanically cleaned to remove burrs and sharp edges. The bare metal was then sprayed with a cold galvanizing product. Panel 3 had a neoprene gasket placed between the two plates prior to fastening. Panel 4 had the two plates in direct contact with a bead of silicone caulking around the edges for a seal. The study team used grade A325 bolts and washers for fastening, and the same fastening sequence as used for panels 1 and 2.

Seal-Weld Attachment Prep

For panel 5, the team masked around the edges of the attachment plate to simulate the practice of masking the edges of the bracket in the shop (to prevent contamination of the weld in the field). Following shielded metal arc welding, the damaged areas at the heat-affected zone (both plates) and the back side of the plate (tank side) were

Table 1: Results for ASTM D5894

@ 3 Cycles

Panel ID	Blisters ASTM D714	Rust ASTM Ds10	Other Observations*
Panel 1	10	10	Rust Bleed from bolts
Panel 2	10	10	Rust Bleed from bolts
Panel 3	10	10	No other effects
Panel 4	10	10	No other effects
Panel 5	10	9P (on top plate only)	No other effects

Note: There was some superficial light rusting or discoloration on all the panes on the base (large) plate
*Edge condition after taking panels apart not included here.

@ 6 Cycles

Panel ID	Blisters ASTM D714	Rust ASTM Ds10	Other Observations*
Panel 1	10	10	Rust Bleed from bolts
Panel 2	10	10	Rust Bleed from bolts
Panel 3	10	10	No other effects
Panel 4	10	10	No other effects
Panel 5	10	8G (on top plate only)	No other effects

Note: There was some superficial light rusting or discoloration on all the panes on the base (large) plate
*Edge condition after taking panels apart not included here.

cleaned to an SSPC-SP 11, "Power-Tool Cleaning to Bare Metal," to establish a minimum profile and feather the intact coating. The exposed areas then received two coats of epoxy and polyurethane. Each assembly was inspected before crating for shipment to the test facility.

Laboratory Test

The panels were sent for laboratory testing to compare the exterior exposure performance of the bracket assembly coating repairs using capacitor-studs, bolted assemblies, and seal-welded assemblies. When the lab received the panels, workers applied vinyl tape around the edges and back to protect these surfaces from the elements. The panels were then subjected to six cycles of corrosion weathering per ASTM D5894-05 "Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal" (www.astm.org).

The large panels were fitted into accelerated weathering test (QUV) cabinets horizontally, without using panel racks. In some cases, the panels were widened slightly by bending an aluminum panel around the edge, to form a "V." This practice enabled the panels to lie on the edge of the cabinet opening. Open areas in the cabinet were masked with bare aluminum panels. The panels were photographed and rated at Cycles 3 and 6.

Fig. 3: Cycle 6 results on stud-welded panels

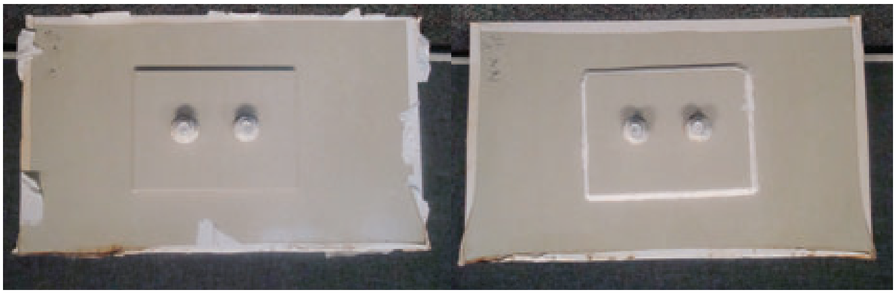


Fig. 4: Cycle 6 results on bolt attachment panels

Results

The results, represented in Table 1 and further explained below, are based on three ASTM standards.

- ASTM D5894-05: Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal
- ASTM D714: Test Method for Evaluating Degree of Paint Blistering
- ASTM D610: Test Method for Evaluating Degree of Rusting

Stud-Weld Results

Sample panels 1 and 2 showed extensive rusting at Cycles 3 and 6 (Fig. 3). However, the observed rusting was attributed to rust-bleed coming from the copper stud itself. Upon separating the plates, panels 1 and 2 showed no rusting on either plate surface. In addition, no rusting was observed from contact with the neoprene gasket, or direct contact with the edges sealed with silicone.

Bolt Attachment Results

Similar results were observed with the outer face of test panels 3 and 4 (Fig. 4), where oxidation appeared limited to the fastener materials (which were not an intended part of the study). It is possible that the bolts provided some sacrificial protection. After the panels were taken apart, results were similar to those observed with test panels 1 and 2; there was no rusting of either plate surface in contact with the neoprene gasket. Where the edges were sealed with silicone caulk, minor pinholing, typical at edges, was observed on panel 4 and was equivalent to No. 9 following ASTM D610, "Evaluating Degree of Rusting."

Seal Weld Results

Minor rusting from pinholing was observed equivalent to No. 8 on both the front and backsides of the panel at the heat-affected zone (Fig. 5.) On further observation, the pinhole rusting appeared to be the result of weld spatter not fully removed.

Fig. 5: Cycle 6 results on seal-welded panel

Further Inspection

All penetrations (holes) were inspected following plate separation to check for early signs of rusting, undercutting, or other modes of coating system failure around the edges. No failures were identified on any of the test panel plates.

CONCLUSION

Because of its structural properties, seal welding has been the preferred method for attaching support brackets for telecommunications equipment. However, the damage caused to the coating system, adjacent areas, and reverse-side immersed surfaces can be severe. This damage can add time and

costs related to tank draining/sterilization, spot repairs, equipment remobilization, and temporary sector shutdowns.

Simulated testing of exterior conditions indicated that properly painted and fastened stud welding and bolt attachment methods can perform as well as seal-welded attachments. Bolt attachments should always be installed opposite a dry tank interior and both methods must include strict adherence to specifications regarding shop surface preparation, painting, and inspection. The placement of a 1⁄16-inch neoprene gasket between the painted tank and bracket plate surfaces might provide better protection than silicone caulk against corrosion. Extensive rust-bleed was observed on plate surfaces from rusting copper studs, but it can be remedied by placing flexible plastic caps over the studs. It appeared that the use of a nylon washer, followed by a stainless or galvanized washer, and then a nut or bolt head might have been more effective in protecting the paint than the use of only a metal washer and a nut or bolt head.

The method of attachment should be based on the overall cost/benefit to the tenant and the tank owner. For the tenant, following the prescribed attachment fastening variations helps keep the project on schedule, reduce the potential for punch-list items related to weather, and decrease project costs. For the owner, the proper attachment and repair method will ensure the integrity of the tank and its coating system.

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Photos courtesy of the author

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Preventing Coating Damage in the Supply Chain of Pipelines

A completed and operational pipeline is the result of cooperation among parties in the supply chain. Their roles, which are sequential and overlapping, include the design, manufacture, surface preparation, coating, handling, storage, transport, and construction of the pipeline (Fig.1). Modern coatings such as three-layer polyethylene and fusion-bonded epoxy should resist damage associated with 'normal' handling and storage, but damage does occur because handling and storage are often done incorrectly. In fact, after a line pipe is coated, many logistic operations follow in which damage can be introduced[1] or is even inevitable.[2] The most common modes include those resulting from forces associated with impact or abrasion.[3] During field work, other types of damages are also encountered with 'normal' logistic operations.

If the pipe coating gets damaged during the logistics operations, it should be repaired. While each repair is project specific, the causes of damage and coating failure during logistics are not uncommon. Unfortunately, the failures might go unnoticed until they lead to in-ground coating problems.[4] For instance, some types of damage, such as UV degradation, can stay undetected for a long time or are very difficult to detect.[5] Awareness of the causes of damage to coatings between manufacture and installation is crucial to reduce in-ground coating problems.

Thus, the question arises: Can damages in the supply chain due to logistic operations be prevented or minimized? This article aims to shed some light on this issue, in part through in-house employee observations of coating dam-

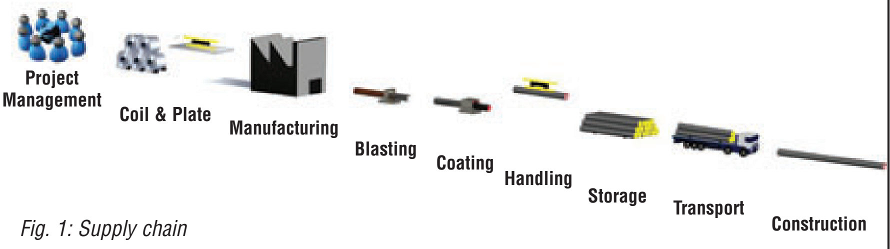


Fig. 1: Supply chain

age in the field during incorrect handling, storage, and transport of pipes. The results from the in-house findings were combined with a literature study to verify that types of damage between manufacture and installation are not specific or incident based but are generally encountered. This article then discusses the root causes of coating damage and ways to prevent it, including the use of special handling and storage equipment.

Handling of Coated Pipes

Pipes are handled multiple times in the supply chain as they are moved from the coating plant to storage, to construction. To make these transitions, the pipes are lifted and loaded on trailers, trains, or vessels. Lifting can be done with hooks, forklift, or hydraulic spreader, and vacuum equipment.

It is commonly known that badly designed pipe hooks can damage beveled pipe ends. Bevel protectors can be used to overcome the problem.[6] Less known is that hooks can also damage pipe coatings during loading operations. Buying a well-designed pipe hook is one thing, but knowing how to use it properly it is something different. Employees in the field have reported the careless use of hooks. For instance, hooks frequently hit the pipes, causing impact damage to the coating. Personnel who load the pipes and apply the hooks seem unaware that a coated pipe should be handled with care, especially in harbor environments where pipes are stacked high; unfortunately, the pipes are often treated as just another cargo that has to be loaded into the vessel as quickly as possible.

Proper handling of coated pipes is possible, even with pipe hooks. Employees must be made aware of the vulnerability of pipe coatings. But making people aware is not enough; you cannot address every single employee. Selecting adequate handling equipment is key.

Forklifts are frequently used for handling pipes. Damage to coated pipes is caused when forks are not covered with material that protects the pipe coating. In some harbors, workers have seen forklifts drive the forks into the open pipe ends and lift them, damaging the pipe, especially when coated inside. Custom-made forklifts with soft, covered grippers are available to hold the pipes when driving. There are also more efficient ways of handling pipes.

The best equipment for handling coated pipes are hydraulic spreaders or vacuum lifters. This equipment is designed to minimize the risk of damaging pipe coatings. An investment is required, but well worth the effort. Compared to other handling methods, the hydraulic or vacuum equipment needs fewer workers on the ground and reduces the time needed for loading and unloading.

Storage of Coated Pipes

Pipes are also stored a number of times before they reach their destination. In most cases, pipes are stacked on top of each other so that a fattened pyramid is built. During storage, the pipe coating is subject to hazards such as high pressure, overexposure to ultra-violet (UV) light, inadequate design of bottom support, and contamination.

Impact of Storage Method on Coating

When pipe stacks are built layer on layer, the forces on the bottom pipes can be calculated by multiplying the number of pipe layers by the weight of one pipe. The forces have to be transmitted by the bottom pipes to the ground. Pipes in the stack deform as a result of these forces. It is beyond the scope of this study to detail pipe deformation.[7] However, it should be noted here that when pipes are coated and stacked for storage, the coating is subject to the deformation forces as well. The resulting pressure on the coating must be considered to avoid damage.

The area that transfers the forces should be estimated carefully. The area could be the contact area between the pipes or the area between the bottom pipe and the support that carries the pipe. In either case, contact of the pipes at the 3 and 9 o' clock positions should be avoided, because the load on top of the pipes gives them, temporarily, an oval shape. When the pipe sides are in contact due to this change in shape, the pressure on the coating can become extreme. There should be just enough distance between the pipes to make sure that the sides do not come into contact, preventing deformation after the stack has been completed. To prevent contact between pipe sides, some manufacturers apply ropes around the pipes.

To support the pipes in a stack, every pipe should be blocked to prevent rolling. If stops are used only at the end of the stack, forces build up at the ends, so the practice is not recommended. The more layers of pipes there are, the more force adds up (Fig. 2). The diagonal lines in Fig. 2 represent the forces that the pipes transfer to the pipes underneath. The bottom pipes in the middle of a stack are subject to the same forces from the left and the right and are in balance. However, the forces on the outer pipes in the stack are not in balance. If only end stops are used, the bottom pipes transfer the forces to each other; the forces accumulate and are transferred to the last pipe. The end stop must then block the accumulated force, but doing so is not always possible. Depending on the surface of the end stop, the pressure on the coating can be (too) high. Steel supports like those shown in Fig. 3 only block the pipes at the end.

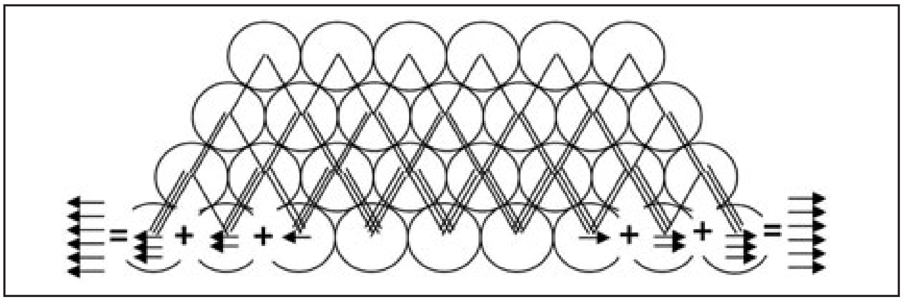


Fig. 2: Forces add up towards the end of the stack when using only end stops

Similar calculations of the area that transfers forces were made for stacks in a vessel. The pipes are blocked by the vessel's cargo hold and sometimes pipes are stacked higher in the vessel than on land.

