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The Voice of SSPC: The Society for Protective Coatings

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The Society For Protective Coatings

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Youth wasted on the young? I think not.

Each year *JPCL* publishes a bonus issue in August, giving our editorial staff the opportunity to explore subject matter at a level of depth that our regular monthly issues do not provide. This August, our bonus issue will showcase the younger faction making its mark in the coatings industry.

Over the past few years we've seen many of this industry's gurus and rock stars retire after having spent decades furthering the technology of and techniques for preventing corrosion with protective coatings. SSPC is currently focused on engaging the younger workforce and *JPCL* is interested in contributions from a new generation of coatings professionals — a generation comfortable with mobile devices, information on demand and a plethora of technological advances — a generation that regards these tools as having always existed, while many who have come before find these platforms as foreign as teleportation and flying cars may be to the younger set someday.

The truth is there are young people excelling in all facets of coatings today — applicators, formulators, inspectors, corrosion engineers and more. They bring with them a new approach to the work that they do, combining the valuable knowledge they glean from their mentors with innovative, 21st-century ways of working.

I know of established professionals who are investing in the future of the coatings industry by embracing younger workers — taking these individuals under their wings and passing on the knowledge they've acquired over the years — preparing this next generation to accept the torch and continue the work, striving to bring ongoing efforts to fruition.

We look forward to getting to know this next generation of coatings professionals and learning from them as they have learned from many of you.

Is there a younger person whom you feel deserves to be featured in this special issue, "Coatings Professionals: The Next Generation"? Nominate him or her today at http://www.paintsquare.com/nextgen.


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Free Webinar on Oil and Gas Industry Available

Webinar Education Series

"Standards, Training and Certification for the Oil and Gas Industry," the latest online offering in the 2015 SSPC/*JPCL* Webinar Education Series, will be offered for free on Wednesday, March 18, from 11:00 a.m. to noon, EST.

This webinar will provide guidance on how to properly specify and select a coating system for a specific substrate (including steel, concrete, metal and previously coated surfaces), structure and environment in oil and gas industrial settings. Participants will be eligible to receive credit from SSPC.

Ernst Toussaint, a senior coatings engineer with TransCanada Corp., will present this webinar.


Ernst Toussaint

Toussaint has more than 13 years of experience in the coating industry and is a Licensed Professional Engineer in the state of Texas. He is an SSPC-certified Protective Coatings Specialist and Master Coatings Inspector and a NACE Level III-certified Coating Inspector. He holds a Bachelor of Science degree in chemical engineering from the University of Florida.

Registration, CEU Credits

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

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

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

SSPC Expands Training Reach to Saudi Arabia

Global Insignia for Technical Services in Saudi Arabia has been approved by SSPC: The Society for Protective Coatings as an authorized licensee for the Society's Abrasive Blasting (C7), Spray Application Basics (C12) and Protective Coatings Inspector (PCI) programs.

Global Insignia was formed in 2012 exclusively to conduct SSPC training and certification in the Middle East. Its parent company, Al-Estagamah Global Group Co., was founded in 1994. Jayes Mathews, manager of technical and training affairs for Global Insignia, stated, "Global Insignia recognizes its obligation to SSPC to maintain high standards in delivering courses. Becoming a licensee in Saudi Arabia will allow candidates to take the class locally, which will save them time and money."

As with all new SSPC licensees, Global Insignia underwent a rigorous review of its personnel, organization and procedures, to ensure their capability to administer quality SSPC training programs. By working together, SSPC and Global Insignia are bringing their extensive

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"From Thinner Coating, a Stealthier Sub" *(Jan. 9)*

Nearly five years after photos emerged of sound-absorbing rubber tiles peeling off of the fairly new, $2 billion nuclear sub, the USS Virginia, making the technology's shortcomings painfully apparent, a research team of French and Canadian scientists says it has developed a coating that can offer the same protection as the conventional perforated rubber tiles, but at a fraction of the thickness.

Most Popular Poll *(as of Jan. 30)*

M/W/DBE fraud has been widely reported lately. What's the best way to address that problem? *(Jan. 19–23)*

Step up enforcement until it has a deterrent effect.	28%
Leave it alone; enforcement shows the current system is working.	22%
Scrap these set-aside programs; they incentivize fraud.	50%

Joseph Brandon: *"The most effective deterrent is stepped up monitoring, which takes a small percentage of the effort of enforcement. When people behave poorly, it is a signal that monitoring is insufficient."*

M. Halliwell: *"Although I understand the reasoning behind DBE/WBE type programs and set-asides, most times the way the programs are organized doesn't sit well with me. I agree that under-represented groups need the opportunity to compete on an even footing, but I'd prefer to see it as a program to get them up and running and sufficiently qualified so they can be competitive, not mandating reverse discrimination or reverse sexism to force work to them."*

PSN TOP 10 *(as of Jan. 30)*

- Paint Maker to Pay $950K in Death
- Engineer Admits to $700K Bridge Scheme
- Series of Deals Fatten Graco's Reach
- N. America to Lead Silica Sand Boom
- Kiewit Fined $170K on Bridge Job
- Game of Pros: Experience v. Credentials (Blog)
- In PA, Search Effort Ends Sadly
- PPG Announces 'Successful' 2014
- DBE Fraud Dogs Federal Projects
- Worker Killed in OH Overpass Collapse

MOST POPULAR Quiz *(as of Jan. 30)*

True or false: The adhesion of a coating to a steel substrate depends entirely upon the mechanical attachment or hooking of the coating to the profile of the steel.

Answer: False. Adhesion also depends upon primary or secondary valency chemical bonding of the coating to the steel.

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On Defining "Equivalent" Within a Specification

When a specification requires Manufacturer X's system "or equivalent," what does "or equivalent" mean, and who decides what's equivalent?

Jeffrey Stewart
Blome International

What "or equivalent" should mean is similar chemistry and performance properties. The true answer lies in the second part of the question. Only the specification writer can truly answer what he or she meant by "or equivalent." Some other possible interpretations are, "I'm not really sure, so I'm open to suggestions," or "I'm only going to use the named product but I'm not allowed to officially sole-source any product." Because the "or equivalent" is by its nature so ambiguous, it is best to pre-qualify any alternative with the specifier and/or purchaser prior to submitting.

Sarah Geary, RockTred

Many times "or equivalent" may mean "I'm sure there's another system out there that is capable of performing similarly, but I do not have the money, time or interest to find and qualify any more product systems." Testing a system's compatibility can be very time-consuming and costly. I guess it loosely follows the saying, "If it isn't broken, don't fix it." Why look for another solution when I know this specific one works?

Michael Quaranta
OPERATIONS 40

What would the world of construction materials be like if there was true sustainability-certified documentation for a given product listing — say, exterior building wrap, both fabric and liquid? Which one would qualify as the equivalent? Under documentation, the "differences" and commonality of performance would be in verified test data and MSDS/SDS reports for a meaningful decision to substitute as an equivalent. However, this documentation does not exist. The last part of the question points to the age-old consensus/marketing product "standards" with the hope you made the right replacement selection that will meet the meaningless stated authorization for an equivalent, with a suitable warranty.

Phil Kabza, SpecGuy

The key to applying the term "equivalent" or "comparable" (which I prefer) is evaluating the proposed product with respect to the owner's design requirements. Two products may not be identical. The basis-of-design product may have several characteristics that significantly exceed the proposed product; however, if the owner does not require that excessive a level of performance, the design professional is not inappropriate in approving the substitution. Obviously, the more closely the basis-of-design product represents the owner's requirements, the better the original specification. But this system of specifying is intended to allow the owner to maximize value, and when handled properly, it does.

M. Halliwell
Thurber Engineering Ltd.

As to the "who decides" question, I think it depends on what is being specified and how it is specified. I know that for environmental liners, we usually give three or four performance parameters for which several products would meet the requirement. Sometimes, a specific product is mentioned, but the performance numbers are the bigger part of the spec. If the preferred brand meets the performance parameters, it's equivalent. If a client specifies "Brand X or equivalent," I know a lot of contractors will look at spec sheets, find the competitor's product that is cheaper and close to the same specs, and then ask the owner, "Is this okay?"

Q&A with Alfred D. Beitelman

A general scientist for the U.S. Army Corps of Engineers in Champaign, Ill., Beitelman has held several positions with the USACE since 1970, including director of the Paint Technology Center at the Corps' Engineer Research and Development Center - Construction Engineering Research Laboratory (ERDC-CERL). Although he no longer conducts research projects for the USACE, he still provides significant contribution to the Corps including personnel training, consulting on large painting projects, oversight of painter certification and coating evaluations on structures around the world.

Beitelman is a past recipient of the SSPC Technical Achievement Award, and on Feb. 3, at SSPC 2015 featuring GreenCOAT in Las Vegas, he was presented the John D. Keane Award of Merit, given for outstanding leadership and significant contribution to the development of the protective coatings industry and to SSPC. He holds a B.A. degree in chemistry from Wartburg College in Waverly, Iowa, and is an SSPC-certified Protective Coatings Inspector and a NACE-certified Coating Inspector.

JPCL: How did you get your start in the industry?
AB: Nothing was planned. After graduating with a chemistry degree, I had the attitude that I could do anything. I was drafted into the Army and worked in a weapons laboratory for the duration of my service. Following the Army, I took a job in a government lubrication laboratory but was caught in a "reduction in force." At that point, in 1970, I took a job with the Corps of Engineers in their Rock Island District paint lab. My boss was Fletcher Shanks, one of the original developers of the Steel Structures Painting Council (now SSPC). Shanks and Willard Lappin were dedicated researchers who saw a need to develop new coatings for the navigation structures on the inland waterways. When I was hired, both were nearing retirement, so they devoted a lot of their time to training me to carry on their work.

JPCL: What aspects of the coatings and corrosion fields kept you interested enough to make a career out of it?
AB: Shanks and Lappin did not limit their involvement in coatings. They tested existing products, did their own formulation work, developed schools for Corps personnel, conducted onsite and telephone consulting and did quality assurance testing of manufactured batches. I carried on all aspects of their work. With that much variation in a job, one cannot possibly get bored!

I have always enjoyed coming in to work. Perhaps another aspect is the physical size of the Corps of Engineers projects. I have always been impressed with the size and strength of the dams that cross the rivers and the power that is harnessed by the hydropower structures. Without good paint systems, these structures become vulnerable to corrosion. That's another part of the challenge that keeps my interest.

JPCL: Can you talk a bit more about what it's been like working for such a large, federal entity such as the USACE? Do you feel an extra sense of pride or accomplishment knowing that you are partly responsible for maintaining such vital, large-scale infrastructure?
AB: There are always two sides to any issue. Yes, I feel pride and accomplishment for the work I have done. I am proud to be working on the giant structures and feel accomplishment when a student from a class I presented years before comes back to me for additional information or to analyze a problem.

The other side of the issue is the paperwork involved with any large organization. If I wanted to do research into some aspect of surface preparation or a different coating system, I first had to convince someone above me to provide the needed funding. Funding is always an issue, and I had to compete with other researchers who were equally as dedicated in areas of mass concrete, beach erosion, efficiency of hydrogenerators, environmental issues or any of the other issues that are critical for the Corps of Engineers. After the research project became funded, there were the planning, scheduling and budgeting documents as well as quarterly reports and technical reports. A researcher does not have pride of accomplishment when doing this aspect of the work, but it goes along with the job.

JPCL: What are the most significant differences in the industry compared to when you first started?

AB: Again, there is the good and the bad. When I started attending Steel Structures Painting Council meetings, it was an organization of organizations, most of which were in need of the most durable coating systems possible. Today, many SSPC members represent manufacturers and want to market a product. In many cases, this has resulted in specifications that are sufficiently weak to assure that no manufacturer's product is excluded. The result is that the critical needs of the users are compromised in favor of a manufacturer's bottom line.

Beitelman testing equipment for an instruction course.

In the area of education, however, I have seen tremendous strides in the knowledge of both the project engineers and the painters in the field. I was amused in an SSPC meeting years ago when some manufacturers were crying that they were developing much-improved paints, but no one would buy them because they cost more than the traditional paints of the past. SSPC came up with the idea that they should no longer call the products "paint," but instead use the term "protective coating." It worked! The idea not only sold the higher performance products, but also helped convince users and applicators that they needed more education and training to properly specify and apply the protective coatings. SSPC was there to fill the need.

JPCL: What are some of the biggest challenges that you have faced over the course of your career, and how did you go about overcoming them?

AB: The VOC issue has been the biggest challenge. I don't think we can say we have overcome it, but are learning to accept the lower performance coatings and more frequent repaint intervals that it has brought about. Our primary application is one of constant immersion in river water accompanied with a tremendous amount of impact from floating debris. Low-VOC coatings have been developed that provide a good level of performance in quiet water, but they typically cannot handle the impact of floating logs and churning sand. We have evaluated new commercial products, worked with established paint manufacturers to develop new coatings and even tried to formulate our own coatings, but nothing has been found that will provide the performance of our high-VOC products. Work is being done using nano technology that may improve the durability of coatings, but it's too early to speculate on the application of this technology for the high-impact coatings needed on river structures.

JPCL: Is there a job or project that you worked on in the past, or are currently working on, that is particularly memorable?

AB: The thing that has made projects memorable for me has not been the project as much as the location. I have applied coating systems in Alaska in the winter without heat, and in the tropics in the summer. I have inspected coatings inside of a mountain, inside and under dams and canals, inside water tanks and military tanks. I have been in high-security structures both in the U.S. and abroad. I have been inside of missiles, barges and dam gates. I have gotten to the project sites on towboats, rowboats, airboats, cabin cruisers, private planes and helicopters. It is always the unusual that makes the memory.

JPCL: What advice would you have for a younger person interested in entering the corrosion/coatings industry?

AB: The coatings industry is tremendously big. I have worked with industrial coatings all my life but still know nothing about coatings for automobiles or refrigerators. Many colleges teach polymer chemistry and a few actually teach coatings, but in the end, the person needs to be willing to accept the fact that the college education is only enough to get a foot in the door. The graduate needs to decide on the specific sector of the coatings industry that sparks their interest and dig deeper into that aspect of the industry. Yes, there is a big future in the industry, but it is big industry and one that is always changing so getting into it in any depth will also be a big challenge.

JPCL: If you had to go back and choose another career for yourself, what would you choose, and why?

AB: I always wanted to be a carpenter or cabinetmaker. Indeed, these careers paid the bills during my college days, but the work was seasonal, and I think I would have eventually gotten bored with the daily work. I do enjoy these "careers" as hobbies. As a hobby, I don't need to work at them all day, everyday, and I don't have to think about making a living while I'm doing the work.

