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THE VOICE OF SSPC
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The Society for Protective Coatings

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AERIAL ROBOTIC SYSTEMS: A NOVEL APPROACH TO SAFE COATING INSPECTION AT HEIGHTS

By Jamie Branch, Apellix

Aerial robotic technology offers a novel approach to obtaining coating inspection data more efficiently, while reducing an inspector's occupational exposure to dangerous heights. This article addresses the benefits and limitations of utilizing aerial robotic systems as a viable means of coating inspection.

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By Hassan Al-Sagour and Mana Al-Mansour, Saudi Aramco

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By Sang-Moon Shin, Chung-Seo Park, Seung-Gon Choo, Eun-Ha Song and Han-Jin Bae, Hyundai Heavy Industries

According to the international surface preparation standard for welds, preparation grades before paint application are divided into three levels. These grades are described with rough qualitative representations instead of with descriptions of surface treatment methods or measurable conditions. In this article, coating thickness and the corrosion resistance and crack tendency of coated films on welds were evaluated for the grinding range in five levels from mild to severe.

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SSPC Seeks Technical Services Specialist

SSPC: The Society for Protective Coatings is currently seeking a Technical Services Specialist to work full-time out of the Society's Pittsburgh headquarters.

The primary and essential duties and processes of the position are as follows.

- Providing technical support for the membership and the SSPC staff.
- Developing written technical information in the form of presentations and articles on good practice and newer technologies emerging in the field.
- Representing SSPC on industry technical committees such as ASTM, NACE, ISO, ACI, ICRI and SSPC Technical Committees as assigned by the Technical Services Director
- Serving as a subject-matter expert (e.g., write, research, edit and perform QA) on development of new training materials and courses and revisions of existing training and certifications offered by SSPC.
- Managing the Annual Conference Technical Paper Submission, Acceptance and Review Program.
- Serving as technical team lead regarding responses to industry technical inquiries.
- Providing backup for SSPC Committee Administration.
- Conducting technical presentations and coatings workshops for existing and potential customers.
- Representing SSPC at trade shows/exhibits when technical representation is required such as NACE, NSRP, PDA and similar technical conferences.
- Managing the technical side of the SSPC Webinar Development Program.

Qualification requirements include the following.

- A Bachelor's Degree in chemistry, material sciences, biology, environmental science, corrosion engineering, construction management or an engineering discipline or related discipline from an accredited institution plus a minimum of two years of coating industry work experience or equivalent internship.
- Technical writing skills.
- PC proficiency, ability to use the internet and smart devices to search for, process and disseminate technical information.
- Ability and willingness to travel both domestically and internationally and navigate jobsites, travelling approximately 25-to-35 percent of the year.

Applicants for the Technical Services Specialist position must demonstrate a high level of integrity and trust, be customer focused, and possess strong listening skills and a problem-solving acumen. In addition, this position requires sound functional and technical skills, perseverance and good investigative and scientific research skills.

Core competencies that would ensure success at this position include organizing, coordination and scheduling; ability to handle multiple assignments; attention to detail; ability to interface with internal staff, SSPC members and external providers; training ability; ability to perform repetitive work; respond to periods of heightened activity; participative roles in teams and task groups; communication, problem-solving and interpersonal skills.

To apply for this position, please send a cover letter and resume to Keith Koebley, SSPC director, operations, koebley@sspc.org.

Upcoming SSPC Webinars

New online sessions focusing on different aspects of the coatings industry – the latest in the ongoing SSPC Webinar Series – will be made available to SSPC members and other individuals seeking to bolster their industry know-how in the coming months.

- "Selection of Coatings for Wastewater Treatment Facilities" will take place on Thursday, July 19 from 1:30 to 2:30 p.m.,

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Eastern. Presented by Randy Nixon of Corrosion Probe Inc., this webinar will focus on the selection of coatings for severe wastewater service over concrete and steel. The most common forms of corrosion mechanisms encountered in wastewater collection systems and treatment plants will be discussed. Then, the focus will turn to the most commonly used coatings in these types of severe environments and why they are used.

- "Frequency of Soluble Salt Testing, held Thursday, August 16 from 1:30 to 2:30 p.m., Eastern, will introduce a recently released guide, SSPC-Guide 24 "Soluble Salt Testing Frequency and Locations on New Steel Surfaces." This new guide is intended to assist owners and specifiers to determine the location of test sites and frequency of testing for measuring the amount of soluble salts on uncoated steel surfaces and shop-coated steel. Ken Trimber of KTA-Tator, Inc., will present this webinar.
- "Confined Space in Construction" will be presented by Jared Rigo of HRV Conformance Verification Associates, Inc., on Thursday, October 18 from 1:30 to 2:30 p.m., Eastern. This webinar will address the hazards and controls in confined spaces, as well as access points, access requirements and other considerations for confined space operations.

All webinars will be held via the GoToWebinar program. You can join the sessions by using a Mac, PC or a mobile device. Continuing Education Units (CEUs) can be earned by registering for a quiz after the completion of the webinar. The quiz is free for members and $25 for non-members.

To register for these webinars, visit the SSPC Webinar Series homepage, www.sspc.org/trn-webinars.

Training Certificates Available for Download Via SSPC Website

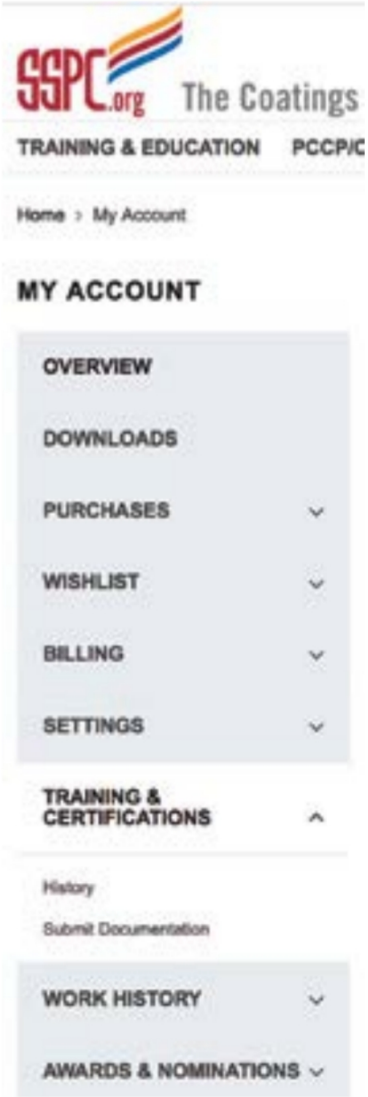
SSPC is pleased to announce the launch of a new feature on its website. After months of hard work and dedication, training certificates can now be downloaded directly from the SSPC website.

SSPC's goal in implementing this feature is to provide its membership of industry professionals with an easier way to access their certificates. Follow these quick, easy steps to download yours today.

1. Go to www.sspc.org and click "Login" in the top right-hand corner of the page.

2. Enter the username as the email you provided for the course and click the "Forgot password?" button.
3. Check your email and click the link to set your new password.
4. Type in a secure password that you will remember.
5. Return and click on the "Login" in the top right corner of the SSPC homepage again. Enter your email as the username and enter the new password you created.
6. At this point, you are logged into your SSPC account and you can see all of your past purchases/downloads/training history. Please review your profile and make sure that all of the information is correct.
7. On the left-hand side on the page, click the "Training & Certifications" tab and then click "History."
8. All of the SSPC courses you have completed will appear and you can click the blue plus-sign icon next to each to show your grades and information.
9. If you would like a digital copy of the certificate, click the "Download Certification" button and you will receive a .PDF copy of your certificate.

If you have any problems with this process, please reach out to Nathan Wyman, SSPC organizational membership specialist, at wyman@sspc.org or call 412-288-6053.



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Enforcement of OSHA Shipyard Silica Rule Begins

The U.S. Occupational Safety and Health Administration (OSHA) began enforcement of its new silica rule in the maritime and general-industry sectors June 23, following enforcement in the construction industry, which began in September of 2017.

The new Respirable Crystalline Silica Standard, adopted in 2016, reduces the permissible exposure limit for respirable crystalline silica to 50 micrograms per cubic meter of air as a, 8-hour time-weighted average. The new action level is 25 micrograms per cubic meter.

According to guidance issued June 7 by OSHA on its initial enforcement of the standard, the agency "will assist employers that are making good-faith efforts to meet the new standard's requirements" for the first month of enforcement. If an inspection shows that the employer does not appear to be making an effort to comply, OSHA will set up air monitoring and consider citations. Any citations pertaining to the rule during its first 30 days will be reviewed by OSHA's national office.

Respirable silica dust is generated in activities including abrasive blasting with sand, sawing or drilling into concrete or brick; and cutting or crushing stone. Exposure to respirable crystalline silica puts workers at risk for silicosis, a potentially deadly lung disease, and other conditions including chronic obstructive pulmonary disease, according to OSHA. In the maritime industry, abrasive blasting with sand is the main source of potential silica exposure.

Sand as abrasive blast media has been regulated for years, and many alternative media have entered the market in recent decades; the first ban on silica sand in blasting came in Great Britain in 1949. The National Institute for Occupational Safety and Health has advised against the use of sand in blasting since 1974. The new OSHA rule tightens restrictions and calls for further administrative and engineering controls for any operations still using sand in blasting.

Provisions of the silica rule beyond the new PEL and action level include the following.

- Limiting workers' access to areas where the PEL could be exceeded.
- Dust controls.
- Respirators where dust controls cannot limit silica exposure.
- Housekeeping methods that do not create airborne dust where possible.
- A written exposure control plan.
- Medical exams every three years for employees exposed to silica above the action level 30 or more days per year.
- Training on limiting silica exposure.
- Recordkeeping on exposure and medical testing.

OSHA offers a small-entity compliance guide for the maritime and general industry silica rules on its website.

SCDOT Details "Explosive" Bridge Cable Rupture

Officials from the South Carolina Department of Transportation (SCDOT) presented the findings of the investigation into last month's cable rupture on the James B. Edwards Bridge, in Charleston, to the SCDOT Commission at its monthly meeting on June 21, revealing that the incident left grout flying "a hundred feet away" from the actual break.

The twin-span structure is the only post-tensioned concrete box-girder bridge in South Carolina; it was closed for more than two weeks after the May 14 discovery of a severed cable within the concrete structure. Less than 30 years old, the bridge has a long history of issues, including leaks and improper grouting. The twin spans carry Interstate 526 over the Wando River.

SCDOT Deputy Secretary for Engineering Leland Colvin walked the commission through the break itself and the subsequent repairs and investigation, explaining that the location of the rupture, in pier 27 in the main span of the westbound bridge, and the

Photo courtesy of South Carolina Department of Transportation (SCDOT).

originally unknown origin of the break led to the decision to shut the span down completely during repairs.

Corrosion due to water intrusion was later blamed for the problem. "Basically, water intrusion and corrosion are an issue on this bridge, no doubt about it," Colvin said during his presentation.

Colvin showed photos of the ruptured cable from both ends of the concrete diaphragm it was encased in, explaining the scale of the break. "It was a violent explosion; it actually burst out of its protective sleeve," he told commissioners.

While the state normally inspects bridges every two years, SCDOT had increased inspections of the Edwards Bridge to weekly after another tendon ruptured at the same pier in October 2016; it was one of those inspections that caught the newly ruptured cable in May. After the May 14 discovery, the inspections on the bridge were increased yet again to daily, Colvin told the commission.

Colvin reviewed past incidents with the bridge, including a 2011 report that found water-intrusion issues in the bridge's structure. That report led to further monitoring of the state of the cables, reapplication of grout and documentation of water intrusion.

