ANNOUNCEMENT

2023 Prestige Awards Now Accepting Nominations

After revamping last year's program to enhance its focus on industrial painting projects, and the people and products that contribute to their successful completion, JPCL is pleased to announce that it has opened nominations for the 2023 JPCL Prestige Awards.

"It's that time of year again to draw our attention towards these outstanding industrial painting projects and the men and women who contributed to their success, as well as the state-of-the-art products they put to use to get the job done" said Charlie Lange, JPCL Editor-in-Chief.

As they did last year, the 2023 Top Project Awards will highlight specific products involved in notable coating projects across an array of industry sectors, including bridge and highway, water and wastewater, marine, energy production and more. Additionally, each Top Project category will include Project MVP awards, which will recognize the team leaders who helped carry these projects through to success-ful completion.

"Last year's Prestige Award winners set the bar high, and we're eager to see the coatings community try to top those outstanding projects."

Eligible projects should have been completed between January 2022 and July 2023. Project nominations should include details about the project and companies involved, including the coating systems used and any surface preparation, application and inspection equipment employed on the job. The Project MVP fields should include information about the individuals involved in the project, including their roles and responsibilities on the job. Nominations should also include high-resolution photos from the project and of the players involved.

Top Project categories for this year are as follows:

Surface Preparation: This award will be presented to a coatings project that involves a considerable amount of surface preparation prior to coatings application. Examples might include an exceptionally large area that needed to be prepared, or the use of novel materials, equipment or processes. Project nominations should include details about the equipment and materials employed, as well as specifications and standards followed.

Steel Coating: This award will be given for a coatings project on a steel structure. The project can involve application of new coatings technologies, and/or involve application on a particularly complicated or challenging structure. Nominees should highlight the coatings systems used and how project challenges were overcome.

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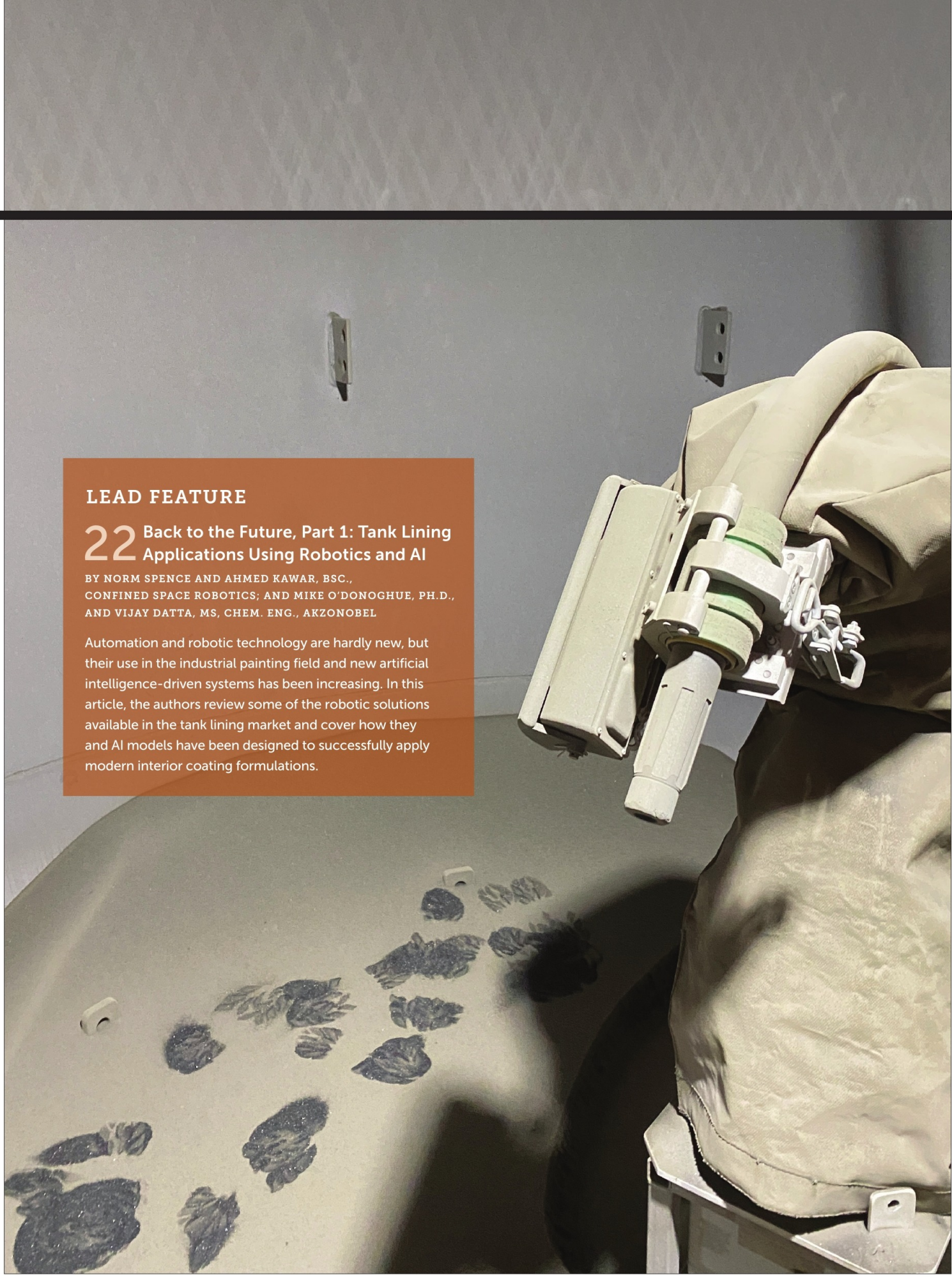