As background for the development of a line pipe storage system, the current method of supporting pipes was studied. Sand berms and wood with wedges were used most often; less commonly used were steel profiles with only end stops.

Numerous examples of badly designed supports were found, such as sand berms that were poorly protected against weather (Fig. 4); in such cases, erosion had made pipe stacks unstable, creating safety risks (as well as risks to the pipe). These problems are especially common when berms are reused without rebuilding. The problems are amplified if the composition of sand and rocks for the sand berms are not specified, which is often the case. Although the time frame for storage is relatively brief compared to the time a pipeline lays in the ground, damage can occur during storage on sand berms. Norman[4] describes a case in which the sand berm was highly contaminated with salts, which affected FBE-coated pipes and caused pitting corrosion. Fortunately, good examples were also found where the sand berms were constructed following a predefined specification with polyethylene to cover the sand and periodic examinations to assess the stability of the berms.


Fig. 3: Steel end stop

Wood and wedges are used in various ways to support pipes during storage. Some parties write specifications for construction of wooden supports for pipe stacks; unfortunately, such specifications were not reflected by the supports observed during field work. Wood observed was heavily weathered and wedges were nailed at places where the nails could puncture the coating on the pipes (Fig. 5). When nails were not removed from the wood after the pipe was laid, they could damage the next pipe stored on the wood.

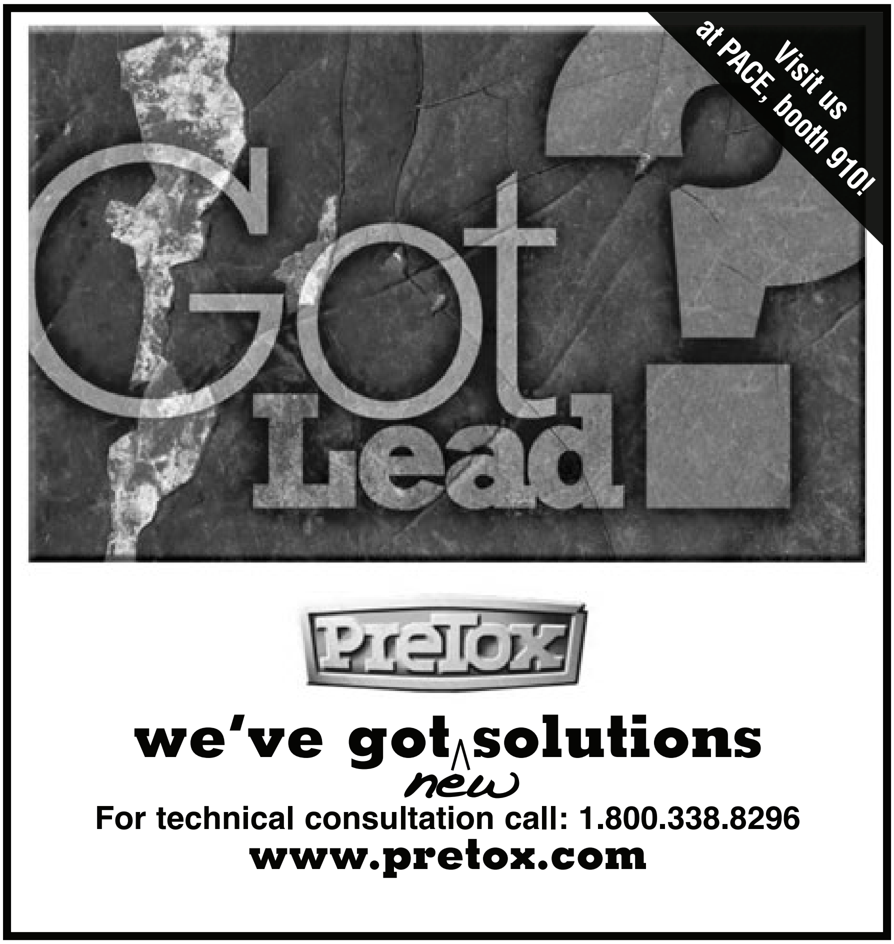
Based on these findings, a product was designed for supporting line pipes during storage or in vessels (Fig. 6, p. 44). The product is formed from low-density polyethylene compound wedges fixed onto a steel reinforced polyethylene compound gear rack. The gear racks can be connected to create the storage length needed. Pipes are raised off the ground by at least 80 mm, and settings can be made so that the distance between the pipes is at least 1% of the pipe diameter. The proprietary pipe stop grips the pipes with its wedges. Because there are two support surfaces instead of one, the deformation of the pipe is reduced. The prototype was

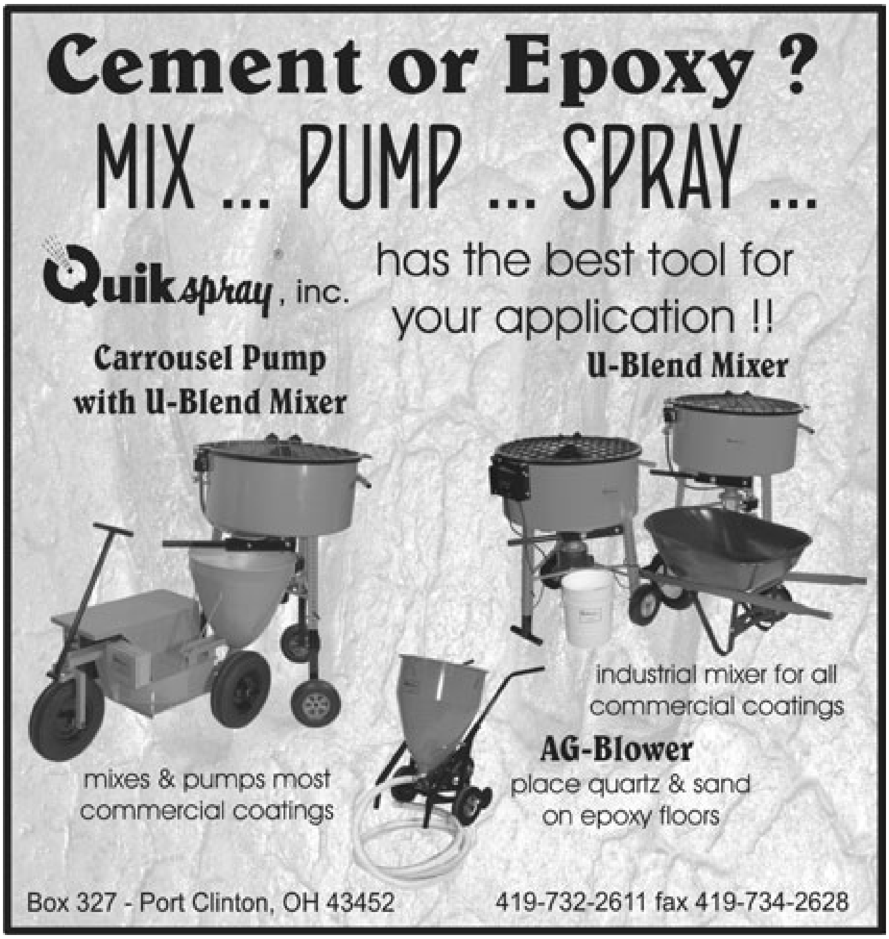
Fig. 4 (Left):
Eroded sand berm

Fig. 5 (Below):
Nails in poor location
on wedge support

tested for months with the cooperation of a large pipe factory, and the design will be checked and certified by TÜV, an independent German testing, certification, and qualification company, before the product enters the market.

UV radiation
UV radiation damage to pipeline is difficult to see with the naked eye. Serious consequences of UV radiation are addressed by Argent & Norman.[8] They give an example of severe coating embrittlement caused by UV radiation. Studies undertaken by Cetiner *et al.*[5] on FBE-coated pipes for the 3,700 km Alliance pipeline proved a loss in coating thickness and flexibility, and a loss of gloss with chalking as a result of degradation by UV light. They concluded that pipes stored outside for longer than one year should be protected against UV degradation. Adding UV stabilizer additives to the coating or using a special pipe stack cover can protect pipes from direct sunlight.





Contamination

Pipes are often contaminated when they are stacked for long periods at project locations or close to the sea. Contaminated surfaces stay moist longer in wet or humid environments. Pipes that were stacked for a long period for emergency repairs at a location in the Netherlands showed heavy weathering (Fig. 7) and contamination in and outside of the pipe, where the coating had disbonded at the pipe ends (Fig. 8). At various locations, objects were found inside the pipes such as tools, wood, animals, cans, and, once, a wheelbarrow (Fig. 9).

Fig. 6 (Top): 28-ton concrete coated pipes on the pipe stop
Fig. 7 (Above): Weathering of stored pipe

Temporary stock locations are often built at unpaved areas close to the construction site. In one case, on a stack of pipes with an inside diameter (Ø) of 1,219.2 mm, mud from passing truck tires had splashed up to the second layer on and inside the pipes. The mud added more labor to the project because the flow coating inside the pipe had to be cleaned.

Shipping pipes by sea is common. Before loading, pipes are stacked close to the port terminal in the humid and salty atmosphere. When the pipe is closed, moist air will be inside it. If the temperature fluctuates, this moist air will continually evaporate and condense, eventually leaving traces of salt on the bottom of the inside of the pipe.

Although the outside of the pipe is protected against corrosion, the inside of the pipe is not commonly coated for corrosion protection, although in some gas pipes, a flow-aiding coating is applied. Pipes should therefore be properly sealed with a product that is suitable for long-term application under fluctuating temperatures.

In the search for better ways to protect pipe during lifting and storage, a product was developed that can be affixed inside the pipe without interfering with the stacked pipe or with the interior of the pipe when lifted. The product also protects the bevel (Fig. 10). To avoid the accumulation of salt in the pipe, desiccant bags with chemicals that do not affect the internal coating, when applied, were developed. Calculations can be made for how many bags are needed depending on the pipe volume, application temperature, climate, and duration of closure. To assess whether desiccant bags need to be replaced, humidity indicator cards are applied to the inside of the plug to monitor the humidity level from the outside. When the indicators rise above a relative humidity of 30%, new desiccant bags can be inserted.

Fig. 8 (Top): Contaminated pipe ends
Fig. 9 (Middle): Wheelbarrow in pipe
Fig. 10 (Above): Closed pipe ends

Also new is the use of active radio-frequency identification and monitoring that allow the conditions of the pipe to be monitored on a computer.

Pipe Clamps

At many sites, a clamp is applied in the pipe-ends in a stack to keep the pipes together and to prevent the stack from collapsing. As described earlier, the heavy pipes exert high forces on the pipes on the bottom. The clamps must be designed to handle these forces. However, the clamps used in the field are not always resistant to the forces in a stack and can easily damage the inner coating of the pipe (Fig. 11). The arms of the clamps must be protected with a relatively soft material to prevent damage to the inner pipe coating.

To ensure that the market uses a satisfactory product, a pipe clamp was designed following a mathematical modeling of physical systems and subjected to practical tensile strength tests to validate the design. Resistance to twisting proved to be the limiting factor. With 20-mm-thick steel pipe clamps, tensile strengths over 80 kilo Newtons were reached, and with a safety factor of 2 that resulted in a safe working load of 40 kN. The arms of the clamps are covered with a soft plastic to protect the inner coating of the pipes (Fig. 12).

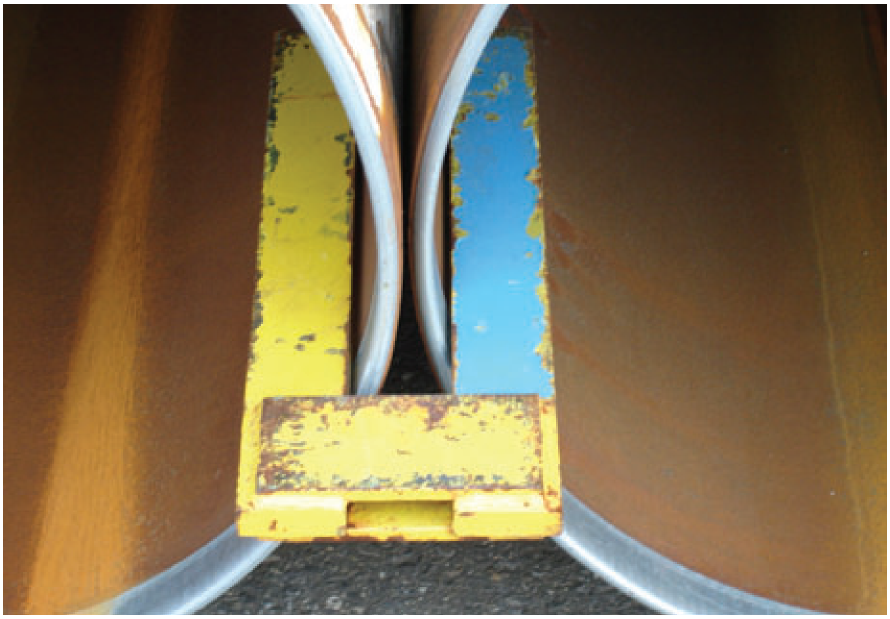


Fig. 11: Poorly designed pipe clamp

Transport of Coated Pipes

Within the supply chain, pipes are transported by truck, train, and ship. During transport, loading, and unloading operations, the pipe and its coating are vulnerable to being damaged.

Pipes need to be stable during transport. In many cases, to prevent pipes from shifting while in transit, wooden beams with wedges nailed on them are used. Because wood is a natural product, it has widely varying material properties, and weather changes can affect its strength. Various specifications were found for the design of wooden supports for line pipes during transport; however, in the field, few workers seem to be aware of the specifications, and the design of the support seemed to depend on the person who made it.

At some point after exposure, the wood is not strong enough to guarantee a safe situation, and employees and materials become exposed to risks. A small number of companies acknowledge the risks and, to avoid them, work with hardwood combined with reinforced steel plating.