The biggest maintenance issue on the bridge, Colvin explained, has been monitoring the status of the tendons within the concrete diaphragms, which he says can essentially only be accessed via destructive testing — which could lead to even more moisture intrusion. Nondestructive testing methods are limited in their ability to assess the cables comprehensively, while testing in the open areas of the concrete boxes is much easier but can't account for the lengths of cable in the 7-foot diaphragms running through the piers, said Colvin.

"The tendon that failed, we tested it 2 feet from the location of the failure and found no signs of corrosion," Colvin told the commission, underscoring the difficulty of inspecting the cables in the concrete box-girder span. "The effectiveness of the testing at the diaphragms is not very good."

While some have called for the state to look into replacing the troubled bridge sooner than later, Colvin outlined SCDOT's plans to keep the spans safe for the more than

20 years that remain in their projected service life.

One part of the plan involves redundancy: the number of external cables in both the westbound and eastbound spans will be increased to account for any future problems with the older cables. These cables, Colvin stressed, are not necessary for holding up the dead load of the bridge, but exist to offset vibrations from traffic and other stresses. "There is a tremendous factor of safety in the bridge," he told the commission.

Additionally, SCDOT is in the process of installing equipment for real-time structural monitoring. The agency has already installed acoustical monitoring equipment including microphones in the westbound bridge and will expand that system into the eastbound span when a power supply is installed.

SCDOT also plans to take "a robust approach to sealing the decks and the pourbacks" on both the westbound and eastbound spans in an effort to stem moisture intrusion.

Colvin closed by noting the 50-year projected design life of the bridge, which opened in 1991, and without giving specific numbers, said the agency expects to get "many, many more years" out of both spans before they need to be replaced.

Trump Executive Order Encourages Offshore Drilling

On June 14, U.S. House Republicans issued a proposal that would saddle states with heavy fees should the states not approve gas or oil drilling off their coasts, while President Donald J. Trump is also repealing an Obama-written executive order that was focused on protecting U.S. waters.

States with proposed lease sales would be allowed to disapprove of drilling offshore in up to half of the lease blocks; putting any more than 50 percent of the blocks off limits would result in the state having to pay a fee equal of at least one-tenth the estimated government revenue that would have been generated if drilling had taken place.

Over the past several months, the U.S. government has spent time preparing to potentially ramp up offshore drilling, months after Secretary of the Interior Ryan Zinke called for opening "nearly the entire

U.S. Outer Continental Shelf" to extraction.

Shortly after that statement in early January, confusion ensued regarding whether Florida would be subject to drilling lease sales or not; Zinke said after discussions with Florida Gov. Rick Scott that he would take Florida off the table due to its reliance on beach tourism as an economic driver. Days later, administration officials said that Florida was in fact not officially exempt from future drilling.

The vast majority of offshore drilling done in U.S. waters is currently taking place in the Gulf of Mexico. Late in his second term, former President Barack Obama moved to declare a moratorium on new drilling in the Atlantic and Pacific, as well as parts of Alaska, but Trump's administration announced plans to repeal that moratorium in January.

Florida's Scott was joined by Maryland Gov. Larry Hogan in opposing the plan to expand drilling to the Atlantic when the announcement was first made, and many environmental and tourism-industry groups have expressed concerns about the possibility since.

Earlier this month, the American Petroleum Institute announced last it had formed a new coalition, known as Explore Offshore, to support the expansion of offshore drilling off the coasts of the southeastern U.S., enlisting a group of former lawmakers and cabinet members from Virginia to Florida to lobby in support of new offshore opportunities.

The newly proposed Republican bill, according to The Washington Post, would create revenue-sharing for states that decided to drill. Alabama, Louisiana, Mississippi and Texas are the only states under current law to receive a share of offshore oil and gas receipts.

Democrats have protested the fee idea, noting that the plan could cost states hundreds of millions, if not more, in said fees. Republicans responded with saying that coastal states cutting off deprives the rest of the country from revenue that would go toward supporting the federal government.

Individual states themselves also do not have veto power over lease sale, said Rep. Paul Gosar (R-Ariz.), chair of the Natural Resources subcommittee on energy and mineral resources. Moving the measure ahead, however, will prove to be difficult due to lack of support.

President Trump is also repealing a controversial Obama-era draft order that was intended to protect the Great Lakes and the oceans bordering the United States. The new executive order promotes more drilling and other industrial uses of the oceans and Great Lakes.

Obama's policy, which was written shortly after the BP Deepwater Horizon offshore drilling explosion and oil spill in 2010, was more focused on conservation and climate change. The order also established

a federal council to oversee various programs that could impact the nation's oceans and Great Lakes.

Republicans and industry members are supporting Trump's new executive order, but critics remain vocal.

"With the action today eliminating the National Ocean Policy, President Trump is trying to wash his hands of responsibility for the real and urgent threats facing America's coastal communities—namely, the impacts of climate change," said Christy Goldfuss, senior vice president for energy and environment at the Center for American Progress.

"In the absence of a president who is willing to lead, it is now more important than ever that coastal governors, tribal leaders, state legislatures and local communities take up the mantle of leadership and work together to defend and restore the health of America's oceans."

European Coatings Show Accepting Papers

The European Coatings Show, Europe's largest coatings conference slated for March 18 to 19, 2019 in Nuremberg, Germany, is now accepting proposals for papers to be presented during its two-day conference.

"Innovative companies as well as academic/governmental research institutes are kindly invited and strongly encouraged to submit abstracts to this event detailing high-level technical contributions and presenting their latest research results that highlight advancements in coatings, printing inks, adhesives or construction chemicals," the ECS organizers said in a statement.

Officials note that the conference will be held in English only, so all papers must be presented in English. The presentation time allotted is 25 minutes, plus five minutes for discussion.

Title and abstract submissions are due September 14; speakers who are accepted will be notified by October 8. Final submissions of full technical papers for the conference proceedings are due January 18, 2019.

Speakers from the industry will be offered a full conference participation including materials at a reduced rate. There will be no charge to academic speakers.

Officials also note that "the most outstanding technical paper" will be honored with the European Coatings Show Award.

To submit an abstract, visit www.european-coatings.com.

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PAINT POLL

paintsquare.com/poll

A Pittsburgh artist is petitioning his county to save a decades-old series of graffiti geese from being blasted and painted over as part of a current rehab job. Can graffiti be worth saving?

Yes. After 20 years, a piece like this has grown to mean something to the community; they should work something out to preserve it.

55%

No. It's vandalism and should be treated as such.

33%

Other.

12%

Tom Schwerdt:

"Typically for steel bridge repainting, the location where graffiti/art is most likely (web face of the girder) is also typically showing the least degradation. Retaining the art is plausible, but as others noted, the actual condition needs to be surveyed."

Stephen Dobrosielski:

"My opinion is that the geese are not 'graffiti,' rather a piece of artwork. I am all for preserving the artwork, but should be re-applied by the 'artist' at the completion of the bridge rehabilitation project — at no additional cost to the taxpayer. This way, the 'artist' receives his recognition and the community has the benefit of looking up to the top strut of the suspension bridge towers to view his masterpiece — at the risk of colliding with other art lovers at 25 miles per hour."

Michael Beitzel:

"The decision should be left up to the owner of the structure. If a public entity is the owner and the artwork was not authorized, no additional cost should be borne by the owner to preserve or to replace the artwork. Those that desire to preserve the artwork should bear all cost."

Robert Ikenberry:

"Public safety is paramount. If the bridge is potentially compromised, it needs to be maintained, but art makes life richer and fuller and is worth some investment. In this case either to preserve or, as suggested, replace."

Michael Woodward:

"I voted other as my answer would be based on the condition of the substrate beneath the graffiti. If there are corrosion concerns in the substrate that are causing structural integrity issues then the coating, no matter how 'decorative,' needs to be removed to remediate the structural integrity. Graffiti can be a true art form as seen in areas around the country such as the Wynwood area in Miami. Graffiti is being used to paint the majority of the buildings in this area including a concrete plant that also uses graffiti to paint their trucks."

Domino's this month announced a plan to fund road repairs in towns that apply for its help. Should a pizza shop be in the business of fixing infrastructure?

Sure, if they think it makes sense for their business. Thanks, Domino's!

78%

No, I'd rather not have a pizza logo imprinted on my street.

14%

Other.

8%

Steve Brunner:
"In Canada, private companies take care of some of the infrastructure, so I have no problem with Dominos taking the lead on this project."

Regina Montgomery:
"Isn't that what taxes are for?"

Brad Boston:
"Motor fuel taxes are collected to fund roads, that's true. But not enough money is collected. Revenue is inadequate. Raise the gas tax!"

Peter Kenimer:
"I agree with a proper road usage tax that taxes based on miles driven. This would mean that whoever uses the road more has to pay more than those that barely drive. This would also make it so people who drive electric or hybrid cars have to input money in the system."

Tony Rangus:
"Fixing potholes is definitely NOT rocket science, so who cares who does it? I seriously doubt there is an extensively detailed 'pothole fix' procedure when using asphalt. About road, gas taxes — why is this part of the discussion? I pay all of this but I live in a private development where all the roads are collectively owned by the property owners. We do repairs ourselves as a community and if we need a major re-chip seal we hire a private contractor and each property owner pays an assessment to cover the cost. Nobody complains or mouths off, it is just done!"

Michael Halliwell:
"Tony, the sheer fact that Domino's feels it has to set up an infrastructure repair fund to help communities fix their roads should be something to care about. Sure, pothole repair isn't rocket science … but when you're paying 30-to-50 percent of your earnings in taxes (between all levels of government), you'd think the government would be able to spare enough change to keep the roads drivable. I shouldn't be ordering pizza and hear 'So, to confirm, that's one medium cheese pizza, one medium deluxe, an order of wings and one road repair.'"

PAINTSQUARE COMMENTS


Photo courtesy of Warren Brand.

In Response to "Thermoplastics: The Genie is Peeking Out of the Bottle"

(PaintSquare Blog, June 18)

Coatings consultant and PaintSquare blogger Warren Brand considered the recent developments in thermoplastic materials and considers the future for these materials in the corrosion protection field – even the potential for these materials to eventually replace the use of traditional thermosetting protective coatings.

Christopher Gatian:

"Great article! The technical obstacles don't appear to differ much from those already encountered with thermosets. The listed advantages over thermosets make thermoplastic systems seem quite appealing. How much research has been done? I'd like to see how certain properties, like adhesion, compare to thermoset systems."

Dana Stiles:

"Great article – the current flame-gun application method for thermoplastics is still a limit. I wonder why they can't use hot air. I have long been interested in PU and PUR coatings, but I believe that site-applied thermoplastics have good promise."

William Feliciano:

"I write and review coating specs for a transportation agency. Thanks for the well-written, interesting article. I don't have much exposure to the thermoplastic industry, so suffice to say I have too many technical questions to post here. As most know, steel bridge painting is solidly controlled by the liquid-applied coatings sector. Yet the sustainability aspects of thermoplastic are intriguing. Hopefully great strides in application technology are made and, more importantly, are made known outside the sectors where thermoplastic is currently employed."

Problem Solving Forum

paintsquare.com/psf

WHAT IS THE FUNCTION OF AN AIR RECEIVER DURING BLASTING?

Rajesh Sukumaran, Br.C.A.T. International Co. Ltd.:
"Safety is the reason behind using the air receiver tank during blasting."

Simon Wadsworth, COWI:
"An air receiver acts as a storage buffer for compressed air. It smooths out pressure fluctuations where the air output varies, such as from a piston-type compressor. Larger air receivers can moderate the demand on the compressor as the mean (average) rather than the peak demand for air."

Om Prakash Jat, Tech International Sharjah Hamriah UAE:
"Air receiver tank provides the following benefits. The receiver tank acts as a reservoir of compressed air for peak demands. The receiver tank will help remove water from the system by allowing the air a chance to cool. The receiver tank minimizes pulsation in the system caused by a reciprocating compressor or a cyclic process downstream."