LEAD FEATURE

22 Back to the Future, Part 1: Tank Lining Applications Using Robotics and AI

BY NORM SPENCE AND AHMED KAWAR, BSC., CONFINED SPACE ROBOTICS; AND MIKE O'DONOGHUE, PH.D., AND VIJAY DATTA, MS, CHEM. ENG., AKZONOBEL

Automation and robotic technology are hardly new, but their use in the industrial painting field and new artificial intelligence-driven systems has been increasing. In this article, the authors review some of the robotic solutions available in the tank lining market and cover how they and AI models have been designed to successfully apply modern interior coating formulations.

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FEATURES

10 Zap! Laser Cleaning on BART's Transbay Tube Retrofit

BY ROBERT IKENBERRY, CALIFORNIA ENGINEERING CONTRACTORS.; WITH JIM HEALY, CALIFORNIA ENGINEERING CONTRACTORS; ETHAN STANDEN, SHIMMICK CONSTRUCTION; AND MARK STEWART, STEWART CONSULTING SOLUTIONS

When the factory-applied coatings on steel plates used for the Bay Area Rapid Transit's Transbay Tube project started delaminating at the edges, the contractors had to come up with a solution on the spot to keep the massive project moving forward. This article outlines how a novel laser cleaning technology was safely employed to prepare the steel for recoating, and previews how the technology could be more widely implemented in the future.

37 Industrial Coatings Projects: 2024 Market Forecast

With infrastructure funds flowing in and construction projects booming, painting contractors need all the help they can get in planning and prioritizing their upcoming projects. This 2024 forecast data has been compiled by Paint BidTracker reporters so that contractors can anticipate where major infrastructure projects will take place in the coming year and get a head start preparing their bids and crews accordingly.

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NAVSEA Comments on Rusty Navy Ships



A recent report states that streaks of rust on U.S. Navy warships have attracted the attention of active and retired navy personnel, after comments on social media sites began pointing out the Navy's switch to environmentally friendly paint.

In August of last year, the rust streaks on U.S. Navy ships reportedly became apparent to Navy officers who worry about the ships' appearances, impressions, standards and reputation when deployed. According to *Naval News*, U.S. Navy ships appear "old and worn" in comparison to foreign navies, according to Naval News.

Naval News reportedly sent an inquiry to the U.S. Navy's Naval Sea Systems Command (NAVSEA) in May, seeking answers to new questions and comments about the rust streaks. According to the report, an answer was received from NAVSEA public affairs the following month, on June 5.

"NAVSEA has worked successfully for decades to improve the corrosion-control performance of coatings while simultaneously reducing the adverse impact of coatings on the environment. In the 1990s, Navy tank coatings had a performance life of five to seven years, but emitted paint solvents when applied," wrote Jamie Koehler of NAVSEA Public Affairs in an email.

"NAVSEA worked with domestic and foreign commercial coating manufacturers to develop ultrahigh solids epoxy tank coatings that do not contain any paint solvent. Since these coatings were first applied in the early 2000s, many coated tanks have remained corrosion-free for 15 to 20 years. These coatings are required on all Navy ships and have contributed to extending the drydocking periodicities."

The "rusty-brown" streaks on the Navy ships reportedly point out how the high-operational "tempo" of the U.S. Navy and the backlog of ship maintenance has led to the battered appearance of Navy ships.

PHOTO: U.S. NAVY BY MASS COMMUNICATION SPECIALIST 1ST CLASS JASON PASTRICK

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Officers in the Navy, when interviewed, reportedly said that one solution to the issue is that the Navy build more ships to replace the old ones. Specifically, the report states that the new USS Constellation-class frigates (FFG 62) and new Arleigh Burke-class (DDG 51) destroyers will help this issue, in addition to ship overhauls and service life extensions on old hulls.

"NAVSEA has had similar success in transitioning the fleet from silicone alkyd topside coatings that required reapplication, to new high-performance and environmentally acceptable polysiloxane coatings that provide extended service life. Because of the durability and color stability of polysiloxane coatings, ship's force is able to use water solvent cleaning kits to clean paint without emitting harmful chemicals into the environment. NAVSEA also has adopted high-performance powder coatings for use on topside parts as powder coatings are inherently hard, durable, and color stable, and contain no paint solvents. NAVSEA maintains lists of qualified polysiloxane coatings to ensure price competition between suppliers," Koehler continued.

"NAVSEA is also the current world leader in adopting metal-based, thermal spray nonskid technologies. NAVSEA researchers are actively involved in efforts such as the National Shipbuilding Research Program that is investigating technologies like drones and robots for coating applications. To date, the most successful use of robotic processes to coat Navy ships has been associated with the metallic nonskid coatings. In this process, a robot is used to apply the thermal spray coating to the flight deck in a controlled, consistent manner."

In a follow-up inquiry, *Naval News* asked NAVSEA again why U.S. Navy ships appear so rusty in more recent years.

"The U.S. Navy has an inherently high operational tempo [around the world]. The vast majority of Navy ships are made of steel, which incurs corrosion from exposure to seawater. As such, any scratches or wear in coatings that expose steel on ships will result in corrosion and rust staining. It's important to note that for our ships and crews, shipboard preservation never stops," replied Koehler an another email from June 16.