Immediate threats to the pipe coating appear when the wooden supports are not constructed with care. Plenty of examples have been found during field work: broken beams, wedges too small to block the pipe, wedges not nailed to the beam, or nailed incorrectly. In some instances, the nails were located at points where the pipe was loaded, and they damaged the pipe coating (Fig. 13, p. 48).

Fig. 12: Pipe clamps in pipe ends

In 2004, using the guidelines for rail transport and VDI 2700 (Association of German Engineers. *Manual—Securing of loads on road vehicles*) as a starting point in combination with above described findings, the development of a safe system for supporting pipes during transport started. The final product is based on galvanized steel beams on which low density polyethylene compound blocks can be positioned to conform to the pipe diameter. The material was chosen for its low hardness compared to the hardness of pipe coatings. The pipe is carried in the wedge of the blocks, which makes the load much more stable compared to pipes carried by wood beams.

Before market introduction, extensive tests were performed to guarantee safety for coating and people, and the calculations that were made for the design were certified by TÜV. After market introduction, the system was expanded to respond to the suggestions of the parties involved. Suggestions included trestles that take into account the curvature of the pipe, and a construction that makes it possible to carry on a trailer two pipes with diameter ranges from 1,270 to 1,524 mm (50–60 inches), as shown in Fig. 14, p. 48.

Conclusion

Damage can be caused to the pipe coating due to logistic operations in the supply chain of a pipeline. A closer look at the root causes revealed that damage occurs during normal operations between manufacturing and installation.

The root causes of damage can be summed up as follows.

- Ignorance of the vulnerability of pipe coatings by parties involved
- Dangling pipe lifting hooks
- Forklifts with bare steel forks
- Extreme pressure on coating in badly supported pipe stacks
- Poor designed pipe clamps damage inner coating
- Unspecified composition of sand berms
- Contaminated sand berms (salts)
- Nail intrusions by badly designed wooden supports
- UV radiation when storage > 1 year
- Contamination at storage locations

Preventive action can be taken by selecting adequate equipment and products for handling, storage, transport, and construction. For each of these operations, the following equipment is suggested.

- Vacuum lifters, hydraulic spreaders, or well-designed pipe hooks for handling
- Pipe Stop for supporting the bottom pipes during storage
- Certified pipe clamps with coating protection
- UV-protection covers for pipe stacks for storage > 1 year
- Closure of pipes against contamination
- Desiccant bags for absorbing moisture in closed pipes
- Correct support of pipes during transport

Fig. 13: Coating damaged from nails on wedge support

Fig. 14: Transport of large diameter pipe

This study focused on damage to pipe coatings encountered during field work, root causes of the damage, and product development to avoid or minimize the risks of damage. Future research will be devoted to the damage introduced during pipeline construction and during direct coating-to-coating contact when transporting and storing pipeline.

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Soluble Salts and Coatings—An Overview

Part 1: A Summary of Recent Research on Allowable Amounts of Salts Tolerated beneath Coatings

By Kenneth B. Tator, P.E., KTA-Tator, Inc.

The issue of soluble salt contamination and the amounts of soluble salts that may be tolerated beneath a coating on a steel surface is of considerable interest and debate in the protective coatings industry. The issue is the subject of a two-part article, with Part 1 presented here and Part 2 to be published in an upcoming issue of *JPCL*.

Part 1 discusses ISO/TR15235, which itself summarizes and reviews some of the earliest reports on the issue. Part 1 also cites, summarizes, and, at times, quotes other notable research efforts. (However, it is highly recommended that interested readers obtain and read the full publications, both of ISO/TR 15235 and the other reports summarized, for all are far more complex, extensive, and, in some instances, controversial than can be described in the brief summary presented here.) Part 1 then presents tables, based on the articles discussed, summarizing tolerance levels of soluble salts on surfaces to be coated.

Part 2 will address mechanisms of coating and corrosion degradation by soluble salts, sources of salts, ways to recognize and test for the presence of salts, and conclusions based on both the research in Part 1 and on the chemistry and practical issues to be covered in Part 2.

The reader is advised that in the review and comparison of the published data presented in the reports summarized below, in some cases, some of the published data appears incomplete, and/or some test results show exceptions to the researchers' conclusions. Accordingly, while the researchers' conclusions are summarized below, the reader is again cautioned to read the entirety of the original publication in order to determine its applicability to specific circumstances. This review is intended to be a summary of key articles, not an assessment of the validity of all of the research.

Summary of Research

In "Chloride Contamination of Line Pipe-Its Effect on FBE Coating Performance,"[1] **Neal and Whitehurst** reported on tests in which they cleaned and prepared segments of 12-inch weathered pipe with various levels of chlorides, left another 12-inch segment of uncontaminated pipe as a control, and then treated the test segments with combinations of a phosphoric acid rinse, and various levels of chlorides before coating them with a fusion-bonded epoxy (FBE) applied in accordance with the manufacturer's recommendations. They assessed chloride tolerance by:

- cathodic disbonding (7 days at 65 C and 28 days at 25 C; platinum anode, 3 mm holiday, -1.5 V/calomel electrode) and
- hot water (65 C, 30 days) knife adhesion.

Their results showed an almost linear relationship between cathodic disbonding and chloride contamination: disbonding nearly doubled when the chloride contamination doubled. Satisfactory performance appeared to be 2 $\mu g/cm^2$ maximum. The amount of chloride remaining on the pipe surface after blast cleaning was 3 to 18% of the original level.

Phosphoric acid washing readily reduced chloride levels to 2 $\mu g/cm^2$ or less. However, they noted that residual phosphoric acid on the steel might adversely affect coating performance.

Steinsmo and Axelsen, in a paper entitled "Assessment of Salt Contamination and Determination of its Effect on Coating Performance,"[2] exposed steel test panels blast cleaned to SA 2.5 (Near-White Metal), then doped with various amounts of sodium chloride NaCl (25, 50, 100, and 300 mg/m^2) and ferrous sulfate $FeSO_4$ (50, 100, 300, and 600 mg/m^2), and then dried. [Note: mg/m^2 x 0.1 = $\mu g/cm^2$.]

Three different epoxy coating systems with a dry film thickness (dft) of approximately 200 μm (8 mils) were applied to the test panels using airless spray (Table 1).

Three different accelerated tests were performed to determine whether or how salt contamination affects coating performance.

- Water immersion—immersion in distilled water at 40±1 C for seven months
- Cathodic disbonding—tests according to ASTM G8, "Standard Test Methods for Cathodic Disbonding of Pipeline Coatings," and BS 3900 part F 10 "Determination of resistance to cathodic disbonding of coatings for use in marine environments." The test duration was not described.
- Cyclic Test, according to the Volvo Corporate Test, STD 1027 (15-minute salt spray on test panels and timed exposures to variable temperatures (35 C and 45 C) and relative humidities (50% and 95%). The test duration was 3 months and 10 days.

The Bresle patch method was used to extract salts from the contaminated surface. The authors state that the efficiency of the Bresle patch extraction is a function of extraction time and of salt concentration on the steel surface. (They used a five-minute extraction time.) Extraction efficiency increased as salt concentration increased (approximately 20% at the lowest salt contamination level to over 80% at the highest). They found that the amount of salt left at the steel surface after the extraction was in the range of 20 to 50 mg/m^2 at all contamination levels.

The authors concluded the following.

- *"Salt contamination at the steel/paint surface reduces the lifetime of the coating considerably when immersed in water.*
- *The salt contamination causes osmotic blistering. The blisters seem to reach a steady state where little or no further blistering occurs.*
- *Salt contamination promotes general coating degradation due to corrosion.*
- *Cathodic disbonding seems to be linearly dependent of salt concentration" (p. 83)*[2] [for both chloride and sulfate contamination; i.e., with no salt contamination, the disbonded distance from a defect in the coating is a given distance, and as salt contamination increases, the disbonded distance increases as a linear function with the increase in salt contamination.]
- The level of salt contamination of the test panel had no significant effect on corrosion creep at the scribe; and maximum scribe creep appeared to be a linear function of time (and not of salt contamination).
- Coating adhesion of the clear epoxy (system III) and the modified 2 coat epoxy (system II) dropped off as sulfate contamination increased.
- *"Zinc-rich primers have a positive effect on the coating system's tolerance to salt contamination at the steel/paint interface" (p. 83).*[2]

Table 1: Coating Systems Tested (Steinsmo and Axelsen)*

System	Type	DFT μm
I	zinc epoxy	35
	mod epoxy	150
II	mod epoxy	2 x 100
III	epoxy, clear lacquer	2 x 100

*From Reference 2, Table 3

Only at the highest level of sulfate contamination—600 mg/m^2 (60 $\mu g/cm^2$)—was there any significant adhesion reduction of system I.

The authors suggest a maximum level of 20 mg/m^2 (2 $\mu g/cm^2$) sodium chloride equivalent to assure coating performance for immersion in water or exposure to marine atmospheres.

Another document worth noting is Technical Report ISO/TR 15235, from **ISO TC 35 SC 12 WG-5** (October 15, 2001): "Preparation of steel substrates before application of paints and related products—Collected information on the effect of levels of water-soluble salt contamination."[3] Ken Tator is Convenor of the WG-5 work group. During the course of work, the work group reviewed original published coating literature where salt tolerance testing was reported to determine if there was a consensus regarding the amount of salt that could be tolerated beneath a coating: 168 publications reporting test results were surveyed up to approximately 1995.

Ten of those publications[4] reported original testing, and their data was collated and summarized in the ISO report. There was no consistency in the coating systems tested, the number and thickness of coats, the type and duration of laboratory and/or field tests used, the means of contaminating panels with soluble salts, the means of measuring or extracting salts from the surfaces being assessed, and the means of assessing coating deterioration, or of determining coating failure.

Tabular data was presented in ISO/TR 15235 as follows.

- Annex A summarized the test results from the 10 qualified publications.
- Annex B reported data from a single coating manufacturer who used stan-

dard laboratory testing procedures for the assessment of salt tolerance for its products.

- Annex C summarized recommendations from 12 coating system manufacturers regarding toleration of salt contamination on a steel surface for their products.
- Annex D summarized, from Japanese work, practical, allowable levels of water-soluble salt contamination before application of paints and related products for steel bridges, and chemical and other industrial plants.

Because of the many variables reported in the literature, protocols for future work were the following.

- Annex E provided a surface inspection protocol for the assessment of soluble chloride and/or sulfate contamination on a steel surface.
- Annex F provided a Recommended Test Procedure when investigating the influence of soluble chloride and/or sulfate contamination on coating service life.

B.P. Alblas and A. M. van Londen conducted a literature review in 1997 entitled "The Effect of Chloride Contamination on the Corrosion of Steel Surfaces."[5] They reviewed some of the publications in ISO TR15235, as well as additional publications. They stated after surveying 32 publications that "*at present, a maximum allowable chloride level of 20 mg/m*^{2} [2 µg/cm^2] *can be taken as a safe critical value" (p. 23).*[5]

They further concluded:

> *"It is not possible to establish a definitive allowable level of chloride contaminants. A maximum chloride level of 10 to 50 mg/m*^{2} [1 to 5 µg/cm^2] *is allowed, depending upon the use and exposure conditions. This is only a rough guideline. Under specific conditions, higher maximum levels of chloride (up to hundreds of mg/m*^{2}*) are allowed for special, durable paint systems (e.g., zinc silicate). Exposure to marine conditions and/or industrial environments considerably increases the chloride contamination on steel. Abrasive blasting does not remove all the chloride. Results of detection methods for soluble chlorides are affected by temperature, mechanical forces, and the chemicals and type of analytical method used" (p. 25).*[5]

H. Mitschke reported on the "Effects of Chloride Contamination on the Performance of Tank and Vessel Linings."[6] He concluded that *"these results* [exposure in tap water] *demonstrate that chloride threshold levels varied considerably (about 4-20 µg/cm*^{2} *at 75 F [24 C]) for nine different modified epoxy linings* [epoxy, epoxy-phenolic and epoxy-novolac]. *For elevated service temperatures* [190 F, 88 C], *even 1 µg/cm*^{2} *has an effect that lowers the maximum service temperature of the lining by about 10 degrees F (6 degrees C). Also, there does not appear to be a significant long-term deterioration for chloride levels at or below the threshold level.... Most but not all the linings used in the gasoline/water immersions were found to have lower thresholds for chloride than for immersions in water only.... In many cases, especially at elevated temperatures, the maximum allowable amounts* [for water/gasoline] *could be non-detectable levels" (p. 56).*[6]

B. Appleman, in his publication, "Advances in Technology and Standards for Mitigating the Effects of Soluble Salts"[7] discusses, among other things, data on the effectiveness of wet and dry methods in removing chlorides. Tabulated data in his publication, "Comparison of Salts from Wet and Dry Cleaning Methods," is presented in Table 2 of this article.