Adam Weil, Apache:
"I've known it's also called an air reserve outside of blasting. If you have a short-term but high-demand use for the compressed air, paired with a compressor that is undersized for directly supplying the demand, a large enough reserve might save the day and pocket book."

David Zuskin, EXCET/U.S. Naval Research Lab:
"An air receiver tank is generally configured with the air entering the side of the tank and exiting the top of the tank. When the air and water/moisture enter the tank through the side, the water in the air hits the side of the tank and swirls around the interior of the tank. Gravity pulls the swirling water down and moisture is discharged via a ball valve on the bottom of the tank. Some air receivers are empty tanks. Others are equipped with desiccant tablets. In this case the air enters the side of the tank below the desiccant, which is contained in the upper half of the tank and sits on an expanded metal screen. The water still swirls down and as the compressed air rises through the desiccant, additional moisture is drawn out of the air."

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Marketing an Industrial Painting Company

BY KIRBY SOUTH, DECO COATINGS

In a world of hardhats and epoxy coatings, everything is evolving: from the way coating contractor businesses are run, to the diversity within the companies.

As a founding stakeholder of a paint contracting business, I have been accustomed to doing business face-to-face or office-to-office. Handshakes, personal phone calls and office meetings were "the way," or so I thought. And I felt comfortable in this sandbox. But like everything else, that's changed too.

I remember the day in the office when I was told that we had a new employee who would work around the clock 24/7 with no benefits, no sick days, never arrive late, required no salary and would travel around the world. I said, "Ok, I'll take one hundred of them, now what's the joke?" The new employee was our first website.

The website, it turns out, was just the beginning. It was my business partner and our executive director who convinced me we needed to hire a marketing company to take over that area of our business in order to grow. Being in business for over 40 years, I am always suspicious of something new or innovative until it has proven itself in the marketplace. I need to see if something works before I buy in.

Their ideas sounded good to me, but did it benefit our company goals and effectively reach out to prospective customers? I have seen hundreds of websites advertising

businesses or services with colorful photos of their accomplishments. But there was more. Did we need to be on Facebook? Did we need to be on Twitter or Instagram? Should I embrace this new era of media? Two leaders in our company, Janet and Laura, thought it was an important addition to our advertising budget. "To be relevant in today's economy we need to begin a journey down this road," they said. They talked about things — I had no idea what they were saying — HTML, drop-downs, search engines, promoted posts, ad words and so on.

Until we started working with a West Coast-based social media company, I hadn't realized the power of social media in the coatings industry. This third-party business made sure that our online world was regularly updated with everything relevant to our company: photos, videos, sneak peaks into how sports stadiums are coated, events we're attending, blogging — our blog readers are tracked from all over the world — and a montage of other things that I just call "web stuff." The numbers and results that showed after a few months had me convinced. Social media helped us take our business to the next level. I was truly surprised.

That said, I have asked the hard questions to the three women who made our online marketing and social media happen: Janet South , Laura Blechl and Elisabeth South.

INTERVIEW SUBJECTS

Janet South is president of DECO Coatings and Laura Blechl is the executive director of business for DECO Coatings. Elisabeth South is the founder and president of SouthHaus Group.

Kirby: How does the cost of online marketing break out?

Janet: We maintain that any solid advertising campaign combines both print and digital marketing. I believe they go hand-in-hand — but in order to advertise effectively, a dynamic website is necessary. The cost to maintain relevant website information and updates is a budget item that replaced the Yellow Pages, but for me, it was important to find a company that could both build our website and manage our social media presence. For anyone looking to do the same thing, I will say this: there is a learning curve to teaching someone about my company, so extending the social media marketing only makes sense to sole source — choosing a company that handles your website, social media and online marketing and advertising. They don't have to be experts in your field, but they certainly must understand what you do and the key elements of your expertise if they're going to make your marketing dollars count.

Laura: As opposed to looking at dollars, one should look at audience size. The cost is insignificant when you take in account what you get out of it. There are estimated to be over 2.2 billion active users on Facebook[1] and six new profiles created every second[2]. LinkedIn has 500 million users and two new users join every second[3].

Kirby: How do you feel we have been able to connect on a deeper level with our customers by using social media?

Janet: Virtual visitors are able to experience who we are and what we do. In a few brief minutes, virtual guests can learn about the culture, vision, goals, safety, real-time projects, photo and video galleries, and all about the latest technology that we're implementing. It's almost like speed dating for business. It's a great overview and helps a visitor decide whether or not to take the next step and contact us.

Laura: We absolutely connect on a deeper level — you are able to see what your customers' interests are, what they are concerned about or are celebrating and what industry events people are attending. Many times what they do in their spare time and with their families is interesting as well. One of my best customers is always traveling and posting pics of the outdoors. So the next time I see him I say, "Hey, how was your trip in Michigan?" We begin talking about that leads into building trust and confidence in each other.

Elisabeth: What our company is able to do through social media is very new for the construction and coatings industries. Most communication was once via email, phone and onsite. You had to send someone out to see a job, or send them photos through email, or pay a lot to constantly update your website. Laura and Janet are constantly connecting with clients on social channels. And we see how many people are visiting our client's website and can correlate social media campaigns through that; numbers don't lie.

Kirby: How has online marketing changed the way we do business?

Janet: Time is precious. Being relevant and getting our message out has to be simple and laser-focused — often, all we get is a glance. If that glance doesn't spark the interest to dive deeper, we've lost an opportunity for a project or perhaps a potential customer. We take our online marketing very seriously. That is why we vetted several companies to partner with us on marketing. It is a true partnership because they must deliver tangible metrics and results to accomplish targeted goals. We have experienced many online marketing companies who are cookie cutter, one size fits all. But there is a science to online marketing, and finding the right partner is key.

Laura: We are very cautious of our posts and likes. As much as we personally and professionally want to share all of our opinions, ideas and projects, we have to be aware of every detail. Every post, blog or website update is strategic. We have to remember to take appropriate pictures and videos for our social media partner. They'll critique the images, send us a final post and handle the rest. Then comes the data. The numbers are fascinating to evaluate; seeing who's clicking where, what they're reading and how long they're on our site. This helps us to continue to evolve and adjust our marketing plan as needed.

Elisabeth: For the world at large, online marketing has completely changed the way we do business. For coating contractors specifically, social media has made companies more accountable and has also given them endless opportunities for constant advertising. In the past you would see signs on jobsites or put an ad in the Yellow Pages. Now it's Facebook, Instagram, Twitter, LinkedIn and Snapchat.

Kirby: In the past we used photos to showcase jobs. Now we're doing a lot of video. How do you choose what videos to shoot and what's the reason for the big shift?

Janet: We can't take all the credit for this shift. It came as a strong recommendation from our media marketing partners. They are experts and we rely on their expertise to keep us informed and on the cutting edge of marketing trends. They tell our story while we focus on our industry expertise. Our marketing partner makes us look good and we trust them because they deliver.

Laura: Video tells more of the story. Photos can sometimes get cropped or limit the meaning of the shot. In 30 seconds, you can showcase a lot in a video as opposed to 30 photos. Who has time to look at 30 photos? Videos are the new best thing and are used more often by younger adults. YouTube is the second-largest social networking site, behind Facebook and well ahead of LinkedIn and Twitter[4]. Think about it — when was the last time you watched something on YouTube or googled a "how-to" question and a YouTube video popped up at the top?

Kirby: What surprised you most in the past year regarding your company's social media presence?

Janet: I was surprised by how it works and the work that it takes to gain a presence in social media. It takes time and effort to put a plan together, but far more time and effort to implement the plan. It is not a one-and-done sprint but rather a paced, long distance.

Laura: The numbers. We've never been able to track our advertising traffic as much as we can today. It motivates us even more to continue to post and stay on top of it. Also, people are reaching out to me about things they saw us post. They'll say, "Hey, I saw that coated tank you posted — I had no idea you had that capacity," or, "I loved your blog on that subject, can you tell me more?"

Kirby: We now have business pages on multiple social media platforms. Why didn't you just choose one platform and focus on that?

Laura: For the same reason that we don't focus on just one coating. There's a proper coating for different applications. Everybody has their own preference on what they read and how they get their information. The bigger the audience, the bigger the return. That being said, posts have to be similar in nature while still using that specific platform's criteria.

Elisabeth: Say you want to get to know a person. You might find them online to gather all the info you can about them. If all they have is one social media profile, you will get to see a bit about them; but if you find links on their profiles, you'll see short videos they're posting on Instagram, find articles they've written on LinkedIn — you'll have a broader view of them and a much more educated summary of who they are. That's how social media works for businesses too. Give people a chance to really get to know you; put your business everywhere online that makes sense, because people don't have a lot of time to look around for you. Make it easy to get to know your company.

Kirby: What is one piece of advice you would give to any coating contractor wanting to build their online presence and handle their social media?

Janet: Whether you select a full-time employee or an outsourced online marketing professional, take the painstaking time to partner with the right one. Don't be afraid to change midstream if the plan is not working. Of course, sometimes a specific campaign may not produce what was planned, but excuses for lack of results indicate that the partnership should be severed.

Plan on taking the time to communicate with your marketing team. Make sure you all have the same vision and goals. Promptly respond to your marketing team when they ask for information; they cannot be effective without your help. They are experts in what they do and we are experts in what we do. It is your responsibility to feed your marketing team detailed information so they can sort and revise to deliver a compelling, effective online presence for you.

Laura: Find a social media marketing company that is an expert in the field; not a website developer. You need a social media marketing partner who understands how your industry world works and is aware of the latest trends. Get a referral for a great company to use.

Elisabeth: Hire a social media company that can do everything for you. Do you really have time to spend five hours a day creating posts that may never even be seen because they aren't hashtagged correctly, or because they're not interesting posts? I don't want to become a dentist to clean my own teeth; I don't understand why someone would spend ungodly amounts of time and waste a small budget on something that is not going to do much for them.