JPCL: What else do you like to do outside of work? How do you spend your free time?

AB: I volunteer with the local Habitat for Humanity chapter. I enjoy helping out with interior work like drywall and baseboards when they need an extra hand. I also enjoy making things with a MIG welder. My favorite artistic medium is the concrete reinforcing rod!

JPCL

Fig. 1: Coating compatibility is a bigger problem for overcoating than many believe. All photos courtesy of the author.

Overcoating: Maintenance or Mayhem?

Best Practices for Writing an Overcoating Specification

By Richard A. Burgess, KTA-Tator, Inc., Series Editor

Whether a bridge, tank, pipeline, vessel, manufacturing facility, architectural structure or amusement park ride, at some point there will be a need for maintenance painting. The "paint guy" will share responsibility with those involved in general maintenance, funding, prioritizing, public relations and safety.

Those familiar with maintenance painting may recall the four maintenance painting strategies:

Do nothing: The structure, including the coating system, is in good or very good condition. Maintenance painting is simply not necessary or needed. A second "do nothing" option involves the "extreme condition," when the coating and corrosion breakdown of the structure or item is so poor that it will be demolished, retired or decommissioned.

Spot repair: Cleaning and coating only a few areas or sections of a structure will enhance corrosion protection, is relatively inexpensive and the aesthetics are not a major consideration. Localized areas are cleaned and spot rust and degraded or poorly adhered coatings are removed. One or more protective coating layers are applied to the area.

Spot repair and overcoat: Coating deterioration and breakdown in one or more of the existing coats is providing some protection from corrosion, but erosion, weathering or other environmental conditions have compromised the barrier protection and/or detracted from the desired aesthetic condition. Overcoating may be applied to the entire surface or be limited to specific areas such as those visible to the public.

Remove and replace: This maintenance option is employed when existing coating systems need to be entirely removed and replaced due to extensive breakdown and corrosion of the structure or item. Depending on the service environment and other considerations, this approach may apply to all or only sections (zones) of the surface area.

This column focuses on overcoating, which nearly always includes some degree of spot repair and touch-up application. Whether to enhance corrosion protection, restore and improve aesthetics or both, pre-planning and providing effective, straight-forward specifications are critical to success. Considerations appropriate for overcoating, or any other scope of maintenance painting for that matter, are briefly described simply to provide some context for determining if overcoating is a reasonable maintenance option. Recommendations for project specifications follow these considerations.

Pre-Planning

Maintenance painting is most frequently triggered by some visual condition, be it corrosion and rusting, loss of gloss or color and at times for regulatory purposes (safety color codes). This may result in execution of a maintenance plan or program that already exists (for example, in petrochemical facilities), or alert the owner that maintenance painting will be needed, and planning and preparing work orders or contracts should be initiated. The impact on operations, safety and access are evaluated to determine the possible implications that may be imposed by maintenance painting activities, including shutdown times, lane restrictions on bridges and contractor access.

Coating Condition Assessment

A coating condition assessment may be limited to a visual assessment or involve a closer inspection of the coating system. The physical and chemical characteristics of the existing coating system, including adhesion, coating layers and thickness, degree of rusting or corrosion, topcoat resin type and the presence of heavy metals (e.g., lead or chromium) may all be measured or evaluated when extensive assessments are conducted. Refer to to SSPC "Technology Update No. 3, Overcoating" (SSPC-TU 3) for discussion on the use and possible interpretation of such collected data. When overcoating appears to be a viable option for

Fig. 2: Edge coating should include a stripe coat, even for spot repairs.

Fig. 3: Overcoating does not need to be a "one-and-done" strategy.

maintenance painting, the use of test patches to evaluate surface preparation and candidate coatings should be considered early in the project planning phase.

Project Planning

The scope of the maintenance painting to be performed may be established based on historical experience, the coating condition assessment (general or detailed), available funding or test patch and other testing results. However, once the scope has been established, the details of the project and its impact on operations, the public, budget, duration, season, timing and details for execution can be used to establish the details for contracts, work orders, special provisions and specifications.

Any additional aspects of the overall scope of the project should be detailed. This may include repair or replacement of steel elements or components, identification where specific procedures may be required (coating tie-ins), remediation of soluble salts, specific cleaning agents or processes to neutralize or sequester surface contaminants, and limitations on the surface preparation and/or application procedures permitted.

When abrasives are used, restrictions, such as the use of silica sand, should also be considered. Safety, health and environmental issues are also part of the project planning. Lead paint is lead paint, whether it is on a process vessel, bridge or water tank.

Compliance with all regulatory requirements must be included in planning, as well.

Seemingly mundane details can escape consideration if not included in the detailed plan, such as who will supply power, compressed air, water, scaffolding and controls access (contractor or owner).

Contract Documents and Work Orders

Preparation of the contract or work order documents should include general and specific conditions, responsibilities of the contractor, owner and other parties that may be part of the agreement. Insurance, bonding, definitions, schedule and time allotment are also included. The key component of interest here are the technical specifications for overcoating that are a part of the contract requirements. If you intend on using an existing maintenance painting specification, make sure that it is up-to-date and not simply "copy-and-pasted" pieces of specifications or based strictly on coating manufacturers' recommendations. Because the specifications are contractual, a critical review of the draft specification should always be performed by someone with the experience and credentials to do so. This can be the internal "paint guy (or gal)," a trusted vendor or a consultant.

Technical Specifications for Overcoating

Ultimately, in the eyes of a contractor, the responsibility for the specification will rest with the owner, and rightly so, as the specification is part of the owner's contract documents. When you are tasked with preparing a specification, whether you work for or are retained by the owner, where do you think the content responsibility will lie in the eyes of the owner?

Correct! The engineer, consultant or coating manufacturer that prepared them.

The quality of the contract and specifications can contribute to a relatively smoothly running project or can lead to Mayhem (you know, that guy from the insurance commercials).

Specification for Overcoating Structural Steel

General

The general section of the specification should include the scope of work to be performed; definitions for words and terms used in the specification; a list of

Fig. 4: Spot repairs on the underside of this bridge seemed sufficient, but later proved to be unsatisfactory.

published reference standards, test methods, procedures and regulations and other pertinent informational documents relevant to the work. Safety requirements that the contractor is responsible for, as well as the qualifications of the contractor and personnel may be included here unless addressed elsewhere in the contract. Project documentation and submittal requirements should also be included here.

For the purpose of this article, the scope will involve a small truss bridge where rust is to be removed, tightly adhered coating is allowed to remain and the surfaces are to undergo spot repairs and overcoating.

Materials

The materials section allows the owner or specifier to establish the quality, type and source of materials used for the project. Among the items that may be included in this section are abrasives (required, permitted or excluded); cleaning agents (soaps, alkaline, degreasing); water (potable, non-potable); additives (chloride remediation, corrosion inhibitors); equipment (type, size) and, of course, coatings. Proprietary or similar products that are to be used should also be listed. If substitutions or alternates will be considered, state what documentation or reasoning must be submitted with the request for substitution. The general rule used when selecting an overcoat product is that the same resin can be applied over the existing resin. Use of test patches can confirm compatibility. Tie coats of penetrating epoxy sealers or a "universal" primer may be needed and also evaluated by test patch.

Execution

The execution section provides the detail regarding pre-cleaning requirements (pressure washing); surface contaminants (diesel fumes); surface imperfections (weld spatter, sharp corners, steel defects); items to be protected, and control and containment of the work area. Certain procedures or processes can be excluded (including prohibiting abrasive blast-cleaning) but otherwise leave the means and methods to the contractor. Use performance-based language for surface preparation, coating application, quality control and repair procedures. Note that it is a responsibility to state what is to be done, but ensure there is a performance and/or acceptance criteria and state what methods or standards will be used to measure and test.

Pre-clean all surfaces to be prepared and painted with low-pressure water at no less than 4,000 psi to remove surface contaminants. Prior to pressure washing, remove bulk deposits of dirt, soil, leaves and bird droppings manually. Place all collected debris in containers for disposal. Supplement cleaning with brushes, brooms, rags and wiping to produce no less than a chalk rating of 8 on remaining coating when measured in accordance with ASTM D4214, "Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films."

Surface Preparation

Spot Repairs

Clean all areas of visible rust and corrosion in accordance with SSPC-SP 15, "Commercial Grade Power Tool Cleaning." Remove pack rust and crevice corrosion using impact tools to the satisfaction of the project engineer. Prepare areas of blistered, cracked and delaminated coating in accordance with SSPC-SP 3, "Power Tool Cleaning." Surface temperature should be a minimum of 5 F above the dew point before performing surface preparation. Spot-abrasive blast-cleaning to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" would only be justified if there were numerous spots or locations where the size of spots were quite large or abundant. In such an instance, full removal and replacement may be a more desirable maintenance option.

Intact, adherent coating surrounding rusted and/or degraded areas must be feathered back such that the repair coating will extend at least 2.5 to 5 centimeters (1 to 2 inches) onto the intact coating.

Soluble Salt Mitigation

When removal of soluble salts is necessary, the requirements are included

in the surface preparation section because the criteria must be achieved prior to coating application. Additional surface preparation and cleaning may be required. Use of proprietary products may be used when salt removal is difficult and salt levels are high. The locations and frequency of testing are important. In the writer's opinion, the most important surfaces to test are those that have already exhibited corrosion and are the most difficult to prepare. Random testing should also be used to demonstrate absence of soluble salts.

Coated Surfaces

Coated surfaces must be cleaned using low-pressure water during the pre-cleaning process. However, additional cleaning may be appropriate if the surfaces have become contaminated from other operations, such as removal of blistered, cracked or delaminating coating. Glossy and slick surfaces may require scarification to aid in bonding of the overcoat. If SSPC-SP 7, "Brush-Off Blast Cleaning" is warranted, the abrasives should be fine and the nozzle pressure should be kept low. When thick coatings are present and brittle, SSPC-SP 7 may damage otherwise sound coating. Use of abrasive blast-cleaning, even brush-off blast-cleaning, can significantly add to time and cost for an overcoating project and should be carefully considered.

Coating Application

Ambient Conditions

Relative humidity (RH); the temperatures of the air, surface and material (Ta, Ts, and Tm); and the dew point (DP) are all to be considered before performing coating application. Minimum and maximum values can be established by the specification. Alternatively, requiring that the ambient conditions conform to the manufacturer's published requirements is certainly appropriate. This can also avoid confusion or "push-back" by applicators when the manufacturer has more liberal limits than the specification. Yet, if there are sound reasons for being more restrictive, then by all means specify the limits appropriate to the situation.

Mixing and Thinning

Complying with the manufacturer's instructions is recommended. Thinning may be prohibited, but when permitted, it should comply with the manufacturer's recommended products for the temperatures and/or VOC limits of the workplace. Induction time and pot life should be considered based on the ambient conditions and the quantities to be mixed.

Spot Application

When application begins, the surface to be coated should meet the surface preparation standard required by the specification. The coatings selected for spot application should lend themselves to brush and roller application and should be applied so that the film extends onto the feathered area of the intact coating. These are typically surface-tolerant coatings such as epoxy-mastic or moisture-cured urethane, among others. Penetrating epoxy sealer (100%-solids) can be used as a first coat where pack rust, crevice corrosion or difficult-to-remove corrosion is present and the spot primer has been applied over it. Stripe coating should be performed with the spot primer and/or tie coat when used. A stripe coat of the finish coat may also be applied, particularly where edge corrosion exists.

Overcoat Application

Following adequate cure of the applied spot coat, a full coat is applied. This may include a tie coat and finish coat or a finish coat compatible with the existing coating resin. Test patches will help to determine which overcoating systems perform better than others. The products used should provide the desired finish (gloss, semi-gloss) and color(s). Brush and roller or spray application can be used depending on surface area, location and how protection of other surfaces from splatter, spits and overspray will be accomplished. It was mentioned earlier that spray application may be prohibited by some owners or circumstances. It is worth noting here that a full overcoat does not necessarily mean to all surfaces. Non-visible surfaces (under deck beams and diaphragms) may not need an additional coat when exposed steel is being overcoated. This is particularly true when the major factor in maintenance painting is aesthetics.

Repairs and Deficient Coating

A process for addressing coating repairs from mechanical damage and defects due to preparation or application should be established. In particular, edges of the old coating system may lift when overcoated if thick and not feathered, or if not tightly adhered. These require correction which may be as simple as re-applying the spot coat and/or overcoat, or in the worst cases, removal, preparation and re-application of the spot primer and overcoat.

Quality Control

Quality control must be exercised to achieve a completed project compliant with the specifications, including referenced standards and performance criteria when tested or examined by the methods called for in the specification. We teach that quality control is the responsibility of the contractor. It is; however, the contractor should realize that control over quality is actually in the hands of the craftsmen doing the work (be it surface preparation, mixing or applying the paint) rather than, or in addition to, the foremen and superintendents at the project. The owner and engineer are obligated to clearly state the performance required, the criteria and the manner by which it will be measured. A requirement to submit quality control reports on a regular basis should also be included.

Demobilization

Demobilization is just as much a part of the project as mobilization. It has been included as part of the overcoating specification as a place to house requirements for leaving the site. Requirements typically include cleaning the work and laydown areas, collection and proper disposal of all wastes (including wastewater from low-pressure water cleaning, if applicable) and ensuring no reusable materials leave the site with contamination when toxic materials are involved.

Conclusion

The specification guidance provided herein cannot address every situation or circumstance; no static document can. The complexity associated with what, on the surface, may appear to be a simple spot-and-overcoat solution, has also hopefully been conveyed.

Overcoating specifications and methods that are tried-and-true are the progeny of the mistakes, errors, screw-ups and mayhem that came before. Future overcoating specifications will be superior to the ones in use today simply because over time we will notice the scars, warts and shortcomings.

Surfaces, Standards and Semantics: A Close Look at Visual Surface Cleaning Standards

By Rob Francis, R A Francis Consulting Services Pty Ltd

Poor surface preparation is often considered the main cause for premature coating breakdown. Visual cleanliness of a steel surface is perhaps the most important requirement influencing coating durability. However, there are arguments, confusion and disagreements regarding both cleanliness levels and correlation between the various industry standards. Furthermore, new methods of power-tool cleaning are being introduced, which claim to provide cleanliness levels approaching those of the higher classes of abrasive blast-cleaning. Of course, visual cleanliness is not the only surface preparation parameter influencing coating durability, with surface profile, removal of oil and grease, treatment of soluble salts and other requirements also being important.