Appleman found that wet blasting (abrasive blast cleaning with water injection) is most effective in removing soluble salts (96.2% extracted), closely followed by water jetting and UHP water jet. White

Table 2: Comparison of Salts from Wet and Dry Cleaning Methods (Appleman)*

Method	Remaining Salt (µg/cm2)	% Extracted
Wet blasting	0-3.2	avg: 96.2%[a]
Water jetting (35 ksi)	0-2.4	avg: 95.9%[a]
Hand tool (SP 2)	160-288	avg: 43.8%[a]
Power tool (SP 3)	212-296	avg: 35.4%[a]
Blast (SP 6)	44-68	avg: 83.0%[a]
UHP water jet	1.6-1.8	avg: 93.5%[b]
Blast (SP 10)	3.3	84%[b]
Needle gun (SP 3)	11.4	3%[b]
Wire brush (SP 2)	15.2	9%[b]
Blast (SP 5)	<3.2-3.4	avg: 90.2%[c]
Power tool (SP 3)	16.2-24.1	avg: 43.5%[c]
SP 3 + steam	8.6-12.9	avg: 69.9%[c]
Power tool (SP 11)	7.0-13.9	avg: 72.1%[c]
SP 11 + steam	3.9-7.7	avg: 84.5%[c]
Power tool (SP 3)	22-97	avg: 45.4%[d]
Power tool (SP 11)	41-124	avg: 17.2%[d]

*From Reference 7, Table 3

[a] Salts extracted by Bresle and analyzed by conductivity

[b] Methods not included in paper

[c] Salts extracted by boiling and analyzed by selective ion electrode

[d] Salts extracted by swabbing and analyzed by conductivity

Table 3: Flash Rusting vs Surface Chlorides (Richards)*

Surface Contamination, NaCl (µg/cm^2)	Time to Visible Discolouration (Hours)
3.5	120
5.3	20
30.9	0.5

*From Reference 8, Table 6

Table 4: Contamination Levels at Coating Metal Interface Studied by All Partners (µg/cm^2) (EC Report)*

Chloride ($NaCl$)	Sulphate ($MgSO_4$)	Chloride/Sulphate combination	Chloride ($CaCl_2$)	Nitrate ($NaNO_3$)
5, 10, 15, 20	10, 20, 30, 40, 50	5:10, 5:20, 5:40, 10:40, 20:40	5, 10, 15	10, 20, 40

*From Reference 9, Table 2

metal blast cleaning (SSPC-SP 5) is the best non-water technique, followed by Near-White (SSPC-SP 10) and commercial blast cleaning (SSPC-SP 6). SSPC-SP 11 (Power Tool Cleaning to White Metal) plus steam cleaning is comparable to all blast cleaning methods, and all other surface preparation methods (other blast cleaning plus steam cleaning as well as power tool and hand tool cleaning) remove fewer contaminating salts.

D. M. Richards, reporting on the "Effects of Salt Contamination of Abrasives on the Performance of Long Life Coatings for Steel,"[8] showed that abrasives contaminated with increasing amounts of salt when used for blast cleaning will deposit increasing amounts of salts onto a steel surface. He established abrasive specification limits of 150 mg/kg of total dissolved salt for his abrasives; 105 mg/kg of NaCl in the abrasive; and a salt surface contamination maximum of 3.5 µg/cm^2.

He correlated flash rusting versus surface chlorides (20–26 C, 45–75% RH), shown in Table 3 of this article.

In the same article, Richards referred to a separate study in which he concluded that the traditional 3 C (5 F) minimum surface temperature above the dew point criteria may be inadequate when certain salts, notably zinc chloride and calcium chloride, remain on the substrate.

He also correlated sodium chloride conductivity with surface salt level and diagrammed the correlation. He concluded that conductivity, used as a tool, may be useful as an indicator of salt contamination levels.

The **European Commission** in 2005 issued a technical steel research finishing and coating report entitled "Soluble Salt Contamination on Blast-Cleaned Surfaces, and the Effect on the Durability of Subsequently Applied Coatings."[9] The EC funded the study.

The main objective of the testing was to assess the impact of salt contamination on steel on the performance of a subsequently applied coating and to establish realistic working limits for such salt contamination prior to coating application. Freshly blast cleaned panels (Sa 2.5, Near-White) were seeded with different levels of the appropriate salt ($CaCl_2$, $NaCl$, $NaNO_3$, $MgSO_4$) at appropriate concentrations (Table 4). Samples without any surface contamination were used as a control.

Also, chloride contamination was introduced onto some test panel surfaces by exposure for 30 hours in a 5% salt spray cabinet, and to sulfate in a Kesternich cabinet. The contaminated test panels were overcoated with the systems shown in Table 5.

Three coating systems (SC1, SC2, SC4) were exposed for 30 months in a

Table 5: Details of the Coating Systems with Generic Name, Recommended Dry Film Thickness and Uses (EC Report)*

Coat. ID	Generic name	Thickness µm (mils)	Exposure environment
SC1	Zinc silicate pre-fabrication primer	25 (1)	Raw/potable/distilled water, Atmospheric
SC2	Zinc rich epoxy primer MIO finish Acrylic urethane gloss finish	50 (2) 125 (5) 50 (2)	Raw/potable/distilled water, Atmospheric
SC3	Fusion bonded epoxy powder	350 (14)	Raw/potable/distilled water, Atmospheric, Marine Immersion, and Splash Zone
SC4/ M400	Glass flake epoxy with zinc phosphate anticorrosive pigments	400 (16)	Raw/potable/distilled water, Atmospheric
T300	MIO polyamide epoxy primer Glass flake polyamide epoxy base coat	50 (2) 250 (10)	Marine Immersion and Splash Zone
T500	MIO polyamide epoxy primer Glass flake polyamide epoxy base coat	50 (2) 450 (18)	Marine Immersion and Splash Zone
S450	Polyurethane zinc primer Polyurethane base coat	150 (6) 300 (12)	Marine Immersion and Splash Zone

*From Reference 9, Table 1

Table 6: Critical Levels of Soluble Salt Contaminants for Each Coating System Tested in Different Service Environments (EC Report)*

Coating system	Immersion/Splash		Atmospheric		Cathodic Disbonding	
	Cl^- µg/cm^2	SO_4^{-2} µg/cm^2	Cl^- µg/cm^2	SO_4^{-2} µg/cm^2	Cl^- µg/cm^2	SO_4^{-2} µg/cm^2
Zinc silicate primer (SC1)	Not Available	Not Available	15$^+$	20$^+$	Not Available	Not Available
Fusion bonded epoxy (SC3)	10	40	15	50	<5	40**
Glass flake epoxy (SC4/M400)	5	<10	15	20	<5	<10
Mio polyamide primer + glass flake epoxy polyamide (T300 & T500)	Critical levels not determined, adhesion tests performed only on the highest levels, however, trends suggest similar tolerance as Glass Flake Epoxy (SC4)				NA	Not Available
Zinc rich three layer system (SC2 & S450)$^{++}$	40	40	40	40	NA	Not Available

*From Reference 9, Table 24

**Cannot be higher than levels for immersion +Based on six months natural exposure ++ Similar performance achieved

rural atmosphere in El Pardo-Madrid, Spain; SC1 panels were exposed for 6 months in a rural atmosphere in Rotherham, UK; and SC2, SC3, and SC4 panels were exposed for 24 months to the marine atmosphere of Rye, UK. Coated, pre-contaminated test panels (SC4, SC5) were also exposed to the splash and immersion zones in the harbor of Boulogne-sur-Mer in the French channel. Both exposures lasted 21 months. Natural contamination on blast-cleaned steel panels was induced by exposing the panels for 3 months in 3 different Spanish exposure sites: Madrid (urban), Avilés (industrial), and Cabo Vilano (marine).

Additionally, pre-contaminated, coated test panels were exposed to laboratory accelerated tests (cyclic humidity, condensing humidity, hot potable water immersion, cyclic hot salt spray, salt spray, and immersion in artificial seawater). After exposure, panels were assessed for coating deterioration through visual examination of the plane surface areas; visual evaluation along the scribe; and examination of the change in adhesion strength and fracture type of the coating. Most samples of all systems showed significant blistering and rust creep at the scribe, including the reference (uncontaminated) samples, independent of the level of soluble salt contamination. In these cases, the effect of the aggressive exposure environment was more detrimental than the pre-contaminated salt levels on the panel surface beneath the coating.

Table 24 of the report, reproduced here as Table 6, summarized the critical levels of soluble salt contaminants for each coating system tested in different service environments.

It is clear to the researchers that different coating systems could tolerate different levels of residual salts, and the maximum salt levels for a specific coating system varied, depending on the exposure conditions.

(The EC report is quoted below at length because in Tator's opinion, the EC-funded study, prepared by several teams of researchers, is the most comprehensive study on the subject to date and deserves special attention.)

The researchers remark that *"[t]he doping method used to determine soluble salt limits was a worst case method and the limits suggested by the work and reported in Table 24 are likely to be conservative."*[9]

They also say: "*Table 24 illustrates the suggested contamination levels, which can be tolerated by each of the coating systems studied in this project under relevant exposure conditions. Three different service environments have been suggested, Immersion/ Splash, Atmospheric, and Cathodic Protection Conditions. In each environment it appears that different levels of contamination can be tolerated and even within a particular category, the various coatings evaluated can tolerate different levels."*[9]

"The zinc-rich coating systems are most tolerant of salt contamination. Three zinc-rich systems were tested, a zinc-silicate preconstruction primer applied at 25 microns (1 mil), an epoxy zinc system (SC 2) and a polyurethane zinc system (SC 450). The latter two full thickness systems had good tolerance for salt contamination, while the thin preconstruction primer's salt tolerance was comparable with all other coating systems in the atmospheric exposure."[9]

"The deleterious effect of sulfate contamination, particular under immersion and cathodic protection conditions was surprising, either when present alone or in combination with chloride."[9]

"The two systems evaluated under

cathodic protection were both very sensitive to contamination. The FBE (fusion bonded epoxy) appeared sensitive to chloride but not sulfate while the single coat GFE (glass flake epoxy) was sensitive to both.” [9]

“The values on maximum tolerable contamination levels are thought to be conservative, in that artificial doping was felt to be more aggressive than natural contamination.” [9]

“Potable water immersion test seems to be the most critical accelerated test for the evaluation of the effect of soluble salts at the steel/coating interface.” [9]

In addition, the researchers investigated the effectiveness of various cleaning methods of removing soluble salt contamination from the steel surface prior to coating application.

The conclusions of this portion of the EC Report are as follows:

- *“Blast cleaning appears highly effective in removing both Cl^- and SO_4^{-2} where contamination levels are low or when relatively high but also freshly deposited. In fact at all levels of SO_4^{-2} no matter how distributed, blast cleaning was effective at removing it to acceptable levels. The picture for Cl^- contamination, however, is less clear. It appears that when extensive pitting of the steel has occurred over a significant period of time then even a combination of high pressure water washing and blast cleaning struggles to bring down the levels to below 20 µg/cm^2, presumably because of entrapment deep in the bottom of corrosion pits.”* [9]
- *“Extent and the distribution of salt at the interface are not a straightforward function of exposure time, but can be influenced by the weather conditions.”* [9]
- *“Blast cleaning is effective under conditions where residual levels are low or where the steel has not been allowed to corrode (pit) excessively.”* [9]
- *“High pressure water cleaning accompanied by blast cleaning can be required where contamination levels are high or where excessive pitting has occurred.”* [9]
- *“Commercially available chemical cleaning solutions were shown to be not effective.”* [9]

The report also investigated the effects of salt contaminated abrasive grit, and concluded *“the transfer of the soluble salts contamination from polluted abrasives to a blast cleaned steel substrate was at risk for abrasives with conductivity values in the range 1000-3000 µS/cm. If metallic grit is recycled when blasting severely contaminated surfaces, frequent control of the grit is recommended to avoid the transfer of soluble salts onto the substrates.”* [9]

The EC report showed in graphs and tables the levels of chlorides and sulfates both before and after blast cleaning in various atmospheres.

The report, in a separate study assessed various methods of extracting chlorides and sulfates both before and after blast cleaning in various atmospheres. The report concluded *“As can be seen, the extraction efficiency was always higher after cleaning. This is because the contaminant that is trapped in the rust and difficult to leach out, is loosened after cleaning.”* [9]

Test panels were also exposed at natural weathering sites and after various exposure durations. The panels were cleaned by various cleaning methods and analyzed to determine the amount of residual salt contamination. *“The determination of the contamination was carried out by extraction in boiling water and then by quantification with ion chromatography. The contamination values measured by ion chromatography… each value is the average of three measurements.”* [9]

The values are given in Figures 1 and 2, which are Figures 60 and 61 in the EC report.

“The results disclose that contamination does not depend on the exposure duration but rather on the season of exposure. During rainy weather, contamination is washed from the surface. Contamination by salt spray in marine environments is likely to increase in the autumn (in Europe) due to storms.” [9]

Additionally, a 2007 publication by **D. de la Fuente, M. Bohn, C. Houyoux, M. Rohwerder and M. Morcillo** entitled “The Settling of Critical Levels of Soluble Salts for Painting”[10] describe some of the same testing that was detailed in the European Commission report. This is not surprising, because the authors helped write the European Commission report.

Baek, Park, Kim, Chung and Park, in a paper entitled “Effect of Blasted Surface Contaminants on Coating

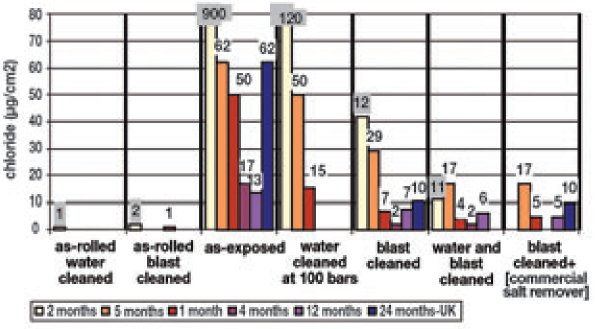

Fig. 1: Panels exposed in Boulogne-sur-mer for 1,2,4,5 and 12 months and in Rye (UK) for 24 months, chlorides contamination measured by chemical analysis (Fig. 60 in EC report)[9]

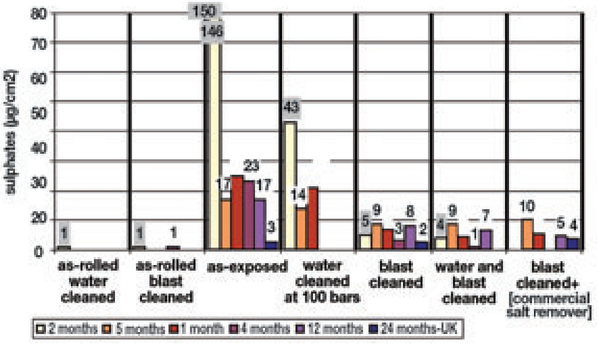

Fig. 2: Panels exposed in Boulogne-sur-mer for 1,2,4,5 and 12 months and in Rye (UK) for 24 months, sulphate contamination measured by chemical analysis (Fig. 61 in EC report)[9]

Performance,"[11] contaminated, with various levels of sodium chloride, test panels blast cleaned to SA 2.5 (Near-White). The contaminated panels were then overcoated with commercial epoxy coatings currently used in shipbuilding industries for water ballast tank sections and other immersion service. The test panels were then exposed to the NORSOK-M501 (revision 4) cyclic test consisting of 80 hours of exposure in a QUV weathering chamber, 72 hours in a salt spray chamber, followed by 16 hours of drying in an ambient environment. All coatings were subjected to 25 cycles for a total of 4,200 hours.