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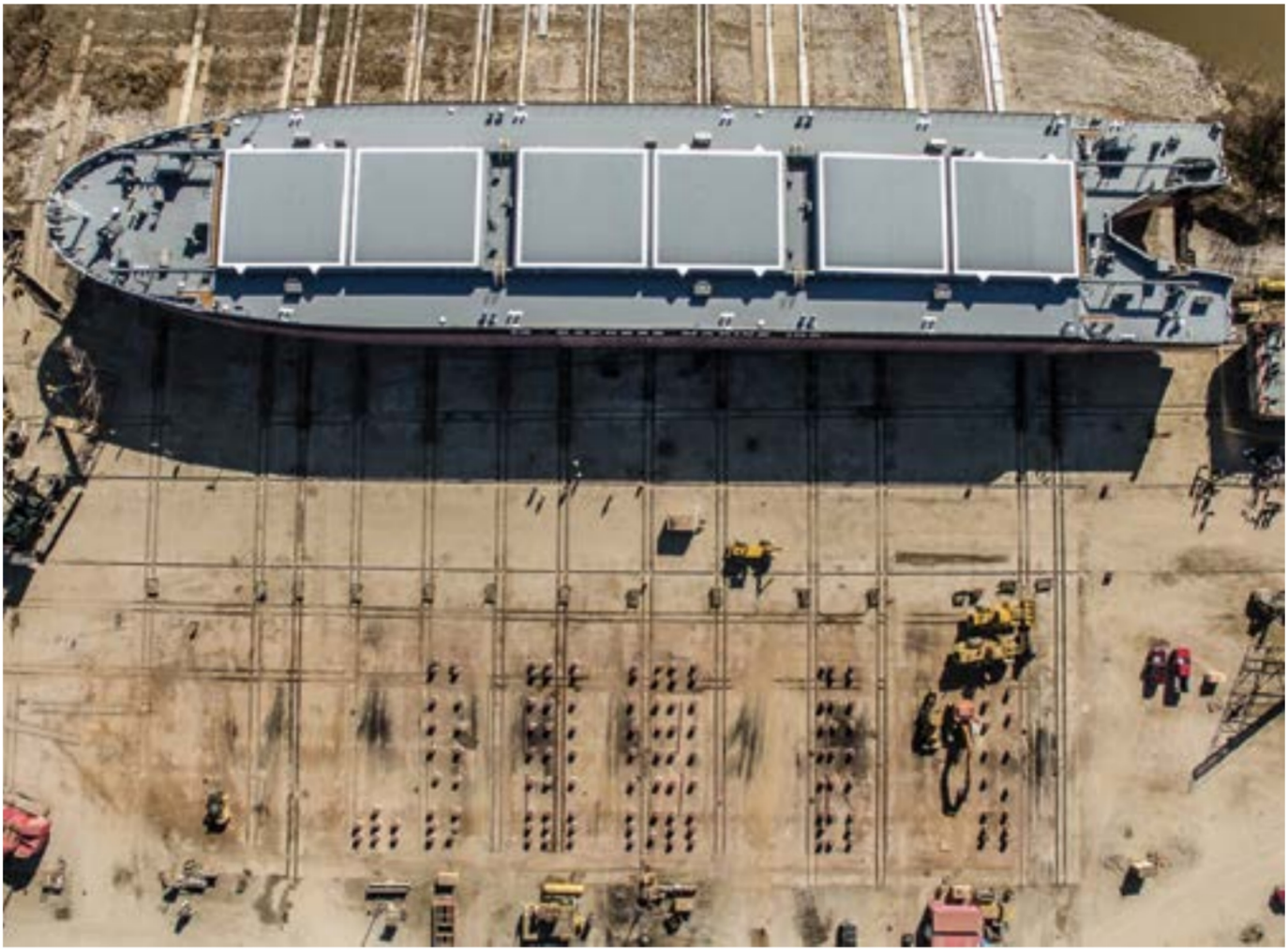


A team of over 50 painters, 100 welders, three inspectors and a number of other parties coordinated their efforts during the construction of a new 464-foot-long hopper barge. Photos courtesy of PPG Protective and Marine Coatings and Express Marine Inc.

Building a Better Barge

An east coast-based marine transportation company ("the owner") planned to construct a new 464-foot-long oceangoing hopper barge to add to its fleet.

The owner had previously experienced some coating breakdown and corrosion issues in the atmospheric exposure zones on a number of similarly modeled ships that used traditional protective coatings systems, and sought to avoid the same issues on the new barge.

Of particular concern was the ballast area, where the owner hoped to avoid making very costly repairs and replacements if the coatings were to break down or underperform. In service, these areas face constant cycles of seawater immersion and exposure to the ambient conditions inside the ballast tanks, resulting in plenty of corrosion-promoting moisture and salts left on the surface.

Before putting the project out to bid, the owner met with a coating manufacturer's representative, who developed and proposed an alternate painting specification for the new ship that addressed the owner's concerns and sought to offer more longevity than the coating systems used on ships in the past. This included applying a primer plus two stripe coats and two full coats of an edge-retentive epoxy to the edges and other hard-to-reach areas of the ballast tanks, as well as using a UV-resistant polysiloxane finish on exterior

Exterior above-waterline surfaces received a polysiloxane finish coat for UV resistance and longevity.

A number of coating systems were utlized on the new barge, including dual stripe and finish coats on difficult-to-access ballast tank edges and an abrasion-resistant epoxy for cargo hold areas.

above-waterline surfaces instead of the urethane-based topcoats favored in the past.

With this updated specification, which tightly adhered to the current International Maritime Organization (IMO) performance standards, the new project was awarded and sent to a midwestern shipyard on the Ohio River for construction. The shipyard subcontracted with a coatings contracting firm ("the contractor") for the painting portion of the job, and work was carefully coordinated between the contractor's 50 painters and the shipyard's welding team of 100-plus.

In addition to the laborers constructing the ship, three inspectors were employed on the job – one by the owner, one by the shipyard and one by the contractor – who were present throughout the duration of the six-month project, ensuring that work adhered to the specification and that any possible discrepancies were addressed and corrected immediately. The coatings manufacturer also provided an on-site technical representative to assist with all aspects of the coating application, including the hold-point inspections for surface preparation, review of each coat of paint applied and the final coating inspection.

The project began in August and continued through the winter months into February of the next year, with all work taking place outdoors on the shipyard's riverside dry-docking area. While below-freezing weather delayed work on some days, the teams were able to coordinate work around the weather – even scheduling exterior work around which side of the ship was exposed to the sun at that particular time of day – to stay on schedule.

With the ballast area fully contained, interior surfaces of the nine ballast tanks, each approximately 120 feet in length, 45 feet in width and 34 feet in height, were abrasive blast-cleaned to an SSPC-SP 10/NACE No. 2, "Near White Blast Cleaning" finish using coal slag abrasive material. Coating application – including spray application

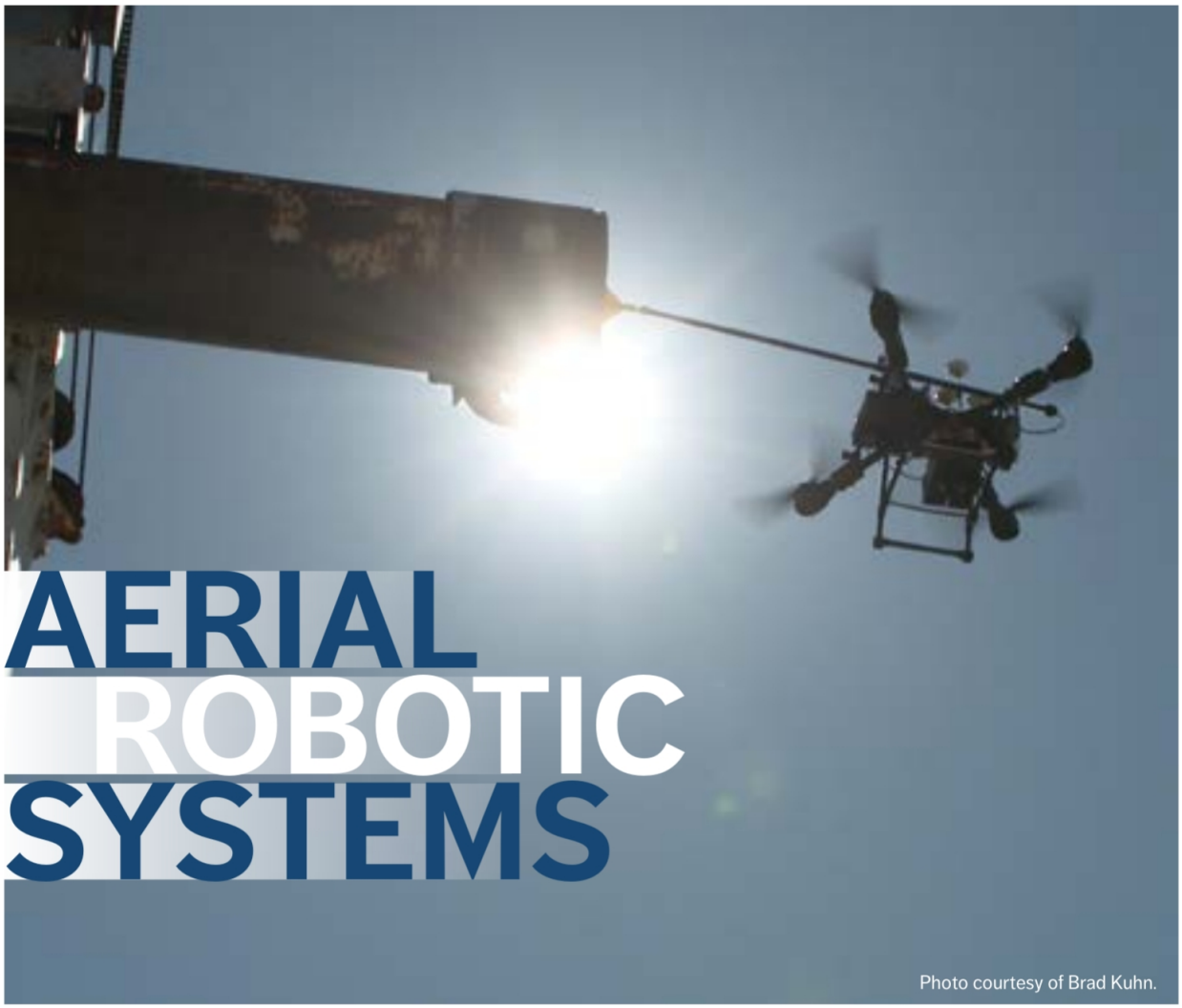
Once completed, the barge was transported via tugboats down the Ohio and Mississippi rivers, continuing south through Mobile Bay and eventually the Gulf of Mexico, where it currently carries loads of limestone from Florida to Alabama.

and hand-applied stripe coats to edges and other areas inaccessible by spray equipment — proceeded with the use of heating and dehumidification, which allowed the coatings to cure properly in the winter months.

The exterior surfaces of the ship had received a pre-construction primer before welding, so welding edges were ground and the steel was pressure washed and coated with a zinc-rich epoxy primer, an epoxy intermediate and the polysiloxane finish coat the owner and the coating manufacturer's representative had selected. Below-waterline surfaces received a more traditional antifouling finish coat instead. The cargo hold and other loading areas on the barge also received an abrasion-resistant epoxy system designed to withstand heavy traffic and equipment.

All in all, coordination between the parties involved – particularly the inspectors, who worked together around multiple checkpoints to ensure that work matched each detail of the customized specification – made for a satisfactory result for the owner, who put in extra time, research and, ultimately, money in advance to ensure that more expensive repairs down the line would not be needed.

Once completed, the barge was floated down the Ohio to the Mississippi River, where it headed southward to Mobile Bay in Alabama. From there, the barge made its maiden voyage across the Gulf of Mexico to Florida, where it now receives loads of limestone and other heavy materials to carry back to Mobile – corrosion issue-free, so far.



AERIAL ROBOTIC SYSTEMS

Photo courtesy of Brad Kuhn.

A Novel Approach to Safe Coating Inspection at Heights

BY JAMIE BRANCH, APELLIX

Traditional coating inspection techniques require extensive manual testing by the inspector, often at vertical heights that must be accessed by equipment such as scaffolding, lifts and ladders. Aerial robotic technology offers a novel approach to obtaining big data more efficiently, while reducing an inspector's occupational exposure to dangerous heights. This article addresses the benefits, as well as limitations, of utilizing aerial robotic systems as a viable means of coating inspection.

Dry film thickness (DFT) is an integral component in determining the quality of a coating job. Structures with large surface areas will require enormous quantities of data to ensure that a coating is in compliance with the applicable standards and specifications. For example, if 300,000 m^2 of flat surface called for coating inspection by DFT, a minimum of 45,000 gauge readings would be required for compliance with SSPC-PA 2. To obtain these measurements, the inspector must manually touch the probe to the material being measured. Current handheld electronic Type 2 DFT

Fig. 1: Robotic aircraft takes DFT readings on a ship. Photo courtesy of Jeremy Countryman.