"Our crews devote considerable time and effort to preserving and maintaining the interior-exterior areas of ships while balancing operational requirements and adhering to Navy shipboard procedures and environmental regulations. We take a methodical approach to preserving our ships, synchronizing efforts with other maintenance requirements to ensure ships are ready and fully mission capable."

Additionally, regarding the destroyer USS Stout (DDG 55) – which had reportedly spent 215 days at sea – the U.S. Navy's Mass Communications Specialist 1st class Jason Pastrick stated that the ship's rust was removed quickly, and the ship was repainted after its return to Naval Station Norfolk in October. According to the report, the USS Stout's maintenance illustrates the Navy's "never-ending battle" against the weather and the sea.

In an article from *The Washington Times* last year, Admiral Mike Gilday, the Chief of Naval Operations, said about the ships' rust: "Appearance is important. You've got to look sharp. We're the world's premier navy, [and] we've got to look like it."

READER COMMENT

"NAVFAC has more success than NAVSEA in corrosion mitigation and control. This is clearly stated and visible in their specifications, which address soluble salt remediation as a mandatory part of surface preparation. Similarly, 'where there is smoke, there is fire' applies here, because of the notion that the presence of visible corrosion is not just an aesthetic issue, but more importantly relates to structure-critical considerations pertaining to joints, connections and structural steel integrity that could impair their vessels and infrastructure functionality, long-term stability and service life."

—Regis Doucette

COVERAGE

139B Gallons of White Paint Could Help Climate



According to a professor at the University of California, Davis, if the world's whitest paint covered 1 to 2% of the Earth's surface, global temperatures would stop rising due to the amount of light being reflected back into space.

Jeremy Munday, a professor of electrical and computer engineering who researches clean technology, has recently calculated the numbers to potentially reap the benefits of Purdue University's "whitest white" paint as reports indicate the climate crisis is worsening.

A research team led by Xiulin Ruan, a professor of mechanical engineering at Purdue, initially created an ultra-white paint in October 2020. Since then, the team has been pushing to reformulate it for even "cooler" properties. In 2021, the team published a paper about its findings in the journal ACS Applied Materials & Interfaces.

At the time, researchers went as far as to say that their white paint was the closest thing available to an equivalent of "Vantablack," which absorbs up to 99.9% of visible light. On the flip side, the new whitest paint reflects up to 98.1% of sunlight, compared to 95.5% in the researchers' previously developed ultra-white paint. Typically, white coatings expect to reflect 80-90% of sunlight.

There is one key element on achieving the white coating: barium sulfate. But it's not just the high concentration of barium sulfate, it's also that those particles are deliberately different sizes in the paint. How much light each particle scatters is directly dependent on its size, and a wider range of sizes allows the paint to scatter more of the light spectrum. However, if there is too high of a concentration, the durability of the paint is negatively affected.

To test the cooling traits of the paint, researchers used thermocouples to demonstrate outdoors that the paint can keep surfaces 19 degrees Fahrenheit cooler than the ambient surroundings at night, and 8 F below their surroundings during high noon. Reportedly, the paint even works in winter climates.

Then, in October last year, the coating was formulated to be thinner and lighter, making it ideal for radiating heat away from cars, trains and airplanes, according to a release from Purdue University at the time.

At that time, Ruan's team began experimenting with other materials to push the limit of its capability to scatter sunlight. According to Purdue's release, the latest formulation is a nanoporous paint incorporating hexagonal boron nitride as the pigment, a substance

PHOTO: BAGI1998 / GETTY IMAGES

mostly used in lubricants. As a result, the new paint achieves nearly the same level of solar reflectance at 97.9% with a single 150-micron layer of paint.

Purdue reports that the paint also incorporates voids of air, which make it highly porous on a nanoscale. This, in combination with the thinner application, makes the new paint weigh 80% less than barium sulfate paint while achieving nearly identical solar reflectance.

"We weren't really trying to develop the world's whitest paint," Ruan said in an interview. "We wanted to help with climate change, and now it's more of a crisis, and getting worse. We wanted to see if it was possible to help save energy while cooling down the Earth."

According to The New York Times, Munday calculated that if materials such as Purdue's ultra-white paint were to coat between 1-2% of the Earth's surface, slightly more than half the size of the Sahara, the planet would no longer absorb more heat than it was emitting, and global temperatures would stop rising.

Because the total surface area of Earth is around 197 million square miles, the paint would roughly need to cover between 2 million and 4 million square miles. If a gallon of Purdue's paint could cover 400 square feet, about 139 billion gallons of the white paint would be needed to cover just 1% of the Earth's surface, doubling to 278 billion for 2%.

For reference, Business Insider explains, the total land area of the United States is just over 3.5 million square miles, so a whole country would need to be covered in the coating. This also doesn't take into account oceans, deserts and forests.

However, Munday added that covering half of the Sahara or other locations with that much radiative material shouldn't happen for a number of reasons, among them practicality, wildlife concerns and weather disruptions caused by one region suddenly becoming much cooler. Setting these radiative cooling spots could potentially yield global and local benefits, though, like offsetting the urban heat island affect.

"This is definitely not a long-term solution to the climate problem," Munday said. "This is something you can do short term to mitigate worse problems while trying to get everything under control."