Based on the test results, for commercial epoxy coatings generally used for water ballast tank sections, the authors suggest *"the maximum allowable chloride to be 50~70 mg/m^2* [5 to 7 µg/cm^2] *for immersion service. However, the maximum allowable chloride level ma*[*y*] *vary with different coating systems and in different service condition (p. 5)."* [11]

Morcillo and Simancas, in their paper, "Effects of Soluble Salts on Coating Life in Atmospheric Services," reported the results of 14 years of test panel exposure testing in urban, rural, and industrial atmospheres and 4.5 years of panel testing in marine atmospheres.[12]

- Rural, urban, and industrial environments: Hot rolled steel was shot blast-cleaned to SSPC-SP 5 "White Metal" and contaminated with 20, 100, and 500 mg/m^2 NaCl, (2, 10, and 50 µg/cm^2 respectively, and Cl$^-$ of 12.1, 60.7, and 303.4 mg/m^2) and 150, 250, and 500 mg/m^2 $FeSO_4$ and 94.7, 157.9, and 315.8 of mg/m^2 $SO_4^{=}$ respectively). Alkyd, polyurethane, epoxy-polyurethane, and zinc silicate (untopcoated and topcoated) coatings were applied at 4 thicknesses on the panels. The test panels were exposed in rural, urban, and industrial atmospheric environments for 14 years. The authors conclude that *"chloride interfacial contamination (303.4 mg Cl$^-$/m^2)* [about 30 µg/cm^2] *supposes a high risk for the integrity of all of the paint systems exposed… except those with a zinc silicate primer.…Sulfate contamination (up to 315.8 mg $SO_4^{=}$/m^2)* [about 32 µg/cm^2] *does not seem to visibly affect*

Table 8: Salt Water Immersion (Tator Summary)

Tolerance Level (µg/cm^2)				
Coating System	**Chloride (Cl$^-$)**	**Ref**	**Sulfate (SO_4^{2-})**	**Ref**
Organic 3 coat*	50	TR-6	50	TR-6
	5	TR-6	40	TR-6
	5-16	TR-9	40-125	TR-9
	2	Steinsmo**		
	5-7	Baek		
Zinc Rich 3 coat	40	EC	40	EC

**non-zinc-rich coating system, usually an epoxy, except as indicated otherwise by FBE, GTE*
***Steinsmo and Axelsen tested an organic 2-coat system*

TR-refers to ISO Technical Report 15235, and the reference cited is the reference in the document.
Those references are presented in Appendix 1 of this paper.
EC refers to the European Commission study.
Other references are by author, and the reference is footnoted in this paper.

Table 7: Fresh Water Immersion/Condensing Humidity (Tator Summary)

	Tolerance Level (µg/cm^2)				Cathodic Disbonding Tolerance Level (µg/cm^2)			
Coating System	**Chloride (Cl$^-$)**	**Ref**	**Sulfate (SO_4^{2-})**	**Ref**	**Chloride (Cl$^-$)**	**Ref**	**Sulfate (SO_4^{2-})**	**Ref**
Organic 3 coat*	5	TR-4	20	TR-4	2-FBE	Neal		
	50	TR-6	90	TR-6				
	4-20	Mitchke						
	10-FBE	EC	40-FBE	EC	<5-FBE	EC	40-FBE	EC
	5-GFE	EC	10-GFE	EC	<5-GFE	EC	<10-GFE	EC
	5	TR-10	250	TR-10				
	2	Steinsmo**						
	5-7	Baek						

**non-zinc-rich coating system, usually an epoxy, except as indicated otherwise by FBE, GTE*
***Steinsmo and Axelsen tested an organic 2-coat system*

TR-refers to ISO Technical Report 15235, and the reference cited is the reference in the document.
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Other references are by author, and the reference is footnoted in this paper.

the integrity of the different paint systems tested, at least during the first 8 years of atmospheric exposure" (p. 49).[12] However, after 14 years, *"deterioration induced by sulfates has been observed at the interface in some of the paint systems, particularly at the highest contamination level (315.8 mg $SO_4^=/m^2$) and the lowest dry film thicknesses.…Paint systems that incorporate a zinc silicate primer with a high zinc content seem to tolerate interfacial saline contamination analyzed in this study" (pp. 49-51).*[12]

- Marine environments: chloride levels of 5, 10, 25, and 100 mg/m^2, and sulfate levels of 500, 1,000, and 2,500 mg/m^2 were used to contaminate test panels that were exposed in marine atmospheric, salt water immersion, and alternate immersion environments for 4.5 years. At the time of the paper, only the marine atmospheric exposure results were available. The authors concluded that *"Interface contaminations of 500 mg/m^2* [50 µg/cm^2] *or greater of $SO_4^=$ or 100 mg/m^2* [10 µg/cm^2] *or greater of Cl^- suppose a high risk for the integrity of most of the paint systems in marine atmospheric service conditions. Again, however, contamination levels below these ranges, particularly with the smaller film thicknesses than those normally specified and prolonged exposure times, may also suppose a high risk of premature failure for some paint systems" (p. 51).*[12]

Tolerance Limits of Salts Beneath Coatings

Experience and the research cited above have shown that there appears to be a threshold limit of salt contamination that a given coating/coating system may tolerate in a given environment. Unfortunately, there are infinite variations of environments and a wide variety of coating systems, especially when coating thickness and surface preparation variables are considered.

However, having said this, perhaps

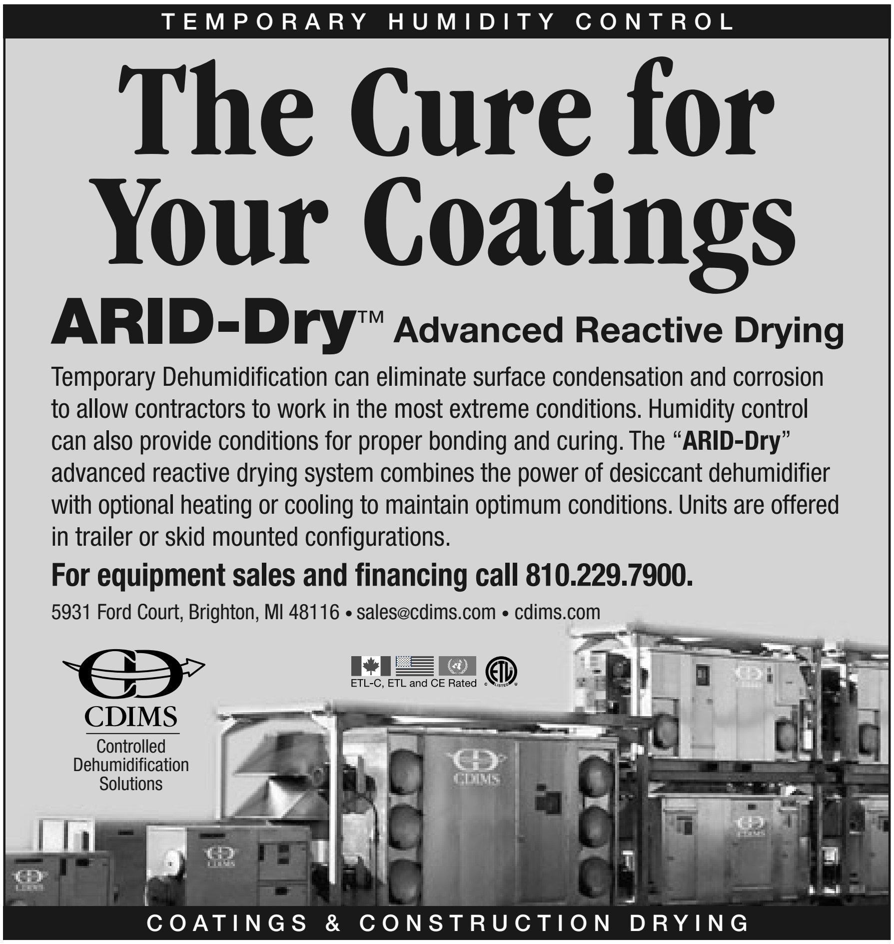

Table 9: Atmospheric (Industrial Marine) (Tator Summary)

Tolerance Level (µg/cm^2)				
Coating System	**Chloride (Cl^-)**	**Ref**	**Sulfate ($SO4^{2-}$)**	**Ref**
Organic 3 coat*	<10	TR-2/3	100	TR-2/3
	10	TR-5	50	TR-5
	<10	TR-9	<20	TR-9
	15-FBE	EC	50-FBE	EC
	15-GFE	EC	20-FBE	EC
	2	Steinsmo**		
	10	Morcillo, Ref. 12	50	Morcillo, Ref. 12
Zinc Rich 3 coat	>50	TR-5	50	TR-5
	7 to <50	TR-9	14 to <100	TR-9
	40	EU	40	EU
	>30	Morcillo, Ref. 12	>50	Morcillo, Ref. 12

**non-zinc-rich coating system, usually an epoxy, except as indicated otherwise by FBE, GTE*
***Steinsmo and Axelsen tested an organic 2-coat system*
TR-refers to ISO Technical Report 15235, and the reference cited is the reference in the document.
Those references are presented in Appendix 1 of this paper.
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Other references are by author, and the reference is footnoted in this paper.

some generalities can be made for guidance purposes. Tables 7–9 (pp. 58–60) , prepared by **Tator**, summarize the results of the research efforts reported above, including ISO TR 15235.

The reader is cautioned that this summary, done by the author, did require some interpretation of data, and examination of testing detail. It is a summary of information presented in the original publications. The original publications have more detail and include some coatings/coating systems that were omitted by the present author. Because there was little information on testing conditions besides fresh and salt/sea water immersion and atmospheric exposure, only those exposure conditions are included in Tator's summary Tables 7-9. Similarly, because there was little information regarding the effect of nitrates or other anions, and no information on the effects of cations, those species are not included in the tables. Only coating systems were considered (not clear and thin, single-coat epoxies, or pre-fabrication zinc-rich primers); some coating systems not currently used, such as vinyl and chlorinated rubber systems, were not included. The reference for each entry is provided.

Discussion of the Threshold Limits Summary Tables

There appears to be a high variability between researchers on the tolerance of coatings they tested for salt contamination. This wide variation likely results from their testing of different coating systems (different formulations, and thicknesses); different tests and testing procedures; different means of artificially contaminating test panels; and differences in the researchers' definitions of "failure." However, some broad-based trends can be seen.

- Chloride salt contamination is more critical than sulfate contamination.
- Coating systems with a zinc-rich primer have more salt tolerance.

- Coating systems exposed in atmospheric environments are more tolerant to salt contamination than those in immersion.

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Appendix 1

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Ken Tator has been Chairman of the SSPC Research Committee and numerous other SSPC and NACE committees; a member of SSPC's first Board of Directors; Director of NACE; and writer for *JPCL*, SSPC, NACE, and ASM.

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SSPC's *Pocket Guide to Coating Information* is now available in eBook format for download via Amazon.com.

In an effort to expand its market reach and respond to the growing interest in eBooks, SSPC decided to make an electronic version available. Due to Amazon's prominence as an eBook provider, SSPC chose the site as its first platform. Although primarily intended for the Amazon Kindle Reader, the eBook can also be read on PC desktop computers (Mac version coming soon), as well as the iPhone® and Blackberry®. SSPC intends to make the *Pocket Guide* eBook available on other online stores in the near future, such as the Sony eBook Store.

The *SSPC Pocket Guide to Coating Information* contains information about and references for charts, standards, and calculations most frequently needed during surface preparation and coating application. The surface preparation chapter addresses key topics, including abrasive selection, dew point factors, dehumidification, and ventilation, while the application chapter covers application tips and techniques, proper storage, and commonly used formulas and calculations. Separate sections are devoted

Continued

Training Roundup


Students at C-2 course held in Shanghai, China


Students at MPCAC class in Lynnwood, WA

SSPC training and certification courses, designed to enhance coatings professionals' skills and marketability, were held recently in China and the U.S.

SSPC's China Chapter hosted the Planning and Specifying (C-2) course in Shanghai, China, on November 23–27, 2009. This was SSPC's second public offering of the course in China. The instructors were Liu Hong Wei and Li Jiang. Eighteen students attended.

SSPC held its Quality Control Supervisor (QCS) Class December 15–16 at the Coast Guard Yard in Baltimore, MD. Instructor Charlie Harvitz led the class, which was attended by nine students. According to one of the students, "The training was a success and Charlie Harvitz was an excellent instructor. SSPC is an excellent source of painting education."

SSPC also held its Marine Plural Component Program (MPCAC) December 11–12, 2009, at Western Industrial, Inc., in Lynnwood, WA. Earl Bowry was the instructor. MPCAC is designed to certify craft workers operating plural-component spray equipment and those applying protective coatings on steel in immersion service by airless spray using plural component spray equipment.