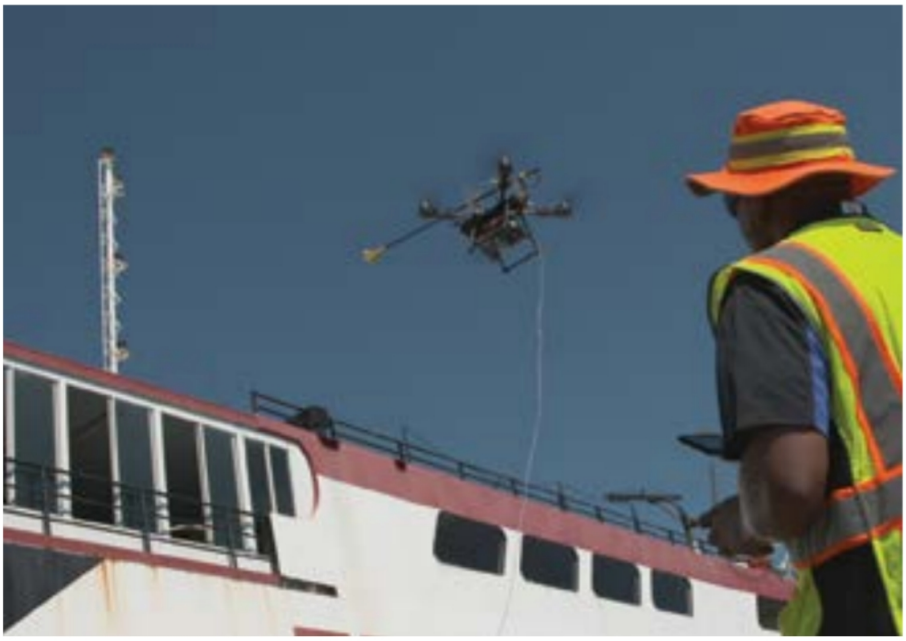


Fig. 2: A pilot navigates the aircraft while remaining safely on the ground. Photo courtesy of Brad Kuhn.

equipment is conveniently designed to be lightweight and portable; however, it requires the inspector to physically access the testing sites, which are frequently located at dangerous heights. Scaffolding, scissor lifts, fall protection and other access equipment are utilized to reach test sites, which are expensive and present fall hazards to personnel accessing them. The Bureau of Labor Statistics reports that 849 workers lost their lives in 2016 from falling while on the job across all industries[1]. The United States Occupational Safety and Health Administration (OSHA) established a hierarchy of hazard protection that specifies that engineering fall hazards out and away from the workplace is the most effective strategy for keeping workers safe. An alternative to performing measurements manually at the test site is to utilize an aerial robotic system to perform the measurements with the worker safely on the ground. This method satisfies OSHA's hierarchy of fall protection by engineering the fall hazard away by removing the necessity of the worker to access heights.

AERIAL ROBOTIC SYSTEMS

Traditional, unmanned aerial vehicles (UAVs), or drones, are not designed to fly near structures. This produces problems for making contact with a material surface for coating inspections such as DFT. In contrast, an aerial robotic system is a hardened custom drone equipped with an array of sensor systems, a full computer and custom software to allow automatic flight to contact wall structures for measurements. The aircraft includes a robotic arm with an end effector, which is the component that physically contacts the material being tested. The end effector contains the

SAFE COATING INSPECTION AT HEIGHTS

Fig. 3: An aircraft inspects at a chemical plant. Photo courtesy of Jeremy Countryman.

inspection measurement equipment, such as a DFT probe. It is important to note that inspection devices (such as a DFT device and probe) capturing the readings employ the same technology currently used by the industry; the aerial robotic system just places the probe against the wall surface instead of a person doing it. The aircraft can be powered by two six-cell lithium polymer rechargeable batteries or be tethered to ground power for all-day continuous flight.

To perform readings, a licensed Federal Aviation Administration (FAA) remote-in-command-certified pilot (commonly known as an FAA section-107 pilot) will navigate the aircraft to a desired measurement area. Once the aircraft is positioned near the desired area, autonomous flight is activated. The

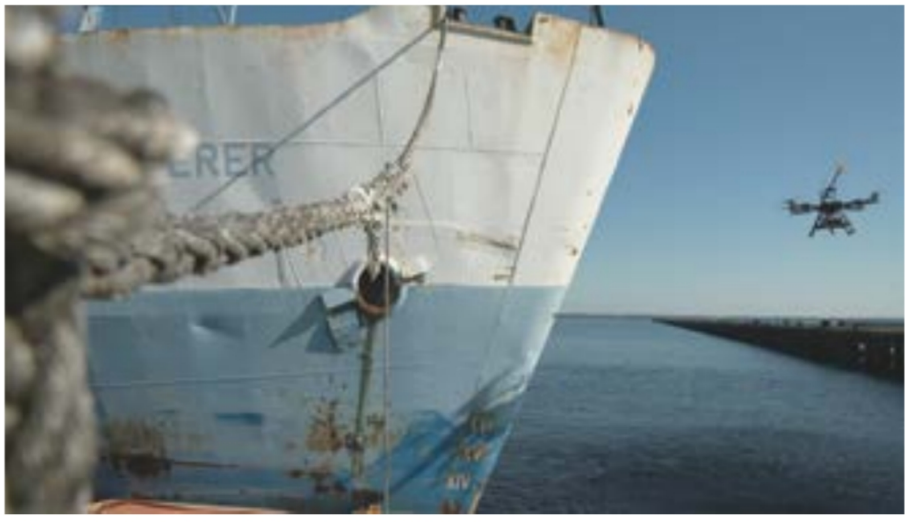


Fig. 4: Robotic aircraft are a cost-effective tool, reducing billable time spent repetitively accessing inspection areas. Photo courtesy of Brad Kuhn.

Fig. 5: Inspection of multiple structure types can be safely conducted by robotic aircraft. Photo courtesy of Jeremy Countryman.

onboard computer programmatically flies the aircraft to the material surface to achieve contact with the wall. Once the onboard software obtains sufficient DFT readings, the aircraft backs away from the targeted wall and returns to a safe position awaiting navigation to a new area by the pilot. Data is transferred in real time to a laptop on the ground, as well as exported to a text-based comma separated (.csv) file for the inspector to review once all measurements are complete.

BENEFITS

Safety

Aerial robotic devices (to perform coating inspections such as DFT readings) provide a safer occupational environment for workers. They eliminate the dangers associated with building scaffolds and moving heavy lift equipment. Workers and inspectors can perform their jobs safely on the ground while the aerial robotic device completes the reading.

Time and Cost Savings

Aerial robotic devices can take 100 or more measurements per hour without waiting for scaffolds to be built or lift equipment to be moved, significantly reducing the amount of time required for inspection completion. Inspectors can spend less time accessing test sites and more time analyzing data and performing other job functions. This is a cost-effective tool as it reduces the billable time spent repetitively accessing inspection areas and gathering measurements. Additional cost savings are realized when the structure or material, such as a ship, can be returned to service more quickly to continue generating revenue. Other associated costs, such as access equipment rental costs or port fees, may also be reduced with a shorter required inspection window.

Big Data Tied to Geospatial Coordinates

As previously mentioned, DFT inspection can require enormous amounts of data. Big data is easily captured by aerial robotic systems and displayed for analysis by the inspector. Data collected by aerial robotic systems are tied to geospatial coordinates and mapped in 3-D so that the inspector can visualize the readings in relation to the structure and locate readings to the corresponding area on the structure.

LIMITATIONS

New Technology

Aerial robotics is a relatively new technology that has yet to be commonly integrated throughout the industry. As with the development of any new technology, several versions will likely be produced before a polished product that fully satisfies customer expectations is available. With each improvement, the aerial robotics' safety, efficiency and cost savings should also improve, resulting in enhancements to the industry and better coating inspections.

Wind

UAVs have difficulty maneuvering at higher wind speeds. This difficulty increases significantly when the task of the aircraft is to make stable contact with a material surface. Current aerial robotic devices used for performing contact based measurements have been safely operated in wind speeds up to 12 knots (14 mph). Further testing is required to analyze the safety of operating at higher winds. This can limit the number of days a device can be used to perform work.

Confined Spaces

UAV propellers disturb the surrounding air mass. In small confined spaces, this propeller wash may affect flight. Therefore, most UAVs and aerial robotic devices are not equipped to handle confined spaces of certain sizes.

Geometry

The end effector on the aerial robotic device contains the measurement probe and sticks out approximately two feet from the main body of the aircraft. Measurements on the aircraft are performed by approaching the surface straight on. This makes the aerial robotic device well-suited for flat or curved surfaces. The aircraft is not well-suited, however, to performing measurements in or immediately adjacent to a crevice or corner, or against oddly shaped geometry.

CONCLUSION

Working at heights to perform coating inspections can require personal fall protection, scaffolding or heavy access equipment. These methods create risk for the inspector collecting the readings. Using aerial robotic platforms can remove humans from harm's way and provide a more time-efficient and cost-effective method of gathering readings.

Performing coating inspection measurements using aerial robotic systems seeks to improve occupational safety and reduce injuries and deaths attributed to falls by allowing measurements to be taken with the worker safely on the ground and the aerial platform in the air. Using aerial robotics to perform contact-based inspections at heights is a novel approach that has yet to be integrated into standard operations at industrial facilities.

ABOUT THE AUTHOR

Jamie Branch is a corrosion engineer at Apellix, an aerial robotics company located in Jacksonville, Florida. She enjoys driving the advancement of non-destructive testing (NDT) technology and innovating ways to make cleaning, coating and NDT processes safer and more

cost-efficient. Prior to joining Apellix, Branch spent four years working at a petrochemical facility as a reliability engineer. Climbing towers and performing inspections off of scaffolding enabled her to recognize firsthand the opportunities aerial robotics can provide to industry. She completed her Bachelor of Science degree in mechanical engineering from the University of Kansas, and her Masters degree in mechanical engineering from the University of Auckland, New Zealand. Branch is NACE-certified Level I Coating Inspector.

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QUALIFICATION TESTS FOR HIGH-TEMPERATURE FBE COATINGS

BY HASSAN AL-SAGOUR AND MANA AL-MANSOUR, SAUDI ARAMCO

To protect oil and gas pipelines from corrosion, fusion bonded epoxy (FBE) coatings supplemented with cathodic protection have been performing well for decades. However, as deeper gas wells have been discovered, gas is produced at higher temperatures than before. As a result, the need for higher glass transition (Tg) coatings has emerged to resist the higher temperatures that conventional FBE coatings cannot handle, especially in gas flow lines.

Most of the common FBE coatings have been used at a maximum operating temperature of 90 C (194 F). These newer conditions have revealed temperatures as high as 140 C (284 F) and for that, new generations of FBE have been formulated with a thermal resistance for such high temperatures. The challenge for manufacturers was to maintain an acceptable performance in terms of chemical resistance, adhesion, impact resistance and flexibility. Unfortunately, some properties are compromised as temperatures increase. Depending on the targeted use of these coatings, the new set of properties should be evaluated as a matrix with acceptance criteria more tolerant than those for conventional FBE coatings.

For chemical resistance and cathodic disbondment properties, test methods had to be modified. These tests had been conducted at 90 C for conventional FBE coatings by maintaining a test temperature of 90 C for both the solution and test panel for a specific duration. For elevated temperatures, the test panels were set at a much higher temperature than that of the solution to simulate actual operating conditions of subsea pipelines.

In this article, we will address the qualification test methods used to evaluate four different FBE coatings for a maximum operating

temperature of 140 C in immersion conditions. Special emphasis will be focused on the chemical resistance test in a 5-percent NaOH solution at such a high temperature.

EXPERIMENT DESIGN AND TEST METHODOLOGY

In order to have representative data, the study involved four high temperature FBE products, from three different manufacturers carried out at third-party laboratories. Coatings A and A' are the same product, the difference being that Coating A is spray applied and Coating A' is dipped. For fair comparison, all candidate products were tested by the same methods, at the same conditions. The evaluation consisted of the following tests.