READER COMMENTS

"While I didn't use a specific spread of particle sizes, the heat-reflecting paint I developed ~25 years ago did contain a significant proportion of barium sulfate. However, it worked even better with a blend of reflective pigments. Primary pigment was lithopone (barium sulfate + zinc sulfide) and a small amount of titanium dioxide. You do need to use an inhibitor to prevent the zinc sulfide darkening over time due to UV exposure. I can see where dropping the zinc sulfide to simplify the formula would make sense if using a spread of particle sizes covers that part of the IR spectrum."

—Tom Schwerdt

"Tom, if you haven't already seen them, you should check out nighhawkinlight's two recent YouTube videos on reflective paint, a spread in particle sizes was a key point in his recent successes, though he switched to calcium carbonate as the pigment for ease of home production."

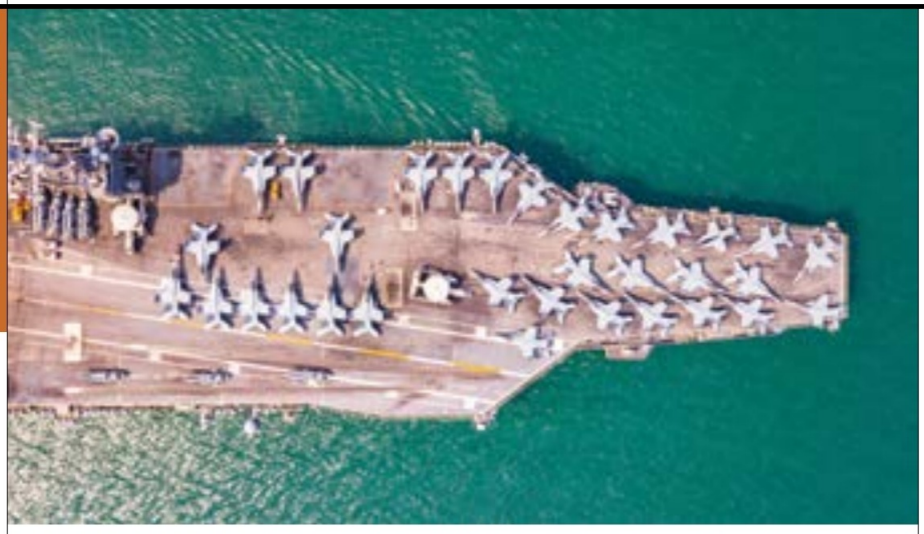
—Dave Murray

"Who, for a microsecond, thought that this might be a good idea? Anyone with a scintilla of understanding about what it would take to mine the raw materials, produce and refine the resins and solvents, manufacture this quantity of paint, put it into drums, transport it to wherever and then apply this volume to millions of square miles of land surfaces, would know that this isn't just folly, it's a sure sign (yet another sign) of environmental madness. This planet, over its life of approximately 4.367 billion years, has been way hotter and way colder dozens or scores of times. They are called 'glacials' or ice ages, and between them, where we are now, is an 'interglacial.' I don't know what is more arrogant: to think that mankind is causing any problem, or that mankind could ever fix it. Earth is doing just fine, all on its own. Leave it alone."

—Mark Dromgool

"Although this talk about the reflectiveness of the paint is very interesting, a) is it water-based or solvent-based paint? And b) what binder system is used and how UV resistant is this binder system? Personally, I would go cover the Sahara with plants as there is enough water far below the Sahara. Once this is green and also the Amazon gets green instead of black from burning, the problem would be much less and in a natural way."

—Guus van Wyk



AMPP Releases Details on DoD Corrosion Conference

The Association for Materials Protection and Performance has announced the dates and schedule for their upcoming 2023 Department of Defense Corrosion Prevention Technology and Innovation Symposium, scheduled to take place from August 14-17 at the El Conquistador Hilton Hotel in Tucson, Arizona.

The conference, hosted by AMPP in conjunction with the DoD, will reportedly include workshops, educational courses on Aerospace Maintenance and basic corrosion, focused tracks, a corrosion poster competition and more. Previously on a three-year hiatus, this year's symposium will be the first one held since the start of the COVID-19 outbreak.

According to a statement from the DoD, the theme for this year's conference will be "Corrosion Prevention as a Readiness Enabler."

The symposium will reportedly run from Aug. 14 to 17 and will include the following.

Corrosion and Coatings for the Aerospace Maintainer. A course to support corrosion prevention and control during the sustainment life cycle of the Department of Defense systems. The course will reportedly familiarize aerospace maintainers with corrosion mitigation and coating application practices through multiple workshops and problem-solving exercises.

Student Research in Progress Symposium (SRIP). An event to encourage graduate and undergraduate students interested in becoming professional corrosion scientists, engineers, or technologists the opportunity to present ongoing research.

Student Poster Session (SPS). Split into three categories, the poster session will evaluate projects pertaining to corrosion science, corrosion engineering and applied corrosion technology the SPS chair will reportedly determine which posters will be presented based on the abstracts submitted by each team.

Young Professionals + Mentor Event. An event to provide opportunities for individuals new to the DoD to engage with established members on topics ranging from career path options to technology development, to navigating the DoD. The event is open to all and will include brief presentations from long-term members of the DoD Corrosion Control Community followed by a question-and-answer period, with time for open discussion and networking.

Additionally, an exhibition hall for industry product and service providers, as well as the student posters and poster judging, will be open from Aug. 14 to 15, for members to engage with the next generation of corrosion engineers and network with professionals in the reception hall.