This article will discuss visual cleanliness for blast-cleaning, with a view on clarifying requirements for the specifier, contractor and inspector.

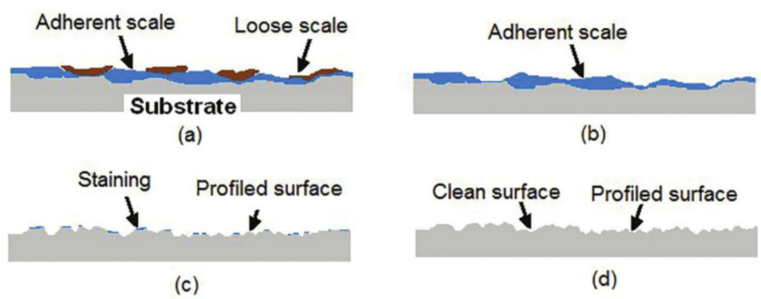

Fig. 1: This figure displays the order in which contamination is removed from a surface, starting with loose material, then adherent contamination and then, finally, staining to leave a clean, profiled surface. Figures courtesy of the author unless otherwise specified.

Removing Rust and Scale

It is important to understand the type of contamination on a steel surface and how it is removed during surface preparation. The three contaminants that influence visual cleanliness standards are mill scale, rust and old paint, which may be adherent or loosely bound to the surface. The increasing standards require more of this contamination to be removed. Loose material will be removed first, leaving adherent contamination. Further treatment will remove this material but still leave traces of adherent contamination known as “stains.” Only after very thorough blasting will these stains be removed to leave a completely clean surface with no contamination visible to the naked eye. These stages are shown in Figure 1, with contamination referred to as “scale” whether it is mill scale, rust or old paint.

Standards for Cleaning Steel

There are two main providers of surface preparation standards. Blast-cleaning standards used in North America are developed jointly by SSPC: The Society for Protective Coatings and NACE International. Each of the five levels of cleanliness is defined in a separate written standard. A set of visual reference photographs (SSPC-VIS 1) has been developed as a supplement to (but not a substitute for) the five written standards. Most other countries use the standard produced by ISO (ISO 8501-1), originally developed in Sweden (where it was Swedish Standard SIS 05 59 00) and still often referred to as “the Swedish Standard.” This standard contains written descriptions, as well as pictures, of abrasive-blasted and hand- and power-tool-prepared surfaces in a single book.

There are differences regarding the relationship between the visual standards and the written standards. With the ISO standards, the visual standards are an integral part of the standard; that is, the reference to the applicable pictures is part of the written description. The visual standard SSPC-VIS 1 can be used to supplement the written SSPC/NACE joint standard definitions for abrasive blasting, but the written standard takes precedence over the visual standards in any dispute.

Relationship Between SSPC/NACE and ISO Standards

Highest Standard of Cleaning

In the SSPC/NACE joint standard, the highest standard of blast-cleaning is SSPC-SP 5/NACE No. 1, designated as "White Metal" and defined as follows:

"A white metal blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter."

The highest standard of cleanliness in ISO 8501-1 is Sa 3, designated as "visually clean steel" and defined as follows:

"When viewed without magnification, the surface shall be free from visible oil, grease and dirt, and shall be free from mill scale, rust, paint, coatings and foreign matter. It shall then have a uniform metallic colour and correspond to the prints designated Sa 3 in ISO 8501-1."

Both standards require the surface to be completely clean with no visible contamination when viewed without magnification. There is little doubt that the two standards are identical in intent, and it would be impossible to produce a blast-cleaned surface that met one standard but not the other.

Second-Highest Standard

The joint standard for the next-best class is SSPC SP-10/NACE No. 2, "Near-White," and is defined as follows:

"A near-white metal blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter. Random staining shall be limited to no more than 5 percent of each unit area of surface ... and may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coating."

ISO's second-highest class of cleaning is Sa 2½, or "very thorough" blast-cleaning, defined as follows:

"When viewed without magnification, the surface shall be free from visible oil, grease and dirt, and shall be free from mill scale, rust, paint, coatings and foreign matter. Any remaining traces of contamination shall show only as slight stains in the form of spots or stripes."

Both definitions require a very clean surface with no rust, mill scale, old coating or other matter. However, there are two differences. First, both allow "staining" but define it slightly differently, although not clearly. The 2007 revision of ISO 8501-1 Sa 2½ implies that staining is "traces of contamination." Although "staining" is not defined in the 2007 joint standards, SSPC's *Protective Coatings Glossary* defines staining as "An area of a surface which, when compared to adjacent areas, has an equal surface profile but is discolored (usually darker) with a material having no apparent volume. The material cannot be removed by methods commonly used to remove dust, but can be removed by more thorough abrasive blasting when abrasive blasting is used, or more thorough power tool cleaning when power tool cleaning is used."

It would appear that both standards have the same requirement in this respect — namely, that the surface shall be completely clean, but traces of discoloration are allowed.

The second difference is that the joint standard actually quantifies this level of staining to no more than 5 percent, whereas the ISO standard uses the word "slight."

Third-Highest Standard of Cleaning

The next level of cleanliness in the joint standards is SSPC-SP 6/NACE No. 3, or a "Commercial" blast-cleaned surface. This is defined the same as "Near-White" except that the amount of permissible staining for a "Commercial" finish is increased to 33 percent of the surface.

"A commercial blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other

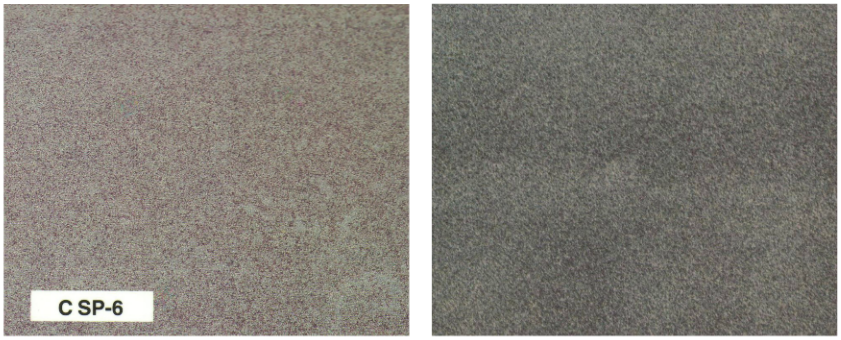

Fig. 2 The photo on the left shows a "Commercial" blast-cleaned surface (SSPC-SP 6/NACE No. 3), while the photo on the right shows a surface prepared to ISO Sa 2. While the two photos may appear similar, the joint standard is actually a higher degree of cleaning.
Photos courtesy of SSPC and ISO.

foreign matter. Random staining shall be limited to no more than 33 percent of each unit area of surface ... and may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coating."

The next level of cleaning according to ISO is Sa 2, or "thorough" blast-cleaning. The important visual aspects of this definition are as follows:

"When viewed without magnification, the surface shall be free from visible oil, grease and dirt, and from most of the mill scale, rust, paint, coatings and foreign matter. Any residual contamination shall be firmly adhering."

Sa 2 requires only that most mill scale, rust and old paint be removed, and says nothing about whether staining is allowed on cleaned areas. Contrary to the popular view that "Commercial" is equivalent to Sa 2, the joint standard is clearly a better method of cleaning as it requires all mill scale, rust and old paint to be removed, whether adherent or not, with "white metal" over two-thirds of each unit area of surface and staining over one-third. Comparing the two photographs in Figure 2, although the "Commercial" grade appears to have a greater percentage of "white metal," the difference in appearance between the remaining contamination, whether

Table 1: Permitted Levels of Contamination for Blasting Standards

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

staining or adherent, is not readily apparent.

In 1999, a joint standard was introduced with a lower level of cleanliness than "Commercial," known as SSPC-SP 14/NACE No. 8, or an "Industrial" blast-cleaned surface. This allows evenly distributed traces of tightly adherent mill scale, rust and coating residues to remain on 10 percent of each unit area of the surface. Staining may be present on the remainder of the surface.

Unlike "Commercial," the "Industrial" class does allow some tightly adherent contamination on the surface, similar to ISO Sa 2. The definition of "tightly adherent" is the same for both standards; as with the ISO standard, contamination is considered to be tightly adherent if it cannot be lifted with a dull putty knife. The joint "Industrial" class allows stains over the remainder of the surface (i.e. area that does not have traces of contamination), whereas the ISO class does not mention stains. The "Industrial" class quantifies the amount of adherent contamination that is allowed whereas the ISO standard only requires that "most" of the adherent contamination is removed. This would appear to be the only difference between the two; that is, whether "most" can be quantified as 90 percent. Certainly, Sa 2 is very close to "Industrial," but not as clean as "Commercial." In addition, "Industrial" blast-cleaning exempts configurations such as back-to-back angles from the 10 percent criteria and allows contamination to remain as long as an effort has been made to remove it. ISO Sa 2 does not discuss this issue.

Lowest Standard of Cleaning

The lowest standard of cleaning in the joint standards is SSPC-SP 7/NACE No. 4, "Brush-Off" blast-cleaning. This requires all loose material to be removed but tightly adherent contamination may remain. Similarly, ISO's lowest class of cleaning, Sa 1 or "light" blast cleaning, simply requires the surface to be free from poorly adhering mill scale, rust, paint, coatings and foreign matter. In both descriptions, all loose material must be removed, but tightly adherent material may remain over the entire surface. Adhesion is defined similarly for both. The joint standard has additional information regarding the appearance, but the two descriptions are almost identical. It would be impossible to find a surface that met one class without meeting the other.

Quantitative Descriptions

One important feature of the joint standard definitions is that they provide a numerical guide to acceptable levels of contamination. ISO provides qualitative descriptions such as "slight" and "most" regarding areas contaminated or cleaned.

Applying numbers to a quality level would generally be expected to provide a clearer, more concise and less ambiguous method of describing surface cleanliness. However, it does not assist. If a number is asked for as a quality parameter in a standard or specification, there normally has to be some means of measuring the parameter in question. In the case of surface cleanliness, the surface is judged visually. That is, the level of contamination is not, and practically cannot be, measured but only estimated. Despite the quantitative requirement, a qualitative assessment must be made. Therefore, the qualitative descriptions given in the ISO standards are arguably just as valid and, in many ways, preferable, as they implicitly recognize that area estimation of contamination levels cannot be measured.

Summary of Blasting Standards

Table 1 provides a summary of the allowable levels of contamination for the various standards of blast-cleaning showing equivalence between the cleanliness levels. SSPC-SP 6, NACE No. 3, "Commercial" blast-cleaning is the only standard that clearly does not have an ISO equivalent, although it is often considered to be equivalent to ISO Sa 2. However, the table shows that "Commercial" is closer to ISO Sa 2½ than to ISO Sa 2. "Commercial" cleaning has been specified for more exacting coatings such as inorganic zinc silicates, and the fact that it is a very clean surface would explain why this

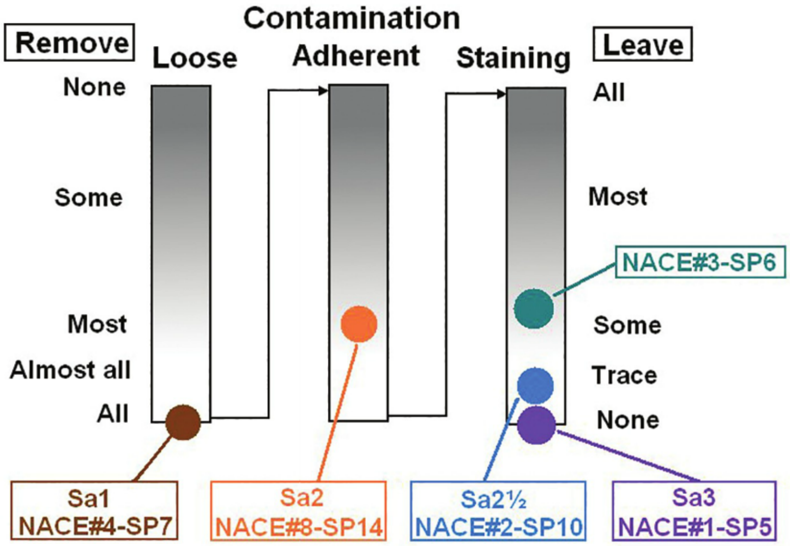

Fig. 3: This figure shows what contamination is allowed to remain and what needs to be removed for each of the referenced blast-cleaning standards.

has been successful.

The process of blasting looking at the stages of removal of contamination discussed earlier, and the standards achieved, are shown schematically in Figure 3.

While the joint and ISO standards display many similiarities, it is important to always adhere to the surface preparation standard that is written in the specification.

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Fusion bonded epoxy (FBE) and three-layer polyolefin coatings are the most used coating systems for corrosion prevention of oil and gas pipelines. Coating is the primary component of the corrosion prevention system for a pipeline. The secondary component is cathodic protection. Scratches, holidays and other coating damage, resulting in exposure of bare steel, can occur during production, transportation, installation and even after burial in the field, and cathodic protection safeguards the steel in those areas.

Cathodic protection can cause coating delamination around such coating damage. This delamination is called cathodic disbondment (CD) and is the result of electrochemical reactions in the damaged area causing loss of adhesion between the coating and the steel surface of the pipe. CD resistance, the ability of a coating to minimize CD, is an important property for a pipeline coating. There are a large number of national and international cathodic disbondment test (CDT) standards used to measure the CD resistance of a coating. The various procedures differ in apparatus, temperature, electrolyte solution, test duration and voltage.

As a laboratory test, the CDT is used for ranking CD performance of various candidate coatings and may not simulate the exact operating conditions in the field. It is also used as a qualification test and as a quality control evaluation of the pipe-coating application process. To be a useful test, one should be able to obtain similar test results in different testing facilities.

For an operating pipeline, coating quality is a key factor in cathodic protection cost. Because the required current for cathodic protection is related to coating quality, a high-quality coating with many holidays can increase the level of required current. With a given coating, the current cost is related to the number of holidays and the total surface area of exposed steel. Disbondment increases the exposed area.

For that reason, the CDT is often one of the most important tests in the view of end users. A coating's future performance and adhesion is related to surface preparation. With the help of the CD test, end users can better understand the surface preparation and adhesion quality of the coating and use that to develop a prediction for long-term cathodic protection performance.