- Attenuated Total Reflectance — Fourier Transform Infrared Spectroscopy.
- Thermal Analysis — Differential Scanning Calorimetry (DSC).
- Flexibility (Bending Test).
- Impact Resistance.
- Cathodic Disbondment.
- Chemical Resistance.
- Dry-Film Thickness Measurements (DFT).
- Pull-off Adhesion.
- Electrochemical Impedance Spectroscopy.

Attenuated Total Reflectance — Fourier Transform Infrared Spectroscopy

Attenuated total reflectance — Fourier transform infrared spectroscopy (ATR-FTIR) was used to analyze the coating powders' microstructure from their characteristic absorption bands and their content by the band intensity, so that the FBE coatings could be identified and/or quantitatively analyzed.

Table 1: Thermal Characteristics of the Four Coatings.

Coating	Tg1 (C)	Tg2 (C)	Tg3 (C)	Tg4 (C)	ΔTg (C)	ΔH (J/g)
A	54.4	148.0	157.1	157.7	-0.6	125.1
A'	54.4	148.0	157.4	157.4	0.0	125.1
B	96.4	136.2	140.3	140.6	-0.3	31.3
C	57.7	148.5	154.3	155.3	1.0	41.2

Thermal Analysis — Differential Scanning Calorimetry (DSC)

DSC is the method used to determine the thermal characteristics of the candidate coating powders. In accordance with CSA Z245.20 Series-10, "Plant-applied external coatings for steel pipe," the test was used to determine the glass transition temperatures Tg_1, Tg_2, Tg_3, Tg_4 and the curing reaction heat (ΔH). Degree of cure ΔTg was also evaluated based on the readings of Tg_3 and Tg_4. Tg is the temperature at which polymers change from a glassy state to a rubbery state or vice versa. ΔTg is the degree of cure, or is a measure of the cross-linking degree of polymers.

For all four coatings, the DSC results showed that the coating was fully cured (Table 1). The candidate coatings had transition glass temperatures greater than 150 C (302 F), except for Coating B whose Tg was around 140 C. For operation in a dry environment, Coating B may be able to perform well at 140 C, but would most likely fail if used in wet conditions at this temperature, as 140 C is almost the same as its Tg. This can be confirmed in immersion and chemical resistance tests. Figure 1 (p. 38) shows sample graphs from Coating A, which explains how the numbers in Table 1 were obtained.

Flexibility (Bending Test)

Because these coatings were targeted for the external corrosion protection of pipelines, they needed to be tested for flexibility to endure bending during pipe transportation and installation. It is critical that a coating retains its film continuity to protect a substrate.

This test was conducted in accordance with material specification 09-SAMSS-089, "Shop-Applied External Fusion Bonded Epoxy Coating for Steel Line Pipes." Specimens were placed in a freezer at 0 C (32 F) for 30 minutes, then removed and clamped in a bending machine with the coated side up. The test specimens were bent at 60-degree angles over a 25.4-mm-thick mandrel, the dimensions of which are equivalent to a degree bend of 5.5-degree/pipe diameter. Some coatings cracked at this initial degree of bend but knowing that these new-generation coatings would not be as flexible as conventional FBE, this mandrel dimension was used as a starting point and then adjusted for lower flexibility and used to assess the limits of each.

Bending was accomplished in less than 30 seconds. When the coated samples reached ambient temperature, they were inspected for cracks at 10-times magnification and holiday tested.

As seen in Table 2 (p. 38), the flexibility test was not done for Coating A' as it was assumed that because Coatings A and A' are the same material, the flexibility results would be uniform. Of the other coatings, Coating B had the highest degree of bend per pipe diameter. Our requirements for conventional FBE coatings mandated a degree of bend equivalent to 5.5-degree/pipe diameter and we did not expect the higher-temperature FBE coatings to maintain such flexibility. As predicted, all the tested coatings exhibited a very similar lower flexibility. This fact further confirms that the higher the Tg, the more compromise there is in flexibility.

Impact Resistance

Pipeline coatings are subject to mechanical damage during transportation and installation and mechanical impact may harm the continuity of the coating and cause breaks, scratches or holes that could allow corrosive media to penetrate.

The impact test was conducted according to ASTM G14-04, "Standard Test Method for Impact Resistance of Pipeline Coatings (Falling

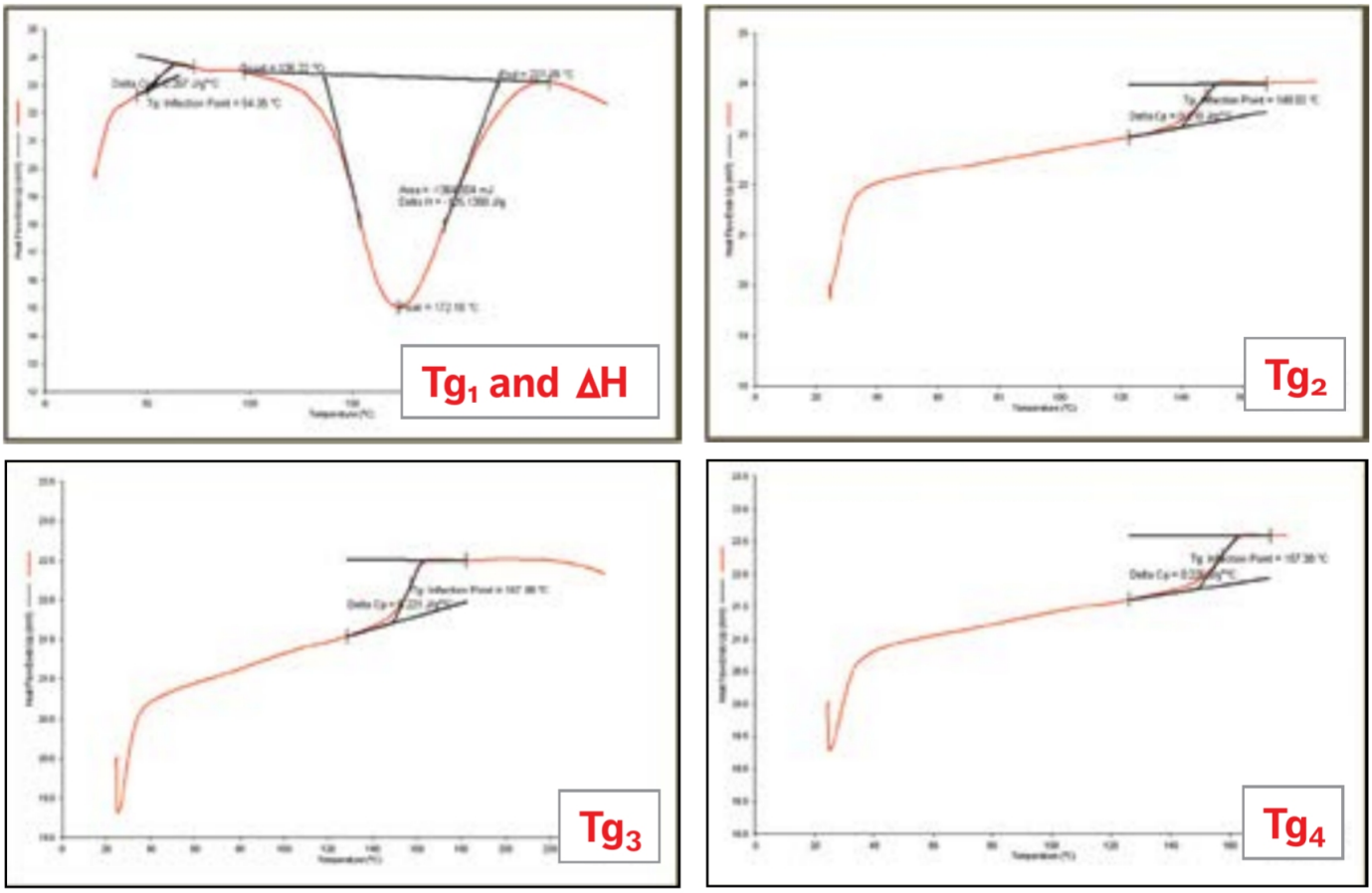

Fig. 1: Sample DSC graphs for Coating A. Figure courtesy of the authors.

Table 2: Flexibility Readings (in °/pd).

Coating	A	B	C
@ 0 C	2.10	2.25	2.5
@ 25 C	3.30	2.92	3.0

Table 3: Impact Resistance Measurements.

Coating	A	A'	B	C
Impact (J)	10	6	8	8

Table 4: Average Disbondment.

Coating	A	B	C
Radius of Disbondment (mm)	7.8	3	5.4

Table 5: Visual Examination Post-Immersion.

Coating	Distilled Water	5% NaCl	Sea Water	5% NaOH
A	No defects	No defects	No defects	Discoloration
A'	No defects	No defects	No defects	Discoloration
B	No defects	No defects	Not done	Discoloration
C	No defects	No defects	No defects	No defects

Table 6: DFT Measurements Post-Immersion in NaOH Solution.

Coating	A	A'	B	C
Control Sample (microns)	633	527	775	506
Post-Immersion (microns)	697	593	911	504

Weight Test)" on sample plates (as opposed to tubular samples — a modified version to address our specific requirements) after measuring the coating thickness and conditioning the samples at 10 C (50 F) for one hour. Each sample was impacted a few times within 30 seconds, with each impact point more than 25 mm away from the previous impact point. At room temperature, the samples were evaluated visually and by holiday detector (67.5 V). Table 3 shows the impact readings.

All four coatings were capable of handling impact of 6 joules or higher. The dipped panels with Coating A' were less resistant to impact than the sprayed samples of Coating A. Coating B was the only coating that exhibited a brittle mode of failure. In general, the impact resistance of all coatings is considered acceptable.

Cathodic Disbondment

Cathodic protection is normally the second line of defense against corrosion. In the case of partial coating failures, the current produced by the cathodic protection system should be adequate to counterbalance the corrosion circuit's current and thus control corrosion. Therefore, the selected coating must work properly with cathodic protection.

This test simulates the cathodic protection

conditions found in the field to evaluate a coating's performance. The electrical current produces an aggressive, highly alkaline environment at the substrate/coating interface, at an artificial holiday.

The test was set up to maintain the test solution at 90 C (194 F) (electrolyte temperature) in accordance with ASTM G42, "Standard Test Method for Cathodic Disbonding of Pipeline Coatings Subjected to Elevated Temperatures," with a modification that included sample size and test temperatures. After 30 days, the test was discontinued for evaluation, mainly thickness measurements and radius of disbondment. Radial cuts were made into the coatings and a knife was used to lever detached coatings from the substrate. The distance of disbondment was measured and the averages reported in Table 4 (p. 38).

As Coatings A and A' are the same product, the cathodic disbondment test was not done for Coating A'. Both coatings A and C had a very similar radius of disbondment. Even though much greater than that of Coating B, the radii were still acceptable. When the exact test conditions were investigated further, it was discovered that an error had been made — that the test temperature for Coating B had dropped earlier to 125 C (257 F), which is 15 degrees (C) lower than that of the other two coatings. Disbonding of only 3 mm for Coating B is a clear indication of the effect of temperature in this test.

Chemical Resistance

A chemical resistance test is used to evaluate a coating's performance under simulated conditions to the targeted destinations of the pipelines. The coatings were tested with various reagents/solutions: distilled water, 5 percent NaCl, synthetic seawater and 5 percent NaOH. In this article, we will focus on the test results in caustic soda solutions (5 percent NaOH) because that has been found to be the most challenging.

To test the resistance of the different coatings to these reagents, 3-inch-diameter cells made of fluorocarbon (a high-temperature stable material) were placed over coated panels and firmly fixed to avoid potential leaks. The coated panels were maintained at 140 C and condensers were connected to the system to prevent evaporation by maintaining the solution's temperature at 85-to-95 C (185-to-203 F).