Lisa M. Marple of Western Industrial had this to say about the MPCAC course: "Out of all the classes we have provided to our employees, this one received the most positive feedback. I think the hands-on training works really well with our guys. Everyone liked the instructor, everyone was ready and eager to learn. Even the instructor told us that this was one of the most enthusiastic group of trainees he had encountered in quite some time."


Students of QCS class in Baltimore, MD

to key concrete standards, soluble salts, inspection, and international marine regulations. The first edition was published in early 2009; this second edition, published in late 2009, includes updated information for 2010.

To purchase a copy of the *SSPC Pocket Guide to Coating Information* eBook, go to Amazon.com and type in "sspc pocket guide" in the search field.

The printed version of the guide remains available through the SSPC MarketPlace online store at http://shopping.netsuite.com/sspcmarketplace and the SSPC Products Catalog.

SSPC Individual Member Update

Below is a list of people who joined or renewed their SSPC membership in October through December 2009. Individual Membership benefits include unlimited access to the online collection of SSPC standards, a subscription to *JPCL*, and discounts on SSPC products and services. For information about joining, contact Terri McNeill, mcneill@sspc.org.

- Rehan Ahmed, Doha, Qatar
- Oliva S. Anderson, Silverdale, WA
- Magnus Andersson, Champaign, IL
- Robby Anggiansah, Jakarta, Indonesia
- Jason Antonelli, Celina, OH
- Andy Axtell, Wixom, MI
- Luc Baril, Schomberg, ON, Canada
- John Barlow, Hamilton, OH
- Timothy Barnes, Newport News, VA
- Matthew Barwick, Winter Haven, FL
- Abdul Basit, Lahore, Pakistan
- Anthony Batista, Colchester, CT
- Toby Belzeski, Ponte Vedra Beach, FL
- Dwayne Bingham, Jacksonville, FL
- Jorge Bosquez, Houston, TX
- Bud Brannock, Raleigh, NC
- Edward Brown, Emporia, VA
- Eric Brown, Bloomington, IN
- Brian Buchta, Keithville, LA
- Luis Bueno, Ferndale, WA
- Gene Burr, Denver, CO
- Martin Burruel, San Diego, CA
- Sina Calupitan, Newport News, VA
- Ricardo Campos, Sunnyside, WA
- Mary Cannon, Texas City, TX
- Raymond Card, Port Jervis, NY
- Sean M. Carlin, Westlake, OH
- Manuel Carpio, Chula Vista, CA
- Ken Carriere, Edmonton, AB, Canada
- Bruce Castelow, Hobbesville, NC
- Brian Chapman, Cadillac, MI
- YoYo Chan, Mongkok, Hong Kong
- Ray Wong Chi Khuen, Singapore
- Jeff Clark, DeQuincy, LA
- Byron Clipsham, Langley, BC, Canada
- Kim Copeland, Derby, KS
- John Courtney, Erskine Renfrewshire, UK
- Jay Crum, Virginia Beach, VA
- Cory Cur'e, Suffolk, VA
- Jeff Curry, Polk City, FL
- Carolyn Day, Juneau, AK
- Marcus Dehon, Bloomington, IN
- Rich DeMorais, Bloomfield, CT
- Soraya De Quijada, Miami, FL
- Scott Dollison, Jacksonville, FL
- Jeff Eggleston, Salt Lake City, UT
- Matt Emerson, Anchorage, AK
- Randy Emter, Dickinson, ND
- Mark Engquist, Orange, CA
- Kadookkatt Faisal, Kuwait, Kuwait
- Brad Fales, Oakland, CA
- Luis Fernando, Muntnlupa City, Metro Manila, Philippines
- John Filaretou, Tarpon Springs, FL
- Eric C. Foster, Newport News, VA
- Joshua Freedland Chicago, IL
- Daniel Fricano, Syracuse, NY
- Gregory J. Frost, Elmhurst, IL
- Anthony Gaffney, San Jacinto, CA
- Edward Galak, Loweville, OH
- Ernest Garcia, Pueblo, CO
- Danielle Gaulin, Bonnyville, AB, Canada
- Winston Gillies, Kenai, AK
- Malachi Grandy, Portsmouth, VA
- Nathan W. Greer, Midland, TX
- Roman Greysuch, Kibbutz Sasa, Israel
- Kevin Guay, Plattsburgh, NY
- Dan Guillen, Sunnyside, WA
- David Gulash, Emerald Park, SK, Canada
- William Gusnard, Birmingham, AL
- Andrew Hammond, Fulton, NY
- Mike Hansen, Clearwater, FL
- Robert Hathaway Oshkosh, WI
- Wayne D. Hedgepeth, Newport News, VA
- Paul Henderson, North Hollywood, CA
- Jorge Herrera, Hicksville, NY
- Mark Herrman Chicago, IL
- Brandon Hirvi, Moorhead, MN
- Duane Hodgson, Adelanto, CA
- Walter Holmes, Jacksonville, FL
- Robert Horn, Groton, CT
- Eric Houghton, Millstone Township, NJ
- Sebastian Huat, Singapore
- Ardiansyah Irwan, Jakarta DKI, Indonesia
- Andrew N. Jeffrey, Smithfield, ME
- Robert Jenkins, Phoenix, AZ
- Stephen Johnson, East Chicago, IN
- Willoughby S. Johnson, San Diego, CA
- Johnnie Jones, Jacksonville, FL
- Jake Karam, New York, NY
- Lyn Kearns, Cumberland, ON, Canada
- Aaron Kent, Louisville, KY
- Sarmad W. Khaled, Erbil, Iraq
- Andrew King, St. Petersburg, FL
- Tobias King, Newport News, VA
- Douglas Kohl, Everett, WA
- William Korber, Phoenix, AZ
- Park Kweon, Shanghai, China
- Dan Lane, Franklin Park, IL
- Khaw Hang Ling, Singapore
- Michael Long, Tampa, FL
- John Lovik, Port Orchard, WA
- Wayne Lutzko, Saskatoon, SK, Canada
- Lesley Madonia, Fayetteville, NC
- Delin Manuel, Houston, TX
- Pedro Martinez, Apodaca, Mexico
- Daniel A. Marvin, East Peoria, IL
- Bradley Mattila, Monroe, WA
- Delbert L. McCoy, Jacksonville, FL
- Nancy McGuinness, Tulsa, OK
- John McMahon, Groton, CT
- Robert Millette, Torrington, CT
- Justin Mitchell, Houston, TX

- John Mixon, Irving, TX
- Debra Moolin, New York, NY
- Steve Morris, Hayward, CA
- James Music, Jacksonville, FL
- Dan Niles, Goodrich, MI
- Shane Noel, Lexington, KY
- Dennis Nolan, Elora, ON, Canada
- Edward Nuzum, Jacksonville, FL
- Patrick O'Donovan, Worthington, OH
- Tristan Olivier, London, UK
- Rolando Ortanez, Marikina City, Philippines
- Kirk Overcash, Charlotte, NC
- William Overmann, Glen Allen, VA
- Larry Palin, Newport News, VA
- Steve Palmer, Chula Vista, CA
- Tony Rey Parado, Mandaluyong, Philippines
- Lawrence Payne, Port Orchard, WA
- Robert H. Pearson, Chesapeake, VA
- Felix Perez, Chula Vista, CA
- Jarvin Piper Sr., Columbia, SC
- Michael Piper, Atlantic Beach, FL
- Kevin Pitcher, Toronto, ON, Canada
- Harry A. Pizzingrilli, Mars, PA
- Karen M. Powell, Newport News, VA
- Mark Prince, Suffolk, VA
- Tom Radakovich, Arlington, VA
- Malaiyappan Ramajayam, Singapore
- Stephane Randu, Saint Clair du Rhone, France
- Eric Rennerfeldt, Minneapolis, MN
- Mike Rhodes, Burnt Hills, NY
- Jason Riggs, Portland, OR
- Steve Roberts, Richmond, TX
- William Roberts, Jacksonville, FL
- Mark Ross, Bremerton, WA
- Michael Ryan, Rancho Dominguez, CA
- John Sabins, Beaumont, TX
- Neal Sabourin, Providence, RI
- John Sadosky, Chicago, IL
- Rusdi Salam, Singapore
- Tony Salony, Gahanna, OH
- Mike Schaffron, Rochester, NY
- Karen Schortemeyer, Hayward, CA
- Brad Schreck, San Diego, CA
- Mike Sealander, Brooklin, ME
- Rajendran Selvanathan, Singapore
- Tony Seufert, St. Petersburg, FL
- Jason Sewell, Port Orchard, WA
- Ron Shahar, Karmiel, Israel
- Ed Shannon, Kingston, ON, Canada
- Scott Shellenbarger, Goodrich, MI
- John Shreves, Celina, OH
- Jack Sizemore, Tampa, FL
- Marzena Sochacki, Niles, IL
- Tai Son, Seoul, Republic of Korea,
- Aaron Speisman, Cape Canaveral, FL
- Dan Statz, Baraboo, WI
- William J. Strong, Jacksonville, FL
- Tom Sulkowski, Millstone Township, NJ
- Tracy Sykes, Ocean Springs, MS
- Gilbert Sylva, Austin, TX
- Micheal Tignor, Dallas, TX
- Johann (John) Triebe, Sunnybank Hills, QLD, Australia
- Jim Troe, Albert Lea, MN
- Chris Turner, Spring, TX
- Karankumar Vaidya, Westborough, MA
- Gustavo Vargas, Lehigh Acres, FL
- Daniël Vreugd, IJmuiden NH, Netherlands
- Paul Walters, Victoria, BC, Canada
- Steven Wayland, Collinsville, IL
- Jeffrey L. White, Callahan, FL
- James A. Wiles, Jacksonville, FL
- Ricky Wilkerson, Newport News, VA
- Eric Williams, Jacksonville, FL
- Chantal Wegner, Nepean, ON, Canada
- Steven White, Newport News, VA
- Jeff Wilkins, Austin, TX
- Kerryn Wilson, Melbourne, VIC, Australia
- Sebastian Wszolek, Amherstburg, ON, Canada
- Nicholas Yeoh, Petaling Jaya, Malaysia
- Donald `Rick' Younce, Lexington, KY
- M.K. (Hal) Yousuf, Adrian, MI
- John Yovanoff, Buffalo, NY
- Kenneth Zagorski, Houston, TX
- Doris Zografos, Baltimore, MD
- Michael Zonay Jr., Sellersville, PA

associations

San Antonio to Host CORROSION 2010

The NACE Annual Conference and Exhibition, CORROSION 2010, will be held March 14–18 in San Antonio, TX, at the Henry B. Gonzalez Convention Center. The association expects attendance of approximately 5,000 corrosion control professionals from industries including shipbuilding/marine, bridge, petrochemical and energy production, and pipeline.

Some coatings-related programming will be featured. Sessions related to coatings can be found below and are accurate as of press time.

Approximately 350 companies are expected to exhibit at the conference. A list of exhibitors relevant to the *JPCL* readership is listed in the following pages (current as of press time).

For further information, visit www.nace.org.

Forums and Tutorials

- Maintenance Painting in Electric Utility Generation, Transmission, and Distribution Systems—March 15, 1–5:00 p.m.

Chaired by Jerry Arnold, this forum will cover maintenance painting and flow coating in electric substations; maintenance painting in combined cycle natural gas power plants; lining concrete contaminants in potential chemical exposure areas of power plants; maintenance of steel substrates in coal handling areas; and corrosion control of transmission, distribution, and substation structures by coating systems.

- A Complete Overview of Powder Coatings—March 16, 8–10:30 a.m.

This session will cover raw, advanced powder coatings, including proper powder selection, pretreatment options, application equipment, quality control, and troubleshooting. The forum will be presented by Steve Houston, The Powder Coating Institute; Terry Giles, Henkel; Jerry Trostle, Wagner; and Ron Cudzilo, George Koch Sons.

Torch of Friendship
Courtesy of San Antonio Convention & Visitors Bureau

- Application of Coatings: How Green Can You Get?—March 16, 2–4:00 p.m.

E.J. Johnson, director of Carboline Transportation Department, will discuss zero VOC and HAPs railcar coatings and linings, coating specifications, and the definition of green. This will be followed by a discussion of waterborne coatings used in the rail industry. Tom Schwert, Paint Chemist from TxDOT, will present "Introduction to VOCs and HAPs: Reformulation that Maintains Performance."

- Coating Asset Management Forum—March 17, 8–11:30 a.m.

Co-chaired by Terry Greenfield and J. Peter Ault, the discussion forum will be comprised of coatings industry end users/owners that have implemented programs to better manage their protective coatings assets. Each panel member will make a short presentation about their program and share successes and challenges. An open forum discussion will follow.

- Bridge/DOT Forum—Preserving our Bridge Infrastructure: Department of Transportation Forum—March 17, 8:00 a.m.–5:30 p.m.

This one-day forum will consist of two half-day sessions and is chaired by Johnnie S. Miller, P.E., Texas DOT. The morning session will provide state DOT personnel an opportunity to discuss in an invitation-only setting some of the challenges and opportunities facing the nation's bridges. The afternoon session will be opened up and continue the discussion with solution providers.

- Coatings Program Management Tutorial—March 17, 2–5:30 p.m.

Co-chaired by Terry Greenfield and J. Peter Ault, this tutorial will cover the following topics: achieving an accurate understanding of conditions, knowledge-based standards, requirement-based specifications, qualified materials processes, training and qualification of personnel, quality control and assurance, data management systems, and

Continued

coatings and corrosion condition surveys.

- Coating Applicator Training and Certification to the NACE/SSPC Standard for Coating Applicators—March 18, 8–9:00 a.m.

Presented by Mike Moss, NACE Education and Training; Robin Frye, NACE Program Manager, Coatings; and industry representatives. This forum will cover the program developed by NACE International and the National Center for Constuction Education and Research (NCCER) for companies to use when training coating applicators to the SSPC/NACE standard on industrial coating and lining applicator specialist qualification and certification.