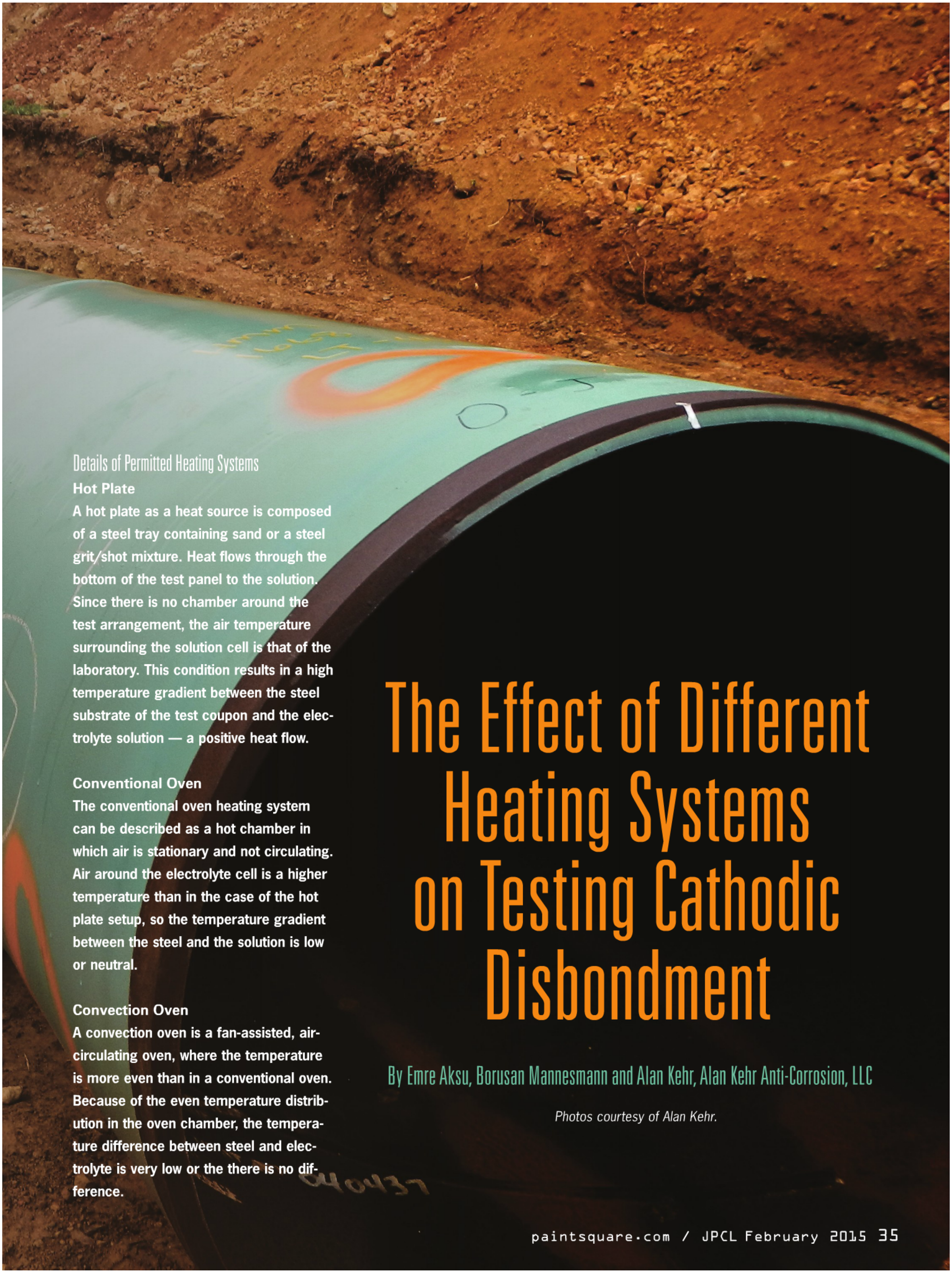
The Test

The test setup is composed of a power supply, a heating system (if the temperature of the test is higher than room temperature), an electrolyte, a coated sample, an electrode and a reference electrode. Drilling a hole through the coating to the steel creates artificial damage of known and quantifiable dimensions. The intentional defect dimensions are prepared according to the requirement of the standard used. The bare steel intentional holiday is brought into contact with the electrolyte and a conductive solution, either by immersing the test specimen into the electrolyte or by attaching a cell and filling it with electrolyte.

The direct-current power supply provides the electrical potential specified in the standard. The electrode (anode) connects to the positive (+) pole of the power supply and together with a reference electrode they are introduced to the electrolyte (Fig. 1, p. 36). The test specimen's bare steel (cathode) is connected to the negative (-) pole of the power supply. The power supply is switched on and adjusted until the potential measured between the reference electrode and the test specimen reaches the required value of the standard. The test setup is held under the applied potential and specified temperature for the required duration.

After test completion, the cell is dismantled and cooled to room temperature. Eight radial cuts are made and chips of the coating are removed from the initial hole with a utility knife. Finally, the disbondment radii for each chip is measured, and the average of the eight radii gives the disbondment value of the test sample (Fig. 2, p. 37).

The effect of temperature is an important issue for the test. In general, the test temperature is selected based on the expected pipeline service temperature, and disbondment increases with increased temperature. Typically, standards do not clearly outline the heating system for the test temperature and may define it as either a hot plate or an oven. Therefore, testing laboratories use hot plates; conventional ovens; fan-assisted, air-circulating convection ovens; and hot plates covered with an isolation chamber. All of these heating systems are permitted and meet the requirements of the standards; however, our findings show that the selection of the heating system can significantly affect test results. Therefore, the standards need an update that clearly defines the choice of heating procedure in the CDT protocol.



The Effect of Different Heating Systems on Testing Cathodic Disbondment

By Emre Aksu, Borusan Mannesmann and Alan Kehr, Alan Kehr Anti-Corrosion, LLC

Photos courtesy of Alan Kehr.

Details of Permitted Heating Systems

Hot Plate

A hot plate as a heat source is composed of a steel tray containing sand or a steel grit/shot mixture. Heat flows through the bottom of the test panel to the solution. Since there is no chamber around the test arrangement, the air temperature surrounding the solution cell is that of the laboratory. This condition results in a high temperature gradient between the steel substrate of the test coupon and the electrolyte solution — a positive heat flow.

Conventional Oven

The conventional oven heating system can be described as a hot chamber in which air is stationary and not circulating. Air around the electrolyte cell is a higher temperature than in the case of the hot plate setup, so the temperature gradient between the steel and the solution is low or neutral.

Convection Oven

A convection oven is a fan-assisted, air-circulating oven, where the temperature is more even than in a conventional oven. Because of the even temperature distribution in the oven chamber, the temperature difference between steel and electrolyte is very low or the there is no difference.

Isolated Hot Plate Chamber

This is a hot plate with an isolation chamber around the plate. In this case, we used an air-circulation fan so it is similar in function to the convection oven arrangement. Some laboratories use air circulation while some do not.

Questions arise. Do these heating procedures provide similar results? How many millimeters (mm) of disbondment difference will occur if we use each of the heating systems for test panels with same coating material, application procedures and thickness?

Finding Answers

We set up the following experiment to answer those questions. A spiral-welded FBE-coated steel pipe was selected to provide the test panels. In the application plant, the pipe joint was cleaned in two consecutive blasting cabinets. In the first blasting cabinet, 100 percent shot S390 material was used and in

Table 1: Disbondment Values for Each Heating System

Hot Plate		Isolated Hot Plate Chamber	
Sample 1	4.06 mm	Sample 13	7.78 mm
Sample 2	3.61 mm	Sample 14	5.96 mm
Sample 3	4.25 mm	Sample 15	6.71 mm
Sample 4	3.67 mm	Sample 16	6.03 mm
Sample 5	4.17 mm	Sample 17	6.36 mm
Sample 6	4.21 mm	Sample 18	6.83 mm
Average Disbondment	**4.00 mm**	**Average Disbondment**	**6.61 mm**

Conventional Oven		Convection Oven	
Sample 7	5.73 mm	Sample 19	7.38 mm
Sample 8	4.70 mm	Sample 20	6.39 mm
Sample 9	5.02 mm	Sample 21	6.29 mm
Sample 10	3.77 mm	Sample 22	6.35 mm
Sample 11	5.93 mm	Sample 23	6.75 mm
Sample 12	6.48 mm	Sample 24	7.43 mm
Average Disbondment	**5.27 mm**	**Average Disbondment**	**6.77 mm**

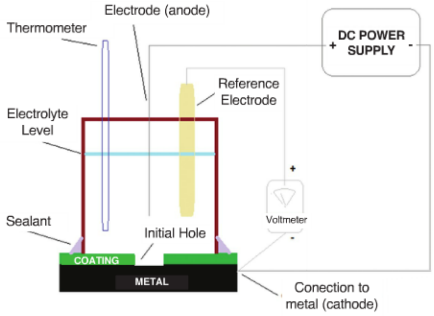


Fig. 1: This illustration shows a typical cathodic disbondment test setup.

the second cabinet, a 50/50 mixture of GL25 and GL18 steel grit.

The surface profile achieved was an SSPC-SP 5/NACE No.1, White Metal Blast of 80-100 µm average peak-to-valley height (Rz). After blasting, the salt contamination level was 0.2 µg/cm, tested as per ISO 8502-6:2006, "Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 6: Extraction of soluble contaminants for analysis — The Bresle method."

After surface preparation, the pipe was acid-washed and rinsed. The acid concentration was in the range of 6 to 10 percent and rinse-water conductivity was below 15 µS/cm. The pipe was then heated to 235 C, followed by FBE application. The resulting dry-film thickness (DFT) ranged from 400 to 450 µm.

Twenty-four test panels were cut from the pipe. The CD tests were done according to Canadian Standards Association CAN/CSA

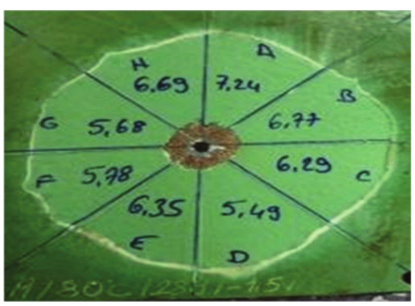


Fig. 2: Disbondment radii measurements for a sample were made along each of the eight cuts. The results are averaged and reported.

Table 2: Temperature Gradient for Each Heating System

	Conventional Oven	Convection Oven	Hot Plate	Isolated Hot Plate Chamber
Metal Temperature	85 C	80 C	96 C	82 C
Solution Temperature	80 C	80 C	80 C	80 C
ΔT	**5 C**	**0 C**	**16 C**	**2 C**

Table 3: Temperature Difference and Cathodic Disbondment for Each Heating System

	Conventional Oven	Convection Oven	Hot Plate	Isolated Hot Plate Chamber
ΔT	**5 C**	**0 C**	**16 C**	**2 C**
Average Disbondment	**5.27 mm**	**6.77 mm**	**4.00 mm**	**6.61 mm**

Z245.20/-Z245.21-02, "External Fusion Bond Epoxy Coating for Steel Pipe/External Polyethylene Coating for Pipe." The test temperature of 80 C was measured with an immersion thermometer in the electrolyte solution. A thermocouple inserted into a 4-centimeter-deep hole drilled into the side of the plate measured the temperature of the steel. Applied voltage was -1.5 V vs. a calomel (reference) electrode, and the solution was 3 percent sodium chloride (NaCl) in deionized water. The initial volume in the each test cell was 300 milliliters (ml) and the test duration was 28 days.

The average thickness of the coating was 435 µm. Six panels were placed in each type of heating system. The solution level was maintained by deionized water, added daily. After 28 days the test samples were removed from the heating system, dismantled, and allowed to cool to room temperature.

The CD values were measured and recorded using the procedure described in the CSA standard referenced above.

As can be seen in Table 2 (p. 37), the average disbondment from the hot plate exposure was 4.00 mm. For the conventional oven, it is higher at 5.27 mm. For the air-circulating convection oven and air-circulating isolated hot plate chamber, results are quite similar at 6.61 mm and 6.77 mm. If we take the average of all 24 samples, the disbondment value is 5.66 mm with a standard deviation of 1.28. Therefore, the difference between the average disbondment of the hot plate and the convection oven of 2.77 mm is significant.

The data show that the thermal gradient has a significant effect on the results. An immersion thermometer and a digital thermocouple were used to measure the temperature difference between the solution and the metal for each heating system. To measure the temperature of the electrolyte, the immersion thermometer was placed in the solution near, but not touching, the test panel. The digital thermocouple was placed in the hole drilled into the metal plate. The maximum thermal gradient is observed with the hot plate setup and the minimum gradient with the convection oven, as seen in Table 2 (p. 37). With the solution temperature controlled at 80 C, the table shows that the hot plate has a gradient of 16 C compared to no gradient for the convection oven.

Table 3 shows an inverse relationship between the test plate temperature required to maintain the electrolyte temperature in the various heating conditions and the amount of disbondment.

Conclusion

The CDT is one of the most popular in pipe-coating evaluation. There has been significant research reported to provide understanding of the electrochemical reaction mechanism, the effect of coating type, coating thickness, electrolyte type and concentration, oxygen concentration in the electrolyte, test duration, voltage and temperature. However, CDT results are affected by the heating system used in the test. Each of the different heating systems meets the requirements of major standards, but data show that the standards should clearly define the heating system and thermal gradient to achieve better reproducibility between laboratories and facilities.

About the Authors

Emre Aksu is currently working as coating technology engineer of Borusan Mannesmann, a pipe production and coating facility in Gemlik, Turkey. Aksu has seven years of experience in the pipe coating and custom coating industries. He is responsible for the internal and external coating processes. Aksu is currently a NACE Level 2 Coating Inspector.

Alan Kehr is the managing consultant of Alan Kehr Anti-Corrosion, LLC in Lakeway, Texas, which offers worldwide consulting on FBE pipeline and rebar coatings, as well as other services. Kehr has more than 40 years of experience in the pipeline and reinforcing steel coatings industries. He has been active in NACE and was instrumental in standards development for ASTM, ISO, and other industry associations. **JPCL**

Effective Maintenance Painting Practices for Offshore Oil & Gas Structures — Part Two

Mark B. Dromgool, KTA-Tator Australia Pty Ltd

Undertaking maintenance painting of offshore oil and gas assets can be expensive and frustrating due to the complexity of the facility, conflicts with simultaneous operations (SimOps) and the highly corrosive nature of the marine and chemical-rich environment (Fig. 1). However, the author's experiences over many years have shown that there are three simple and synergistic methodologies which — if executed and supported properly — can significantly improve the durability, reliability, cost-effectiveness and performance of on-station structure maintenance.