At the end of 30 days, the panels were cooled, the fluids decanted and the jacketed cells removed. The panels were then examined for visual defects in addition to the thickness measurements, pull-off adhesion and electrochemical impedance spectroscopy (EIS). The visual results are listed in Table 5 (p. 38).

Post-immersion, the four coatings did not show any signs of failure in three test media; namely distilled water, 5 percent NaCl solution and synthetic seawater. Except for Coating C, all of the candidate coatings exhibited a clear change in color. Whether this

discoloration can be considered a failure or not, will require further testing.

Coating C was the only coating system that showed no sign of cracking, softening, loss of adhesion, swelling, discoloration or blistering after being exposed to the NaOH solution. Since discoloration was only experienced with caustic soda (5 percent NaOH), the chemical resistance test was repeated for verification only in this test medium. Again, most coatings showed discoloration. Hence, the thickness measurements, adhesion test and EIS were only carried out on the panels that were tested in the NaOH solution.

DFT Measurements

DFT measurements of the four coating systems were taken with a digital coating thickness gauge and five thickness measurements were taken on each coated panel. The panels had varying coating thicknesses as received from the coating suppliers and DFT measurements ranged from 450 micrometers to 680 micrometers. The final DFT readings were based on the average of five readings per coating system. Table 6 (p. 38) shows the change in thickness that is notable on test panels after being exposed to the caustic soda solution for 30 days at 140 C.

Comparing DFT measurements, Table 6 clearly shows the increase in thickness in coatings A, A' and B. This swelling is an indication of the coatings losing barrier properties and allowing the solution to permeate. This fact was later confirmed by EIS.

Pull-Off Adhesion

This test measures a coating's ability to resist tensile stress, which is also representative of its adhesion to the substrate.

A pull-off adhesion test was conducted according to ASTM 4541-09, "Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers." The surface of the dolly was roughened with sandpaper before applying adhesive, and after the adhesive was cured, the circumference of the dolly was cut through to the substrate. Table 7 (p. 42) shows the average pull-off readings and mode of failure for all coatings before and after immersion in the NaOH solution.

For coatings A, A' and B, adhesion post immersion in NaOH dropped by almost 50 percent. The loss of adhesion for coating C was only 8 percent of the initial measurements.

EIS

One characteristic of the barrier properties of organic coatings is having satisfactory electrical resistance (low conductivity). This electrical resistance decreases as the coating degrades or has deteriorating barrier properties. To measure electrical resistance, EIS is normally used. In this test, the electrical resistance of the coating is evaluated after long-term exposure to an electrolyte.

Again, using the attached cell method, EIS measurements were made using a glass tube (31 mm in diameter) placed onto test panels

Table 7: Pull-off Adhesion Before and After Chemical Resistance Test (psi).

Coating	A	A'	B	C
Before	3,445 - A	3,656 - A	3,000 - A	2,605 - A
After	1,510 - C	1,614 - C	1,670 - C	2,397 - A

Table 8: Electrochemical Impedance Spectroscopy (EIS).

	Coating	A	A'	B	C
EIS (Ohm. cm^2)	Before	2.95 x 1010	4.4 x 108	3.37 x 109	4.79 x 109
	After	4.66 x 105	2.31 x 106	3.94 x 106	1.03 x 109

and filled with 3 percent NaCl solution. One panel of each coating was tested. After 48 hours of immersion at 23 C (73 F), the impedance of the coating was determined at a frequency of 0.1 Hz. A silver/silver chloride reference electrode and carbon counter electrode were used. Impedance measurements were obtained before and after immersion in 5 percent NaOH solution as shown in Table 8.

Except for Coating C, all the other coatings experienced a severe drop in their barrier properties. The degradation in coating A was drastic from an excellent barrier property before immersion to poor. Coatings A' and B began at a good position, but their log Z dropped below 8, indicating their loss of integrity. We found no explanation for the large difference in EIS measurements between Coating A and Coating A'. Most importantly, Coating C displayed very good and consistent barrier characteristics both before and after immersion.

DISCUSSION

Individual test results might not lead to a concrete conclusion, however by looking at these methods combined and evaluating the results holistically, we have concluded the following.

Coating A

Coating A was not qualified for wet operating conditions to a maximum temperature of 140 C. Though it has a very high glass transition temperature (157 C [314 F]), it does not maintain its chemical resistance, adhesion nor barrier behavior in highly alkaline services at a temperature 17 degrees C less than its Tg. Coating A did well with other solutions such as distilled water, synthetic seawater and sodium chloride solutions, but failed severely in caustic soda solution. In its current formulation, it cannot perform well in highly alkaline services at such high temperatures.

Coating A'

General characteristics were the same for Coating A and Coating A', such as FTIR and thermal analysis. Coating A', however, was not as resistive to impact. It had slightly better adhesion and barrier manner, yet both coatings did not perform well in NaOH solution at 140 C.

Coating B

Coating B had the worst performance out of the four coatings, especially after being exposed to highly alkaline service at 140 C. Looking at its thermal analysis, its performance can be understood at higher temperatures. That is, having a glass transition temperature of only 140 C, it should not be expected to maintain its properties at temperatures near its Tg in wet conditions. Its severe color change and notable thickness increase confirm its unsuitability for such conditions, yet it did have some barrier protection level even though it was not expected to do so. The cathodic disbondment test for Coating B could not be considered because it was done at a much lower temperature than with the other coatings.

Coating C

Out of the coatings tested, Coating C was the only coating to be qualified. Its Tg was identified to be 157 C, and it performed accordingly. That is, in all the test solutions included in the chemical resistance test, it maintained all the important properties. At 140 C, Coating C managed to survive with no signs of defect, failure or even discoloration. Its thickness was almost the same, indicating strong barrier properties which was confirmed by

the EIS test. Throughout, it maintained a very strong impact resistance (8 joules) and very strong adhesion (over 2,000 psi). As expected, flexibility was the property compromised with high-temperature coatings, which explains its flexibility of only 2.95 degree/pipe diameter at 25 C. Though low, this degree of bend can still be acceptable for pipes transportation and/or installation.

CONCLUSION

This experiment has helped to confirm some already well-established theories, in addition to a few new findings. The following conclusions can be drawn.

- There are existing FBE formulations that can handle immersion in chemically aggressive solutions at high temperatures.
- Only one product of the three tested qualified for use at this high temperature (140 C). More FBE products that can handle such higher temperatures are needed.
- Notably, there is a compromise in flexibility for high-temperature FBE coatings.
- Highly alkaline media is the most aggressive to FBE coatings at high temperatures.
- Discoloration may be a sign of failure, especially when associated with changes in other properties, such as thickness (increased swelling), loss of adhesion and degrading barrier property (low impedance).
- In immersion, wet glass transition temperature may be much lower than the dry Tg. In more aggressive conditions, the gap between dry and wet Tg may be even wider.
- The type of application used for coating samples may be detrimental to tests. This claim must be investigated further.
- Because coating shops use spray application, testing samples should be sprayed or taken from actual shop application.

FUTURE WORK

Currently, another article is being written to closely evaluate the effect of caustic soda solutions on FBE coatings at high temperatures. The scope of this article will shed light on the discoloration effect and how relevant it is to failure and will run in a future issue of *JPCL*.

ABOUT THE AUTHORS

Hassan Al-Sagour is a coating engineer at Saudi Aramco. He has a Bachelor's degree in mechanical engineering from California State University, Long Beach (2004) and a Master's degree in polymers, colorants and fine chemicals from the University of Leeds (2017). Al-Sagour started his career as a maintenance engineer in refineries and gas plants. He later became a projects/maintenance lead engineer and a shutdown director. Currently, Al-Sagour works in the Consulting Services Department where he is responsible for developing engineering standards, qualifying products and providing technical support to operation and project teams. He is certified by NACE CIP Level II and SSPC C1 and C2.

Mana Al-Mansour is an engineering consultant at Saudi Aramco and the chairman of the protective coating standards committee. He joined Saudi Aramco in 1997 and has been working exclusively in the field of protective coatings including standards development, providing technical support to capital programs and operations, introducing new technologies and mentoring new engineers. Al-Mansour is a member of SSPC Board of Governors. In addition, he is an SSPC-certified Protective Coating Specialist and the chairman of the SSPC Saudi Chapter.

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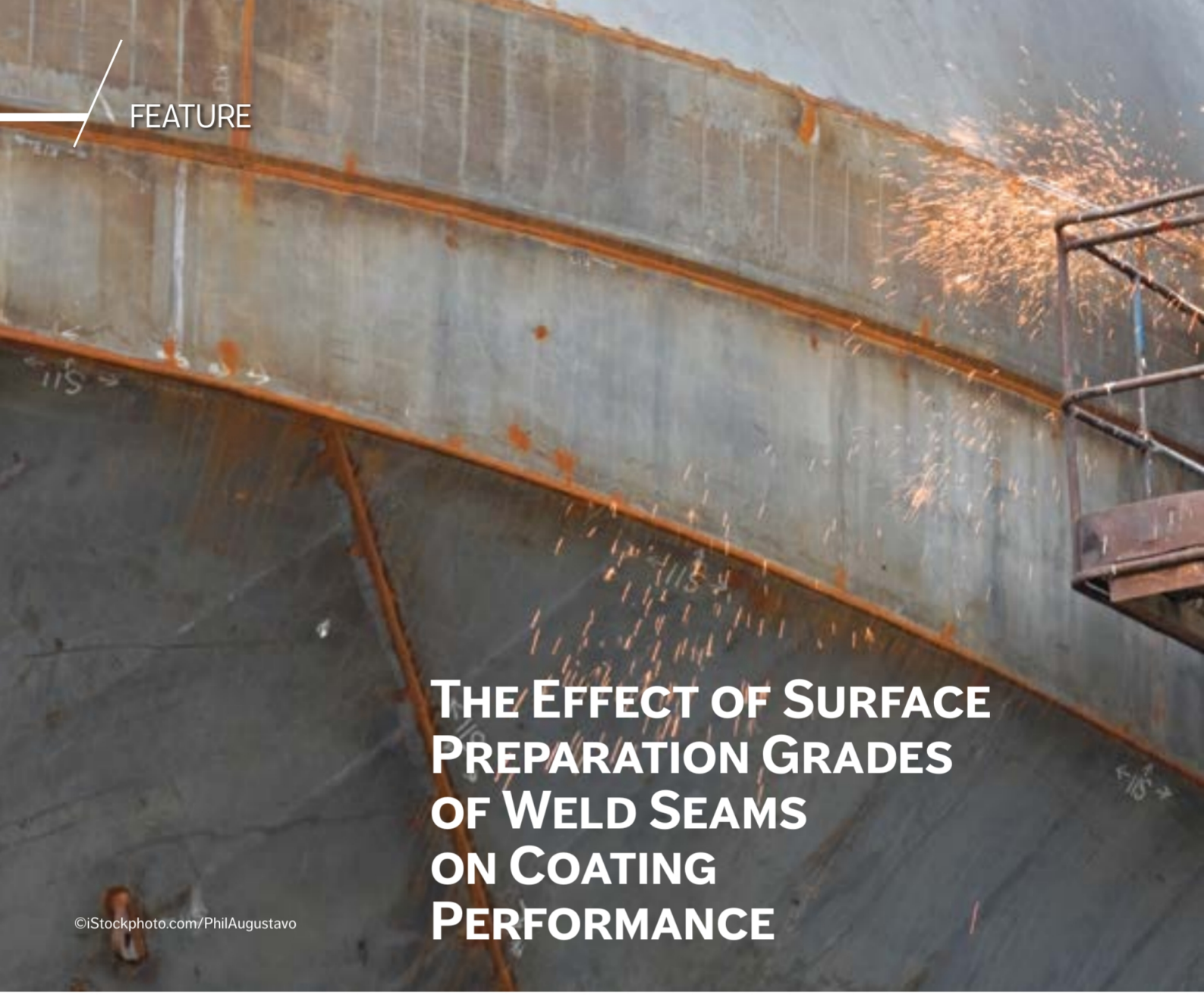

The Effect of Surface Preparation Grades of Weld Seams on Coating Performance

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BY SANG-MOON SHIN, CHUNG-SEO PARK, SEUNG-GON CHOO, EUN-HA SONG AND HAN-JIN BAE, HYUNDAI HEAVY INDUSTRIES

According to the international surface preparation standard for welds (ISO 8501-3, "Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 3: Preparation grades of welds, edges and other areas with surface imperfections"), the preparation grades before paint application are divided into three levels: P1, P2 and P3 (Fig. 1). These grades are described with rough qualitative representations instead of with descriptions of surface treatment methods or measurable conditions. Because of the ambiguous wording in the standard, there have been a lot of arguments about surface preparation grades and abraded condition during construction.