The DoD states that the symposium is the only official DoD conference that is solely focused on impacts, mitigation and prevention of corrosion on weapon systems, equipment and facilities and is co-located with the Defense Corrosion Exhibition.

A release from the DoD, included in the event's brochure, states that the conference works to facilitate the exchange of information and share ideas, capabilities, initiatives and lessons learned between all members of the DoD corrosion community, as well as members of corrosion prevention and control organizations.

The conference will conclude on Thursday afternoon with a meeting on corrosion prevention from 1 to 3 p.m. More information about the event, including the brochure with an in-depth schedule for each day, can be found at dodcorrcon.org.

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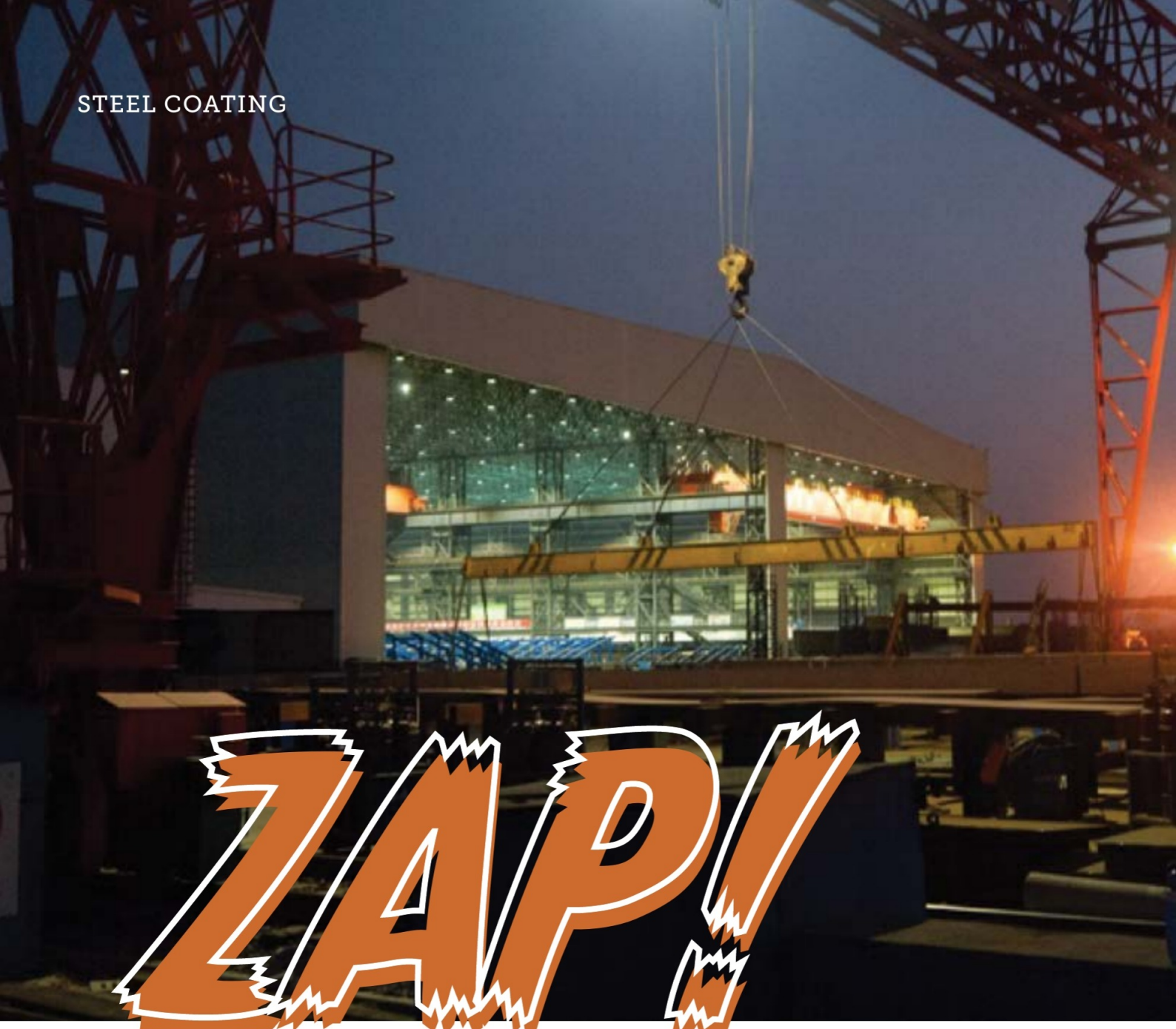

LASER CLEANING ON BART'S TRANSBAY TUBE RETROFIT

BY ROBERT IKENBERRY, CALIFORNIA ENGINEERING CONTRACTORS;
WITH JIM HEALY, CALIFORNIA ENGINEERING CONTRACTORS;
ETHAN STANDEN, SHIMMICK CONSTRUCTION; AND
MARK STEWART, STEWART CONSULTING SOLUTIONS



FIG. 1: Steel fabrication facility

It is the summer of 2018, and I am at a vast steel fabrication plant ***(Figs. 1 and 2)***. The first sets of steel plates for the BART (Bay Area Rapid Transit) Transbay Tube lining project are being shop coated. The 100%-solids epoxy system specified requires heated plural-component application equipment and the coating is notoriously intolerant of surface contamination. The onsite painting crew is relatively unfamiliar with the sophisticated equipment but has hired experts from the coating supplier to provide the plural pump with a skilled operator.