Part 1 of this article (*JPCL* September 2014) demonstrated how much of the damage to coatings occurs to offshore oil and gas platforms and floating production storage and offloading facilities (FPSOs) during the construction, conversion and/or commissioning phases of getting the asset on-station and working to pump and process oil and/or gas. This part covers some practices that have been found to be useful and effective to deal with the damaged coating systems once the platform or FPSO is in position at the oilfield and to address the other degradation that inevitably occurs throughout its operational life. These practices are not exclusive to offshore assets; they can be applied to onshore structures of all types where aged or damaged coating systems are found.

The Three Pillars of Maintenance Painting Practice

The three-pillar concept suggested here is part of an overarching strategy to paint the *right* item or surface, at the *right* time and with the *right* coating system.

Pillar One

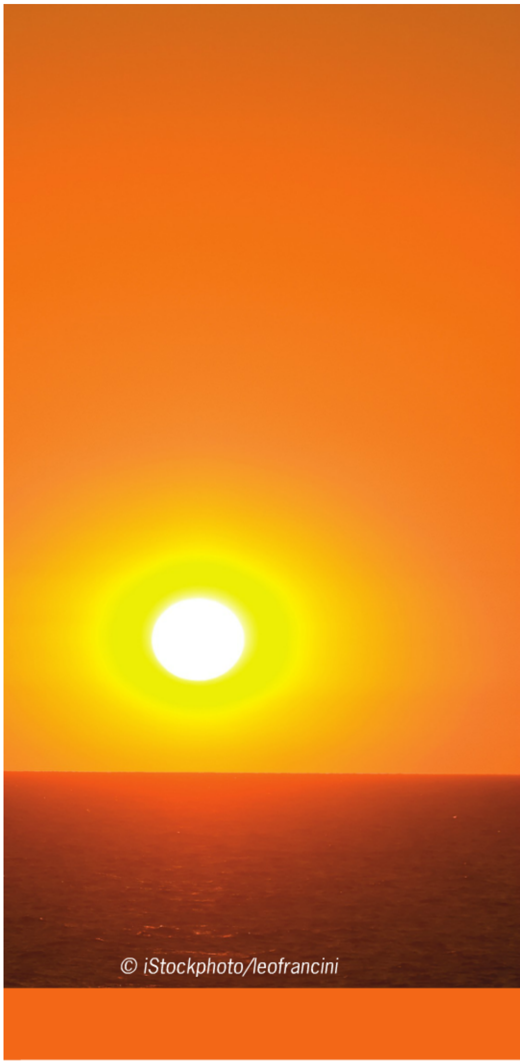
With some regularity, be it annually or bi-annually, commission an on-station coating maintenance repair and touch-up campaign using an experienced and resourced coating application contractor, working to specific directions and instructions on what, when and how to paint.

Pillar Two

Make sure that all corrodible equipment, hardware, structures and components that are supplied to the asset from onshore are properly and fully coated with the right coating system before being shipped. These items are to be protected, packed and handled with care cognizant of the vulnerability of the protective coating system to damage.

Pillar Three

Initiate a program using one or two personnel from the facility's crew to carry out spot coating maintenance and touch-ups — especially when mechanical items, hardware, structural members, pipe spools or even bolts are fitted or replaced — using a narrow range



of multi-purpose coating products that are kept in small kits in the facility's paint locker.

This article discusses how these three processes are interrelated and how they can combine to provide the best asset durability, the best risk management and do so at the lowest practical cost.

Pillar One: Use a Professional Contractor

Too many times the results of inadequate skills, resources or capability employed to plan and carry out coating maintenance duties is evident offshore. This should not be deemed an attack on coating contractors, because they are but a small part of the assembly of skills that it takes to properly perform on-station coating maintenance work. With all due respect, the other participants can be the personnel who carry out the coating condition surveys; those that interpret that information to make priority listings; the specifiers and contract writers who prepare work scopes and develop coating schedules; coating manufacturers or suppliers who may exercise their own agendas on products and systems; the procurement staff that make purchasing decisions on coating suppliers and contractors using price as the single or predominant criterion; the inspectors looking over the work; and last but certainly not least, those employed to manage the SimOps of production, operations and maintenance on a complex offshore oil and gas facility.

As is now obvious, the heading above this section is a misnomer: it's not just the coating application contractor who influences the ultimate quality, efficacy, economy and reliability of on-station coating maintenance. Let's work our way through the process and see who and what else has influence and why.

Fig. 1: The topsides of a typical FPSO is a particularly congested space and presents some unique challenges when coating maintenance and corrosion control is required to be performed. If not undertaken correctly a lot of money and effort can be wasted. All photos courtesy of the author unless otherwise noted.

Extent and Type of Corrosion vs. Rate of Corrosion

The first and most vital task when structure maintenance is being contemplated is to perform a thorough survey and inspection of the facility, and then to interpret this data to develop a sensible and robust priority listing. Sometimes these tasks fall to the same person; in other cases they are separate. Unless the surveyor is particularly skilled and focused, it is easy for this survey to concentrate on the *extent* of coating breakdown or the percentage (penetration) of through-section rusting (and these are not the same thing).

The extent of breakdown or the percentage of rusting are less significant than the rate at which breakdown is occurring. Thus, of greater concern is the rate of section loss and when the integrity of the item, member or structure will be at risk. This is because an item of steelwork could be widely rusted but rusting at a rate of little concern or minimal consequence. Coating and structure maintenance should be performed based on *need* and painting maintenance should — on a well-managed facility — have to compete with other integrity and maintenance issues for funding. Therefore, the need to paint should be directly connected to risk, specifically, the minimization or control of risk. The metric of risk might encompass structural or mechanical integrity, personnel safety, hydrocarbon containment or environmental releases in some order or other depending on the corporate philosophies of the asset operator or the persuasion of the regulator.

Inspector beware: the priority of what to paint, when and how should be driven by the risk to that item, structure or surface from a loss of functionality or integrity caused (primarily) by section loss. This is seldom directly assessable by estimating the visual extent of corrosion or coating breakdown, so it means looking deeper and considering the future consequences that could arise from corrosion causing section loss on the items being scrutinized.

Many surveyors and inspectors tasked with undertaking condition surveys might have trouble articulating or identifying the difference between the extent of breakdown or corrosion and the rate at which section loss is happening, or will happen. Technically, the extent of breakdown or corrosion can be assessed at a single point in time; for example, x percent of the total surface areas is given to a rusted condition and y percent still has paint present (where x plus y equals 100) based on a simple two option demarcation. Rate of corrosion, however, brings in a time factor. Therefore an item would theoretically need to be assessed at different dates in order to determine the rate of change. With some experience and focus the simplistic criterion of *how widely* something is rusting (or showing coating breakdown) can be relegated to a lower importance than an estimate of *how rapidly* the corrosion is occurring and when the consequences of that may become intolerable.

It helps to understand that corrosion on the surface of carbon steel can be partly protective, in its own right, of the underlying metal. By definition, corrosion (rust) is a compound of iron (Fe) and oxygen (O) in one or usually more of the various forms of iron oxide and oxide-oxyhydroxides, for example, Fe O, Fe $(OH)_2$, Fe_2O_3, Fe_3O_4 and so on. These oxidized states of iron are more stable and have less potential to further oxidize than the parent metal. The quite benign and stable nature of iron oxide is one of the main reasons why it is such a very common pigment in paint and coatings. By way of analogy, rust on steel is not like cancer in the human body. It doesn't have to be totally eliminated for the durability of the asset to be reasonably protected. Consequently, the presence of corrosion product does not necessarily imply that a deleterious amount of metal section loss has occurred, and may help to slow down the rate of further corrosion by acting as a scab over a potential breakdown zone.

As a general rule of thumb, higher priority scores for coating maintenance should be assigned to items and surfaces where the risk of repair scope creep and the consequences of coating failure or loss of containment and/or function are highest; not the items where the amount of work to perform to correct the breakdown or corrosion is greatest.

A Stitch in Time Saves Nine

Counterintuitively, it is also helpful to assess items or surfaces on the basis of where the consequences of a delay in undertaking maintenance would be worse. This is the old and meritorious saying "a stitch in time saves nine" approach. The underlying logic is that items or surfaces with just a small amount of apparent breakdown are sometimes better candidates for some spot repair or perhaps overcoating before the extent of surface preparation becomes too high (i.e., after more breakdown occurs). This scenario should be compared to where another item has already badly broken down to the point where a wide scale or total area surface preparation is required, but where the repair scope cannot increase even if postponed. An example could be a structure that evidences widespread rust-through of the coating but where the rusting process is slow and poses no imminent threat to structural integrity. So, if a full 100 percent blast was thought necessary as the next maintenance step — yet that surface preparation intensity doesn't change if the work is delayed for a few more years (it will still require a 100 percent blast) — then there is little consequence to the delay thus allowing other more vulnerable items, where a delay does have scope escalation ramifications, to be elevated in priority.

Another principle that should influence work scopes and priorities is opportunism, particularly relating to access. If some areas of the facility can be made accessible with minimal disruption of ongoing oil production (with all the incumbent work permit conflicts), it sometimes makes sense to group together the work scopes on a number of adjacent items and complete all of them contemporaneously.

Collectively, these somewhat disparate influences should be collated to come up with a recommended priority schedule for tackling the coating maintenance work in the best order, remembering that the priority should be focused on risk (structural and integrity), not appearance. When surveyors and inspectors make priority rankings based on the visually dominant criterion of extent of breakdown, the wrong items may unwittingly be selected for maintenance attention.

Twilight Zone or Feathering Zone

The next item to address is which surface preparation and coating system combination to use and what extent of activity to perform. Based on many maintenance campaigns for spot painting the following procedure is suggested.

When the surface preparation is being performed — assuming in this instance that it is being done with power tools, and also that the existing sound coating between the spots is still serviceable — confine the area being cleaned to the zone of breakdown only and just out to the sound coating edge, i.e., don't keep extending the spots unless the adjacent coating is unsound. The aim is to keep the surface preparation (and the priming) within strictly controlled geographic limits. Importantly, the surface preparation ought not to include feathering the edges of the existing coating as this will stress the bond at the critical point: the juncture where the coating has been fractured and where the bare substrate is exposed. By all means, ensure that the edge that has been reached is sound, but then stop there. The only areas where some feathering might be considered, is where an adverse aesthetic situation might exist in highly visible areas. In a nutshell, there are few of these on an offshore structure. Simply, the extra time and effort to perform a low-yielding task like feathering edges would be better spent on actual

surface preparation on other breakdown zones.

Achieving an excellent degree of surface preparation quality is usually not worth the extra effort and expense. Experience indicates that 80 percent of the value of surface preparation for spot coating maintenance is achieved with maybe 35 to 40 percent of the effort. Achieving the balance of the value will take about twice as long for the last 20 percent of value. Moreover, the effective labor cost offshore is very high by the time everything is rolled up. So spending about three times the man-hours on surface preparation per effective square meter is not good economy.

Another difficulty is the differentiation between zones of breakdown that look the same or similar to the coating contractor, often on adjacent items, some of which need attention and others that don't. For example, a badly rusted section on a pipeline containing pressured hydrocarbons and an identical zone of corrosion on a deadleg support stool might both appear to need preparing and painting, yet the risk to integrity of the two could not be more disparate. This can literally mean that coating maintenance in a specific area of the facility does not actually address all the zones of breakdown, sometimes much to the dismay of the non-coatings people on board. The reasoning for intentionally omitting some zones needs to be explained to the coating contractor and to production and operations personnel.

It is important to try and lower the amount of soluble salt contamination, specifically ionic materials such as sodium and chloride, to a level as low as possible before coating surfaces with good surface tolerant coating materials. Very good durability can be achieved without over-preparing the substrate to a pristine condition. There is a trade-off between the extent of surface cleanliness and the amount and type of coating applied for the same achievement of durability.

When painting, the primer coat needs to be applied just to the spot-cleaned areas and out onto the sound coating film by no more than about 20 to 25 mm (0.75 to 1 inch). Painting farther out onto the sound, intact adjacent coating is not recommended, even if another spot repair zone is proximate. At this stage, just paint the bare spots and very carefully brush around the juncture between the bare substrate and the edge of the adjacent sound coating to bind in the exposed coating edge. This ensures further film build with the subsequent coats is added just on the areas that have had the steel substrate exposed. If adjacent spot-prepared areas are joined up with the primer it will not be possible to tell exactly where the bare substrate was with all subsequent coating applications, and staying focused on where the bare steel areas were actually located is extremely important to maximize productivity and durability, and to optimize the use of labor and paint. Many painters may have to be retrained so as to adopt these important aspects because their work history likely involves feathering edges, extending the paint coverage too far with successive coats, joining adjacent spots together and brushing out or rolling the coating so it looks good to the detriment of film build and durability.

Another reason to concentrate on painting just the spots is to avoid adding extra film build, and hence stress, to the adjacent sound coating that already has its full quota of film build. In essence, adding further paint build to a sound and functional film is not only wasteful of paint, but could risk film integrity if the cumulative stresses get too high.

Carefully brushing the primer around the edge of the adjacent coating will sometimes cause the edges to curl up slightly as the primer cures. This is permissible and only if it splits open or becomes intolerable, should it be cut off with a sharp broadknife and reprimed, otherwise it may be just overcoated. Offshore, painting is for performance and durability, not aesthetic appeal.

When the primer and subsequent coats are being applied, it is important to ensure that an adequate and appropriate film build is achieved for each coat applied. Too often spot and patch painting occurs where the extensive effort of surface preparation is not matched with enough of the right paint film build. The theory in play is that in many ways, a slight shortfall in the absolute achievement of surface preparation quality can be compensated by extra film build (providing the right generic type of coating is used and is tolerant of a higher film build). Remember, the cost of a 4 liter (1 gallon) tin of paint is only a fraction of a painter's effective cost per hour, so make sure the paint application is performed in a manner that guarantees enough of the coating film is applied on all areas being painted. By comparison, paint is cheap in this situation. As with the avoidance of feathering during surface preparation, the aesthetics of the paint application are not critical if the priority is protection. This means that brushing out the wet coating so it looks good is not as important as getting the film build everywhere it is needed and only where it is needed.