In this study, coating thickness, the corrosion resistance and crack tendency of the coated films on the welds were evaluated for the grinding range in five levels from mild to severe. Each ground specimen was blasted to Sa 2.5 and coated with two coats of epoxy paints. The performance of coatings on welds with the grades of grinding condition were not significantly different, satisfying the criteria of ISO 12944-5, "Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 5: Protective paint systems" (C5-M medium). After blasting, all ground specimens showed smooth surfaces that did not result in a sharp edge or excessive film thickness.

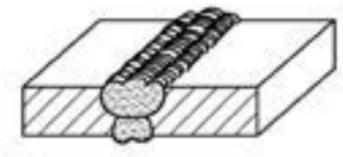


Fig. 1: Cross section of a typical weld bead. Figures courtesy of the authors unless otherwise noted.

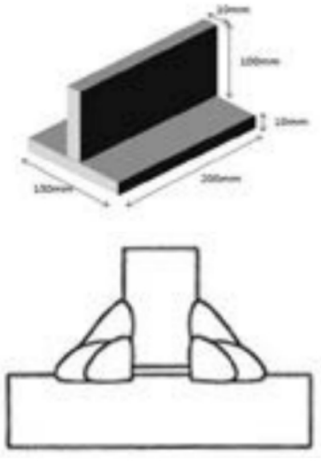


Fig. 2: Configuration of test specimens: T-bar (top) and weld (bottom).

The P3 grade of the ISO 8501-3 standard on the welding line is required to achieve a specified coating thickness and prevent a coating crack in the irregular shape of the substrate. However, due to the ambiguity of expression in ISO 8501-3, there are many arguments in practice on the surface preparation grade and criteria for acceptance or refusal.

In this study, coating thickness, the corrosion resistance and crack tendency of the coated films on the welds were evaluated for five different grinding levels, from mild to severe. Each ground specimen was blasted to Sa 2.5 and coated with two coats of epoxy paint.

VISUAL INSPECTION OF SURFACE TREATMENT ON THE WELDING LINE

T-bar specimens were made by welding with a typical bead sequence as shown in Figure 2. Prior to coating application, weld seams and sharp edges of the T-bar specimens were ground to five different grades, G1 to G5, (no treatment, soft, middle, hard and very hard) and followed by blasting to Sa 2.5.

As shown in Table 1, abrasive blasting as a

Table 1: Appearance of Specimens with Five Grades of Surface Preparation.

Grade	Surface Treatment		
	Step 1: Grinding		Step 2: Blasting (Sa 2.5)
G1			
G2			
G3			
G4			
G5			

Table 2: Test Coating System.

Coat	System 1	System 2
1st Coat	Epoxy 160 µm	Epoxy 160 µm
Stripe Coat	N/A	Epoxy 50-80 µm
2nd Coat	Epoxy 160 µm	Epoxy 160 µm

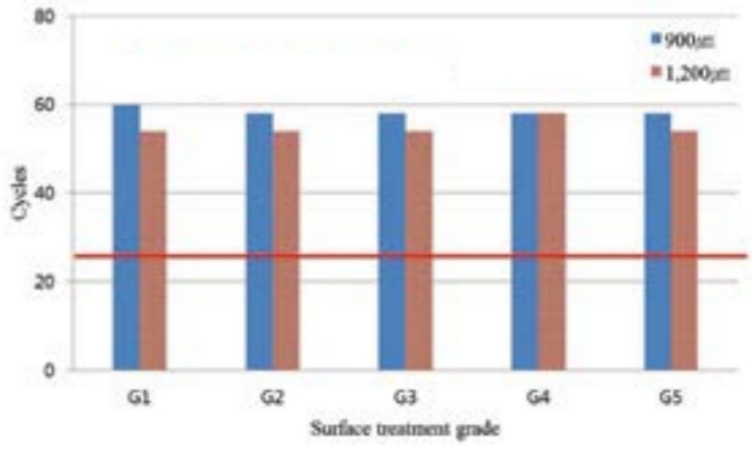


Fig. 3: Crack resistance test results (the number of cycles of crack initiation).

secondary surface preparation method makes the irregular welding bead smooth. After blasting, even the G1 (no treatment) specimen did not exhibit sharp edges or irregularity.

MEASUREMENT OF COATING FILM THICKNESS ON THE WELDING LINE

After blasting to an Sa 2.5, two different coating systems were applied by airless spray (Table 2, p. 45). Coating thickness of the welding area was analyzed using an electron microscope at 50-times magnification. As shown in Table 3, coating film thicknesses at the valley locations (1, 3 and 5) were only slight higher, or similar to, the other locations (2 and 4). However, average coating thickness for each surface treatment grade was not significantly different.

CORROSION RESISTANCE

T-bar specimens with five different grinding grades coated with two coats of epoxy for a total dry film thickness of 320 µm (13 mils) were cured for four weeks at 25 C (77 F). After curing of the test panels, salt-spray testing was conducted to evaluate the corrosion resistance in accordance with ISO 12944, Parts 2 (Classification of environments) and 6 (Laboratory performance test methods) (C5-M very high, for 1,440 hours).

After the salt-spray exposure, no corrosion-related defects such as blistering, delamination or rust creepage were found in any of the test specimens. Also, the degree of undercutting from the scribed line was below 1 mm as shown in Table 4 (p. 48).

From these results, it can be concluded that the corrosion resistance of the test panels prepared with five different grinding grades is almost the same, satisfying the ISO 12944, C5-M criteria.

CRACK RESISTANCE

T-bar specimens with five different grinding grades were blasted to an Sa 2.5 condition and coatings applied at 900 µm (35 mils) and 1,200 µm (47 mils), respectively.

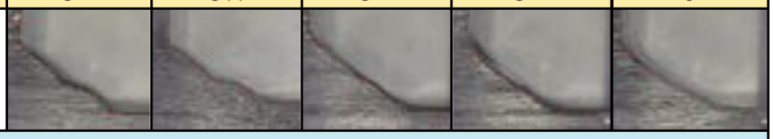
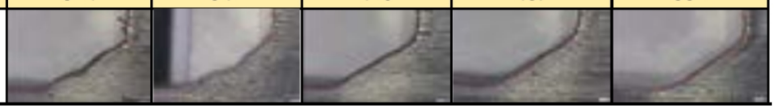
After the test panels cured, crack resistance tests were carried out as per ASTM D6944, "Standard Practice for Determining the Resistance of Cured Coatings to Thermal Cycling" by thermal cycling for four hours at -20 C (-4 F), ramped up to 60 C (140 F) for two hours, then four hours at 60 C and then down to -20 for two hours.

Crack resistance results of the test panels with five different grinding grades was similar, as shown in Figure 3 (p. 45). The number of cycles of crack initiation was between 58 to 60 at 900 µm dry-film thickness and 54 to 58 at 1,200 µm dry-film thickness, much higher than the authors' company's acceptance criteria of greater than 30 cycles.

CONCLUSIONS

To verify the effect of surface treatment grade on the welding beads and clarify

Table 3: Results of Coating Film-Thickness Measurements in µm.

System 1					
Sector	G1	G2	G3	G4	G5
1	314	346	349	343	303
2	326	343	351	349	323
3	423	371	398	383	325
4	329	435	376	350	310
5	357	294	483	392	340
Avg.	322	344	362	360	296
Sectional View					
System 2					
Sector	G1	G2	G3	G4	G5
1	443	362	447	424	343
2	369	358	410	437	323
3	485	401	399	441	378
4	358	313	395	516	331
5	463	422	560	468	347
Avg.	384	342	429	437	330
Sectional View					

the criteria of the surface treatment, paint film-thickness distribution, crack resistance and anticorrosion performance were evaluated for five different grinding levels from mild to severe.

Based on the paint film-thickness measurement results, it was found that after the second surface preparation method (abrasive blasting), all test specimens had enough smooth surfaces that could be completely wetted by coating materials regardless of steel preparation grade. Also, coating performance of all test specimens satisfied the ISO 12944, C5-M criteria with uniform film thickness. We can therefore conclude that determining the lifetime of coated film on weld beads is the second surface preparation process as opposed to the steel grinding preparation (P3). Thus, it is not necessary to grind excessively prior to abrasive blasting to achieve a uniform film thickness on weld beads.

Table 4: Rust Creepage from the Scribe Line After Salt-Spray Exposure for 1,440 Hours.

Grade	Configuration		Rust Creepage
G1			< 1 mm
G2			< 1 mm
G3			< 1 mm
G4			< 1 mm
G5			< 1 mm

ABOUT THE AUTHORS

Sang-Moon Shin is currently employed at Hyundai Heavy Industries in the protective coating research department. He was previously employed at KCC Corporation where he worked on a number of projects including coating formulation design, performance evaluation of films and improved film performance encompassing drying time and corrosion resistance for heavy duty and marine applications.

Chung-Seo Park is a head researcher and team leader of the Protective Coatings Research Department for Hyundai Heavy Industries Co., Ltd. He has almost 20 years of experience in the research and development of protective coating materials used in the marine and oil and gas industries. Park is a NACE-certified Coating Inspector, Level 2.

Seung-Gon Choo is a senior researcher in the Coating and Corrosion Engineering Research Department for Hyundai Heavy Industries Co., Ltd. He has almost 13 years of experience in the research and development of the protective coating materials used in the marine and oil and gas industries. Choo received his Master of Science degree in polymer engineering from Chonnam National University in Korea.

Eun-Ha Song is a senior researcher in the Protective Coatings and Corrosion Engineering Research Department for Hyundai Heavy Industries Co., Ltd. She has almost 15 years of experience in the research and development of the protective coating materials used in the marine and oil and gas industries. Song received a Master's degree in chemical engineering from Pohang University of Science and Technology (POSTECH) in Korea.

Han-Jin Bae is a senior research engineer for the Protective Coating and Corrosion Research Department of the R and D Center of Hyundai Heavy Industries in Ulsan, Korea. He has over 18 years of experience in coating application and surface preparation technology, as well as the automation of painting and blasting equipment. ***JPCL***

500 Million

The number of LinkedIn users, with two new users joining every second.
See page 20.

284 F

The operating temperature of gas produced from newer gas wells drilled deeper, requiring FBE coatings to be reformulated in order to provide thermal resistance.
See page 34.

5

The number of grinding grades on weld beads tested for corrosion resistance as per ISO 12944, C5-M criteria.
See page 44.

55%

Percentage of PaintSquare Poll respondents who believe that graffiti can be worth saving, in light of a Pittsburgh artist petitioning his county to save a decades-old series of graffiti geese from being blasted and painted over as part of a current bridge rehab job.
See page 15.

15,000+

Gallons of paint used to coat ballast tanks and exterior hull surfaces on a new, 464-foot-long oceangoing hopper barge.
See page 23.

100 or more

The number of DFT readings that aerial robotic devices can take in one hour.
See page 28.