The Problem

The 5-foot-by-10-foot plates were successfully coated with a single monolithic coat of 30 mils and cured well. But there is a mysterious problem: on at least one of the plates, along just one edge, the coating is starting to lift. Visually, it looks fine. The cure and color are uniform and look good. The blast profile is angular and has a good 3-4 mil profile. All the QC checks were passed. But the coating at the edge is loose. A putty knife can lift off the coating for a few inches from the edge.

The other edges of the plate were masked for welding, and on those, the exposed edge of the coating is tight and no lifting with a putty knife is possible. Looking at the exposed blast under the lifted coating, it is clean and has the proper profile. No oil, grease or other waxy contaminants that could act as a bond breaker are visible. On the underside of the lifted coating, there is some evidence of slight (dust?)

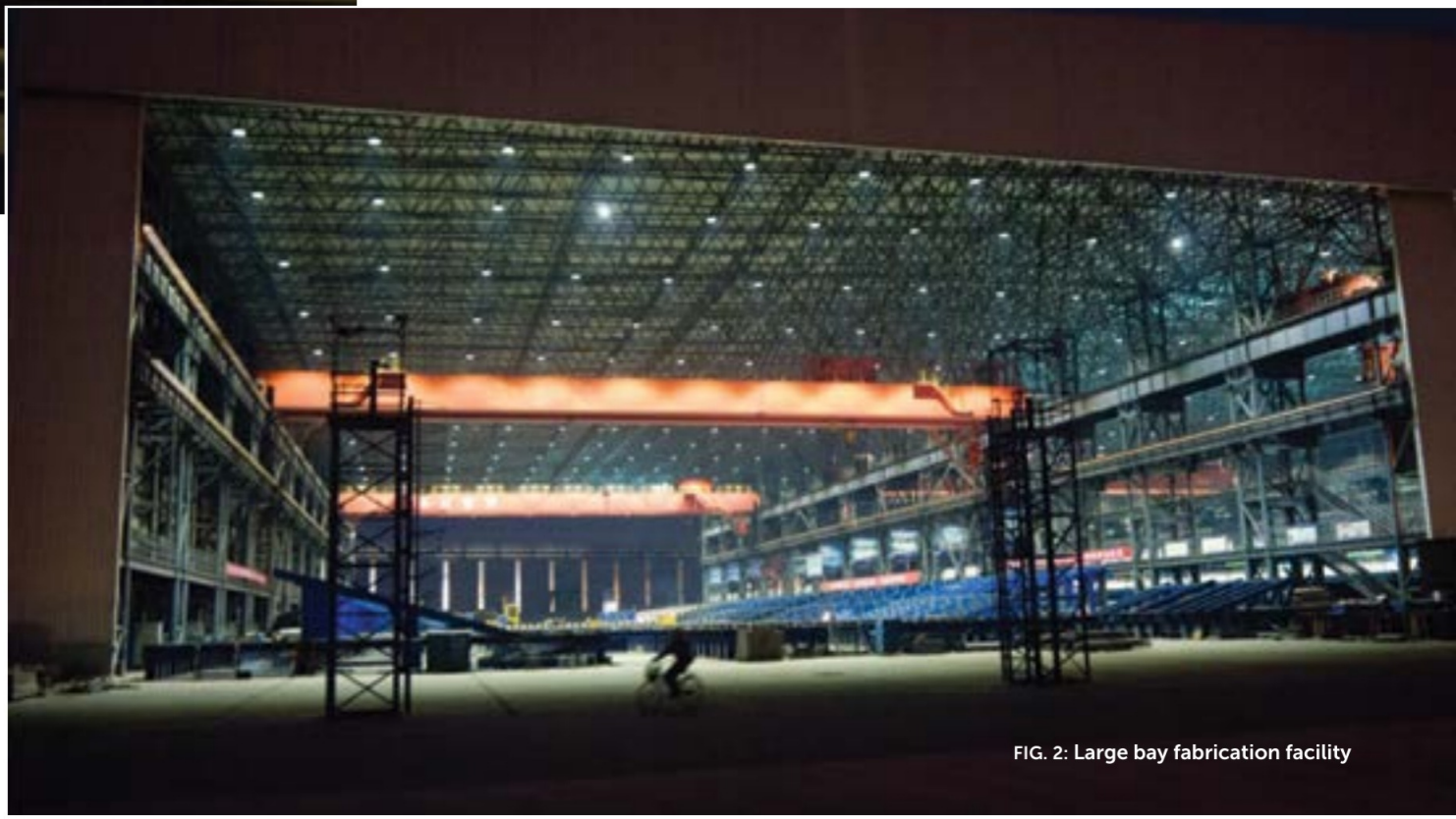

FIG. 2: Large bay fabrication facility

PHOTOS: COURTESY OF ROBERT IKENBERRY





FIG. 3 *(above)*: Plates with masking *(note edge with no masking)*

FIG. 4 *(right)*: Lifted coating and large chip flipped over

contamination. Several inches of the coating on the edge of the plate is loose, but is tightly adhered on the rest of the plate ***(Figs. 3 and 4)***.

After much investigation and head-scratching, the layout foreman finally confessed that he had originally asked the masking crew to mask off the unbeveled edge of the plate, which they had done. Then he realized that only the three beveled edges needed masking, so they had removed the tape. This was done in the blast room. The final step was to blow down the plates before they were moved to the paint

room. Apparently, dust stuck to the small amount of adhesive which was left over and caused a total coating adhesion failure.