Browning's Observation: Less is more

As most oil and gas offshore structures currently in use would have employed epoxy coatings as the primary generic material on their topside systems, the spot-repair products are probably best to be epoxies also. (For a given thickness high-build vinyls are arguably superior barriers than epoxies to oxygen and moisture permeability — as their many decades of use offshore proved — but their use with epoxies in mixed systems is potentially problematic.) As a result, high-build, surface-tolerant epoxies have greater utility as on-station maintenance coatings, perhaps in combinations with a zinc-based primer and high-build polyurethane topcoats (if color is important).

For offshore maintenance painting where the prepared surface is predominantly free of organic paint material — even if there are some oxides or remnants of corrosion products left on the substrate — and except where water ponding or a long time-of-wetness is possible or likely; zinc-rich primers, preferably epoxy zinc-rich materials, are advised. It is not necessary to employ a zinc-rich coating that contains extremely high loadings of metallic zinc, such as 90 percent of zinc by weight. One reason is that they can be too weak cohesively when overcoated with thick-film topcoats. A lower zinc level in the mid-80 percent range has a better balance of resin to pigment and doesn't lose out on the ability to provide a satisfactory level of galvanic protection for the initial few months before this starts to fade. It is widely understood that zinc-based primers have a resistance to residual soluble salt contamination around seven or eight times that of other purely barrier coatings.

If using a zinc-rich primer is not desired or suitable, as in the case where a water ponding risk exists, then epoxy materials used direct-to-metal would be satisfactory. A good quality aluminum-pigmented, high-solids, solvent-based, surface-tolerant epoxy is a very good product choice. What these lose in galvanic capability as compared to a good zinc-rich primer, they make up for in permeability resistance and undercutting resistance, especially if the formulation uses a high-quality aluminum-flake pigment at an appropriate pigment volume concentration (PVC).

Usually it will take a sequence of coating layers — often three or four — to be carefully applied to achieve the required film build and protection on the spot treated areas. The same diligence needs to be observed with all of the coating layers applied after the primer, i.e., with strictly controlled geographic limits of painting, cleanliness between coats and attention to film-build achievements for each and every layer. A contrast of colors must always be used for successive coats to ensure full coverage. The aim is to achieve a high integrity coating over each spot area or zone of painting that achieves a full-system dry film thickness (DFT) of around 18 to 20 mils (450 to 500 microns). This DFT of a reputable surface-tolerant epoxy, applied in a sequence of coating layers (and certainly not as a single- or two-coat application) should comfortably have the potential to provide a good term of durability even if the absolute surface preparation quality of an oxide-free substrate was not achieved.

In this context, the painting is normally favored to be left as non-contiguous spots, unless there is a very good reason why a unifying topcoat should be applied such as a maritime safety directive or regulation. Examples of this are rare though, covering only specific areas of the platform or vessel such as the helicopter deck. A functional paint job that ends up looking like a spotted dog is perfectly acceptable on a producing oil platform or FPSO, providing the paint is in exactly the right places and will provide the durability desired.

If it is decided to apply an overall topcoat (aged systems of sound, weathered coating may need a tiecoat and a topcoat), no painting beyond the immediate zone of the spot-repaired areas should occur until the required minimum DFT has been achieved on all the spot-coated areas because once a full coat of anything has been applied, the locations of spot repair zones where the DFT could be low will then be indistinguishable.

There are certain items that should not normally be painted. This isn't absolute but there is little benefit, for example, in spending valuable time and effort doing surface preparation and painting operating handwheels or levers on valves or actuators. If they finally corrode to the point of being unserviceable, they can easily and cheaply be exchanged for new. Likewise, the expensive time and effort required to clean and paint bolts offshore is wasteful. Bolts are cheap and if corroded to the point where they are not functional — and they have to be severely corroded on the heads and nuts before the bolt shank loses tension — simply spin them out and replace them. That said, if some

extensive surface preparation has been performed on a valve body or pipe spool in and around the associated bolts or studs, then it is worth painting the bolts at the same time. Otherwise, do not clean and paint bolts alone and don't resort to replacing corroded mild steel or galvanized bolts with stainless steel thinking a better lifespan will result.

Handrails are another item where enormous effort can be spent cleaning, preparing and painting. Sometimes some small spot repairs are warranted, but if the workscope rises too high, it is usually cheaper and more durable to fabricate and coat new handrail assemblies onshore and fasten them into place as like-for-like replacements. Lighter metalwork members, for example, deadlegs under pipe spool supports have little consequence and would have to lose an enormous amount of their section to corrosion before their integrity were threatened.

Finally, ensure access for structure maintenance is provided by those operating the facility into the locations where the priority demands are highest. SimOps in hazardous zones often mean that production and operations don't want to have painters working where access conflicts with other trades exist. A situation recently occurred on an FPSO offshore northwest Australia where a three month offshore maintenance painting campaign that was intended by the integrity managers to focus on corroding hydrocarbon lines and rusted and pitted decks over crude oil tanks, the painters were pushed away from these zones by production and operations controllers, so instead they spent about three months sanding, feathering and painting the exterior of the accommodation block. The work they did looked beautiful, but nothing was done to improve the integrity of the pipelines and tank deck. The campaign was wasted as it failed to achieve its objectives.

Pillar Two: Onshore-Supplied Items and Equipment

Offshore oil and gas facilities have a high collective maintenance requirement. The whole plant works hard 24 hours a day, 365 days a year. Valves, pumps, motors, actuators, pressure sustaining valves (PSVs) and myriad other proprietary items have only a finite life when working offshore and have to be replaced with some regularity. As subsea fields change in flow rate and yield, it is often required to make adjustments or new additions to the piping, reticulation and drains running to and from the various vessels and equipment. Typically, these items are supplied from an onshore supply base and shipped out to the facility for onsite installation. Thus, there is usually a steady stream of proprietary items and equipment; and purpose-fabricated items, structures, assemblies or equipment making its way offshore.

Proprietary equipment such as pumps, motors, valves and cabinets usually have a manufacturer-furnished paint finish. Unless these individual items are specifically and exclusively used for offshore service — which is rare — their standard paint system will have minimal durability in a severe marine environment and is often just for product or manufacturer differentiation. If the operating lifespan of these items is short (for factors other than corrosion) then it possibly makes no sense to augment the existing paint finish or to insist that the items are supplied with a bespoke offshore-rated protective coating system. Otherwise, if the lifespan and functionality of the item can or will be compromised (if the effects of corrosion prevail over its mechanical, electrical and/or hydraulic end-of-life) then improving the coating system will have some distinct durability and financial benefit. The latter should ideally be performed onshore before the hardware is shipped to the facility. Reinstating the manufacturer's glossy appearance to the item is not the aim here. Adding some compatible and functional additional film build is.

Even a simple alkyd-based, semi-decorative paint system on a pump, valve, PSV or actuator can be augmented with a surface-tolerant epoxy to a reasonable DFT without too much difficulty and expense if this is performed onshore before shipping. The cost and logistics can be offset by a dramatic improvement in durability if this policy is adopted for all possible proprietary items. An urgent breakdown might require procuring and expediting an item that can't be painted in time, but with proper planning, most pieces could and should be pre-painted.

With some negotiation and foresight, it may be possible to get the original equipment manufacturer to prepare and coat his items in the factory with the facility's designated offshore-rated protective coating system. There are realistic durability-related benefits that can arise from this.

Choose Wisely – Part A

With structural items and pieces, some shocking examples have been seen on a variety of offshore facilities where newly fabricated and onshore-coated structures and pieces have been shipped with totally inadequate coating systems for offshore duty (Fig. 2). Every offshore facility operator has in-house coating specifications, or at least they use generic systems detailed by a reputable coating supplier. When large-scale projects for supply of fabricated members are underway, in most cases the correct coating system for the service exposure gets identified and detailed on the drawings or included in the coating specification. For smaller projects, however, where a few members or pipe spools are to be fabricated and supplied, it seems that the link to the desired coating system often gets lost,

Fig. 2: An onshore-coated steel fabrication now fitted to an FPSO that was inadequately coated for offshore service. The DFT measured around 3.5 mils (90 microns). Predictably, little resistance to marine exposure was provided.

perhaps because too many people involved don't sufficiently understand the corrosion and durability consequences. Arguably, they think "painting is just the final color" so it doesn't get or retain the right attention. This is probably not helped by the contractual supply chain where the painting contractor is a subcontractor to a steel fabricator who might himself be a subcontractor to the equipment supplier. This makes the link from the purchaser and specifier (the facility operator) to the painter, quite tenuous or indeed, non-existent. The net result can be that the painter himself makes a choice about what he thinks the steelwork warrants, gets it to the right sort of color and ships it out.

A procurement method that has a robust process of identifying the right coating system to use for each item or member, ensures this is priced into the project quote, keeps the drawing and coating system requirements inseparably linked and has a reliable method to ensure that each item is inspected at each appropriate stage of surface preparation and coating application; has the ability to significantly extend the durability of the member or piece. The long-term rewards for this are large and worthwhile.

Importantly, no item or member should leave the painting contractor's workshop to be sent offshore until it has been progressively and finally inspected by a qualified and experi-

Figs. 3 and 4: Onshore-coated items, structures and piping should be better protected during shipping to minimize damage to the coating system.

enced coatings inspector who understands exactly what protection method and achievements are required.

The next shortfall relates to a systemic problem seen with packing and protecting the coated items at the painter's yard or the fabricator's premises to prevent damage to the coating occurring through every stage of handling until the pieces arrive offshore. It seems few people appreciate the fragility of the finished paintwork and most fail to provide even the most basic care and protection. For instance, it is common to have the flanged faces on pipe spools fitted with plywood discs affixed with electrical cable ties or perhaps bolts. This is generally fine to protect the machined face, but what about the edges of the flange which have been dutifully painted? This where the pipe spool sits when placed, dropped or dragged on the ground or deck and damage seems to be inevitable. This damage is absolutely preventable (Figs. 3 and 4).

Shipping items to an offshore facility involves a lot of handling from the first pickup from the painting contractor's workshop to craning the pieces into laydown once offshore and then erecting these into position. The benefits to the long-term durability and the reduction in costs from finding a way to get these items out to the facility with minimal damage to the applied coating is immense, yet too often, this is very poorly performed. In addition, all packing and protection materials need to be kept intact and prevented from getting wet so atmospheric-grade coating systems are not subject to immersion-like conditions. This can also occur if water ponding is allowed to occur in steelwork sections when in transit or laydown. It goes without saying that soft slings should be used on coated pieces rather than steel chains, meaning crane operators and dogmen should be instructed about how to avoid damage while lifting and loading coated items.

The last aspect to discuss on the topic of onshore-coated items is site touch-up after installation and commissioning. The task of installing newly supplied equipment, structures or hardware is not finalized until the coating touch-up has been fully completed. The final sign-off, therefore, should not occur until the protective coating's integrity and appropriateness has been verified.

On multiple Australian FPSOs a disproportionate amount of the coating maintenance workload is due to inadequately coated onshore-supplied items, pieces and prefabricated structures that are a fraction of the age of the parent facility. Yet the corrosion on these items is far more advanced in its extent and rate of breakdown. This burden is being unnecessarily added to that of the rest of the facility at an on-station cost per square meter that could easily be a full order of magnitude greater than what it takes to prepare and properly paint the same item onshore.

There are large and measureable savings and great benefits to durability that can and will result from making sure that the right coating system, to an inspected quality level, is applied to each and every item that is supplied to the offshore platform or vessel, whether this is a proprietary item or a fabricated member; and ensuring that an adequate and

effective level of protection results through each stage of consigning, shipping, offloading, cranage, laydown, installation and coating touch-up. The aim is to make sure that the future burden of offshore coating maintenance is not increased by the incorporation of onshore-supplied items or members. These new items should be expected to be maintenance-free for a suitable honeymoon period and unless they are at, or close to, optimal condition when installed offshore, they merely add to the future maintenance burden of the facility.

Pillar Three: Crew Touch-Ups and Maintenance

The third item in the recommended methodology list is minor coating touch-ups that are performed on a more sporadic basis as opposed to the larger dedicated painting maintenance campaigns described earlier, that are better performed by professional coating contractors.

Usually, manned offshore platforms and FPSOs have at least two full crews who typically work swing shifts of several weeks each, in rotation. Strangely, there is a reluctance to assign personnel to tasks that include — even part time — performing same basic coating maintenance. Notwithstanding, the potential benefits from this, in conjunction with the two other pillars of coatings attention, can be significant.

If the facility has to rely on organized and formal campaigns with an on-station coating application contractor to perform repainting and coating maintenance at intervals of, say, once a year or biannually, then there is a very good chance that the total workload will exceed the capacity of this resource. It helps enormously to have a small but responsive ability to carry out localized spot painting or touch-up, especially for tasks such as coating repairs after the installation of new or replacement hardware, valves or pipe spools. With respect to how many onshore-coated items and members suffer damage during packing, shipping, craneage, laydown and installation; having a member of the facility's crew who can perform the final coating touch-up without waiting many months for a contractor to mobilize can reduce the size and complexity of the touch-up and increase the performance of the repairs.

The first thing needed is for one or two able crewmen to operate some simple surface preparation tools, typically pneumatic-driven power tools or similar, and to mix and apply a short list of coating touch-up materials. It is not expected that these people should have access to, or operate, complex abrasive blasting or ultra-high pressure (UHP) waterjetting equipment — a short selection of power tools that are capable of producing an SSPC-SP 3 (Power Tool Cleaning) or an SSPC-SP 15 (Commercial Grade Power Tool Cleaning) cleanliness standard is all that is required. This means that only some very basic trade training is probably all that is needed to provide the skills and understanding that these designated crewmen should have.

Besides some training in knowing when the climatic and substrate conditions are suitable for final surface preparation and coating application, the other skills needed are how to mix and apply a multi-component catalyzed coating product properly. Most people, if they had a modicum of interest in undertaking some coating maintenance, could be taught these skills in a day or two with the right teacher.

A strategy already developed and instigated on a number of Australian FPSOs is to use only two or three different coating materials to do almost all of the onboard coating maintenance with crew members. To facilitate this, the ship's locker was emptied of most of the old, mismatched, large kit sized, out of use-by-date paint and coating materials, and was restocked with a short list of coating materials supplied only in small packs. These materials typically consist of one zinc-rich epoxy primer, a surface-tolerant catalyzed epoxy in a few different colors (including an aluminum version), and some acrylic-modified high build polyurethane, again in just a few basic colors. The intention is that 95 percent or more of all coating touch-up needed to be done by the crew can be done with these two or three products used universally all over the facility's topsides.