- How to Avoid Premature Coating Failures—March 18, 8–11:00 a.m.

Mike O'Brien will discuss how premature paint failures cost specifiers, plant owners, contractors, and paint manufacturers loss of time and money. It will provide participants with practical knowledge to reduce or avoid premature coating failures.

Courses

- Basic Corrosion, March 8–12

This course provides a basic review of the causes of corrosion and methods by which it can be identified, monitored, and controlled. The course includes hands-on experiments, case studies, and an open-discussion format.

- Shipboard Corrosion Assessment Training (S-CAT), March 9–13

This course is intended to provide a foundation of coatings, corrosion, and corrosion control knowledge for assessing the condition of tanks and other structures and determining the required actions necessary to effectively maintain fully operational status.

- Nuclear Power Plant Training for Coating Inspectors, March 18–22

This course prepares qualified coating inspectors to conduct inspections in nuclear power plants. The training focuses on challenges in the restrictive and safety-critical environment.

- CIP Level 2, Maritime Emphasis, March 18–23

The course includes topics from CIP Levels 1 and 2, with a focus on coating inspection in the maritime industry. The course covers surface preparation, coating types, inspection criteria, failure modes, and case studies. The course concludes with written and practical exams.

Committee Meetings, Symposia

March 14

- Corrosion Management STG 08
- Land Transportation: Information Exchange on Corrosion and Coating-Related Issues TEG 291X
- Cathodic Disbondment Test Methods: Critical Review of the Existing International Standards TEG 349X

March 15

- Insulative Coatings TEG 424X

Continued

Exhibitors

The following is a list of exhibiting companies (and their booth numbers), as of press time, that are involved in protective coatings and linings work.

3M Austin	1302
Accoat A/S	1326
Advanced Polymer Coatings	1241
Belzona, Inc.	1505
Berry Plastics Corrosion Protection Group	1727
Blair Rubber Company	2432
Bredero Shaw	1033
Canusa–CPS	1132
Carboline Company	1007
Central Plastics Co.	1209
CHLOR*RID International, Inc.	2232
Comex	1147
Conshield Technologies, Inc.	1842
Corrpro	1013
Cortec Corporation	1003
CRTS Inc.	1833
Curran International	2238
Dampney Co., Inc.	1408
DeFelsko Corporation	1513
Denso North America	1325
DESCO Manufacturing Co., Inc.	1949
Elcometer Instruments Limited	2919
Elektro-Physik USA Inc.	1413
Farwest Corrosion Control	1927
Fischer Technology Inc.	1239
Greenman-Pedersen, Inc.	1614
Hempel Coatings USA Inc.	2440
Henkel Corporation	1203
Heresite Protective Coatings	1223
Highland International, Inc.	1307
Hi-Temp Coatings Technology	1911
HoldTight Solutions, Inc.	3015
International Paint	1303
Iowa Waste Reduction Center	2833
ITW Futura Coatings	3007
KTA-Tator, Inc.	1221
Mascoat Products	1207
Monti Werkzeuge, GmbH	2939
Montipower LLC	3026
Oxford Instruments Coating Measurements	1622
Pipeline Inspection Co., Ltd.	1121
PolyCorp	1430
Polyguard Products, Inc.	2005
PolySpec Thiokol	1447
PPG Industries Inc.	1213
Radiodetection Corp.	1814
SAUEREISEN	1527
The Sherwin-Williams Company	1415
Solvay Solexis	1503
Specialty Polymer Coatings, Inc.	2039
Sponge-Jet, Inc.	3021
Tapecoat Company	1021
Thermion Inc.	2743
Tinker & Rasor	2426
Tnemec Company, Inc.	1047
Trenton Corp.	2241
Wasser High Tech Coatings	2540

- CUI: Revision of NACE Standard RP0198, "The Control of Corrosion Under Thermal Insulation and Fireproofing Materials—A Systems Approach" TG 325
- Oil/Gas Coating Technology Symposium (Session I) STG 02, STG 03
- Direct Assessment Methodologies—Continued Development and Improvement Symposium STG 35
- Marine Corrosion: Ships and Structures STG 44
- Coating Inspector Program (CIP) Committee CBC 30
- Coating Systems (External) for Pipeline Directional Drill Applications TG 352
- Coatings, Heat-Shrink Sleeves for External Repair, Rehabilitations, and Weld Joints on Pipelines TG 248
- Marine Vessel Corrosion TEG 181X
- Review and Revise as Necessary NACE Standard RP0281-2004 TG 415
- External Pipeline Coatings: Practices, Test Methods, and/or Test Methodologies for High Operating Temperature Pipelines, Immersion and Buried Service Only TG 336

March 16

- Reinforced Concrete: Corrosion-Resistant Reinforcement TG 057
- Removal Procedures for Nonvisible Contaminants on Railcar Surfaces TG 271
- Oil and Gas Production—Nonmetallics and Wear Coatings (Metallic) STG 33
- External Pipeline Coatings: Field Installation and Inspection Criteria for Maximum Performance TG 337
- Nuclear Buried Piping TG 404
- Piping Systems: Review of NACE SP0169-2007 (formerly RP0169), "Control of External Corrosion on Underground or Submerged Metallic Piping Systems" TG 360
- Corrosion Issues in Military Equipment and Facilities Symposium STG 40
- Oil/Gas Coating Technology Symposium (Session II) STG 02, STG 03
- Railcars : Corrosion Under Tank Car Insulation TG 366
- Waterborne Coatings on Railcars TG 378
- Nonvisible, Nonwater-Soluble Contaminants Affecting Corrosion Protection TEG 423X
- Surface Preparation of Metals to WJ-1 (Clean to Bare Substrate) by High-Pressure Waterjetting TG 275; Surface Preparation of Metals to WJ-2 (Very Thorough or Substantial Cleaning) by High-Pressure Waterjetting TG 276; Surface Preparation of Metals to WJ-3 (Thorough Cleaning) by High-Pressure

Waterjetting TG 277; Surface Preparation of Metals to WJ-4 (Light Cleaning) by High-Pressure Waterjetting TG 278

- Offshore Coating Condition Assessment for Maintenance Planning TG 340
- State of the Art in CUI Coating Systems TG 425
- Materials, Advanced, for High-Temperature Service in the CPI TEG 123X
- Coatings for Elevated-Temperature Insulated or Noninsulated Exterior Service TG 422

March 17

- Review and Revise as Necessary RP0287-2002 TG 419
- Failure Prevention Case Histories TEG 118X
- Pipeline Coating, Plant-Applied Fusion-Bonded Epoxy: Review of NACE Standard RP0394 TG 031
- Managing Corrosion with Polymer Based Materials Symposium TEG 191X
- Marine Corrosion and Transport Symposium STG 44
- Review and Revise as Necessary Joint Surface Preparation Standard NACE No. 6/SSPC-SP 13 TG 417
- Railcars: Coating Application on Exterior Surfaces of Steel Railcars TG 339
- Guidelines for Qualifying Personnel as Abrasive Blasters and Coating and Lining Applicators in the Rail Industry TG 394
- Evaluation, Testing, and Specifying Coating Materials for Elevated Temperatures for Insulated and Uninsulated Service TEG 399X
- Ad Hoc XIV Maintenance Overcoating of Railcar Exteriors
- External Pipeline Coatings: Multi-Layer Polyolefin Coating Systems TG 353
- Review of NACE Standard TM0304-2004 TG 260; Review of NACE Standard TM0104-2004 TG 263; Offshore Exterior Submerged Coatings: Standard Test Method TG 264; Offshore Platforms: Coatings for Atmospheric and Splash Zone New Construction TG 312
- Vapor Corrosion Inhibitors and Rust Preventatives Symposium TEG 093X, TEG 145X
- Surface Preparation by Encapsulated Blast Media for Repair of Existing Coatings on Railcars TG 379
- Review of NACE SP0398-2006 TG 406

March 18

- Pipelines, Steel: Standard for In Situ Internal Cleaning and Coating TG 223
- Coatings and Linings, Protective: Atmospheric STG 02; Coatings and Linings, Protective: Immersion and Buried Service STG 03; Coatings and Linings, Protective: Surface Preparation STG 04
- Fusion-Bonded Epoxy Coating of Steel Reinforcing Bars TG 052
- Advances in Metallic Coatings and Hardsurfacings for Oilfield Applications Symposium STG 33
- Offshore Coatings: Laboratory Testing Criteria TEG 346X
- PSPC Coating Technical File Standard Practice TG 402
- Wet Abrasive Blast Cleaning TG 323
- Reinforced Concrete STG 01

regulations

OSHA Booklet Outlines Chromium Standards

The U.S. Occupational Safety and Health Administration (OSHA) recently published *Hexavalent Chromium*, a booklet outlining industry standards for protecting painters, welders, and other workers who might be exposed to the toxic chemical. Hexavalent chromium is used in pigments, metal finishing, wood preservatives, and fungicides.

"Hexavalent chromium is a powerful lung carcinogen and exposure to this chemical must be minimized," said Assistant Secretary of Labor for OSHA David Michaels. Exposure to the chemical can also lead to damage to the nose, throat, and respiratory system. Inhaling the chemical's fumes can cause allergic reactions or asthmatic symptoms, such as wheezing and shortness of breath.

The booklet explains OSHA's hexavalent chromium standards in a reader-friendly format and is a companion document to the Small Entity Compliance Guide for the Hexavalent Chromium Standards published in 2006. Requirements for exposure limits, exposure monitoring and determination, protective work clothing and equipment, medical surveillance, communication of hexavalent chromium hazards, and recordkeeping are described.

For more information, visit www.osha.gov.

OSHA Plans HAZCOM Hearings

The Occupational Safety and Health Administration (OSHA) will hold three informal public hearings to accept comments and testimony on the proposed rule to align the agency's Hazard Communication Standard (HCS) with the United Nations' Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

The first hearing will begin March 2 at 9:30 a.m. in the auditorium of the U.S. Department of Labor, 200 Constitution Ave., N.W., Washington, D.C. 20210. Additional hearings are scheduled for March 31 in Pittsburgh, PA, and April 13 in Los Angeles, CA. OSHA will pro-

Continued

vide the location for the Pittsburgh and Los Angeles hearings in a future notice.

A number of countries, including the U.S., and international organizations participated in developing the GHS to address inconsistencies in hazard classification and communications. The system provides a single, harmonized system to classify chemicals, labels, and safety data sheets with the primary benefit of increasing the quality and consistency of information provided to workers, employers, and others who work with chemicals.

Technical inquiries should be directed to Maureen Ruskin, OSHA, Office of Chemical Hazards-Metals, 202-693-1950.

OSHA Sets Enforcement Record

The Occupational Safety and Health Administration exceeded its enforcement goals during fiscal year 2008, logging 87,687 violations of its standards and regulations for worker safety and health, with 80% (67,052) of them serious.

The proportion of those violations classified as endangering employees is at the highest level ever. Additionally, in FY 2008, OSHA conducted almost 39,000 worksite inspections, surpassing the agency's goal for the year by 2.4%. On average, 4,000 more workplace inspections were completed each year (38,515) between FY 2001-2008 than during FY 1993-2000 (34,508).

"According to preliminary numbers for 2007, the workplace fatality rate has declined 14% since 2001, and since 2002, the workplace injury and illness rate has dropped 21%—with both at all-time lows. This year's inspection numbers show that the strategic approach used by OSHA—targeting highest hazard workplaces for aggressive enforcement while also using education, training and cooperative programs to improve overall compliance—can help achieve significant reductions in workplace injuries, illnesses, and fatalities," said OSHA's acting Assistant Secretary of Labor Thomas M. Stohler.

Innovative approaches such as the Enhanced Enforcement Program (EEP), Site Specific Targeting, and National Emphasis Programs (NEP) are methods OSHA uses to target the most hazardous workplaces and employers with high injury and illness rates. EEP's purpose is to pursue employers with a history of serious, willful, and/or repeat violations with OSHA.

During the program's first five years (FY 2004 to 2008), OSHA identified 2,471 inspections that qualified for the

EPA Seeks Tougher Smog Standard

The U.S. Environmental Protection Agency (EPA) announced on January 7, 2010, that it is proposing to replace the March 2008 smog standard with the strictest health standards to date for smog. Also known as ground-level ozone, smog is linked to a number of serious health problems, ranging from aggravation of asthma to increased risk of premature death in people with heart or lung disease.

Ground-level ozone forms when emissions from industrial facilities, power plants, landfills, motor vehicles, and other sources, including solvents classified as volatile organic compounds (VOC)—used in some paints—react in the presence of sunlight.

In September 2009, Administrator Jackson announced that EPA would reconsider the existing ozone standards of 0.075 parts per million (ppm). The agency is now proposing to set the "primary" standard, which protects public health, at a level between 0.060 and 0.070 ppm measured over eight hours. Children are at the greatest risk from ozone because their lungs are still developing; they are most likely to be active outdoors; and they are more likely than adults to have asthma. Adults with asthma or other lung diseases and older adults are also sensitive to ozone. Ozone can also harm healthy people who work and play outdoors.

EPA is also proposing to set a separate "secondary" standard to protect the environment, especially plants and trees. This seasonal standard is designed to protect plants and trees from damage occurring from repeated ozone exposure, which can reduce tree growth, damage leaves, and increase susceptibility to disease.

Before making its new proposal, EPA conducted a review of the science that guided the 2008 decision, including more than 1,700 scientific studies and public comments from the 2008 rulemaking process. EPA also reviewed the findings of the independent Clean Air Scientific Advisory Committee, which recommended standards in the ranges proposed.

EPA will take public comment for 60 days after the proposed rule is published in the Federal Register. The agency will hold three public hearings on the proposal: Feb. 2, 2010, in Arlington, VA, and in Houston, TX; and Feb. 4, 2010, in Sacramento, CA.