The fix was simple – the plate was re-blasted and re-coated – but it got me thinking that we had a potential big problem in the tube, when months or years later, after ocean shipment, handling, installation, welding, NDT and exposure to the operating trains, we were going to have to clean and paint all these weld lanes. No blasting would be allowed in the tube, and no solvents would be permitted.



The Search

Finding an efficient, practical and cost-effective cleaning solution was going to be a problem. Plus, the blast profile applied to the plates, including the exposed edges, was solid and we wanted to preserve it if possible. Recent studies, including a personal opinion of one of the authors, questioned the benefit of re-blasting or spot-blasting previously blasted surfaces and the immediately adjacent painted surfaces. The issue was effectively moot, as blasting in the tube was prohibited, but we did know we wanted the cleanest, most angular substrate we could get, while removing all traces of rust, salt, oils, grease and dust (which may be magnetic and statically attracted to the steel). That was going to be a challenge.

In addition to the technical challenge of cleaning the weld lanes, there were immense logistical challenges on the job. The Transbay Tube runs over three miles under the San Francisco Bay and there were only two access points – Oakland and San Francisco. We were lining about 2,200 feet of the bores, one Eastbound and one Westbound, and there were typically five longitudinal weld joints in each tube and circumferential seams every 20 feet. That meant we had about 16,000 linear feet of welds to prepare and coat (about 16,000 square feet) and needed to do the work at the very end of the job when there was tremendous pressure to finish. All materials had to come in on a work train that arrived either after revenue service stopped (around 1:00 a.m.) or, if we were lucky, when the trains could be single-tracked with the other tube bore handling traffic in both directions (starting around 10:00 p.m. at the earliest). In either event, we had to be complete and out of the bore, cured and with trains ready to run by 5:00 a.m.

We considered numerous options for cleaning, including wet methods (water-based caustic cleaners,

Finding an efficient, practical and cost-effective cleaning solution was going to be a problem ... In addition to the technical challenge of cleaning the weld lanes, there were immense logistical challenges on the job.



FIG. 5: Custom painting rail car

Just two questions remained. First, was the steel clean enough? And second, could we safely deal with the risks of a high-powered, invisible infrared laser? As it turned out, there was also a third question: Could we afford it?

detergents and non-flammable solvents) and abrasive methods (abrasive discs, wire wheels, flapper discs, roto-peen scaler, bristle blasters and new technologies). For application of the epoxy coating, we needed to use plural-component systems that could heat the material to about 110 F at time of application. We experimented with air-atomized dual-cartridge kits, but ultimately settled on typical industrial plural-component pumps. To accommodate the owner's requirement not to have exposed solvents in the tube, we developed a closed-loop, air-scrubbed flush kit that prevented exposed solvents and trapped vapor and odors (fuels were allowed in the tube on the diesel trains, so we modeled our system after a typical fuel system and limited the quantity to about three gallons total).

We developed a dedicated painting rail car to transport and handle the paint pumps and to provide elevated access to the interior surfaces of the tube ***(Fig. 5)***. Now, all we had to do was figure out how to clean the welds and the weld lanes.

A Possible Solution

I had been interested in high-energy lasers for field cleaning of steel since we had done a small job for the Lawrence Livermore National Laboratory for one of their NOVA laser guide pipes in the mid-1980s. It always seemed the technology was 10 (or 20) years away and 10 (or 100) times too expensive – much like fusion power.

PHOTO: COURTESY OF ROBERT IKENBERRY

We thought we would take another look at the state of the art in mid-2019. It turned out that the Air Force had been testing lasers for cleaning aircraft prior to painting at Travis Air Force Base, a local base in Fairfield, California. It looked like the Air Force had generally considered their tests to be a success, but I had trouble getting anyone associated with the program to talk to me. Eventually, we located the equipment manufacturer and late in 2019 took a trip to Kansas City, Missouri, to check it out. It was the dead of winter and just before the beginning of COVID-19 lockdowns. We brought a couple of sample pieces of steel, cut from a painted plate, with both blasted (and rusted) steel and coated portions, and put the equipment to the test.

I was impressed with the results. The laser appeared to quickly clean the blasted steel, re-exposing the surface profile applied in the shop, and could put an etch onto the adjacent coated areas ***(Fig. 6)***.

Just two questions remained. First, was the steel clean enough? And second, could we safely deal with the risks of a high-powered, invisible infrared laser? As it turned out, there was also a third question: Could we afford it?

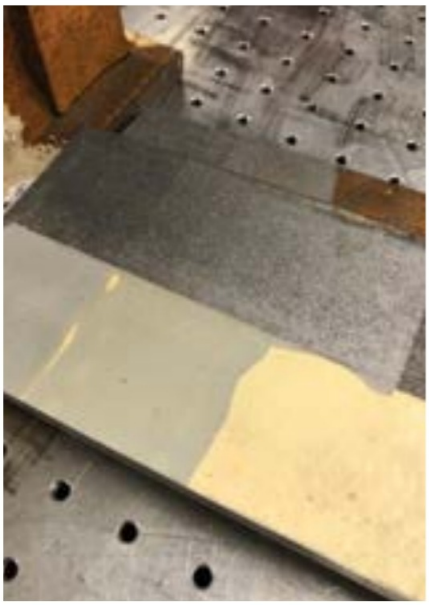

FIG. 6: Laser cleaned steel sample with etched coating in lower area

PHOTO: COURTESY OF ROBERT IKENBERRY

Clean Steel

If it worked, the laser would solve a lot of problems—it could provide us with a scrupulously clean surface and expose the original profile that we knew was done well in the shop. There would be no spent abrasives to deal with and no significant waste generated from the process. The tiny amount of vaporized debris from the steel would be sucked up by a vacuum during the lasing process, and noise levels would be relatively quiet compared to abrasive blasting or grinding. We knew we could not deal with the noise and dust of abrasive blasting, and other methods were proportionally much, much slower compared to the laser method and would not ensure as good a profile. The laser really sounded perfect for our needs.