Choose Wisely – Part B

As many of the good surface-tolerant epoxy coatings have a mix ratio of 4A-to-1B, one facility's progressive coating supplier agreed to put 600 mL of Part A for a surface tolerant epoxy in a 1.0L paint can, and 150 mL of Part B curative/convertor in a 250 mL can. The painter simply opens and stirs one can of Part A and opens one can of Part B, pours it into the larger can and voilà! This assures that the mix ratio is correct every time. There is plenty of room inside the 1.0 L can to accommodate both components and some thinners without spilling during mixing and application. The painter takes the mixed paint and a brush or roller and heads off to do the spot painting. When the items or areas are painted, the unused mixed paint, the brush or roller are simply thrown into the appropriate waste bin. There is no using $5 of solvent to clean a $2 brush. If two or three colors of the same surface-tolerant epoxy are stocked, the Part B curative is usually common to all. The same small kit provision is made for a zinc-rich epoxy primer and a couple of basic polyurethane topcoat colors. This means a very small inventory of onboard paint stocks.

With same basic guidance and training and a clear and logical wall chart for area-of-use information and thinner reference, there is little chance that the crew painters can go too far wrong in selecting, mixing and applying these few material types to most atmospherically exposed surfaces all over the offshore facility. There should be a "no large can" policy in the ship's paint locker; the only containers larger than 4 liters would be for solvent. Small kits such as described are slightly more expensive and not all manufacturers are happy to oblige with these special drawdowns, but the avoidance of waste, the chance of disproportioned mixes being all but eliminated, and the improved logistics and ease of mixing much offset a slight increase in the paint price. The reason this concept was established was because there were too many examples on a number of offshore facilities where the wrong coating, mismatched components or unconverted product was used.

Some real examples demonstrate this. One FPSO had some beautifully painted replacement pipeline valves. The color was brilliant, the gloss dazzling and the coverage and brushwork was excellent. Further research revealed that all of this person's paintwork was done with an architectural

Figs. 5 and 6: The replacement valve has been diligently painted (top), but with what proved to be an alkyd enamel. This column base was one of many coated with multiple layers of polyurethane, but all without the Part B added (bottom).

alkyd gloss, i.e., house paint (Fig. 5). Searching afield, scores of deck spot repair zones that had been diligently power tool cleaned, "treated" with a phosphoric acid rust convertor and then primed with an alkyd primer and an alkyd gloss were seen. This looked absolutely great, for a few months. Then the rust started pouring through again. Not good!

In another classic example, after a large number of rusty column and vessel bases on a process deck were inspected, a good quality surface preparation and coating system consisting of multiple layers of surface-tolerant epoxy was duly specified. A few months later the inspector returned to the FPSO to find a carefully applied coating that had been cut-in neatly around the prepared deck areas in dozens of separate locations. This work had obviously taken many weeks to perform, however, something looked decidedly wrong. The coating film was mostly glossy, but it was also partly wrinkled with embedded dust. A close inspection proved that the painter had applied multiple layers of high-build polyurethane topcoat direct to the spot-cleaned steel, but all of it unconverted. It was Part A only (Fig. 6, p. 56)! It had surface dried but was still cheesy and un-catalyzed right through the film down to the substrate. Sadly, all of this crewman's effort was completely in vain.

Summary

From the sublime to the ridiculous there is only one step.

The three pillars or strategies outlined herein are complimentary. If applied together they have the ability to help facility operators stay ahead of the workload of coating maintenance and corrosion control due to atmospheric corrosion on offshore assets, improve the reliability of the work performed and achieve must better cost-effectiveness. However, they would likely be of little overall benefit if performed alone or in isolation.

To set priorities for coating maintenance based on risk, rather than visual extent of corrosion is the important first step to be understood, and actioned. Performing deep maintenance campaigns using skilled, resourced and experienced coating application contractors who are tasked with following the priority plan and undertaking the surface preparation, cleaning and coating application in exactly the right manner is vitally important to ensure that the *right* surfaces and items are coated at the *right* time with the *right* coating system. Ideally, on an established facility, undertaking an annual on-station campaign with a good contractor working to a good plan can make some positive progress. However, to maximize the value and return from this work, the contractor needs access to the designated areas to execute the priority ranking. This only comes from cooperation from production and operations, who often see painting crews as disruptive.

To ensure that the collective forward burden of coating maintenance is not increased, all corrodible items, structures, controls, equipment and piping that are shipped to the offshore platform or vessel from an onshore supply base, should have an appropriately chosen and diligently applied, undamaged and intact coating system by the time the hardware reaches the facility. After installation and commissioning, all damage and compromises to the coating, howsoever caused, should be fully repaired to achieve full functionality. Attention to all aspects that can influence this can pay large dividends.

Finally, there is a need for an on-station resource to be able to carry out minor coating repairs and touch-ups. It is suggested that this is best accommodated by having one or two members of the facility's crew skilled and equipped to carry out these tasks using a few hand-held surface preparation tools and a short list of widely compatible coating materials that are stowed in the paint locker in small kits. The work by these crew members is not designed to replace the more formal maintenance campaigns undertaken by the separately mobilized coatings contractor, but to augment these resources.

If organized and managed effectively, these three pillars can work synergistically to reduce risks, maximize durability and reduce the costs of offshore coating maintenance.

Acknowledgement

The author is indebted to the late Mark S. Schilling for his valuable input, advice and counsel in preparing this and the earlier Part 1 to this article.

About the Author

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

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

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

Dromgool has qualifications as a mechanical engineer; is an ACA Certified Coatings Inspector; a NACE-accredited Protective Coating Specialist; an SSPC-accredited Protective Coating Specialist and a NACE-Certified Coatings Inspector – Level 3. JPCL

Learn more about the Three Pillars of Maintenance Painting Practice. Visit www.paintsquare.com/offshore for sidebars explaining what not to paint and dos and don'ts for contractors.

Preventing CUI With Thermal-Spray Metal Coating
New Use for a Traditional Process

Photo courtesy of Turner Industries Group. LLC. All other photos courtesy of the author unless otherwise specified.

By Peter Bock, Advanced Polymerics, LLC

Using thermal-spray metal coating on carbon steel to prevent corrosion is a process that has been around for most of a century. Under its traditional and more familiar name of "metalizing," thermal-spray coating has prevented corrosion on carbon steel lock gates, dam components and similar large marine-environment structures since the early 1900s.

Today, thermal-spray coating is applied by arc spray or flame spray; flame spray is the older, more traditional application method, and — in appearance — seems similar to brazing, although in fact, the thermal spray coating process and the protective film it produces are closer to a liquid-applied coating system. Arc-spray application of thermal-spray metal coatings was a shop-bound process until the 1990s, when portable arc-spray equipment was developed and introduced into field maintenance coating procedures.

For refining and petrochemical projects using thermal-spray coating, arc spray is preferred for large, relatively smooth surfaces such as tank roofs or exteriors of large process vessels (Fig. 1).

Fig. 1: Multi-story process vessels provide large relatively flat areas for arc-sprayed thermal spray aluminum. The high cost of lost production on such vessels offsets the higher application cost of thermal spray because of the shorter return-to-service time.

Smaller and more intricate surfaces, such as small-diameter piping, valves and flanges, are done with flame spray. Where a project is large enough, both processes are used to benefit from the advantages of each.

Metal Types

A wide variety of metals can be used for thermal spray coating; the author has watched bronze thermal spray being applied to bronze statues whose surfaces had deteriorated from long-term environmental exposure in a polluted urban environment on the U.S. Gulf Coast. Thermal-spray zinc was originally touted as a competitor to hot-dip galvanizing, although the two processes are significantly different in application and in the resulting corrosion-resistant film they form.

Hot-dip galvanizing is most definitely a shop process, totally unsuitable for any sort of field or maintenance application. In times when environmental considerations were not as strict as they are today, a large-scale galvanizing facility, with huge open vats of strong acids or alkalis and an equally large vat of molten zinc at 700 F was perfectly acceptable; today it is not. Also back in those times, hot-dip galvanizing was considered a "quick" process, where flame-spray metal application was thought to be tedious and expensive.

The protective layer produced is significantly different between the two processes. Because of the strong chemicals, high temperatures and molten zinc used in hot-dip galvanizing, the galvanized steel surface actually has an alloy effect. A hot-dip galvanized surface has highly reactive, nearly pure zinc at the exposed surface, but going down toward the substrate, there are distinct layers of zinc-iron alloy, ending up with all iron at the bottom of the galvanizing layer.

Thermal-spray metal-coated steel is different, whether the metal used is aluminum or zinc. The flame or arc melts the protective metal and the gas or air stream breaks the molten metal into tiny spheres, which are then deposited onto the steel to be protected. Molten metal oxidizes readily, so the tiny molten spheres have formed a thin layer of surface oxide by the time they land on the surface to be protected. They have also cooled significantly, so they do not form a continuous solid metal film, the way hot-dip galvanizing does, but the oxide layer of the metal droplets is in intimate contact with the oxide layer of surrounding droplets and any porosity between droplets is quickly filled in by oxide formation. Think of the steel substrate covered with a thick layer of M&M candies — the candy shell is the oxide layer, and the chocolate inside is the aluminum or zinc metal. In a relatively short period after application of the thermal spray metal, the "candy coating" oozes together without the chocolate inside ever melting.

The thermal-spray metal protective film is actually closer to a liquid-applied coating than to hot-dip galvanizing, except that there is no binder resin, as there would be in a liquid-applied coating.

From its first availability, thermal-spray application was useful for field work, for maintenance, and for the fact that thermal spray metal could be repaired in the field where hot-dip galvanizing could not. Another advantage of thermal-spray coating was the ability to use aluminum instead of zinc as the protective metal. Both aluminum and zinc are anodic, sacrificial metals, but aluminum sacrifices much more slowly than zinc; thermal-spray aluminum (TSA)-coated structures were found to have much longer service life than hot-dip galvanized structures. There was no "hot-dip aluminizing" process available, so taking advantage of aluminum's lower sacrificial tendency coupled with the fact that the oxide layer formed during thermal-spray application slowed anodic metal sacrifice even more, made TSA application a viable competitor of hot-dip galvanizing.

Fig. 2: A large refinery or petrochemical plant will have hundreds of insulated process vessels and hundreds of miles of insulated pipe feeding those vessels.

Usable service life of 30 and 40 years in exposed severe marine environments became the accepted — and expected — norm for TSA-coated, exposed, carbon-steel structures.

The mitigation of corrosion under insulation (CUI) has a much shorter history than thermal-spray metal coating of steel. Until fairly recently, the whole concept of preventing CUI in refineries and chemical plants was totally neglected. To quote the global nonmetallic coatings specifier for a major oil company in 2009, *"…when our plants were built, industry did not understand that the environment under insulation was going to be almost like immersion conditions, so the correct type of coating (immersion grade) was not used. As a result, almost NONE of the surfaces under insulation in every single facility which is older than 15 years old are adequately protected from CUI. CUI is a phenomenon because of our ignorance."*

Until the late 1970s, petrochemical equipment designers and maintenance managers worked under the incorrect assumptions that insulated, hot-operation carbon steel equipment stayed hot enough not to have water under the insulation, and that any corrosion which might occur could be offset by designing equipment with additional steel wall thickness as a "corrosion allowance." Both of these concepts are partially incorrect.

All hot operating equipment cycles hot to cold. Even a vessel or pipe which runs hot continuously until taken down for turnaround maintenance is cycling. The length of the cycle is equal to the operating time between turnarounds, and the vessel or pipe *will* corrode while shut down for turnaround. Additional steel wall thickness may provide some added service life, but corrosion is rarely flat and uniformly distributed across the surface of a pipe or vessel — pinholes or cracks at welds, corners or low spots in the insulation where water may gather under the insulation will eventually perforate the steel, and the results of the perforation can be catastrophic.

Another reason for neglecting CUI was far more straightforward. Until the 1980s, there were very few coatings suitable for use in hot service under insulation. The standard process operating temperature for hot-operation carbon steel equipment in the 1980s was quoted as 350 F. During turnaround steam-out work, this temperature could reach over 400 F. Only inorganic zinc and thin-film silicones had resins which could survive such temperatures. Inorganic zinc was a sacrificial coating; once the zinc had all sacrificed, there was no longer any protection. Silicones could not be built to sufficient thickness to prevent water permeation and even with lead and chromates in the silicone primer, they did not provide adequate corrosion resistance.

Fig. 3: This coupon failed the thermal-spray bend test after testing as specified in SSPC-CS 23.00/AWS C2.23M/NACE No. 12.

A series of major CUI-related equipment failures in the early 1980s showed the problem with using inorganic zinc under insulation. As long as there was zinc left, the coating system protected. Once the zinc was completely sacrificed, active corrosion progressed rapidly. There was no cost-effective way of knowing or judging when the last bit of zinc was gone, and the concept of risk-based inspection had not yet been developed.

There was an active search for relatively thick-film, stable, temperature-resistant, cyclic-service-tolerant protective coatings to be used under insulation. Attempts to formulate coatings using the ethyl silicate resin from inorganic zinc, but without the added zinc, were a complete failure. The introduction of polysiloxane-based elevated-temperature coatings in the early 1990s allowed thick-film build and temperature resistance, but the initial formulations could not tolerate cyclic service. Second-generation polysiloxane-silicone hybrid formulations resolved this problem and provided the necessary temperature tolerance, flexibility for cyclic service and film thickness to survive for years under insulation. TSA coating was suggested as a CUI coating at about the same time.

Although thermal-spray application required an arc or flame, it was actually less hazardous than applying liquid paint. A “hot-work” permit similar to one issued for welding or cutting was obtained for thermal-spray application. Because the deposited metal was cool, the aluminum dust generated as overspray was less hazardous than the solvents released during liquid paint application and the dust could be easily gathered and removed, unlike paint overspray which stuck to everything it touched.

When coatings contractors first offered thermal-spray application in the 1990s and early 2000s, the cost of field application was typically about 10 times as expensive as liquid coatings. These costs included the cost of surface preparation, coating materials, application and inspection, but made no allowance for the amount of time actually required for application and drying, or for the cleanup and disposal costs at the end of the project.

Fig 4: Despite the apparent fireworks, the arc-sprayed thermal-spray aluminum is dry and cool almost immediately after application and is ready for insulation and jacketing. Liquid coatings require additional coats and extended drying time after each coat. Photo courtesy of Turner Industries Group, LLC.

Liquid coatings intended for CUI service typically require two or three coats to achieve the specified 10-to-12 mils dry-film thickness (DFT). Applied DFT for each coat cannot be accurately checked until the coat of paint is dry, which may take 8-to-12 hours, depending on temperature, humidity and air circulation. If low DFT is found, additional paint must be applied, requiring another full coat's drying time.