More information:
http://www.epa.gov/groundlevelozone.

EEP. Site-Specific Targeting allows OSHA to focus its enforcement efforts on workplaces with the highest rated injuries and illnesses. In FY 2008, 3,800 worksites were targeted for unannounced comprehensive safety inspections. The NEPs focus on major health and/or safety hazards of recognized national significance. They also guide OSHA field offices to plan programs and conduct inspections consistently across the nation. Areas of emphasis include combustible dust, lead, process safety management, diacetyl, and trenching. In FY 2008, OSHA conducted 8,730 inspections related to an NEP.

Visit www.osha.gov for details.

CA Toughens Contractor Laws

Unlicensed California contractors now face jail time and stiff fines under new laws that took effect Jan. 1.

Assembly Bill 370 increases the penalties for unlicensed contracting, identified in Business & Professions (B&P) Code Section 7028. Currently, a first conviction for contracting without a license is a misdemeanor with no set jail time or penalties.

As of Jan. 1, a first offense is punishable by up to a $5,000 fine and/or six months in county jail. A second offense is punishable by 20% of the contract price, or aggregate payments to the unlicensed contractor, or $5,000, whichever is greater, and not less than 90 days in county jail. A third offense would be subject to a fine not less than $5,000 nor greater than $10,000 or 20% of the contract price, and a county jail sentence between 90 days and one year.

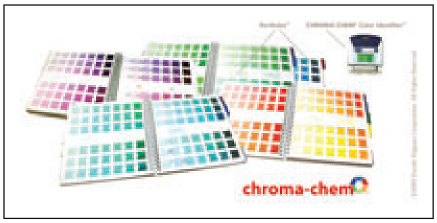
B&P Code requires that all home improvement jobs valued at $500 or more for labor and materials must be done by a licensed contractor. The bill also amends the Code to include that anybody who uses an unlicensed contractor is a victim entitled to restitution, regardless of whether they knew the contractor was unlicensed.

CSLB licenses about 315,000 contractors. For more information, visit cslb.ca.gov.

products

Evonik Offers Color Tools for Coatings

Evonik Degussa Corporation (Essen, Germany) has developed two new tools for the industrial coatings market—the Portfolio of Color® and the Chroma-Chem® Color Identifier™.



The Portfolio of Color®, a color reference book for the industrial coatings market, features over 2,760 colors at two sheen levels and the supporting formulations, the company says. Portholes™ allow the user to position the target or coating sample behind the representative color chip to check for color accuracy.

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The Chroma-Chem® Color Identifier™ is a hand-held device that reads the target or substrate color and then locates the closest acceptable color match in the book. The unit will display three potential matches as "good, better, and best."

For details, visit www.evonik.com.

Solvent for Paint Stripper is VOC-Free

Rhodia (Paris, France) has introduced Rhodiasolv® STRIP, an eco-friendly, safe ingredient developed for dichloromethane-free paint stripping solutions.

According to the company, the product is biodegradable and classified as non-VOC under EU legislation. The product is part of the Rhodiasolv® IRIS eco-friendly solvent range used for applications such as metal and resin cleaning, industrial degreasing, and foundry resin production.

For more information, visit www.rhodia.com.

SW Offers Coating With Rapid Return to Service

Sherwin-Williams (Cleveland, OH) has introduced Cor-Cote HB Urethane, a coating for the municipal and industrial wastewater treatment facilities that offers rapid return to service. The coating can be applied on both steel and concrete substrates.

According to Brad Rossetto, VP of marketing for Protective & Marine Coatings, the product allows return to immersion service within four hours of application. The company says that the coating is low-VOC and reinforced with micaceous iron oxide, delivering high abrasion resistance, increased film integrity, and good edge retention. It can cure at temperatures as low as 20 F (-6.7 C), and application is possible in conditions up to 85% relative humidity.

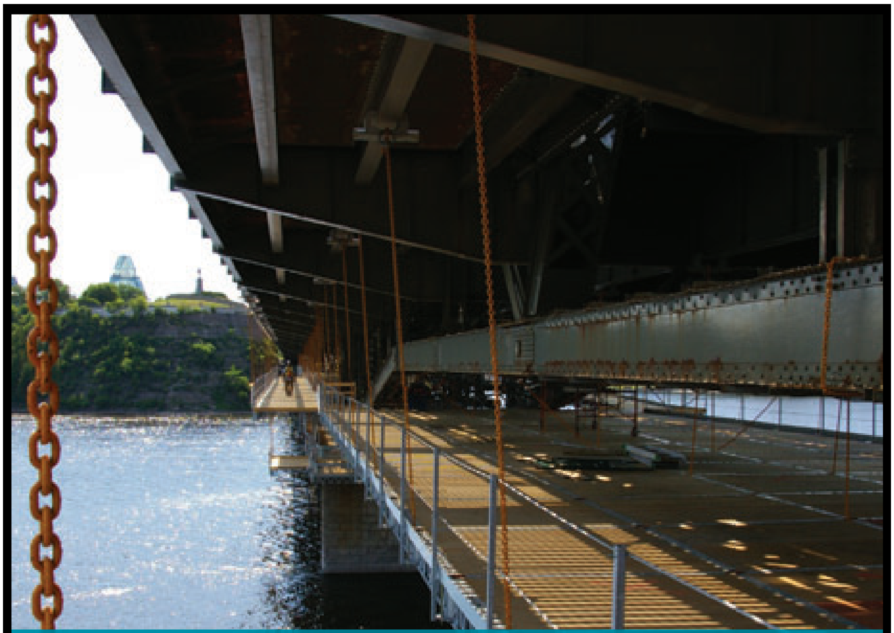
For details, visit www.sherwin-williams.com.

New Foul-Release Coating from Seacoat

Seacoat Technology LLC (Houston, TX) plans to release its new Sea-Speed V5 non-toxic, hard film siloxane foul-release coating for general sales.

According to the company, the coating has the capability to reduce drag and improve speed and fuel economy of ships. It also incorporates an electrochemical mechanism that enables the valence of the coating to change in the presence of water flowing over the coating surface. Based on vessel tests and static testing, the coating minimizes upwards of 95% of fouling from slime, algae, grass, and organisms.

For details, visit www.seacoat.com.



Allied Painting to Recoat Newburgh-Beacon Bridge

By: Brian Churray, PaintSquare

Allied Painting, Inc. (Franklinville, NJ), SSPC-QP 1- and QP 2-certified, secured a contract of $17,607,200 from the New York State Bridge Authority to recoat steel surfaces on the Newburgh-Beacon Bridge. The project involves recoating a 2,100-linear-foot portion of the North Span on the 7,855-foot-long dual articulated deck truss bridges over the Hudson River. The steel, including approach beam spans, girder spans, deck trusses, floor system components, and through trusses, will be abrasive blast-cleaned to a Near-White finish (SSPC-SP 10) and coated with a waterborne acrylic system. The contract includes containment of the existing lead-bearing coatings within a Class 1A containment structure (SSPC-Guide 6).

Erie Painting and Maintenance Wins Movable Dam Rehabilitation Job

Erie Painting and Maintenance, Inc. (Cheektowaga, NY) was awarded a contract of $3,824,464.25 by the New York State Thruway Authority to perform coatings work and electrical repairs on a movable dam that is used in the Erie Canal. The contract, which requires SSPC-QP 1 and QP 2 certification, includes abrasive blast-cleaning and recoating steel surfaces with an organic zinc-rich primer, an epoxy intermediate, and a polysiloxane finish. The contract also includes containment of the existing lead-based paint.

Corrosion Control Corp to Refinish Concrete Reservoir

Corrosion Control Corporation (Pedricktown, NJ) secured a contract of $129,925 from the City of Bridgeton, NJ, to rehabilitate the exterior surfaces of a 100-foot-diameter by 50-foot-high, 2.4 MG concrete reservoir. The exterior surfaces of the tank, including associated overflow piping and access manways, will be repaired, high-pressure waterblast-cleaned, and refinished with a cementitious system. The contract requires the use of a full containment structure.

Vermont AOT Awards Two Bridge Painting Bids

The Vermont Agency of Transportation awarded two contracts for bridge painting work. Hercules Painting Company (New Castle, PA) was awarded a contract of $3,772,485 to refinish structural steel surfaces on seven sets of dual bridges, and Atsalis Brothers Painting (Clinton Township, MI) was awarded a contract of $1,483,100 to recoat the steel on dual bridges over the Winooski River. The two companies are SSPC-QP 1- and QP 2-certified. Both contracts include abrasive blast-cleaning the steel to a Near-White finish (SSPC-SP 10) and application of an organic zinc primer, an epoxy intermediate, and an aliphatic urethane finish selected from NEPCOAT Qualified Products List “B.” The contracts include erecting containment structures to control the emission of the existing lead-bearing coatings.

MK Painting to Rehabilitate Four Tanks

MK Painting, Inc. (Wyandotte, MI) won a contract of $264,000 from the Pecan Grove Municipal Utility District (Richmond, TX) to abrasive blast-clean and recoat the interior and exterior surfaces of two 542,000-gallon-capacity water storage tanks and two 20,000-gallon-capacity pressure tanks. The interior tank surfaces will be lined with a zinc-rich urethane primer, an epoxy intermediate, and an epoxy finish, and the exterior tank surfaces will be coated with a zinc-rich urethane primer, an epoxy intermediate, and a urethane finish.

Maryland Highway Administration Lets Bridge Painting Project

The Maryland State Highway Administration awarded a contract of $7,099,962 to Titan Industrial Services, Inc. (Baltimore, MD) to perform steel repairs and coatings application on a 2,247-foot-long deck truss bridge over the Potomac River and adjacent roadway and railway. The steel bridge surfaces will be abrasive blast-cleaned to a Near-White finish (SSPC-SP 10) and recoated with an organic zinc-rich primer, an epoxy intermediate, and a urethane finish. The contract, which requires SSPC-QP 1 and QP 2 certification, includes containment of lead-bearing coatings.

Maguire Iron to Repaint Two Elevated Tanks

Maguire Iron, Inc. (Sioux Falls, SD) was awarded a contract of $574,870 by the City of Yankton, SD, to recoat the interior and exterior surfaces of a 1 MG toro-ellipsoidal tank and a 1 MG hydropillar. The exterior surfaces of the tanks will be abrasive blast-cleaned to a Commercial finish (SSPC-SP 6) and coated with an epoxy-epoxy-polyurethane system. The interior surfaces of the tanks will be abrasive blast-cleaned to a Near-White finish (SSPC-SP 10) and lined with a zinc-epoxy-epoxy system.

Preferred Sandblasting & Painting Wins Tank Rehabilitation Project

Preferred Sandblasting & Painting (Shelbyville, TN) was awarded a contract of $271,125 by the Town of Dandridge, TN, to repair and recoat three welded-steel water tanks with capacities of 500,000 gallons, 300,000 gallons, and 212,000 gallons. The tank surfaces will be abrasive blast-cleaned and recoated with epoxy systems. The existing coatings on the two larger tanks contain lead, which will be neutralized with a lead-stabilizing pretreatment prior to blast removal.

Coastal Marine Construction Will Repair Drawbridge

Photo courtesy of USACE

Coastal Marine Construction of Venice, FL, secured a contract of $4,394,335.37 by the Florida Department of Transportation to perform repairs and coatings application on an existing drawbridge over the Caloosahatchee River in LaBelle, FL. The contract includes lead-based paint abatement and coatings application on structural steel surfaces, which requires SSPC-QP 2 certification. The project also includes applying an acrylic finish coating to 21,725 square feet of concrete surfaces.

ARRA Penstock Coating Contract Goes To Abhe & Svoboda

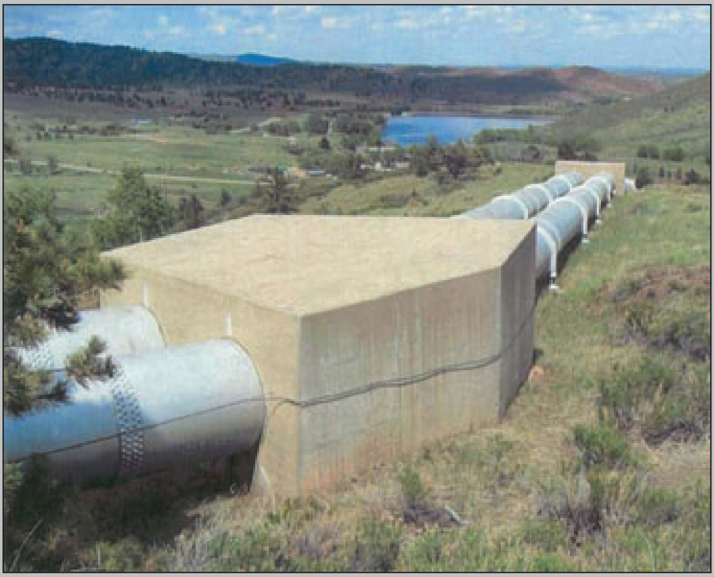


Photo courtesy of USBR

Abhe & Svoboda, Inc. (Prior Lake, MN), SSPC-QP 1- and QP 2-certified, won a contract of $12,235,100 from the United States Bureau of Reclamation, Great Plains Region, for repairs and coatings application on two existing penstocks that are a portion of the Colorado-Big Thompson Project, a large-scale water diversion project that redirects mountain water to the northeastern part of Colorado. The project includes abrasive blast-cleaning the interior and exterior penstock surfaces to a Near-White finish (SSPC-SP 10). Approximately 219,000 square feet of exterior penstock and valve surfaces and 520 square feet of steel appurtenances will be recoated with a zinc-epoxy-polyurethane system. Approximately 223,000 square feet of interior penstock and valve surfaces will be lined with a 100%-solids elastomeric polyurethane system. The contract, which requires SSPC-QP 1 certification, is funded through the American Recovery and Reinvestment Act of 2009 (ARRA).