In contrast, thermal-spray metal coating is a single-coat system; dry and ready to be checked for DFT within seconds of application; and any low-DFT areas that are found can be immediately touched up with additional thermal-spray metal (Fig. 4).

So Why is Thermal Spray More Expensive?

The source of the extra costs is detailed in the joint SSPC/AWS/NACE standard for application of thermal spray coatings, SSPC-CS 23.00/AWS C2.23M/NACE No. 12, "Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection of Steel" (Fig. 3, p. 64). This standard is used for thermal-spray coatings, whether intended for exposed or CUI service and the requirements in it are much stricter than requirements for application of liquid coatings in similar service.

The first bit of expensive news in this standard regards surface preparation. SSPC-SP 5, "White Metal Blast Cleaning" is required for thermal spray in marine or immersion service. Because CUI service is considered intermittent immersion, SSPC-SP 5 is mandatory for thermal spray in CUI service. Achieving a specified anchor profile is also critical for thermal-spray projects, since mechanical adhesion of the thermal-spray layer to the anchor profile of the steel substrate is the only thing keeping the thermal-spray layer attached to the substrate. Many CUI-rated liquid coatings may be applied over lesser surface preparation, or even on top of existing old coatings; the liquid resin in these provides an additional means of adhesion.

Second is the requirement for qualified applicators and helpers. Improperly applied thermal spray may have holidays or poor cohesion. Improperly applied thermal-spray coating which does not tie into the anchor profile may disbond from the substrate during thermal cycling under insulation. Thermal spray can only be applied by specialized arc-spray or flame-spray equipment; liquid coatings can be sprayed, rolled, brushed or even applied by a mitt or dauber, depending on surfaces to be coated, product data sheet or specification.

Third is the need for much more thorough inspection, before, during and after application of thermal spray, than would normally be done for liquid coatings. Properly applied TSA looks like "White Metal" blasted steel, so visual holiday inspection cannot be done as for liquid coatings (Fig. 5). DFT readings must be taken much more frequently than would normally be specified by SSPC-PA 2, and pull-off adhesion testing is mandatory according to SSPC-CS 23.00.

As more and more contractors have become familiar with thermal-spray coating application, prices have come down, but they are still higher than coating the same project with liquid paint. However, thermal spray has two inherent advantages offsetting the restrictions from the SSPC/AWS/NACE standard. Unlike a contractor, who is bidding the time and materials his crews will actually use, the specification engineer or maintenance manager is also intimately concerned with the out-of-service time required to replace a CUI coating system on a vessel or pipe run. To him or her, "out of service" means "out of production." "No production" equals "no income" for the affected unit — and possibly — other units upstream or downstream in the same train, which cannot operate when the affected unit is down.

Fig. 5: Inspection of thermal-spray aluminum requires special care because the visual appearance of thermal spray is almost identical to the appearance of newly blasted steel.

Scaffolding, tenting, removal of jacketing and insulation, surface preparation, and replacement of insulation and jacketing are identical whether using thermal spray or liquid coatings, but where liquid coating application takes three days if drying time between coats is included, thermal spray is a one-day operation. The corrosion control manager at a major Gulf Coast refinery estimated that a 15- or 17-

story contact process tower such as the ones shown in Figure 1, generates a million dollars in revenue per day of operation. Saving two days of downtime by applying thermal spray instead of liquid coating will save the owner $2 million which (the corrosion control manager estimated) is much more than the added cost of thermal spray instead of liquid coating.

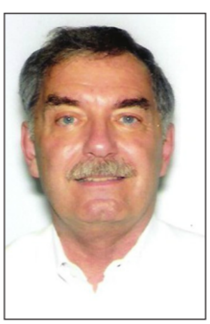
The second savings is length of service life. From a contractor's viewpoint, the cost of a project is the cost of time and materials his crews and inspectors will require to complete a project. From the corrosion control manager's point of view, the *true* cost of a project is the contractor's invoice plus the cost of out-of-service time, divided by the number of years of service life expected from the corrosion-control project.

Major U.S. oil company corrosion-control specifications rate thermal-spray aluminum in CUI service as an expected service life of 20, 30, and in one specification, 40 years without replacement or major repair. These same specifications rate the best liquid-applied coating systems as having expected service life of 8-to-15 years. From this perspective, the price of thermal-spray coating goes from being much more expensive than liquid-applied coatings to being much less expensive, since it is expected to last much longer.

Despite thermal-spray metal coating's nearly a century of successful service on exposed steel in coastal, marine and similar severe environments, the longest properly recorded, properly monitored CUI service for TSA on U.S. refineries or chemical plants that the author can find records for is just short of 15 years. But after that service time, the applied TSA coating is in excellent shape and looks to be good for another ten or fifteen years, approaching the corrosion control manager's dream of the CUI coating system having the same expected service life as the unit itself.

About the Author

Peter Bock is executive vice president of Advanced Polymerics Inc. in Hooksett, New Hampshire. He is an Air Force veteran and holds degrees from Tulane University and the University of Northern Colorado. Bock has 37 years of sales, management and technical service experience in oilfield and petrochemical heavy-duty coatings in the United States, Canada, Mexico, Venezuela, Indonesia and Taiwan.



He has experience with on- and offshore production, drilling and workover rigs, shipyard work, natural gas and LNG, pipelines, terminals, refineries and chemical plants. Bock is a specialist in elevated temperature systems, corrosion under insulation and chemical passivation.

He is a former president of NACE New Orleans Section and of the Houston Coating Society. Bock is a NACE-certified coating inspector and has presented papers and symposia at many national, regional and local coatings and corrosion control events. JPCL

Dallas Welcomes NACE CORROSION 2015

Show Preview


Photo courtesy of Kay Bailey Hutchison Convention Center Dallas.

CORROSION 2015, NACE International's annual conference and exhibition, is scheduled to take place March 15 to 19, 2015 at the Kay Bailey Hutchison Convention Center in Dallas, Texas.

This yearly educational event focuses on the prevention and mitigation of corrosion worldwide and is expected to attract over 7,000 corrosion professionals and over 450 exhibiting companies, according to NACE. Guest speakers, special events and over 1,000 hours of technical presentations across 14 different industry and technology tracks will be available for attendees.

The following is a list of technical session and events at CORROSION 2015 that may be of interest to protective coatings professionals. All information is current as of press time. For complete information on CORROSION 2015, visit nacecorrosion.org.

Meetings, Technical Sessions and Events

Sunday, March 15

- STG 02 Coatings and Linings, Protective: Atmospheric; 8:00–10:00 a.m.

Monday, March 16

- "Protective Coatings Technology Forum"; 10:00 a.m.–5:00 p.m.
- TG 148 Threaded Fastener: Coatings for Protection of Threaded Fasteners Used with Structural Steel, Piping, and Equipment; 11:00 a.m.–noon
- "Corrosion Issues in Military Equipment and Facilities"; 1:00–4:00 p.m.
- "Marine Corrosion"; 1:00–6:00 p.m.
- "Recent Developments in Atmospheric Corrosion (Day 1)"; 1:00–6:00 p.m.

Tuesday, March 17

- "Recent Developments in Atmospheric Corrosion (Day 2)"; 8:00 a.m.–2:00 p.m.
- "High Temperature Issues and Materials for the Process Industry"; 8:00 a.m.–5:00 p.m.
- "Direct Assessment"; 8:00 a.m.–5:30 p.m.
- "Corrosion in Nuclear Systems (Day 1)"; 8:00 a.m.–6:00 p.m.
- TG 339 - Railcars: Coating Application on Exterior Surfaces of Steel Railcars; 9:00–9:30 a.m.
- TG 437 Maintenance Overcoating of Railcar Exteriors; 9:30–10:00 a.m.
- TG 379 Surface Preparation by Encapsulated Blast Media for Repair of Existing Coatings on Railcars; 10:00–10:30 a.m.
- TG 394 Guidelines for Qualifying Personnel as Abrasive Blasters and Coating and Lining Applicators in the Rail Industry; 11:00–11:30 a.m.
- "The NACE DOT Forum"; 1:00–4:00 p.m.
- TG 456 Coating Thickness Measurement, Methods, and Recording—Specific to the Railcar Industry; 1:30–2:30 p.m.
- TG 061 Revision of NACE SP0592 (formerly RP0592), "Application of a Coating System to Interior Surfaces of New and Used Railway Tank Cars in Concentrated (90-98%) Sulfuric Acid Service"; 2:30–3:30 p.m.

Wednesday, March 18

- "Pipeline Integrity Day (Day 1)"; 8:00 a.m.–5:00 p.m.
- "Corrosion in Nuclear Systems (Day 2)"; 8:00 a.m.–6:00 p.m.
- TG 444 Guidelines for Data Collection and Analysis of Railroad Tank Car Interior Coating/Lining Condition; 10:00–11:00 a.m.
- TEG 291X Land Transportation: Information Exchange on Corrosion and Coating-Related Issues; 1:30–2:30 p.m.
- TG 352 Coating Systems (External) for Pipeline Directional Drill Applications; 2:00–4:00 p.m.

Thursday, March 19

- "Nanotechnology in Corrosion"; 8:00 a.m.–3:00 p.m.
- "Pipeline Integrity Day (Day 2)"; 8:00 a.m.–5:30 p.m.

Exhibitors at CORROSION 2015

The following is a list of exhibitors at CORROSION 2015 that may be of interest to protective coatings professionals, known to *JPCL* as of press time. For a complete list, visit nacecorrosion.org.

ACT Test Panels LLC
Advanced Polymer Coatings
American Society for Nondestructive Testing, Inc.
Ashland Performance Materials
Axalta Coating Systems, Powder N.A.
AZZ WSI
Barton International
BASF
Belzona Texoma, Inc.
Binks/DeVilbiss
Blair Rubber Company
Brand Energy & Infrastructure Services
Canusa CPS
Carboline Company
Ceram-Kote Coatings, Inc.
CHLOR*RID International Inc.
Clemco Industries Corp.
CoatingsPro Magazine
Corrpro
Cortec Corporation
Cygnus Instruments Inc.
D.E. Stearns Co.
Dampney Co., Inc.
DeFelsko Corporation
Dehumidification Technologies
Denso North America
DoD Corrosion Prevention and Control
ECKART GmbH
Elcometer
Enviropeel USA
Evonik Corp.
Farwest Corrosion Control Company
Fischer Technology Inc.
GMA Garnet Group
Grace Distributing, Inc.
Greenman-Pedersen, Inc.
Hempel USA
Heresite Protective Coatings
Hi-Tech Industrial Services
Highland International, Inc.
HoldTight Solutions Inc.
International Paint
International Thermal Spray Association
Intertek
IUPAT/Finishing Trades Institute
Jotun Paints USA
KTA-Tator, Inc.
Lone Star Specialty Products LLC
Lonza, Inc.
Mascoat
MATCOR, Inc.
Mobile Pipe Linings and Coatings
MONTI Werkzeuge, GmbH
Montipower Inc.
NCERCAMP
NDT Systems, Inc.
Novatek Corporation
Oxford Instruments
PIpeline Inspection Co. Ltd.
PK Technology
Platt Brothers & Company
Polycorp Ltd.
Polyguard Products, Inc.
PPG Protective & Marine Coatings
Praxair Surface Technologies
Rema Tip Top North America Inc.
Safety Lamp of Houston, Inc.
Sauereisen
Seal for Life Industries
The Sherwin-Williams Company
Simpson Strong-Tie
Southwestern Paint Panels
Specialty Polymer Coatings Inc.
Sponge-Jet Inc.
SSPC: The Society for Protective Coatings
Sulzer MIxpac USA Inc.
Temp-Coat Brand Products, LLC
Tesla NanoCoatings Inc.
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March 2 CAS Refresher, Morgan City, La.
March 2–3 C14 Marine Plural Comp Prgrm, Seattle, Wash.
March 4–5 C13 Water Jetting, Seattle, Wash.
March 2–6 PCI Prot Ctg Insp Level 1, Kuala Lumpur, Malaysia
March 2–7 PCI Level 2, Kuala Lumpur, Malaysia
March 8 PCI Level 3, Kuala Lumpur, Malaysia
March 9 Estimating, Kent, Wash.
March 9–13 NBPI, Daphne, Ala.
March 9–13 PCI Level 1, Portland, Ore.
March 9–14 PCI Level 2, Portland, Ore.
March 11–12 Proj Mgmnt, Kent, Wash.
March 11–13 C7 Abrasive Blast, Orland Park, Ill.
March 12–13 C12 Airless Spray, Honolulu, Hawaii
March 14–15 C7 Abrasive Blast, Norfolk, Va.
March 15 PCI Level 3, Portland, Ore.
March 16–19 C3 Lead Pt Removal, Vallejo, Calif.
March 16–26 PCI Level 1, Singapore
March 16–27 PCI Level 2, Singapore
March 19–20 Bridge Ctg Assess, Cleveland, Ohio
March 20 C5 Lead Pt Refresher, Vallejo, Calif.
March 20 Nav Std Item 009-32, Pearl Harbor, Hawaii
March 21 C5 Lead Pt Refresher, Vallejo, Calif.
March 23–24 CCB Conc Ctg Basics, Hemet, Calif.
March 23–24 C13 Water Jetting, Jacksonville, Fla.
March 23–27 BCI Bridge Ctg Insp Level 1, Frankfort, Ky.
March 23–27 NBPI, Pearl Harbor, Hawaii
March 23–27 PCI Level 1, Pittsburgh, Pa.
March 23–27 C2 Plan & Spec, Norfolk, Va.
March 23–28 PCI Level 2, Pittsburgh, Pa.
March 23–28 CCI Conc Ctg Insp, Hemet, Calif.
March 25–26 C7 Abrasive Blast, Jacksonville, Fla.
March 26–27 C12 Airless Spray, San Diego, Calif.
March 27–28 C12 Airless Spray, Jacksonville, Fla
March 28 PCI Level 3, Singapore
March 29 CCI Supp, Hemet, Calif.
March 29 PCI Level 3, Pittsburgh, Pa.
March 31–April 1 ATT Train-the-Trainer, Norfolk, Va.

Conferences and Meetings

March 9–11 ACA CoatingsTech Conf, Louisville, Ky., paint.org
March 15–19 NACE CORROSION 2015, Dallas, Texas, nacecorrosion.org
March 29–31 AFPM Int'l Petrochemical Conf, San Antonio, Texas, afpm.org

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