We sent back a couple more test coupons, intentionally contaminated with the types of contaminants we would have to deal with (like tool lubricants, salt from the ocean voyage, ultrasonic coupling gel, and metallic dust from the rails) and asked the laser manufacturer to clean them and then carefully seal them and send them back. We then contacted the coatings manufacturer and asked them how best to test the cleanliness and if they would approve the method. They said to paint the cleaned panels and then do some pull tests. If they passed, they would allow the cleaning method. We did this and they passed with flying colors. Our first question was answered.

Safety Concerns

Our second question took a bit more work. We would offer that this is the most important part of this article. Please take careful note that the technology involved here is very powerful,

If it worked, the laser would solve a lot of problems—it could provide us with a scrupulously clean surface and expose the original profile that we knew was done well in the shop ... [with] no spent abrasives to deal with and no significant waste generated from the process.



FIG. 7: **Protective eyewear with OD of 7 for IR radiation at 1064nm**

The human eye's protective reaction to light does not work with infrared lasers. There are no protective "flinches" from your eyes, like looking at the sun or a too-bright welding arc flash ... You do not know you are at risk until your retinas are instantly destroyed.

but invisible, and that constitutes one of the biggest risks. The human eye's protective reaction to light does not work with infrared lasers. There are no protective "flinches" from your eyes, like looking at the sun or a too-bright welding arc flash. Laser energy is at a whole other level. You do not know you are at risk until your retinas are instantly destroyed. Loss of sight is a crippling injury and not one to be taken lightly.

Because the laser light is coherent and collimated, the direct beam from the tool head does not spread, so distance, or reflection from a mirror, is not a safe measure of protection. The diffuse reflections from a non-specular surface (in other words, not a mirror) do spread with an inverse square reduction in intensity. Therefore, reflections from blasted steel or other surfaces are much less risky than direct exposure to the beam, but those reflections are still present.

Raw numbers probably do not mean much, so let us try an analogy. First, it is not a good idea to look directly at the sun on a bright, clear summer day. In fact, if you have normal reflexes, you will turn away in a fraction of a second, because your body knows it is not a healthy thing to do. Now, remember back to playing around with a magnifying glass on a similar sunny summer day. If you had a piece of wood handy, and a steady hand with a bit of patience, you could bring the light of the sun to a point on that wood and char the surface of the wood, maybe even raise a whiff of smoke. If you had a 4-inch-diameter glass and made a bright spot about 1/16th-inch across, that was a concentration of about 4,000 times. So, the sun was 4,000 times brighter to that scrap of wood and it singed it in seconds.

That is nowhere near as bright as our laser. Imagine what concentration power it would take to not just char the wood, but to actually cause the air at its surface to explode in a flash of ionization. We are talking more like millions of times brighter, not thousands.

Another reference is that to safely be around the laser, you need to wear safety glasses that have an infrared (IR) radiation protection factor (Optical Density or OD) in the wavelength of the laser (1,064 nm) of 7+ or less than 1/10,000,000 transmission. These safety glasses block out 99.99999% of the laser light.

To put it another way, if you have ever cupped your hand over a powerful flashlight in a dark room, you can still see a dim red glow through your hand. If IR worked the same way as visible light (it probably doesn't), covering your eye with the palm of your hand likely only provides a visible light OD of about 4 to 6. So, the intensity of the laser light would still be at least ten times too bright to safely look at – through your hand! ***(Fig. 7)***

Ideally, the active laser head would be interlocked to the surface to be cleaned. If an interlock like this was in place, the laser would only work if the head were in contact with the steel. Lift the tool and the laser stops. Unfortunately, we could not locate a head/interlock combination

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that would work reliably – and, as it turned out, the actual use of the tool was most effective when held about 12 inches from the steel surface, not in contact.

Laser Safety Requirements

Referencing ANSI standard Z136.1 on Safe Use of Lasers, there was not a specific part of the standard for what we wanted to do: use a laser on an underground field construction project with adjacent workers, but no public exposure risk. So, we jumped into researching our options and obligations.

Lasers are categorized by risk, from Class 1 (your typical lecture hall laser pointer) through 1M, 2, 2M, 3R, 3B all the way to Class 4. Our Laser was a Class 4. That meant we were required to implement all of the standard's Laser Safety protocols:

1. Control measures
2. Training
3. Utilize a Laser Safety Officer (LSO)
4. Engineering Controls

Fortunately, our project safety team included a member with laser safety experience. He was qualified to act as our LSO and could guide the review of risks and help implement the necessary training and develop the Laser Safety Program and Laser Hazard Assessment.

We were confident we could operate the laser safely (more about that later). But could the laser do the job in the time limit we needed? And could we get the equipment in time? Testing showed that the laser was fast and that we could probably clean about 200 square feet per hour.

As mentioned before, time in the tube is critically important, as the trains can only be shut down for a few hours per night. The entire operation must be completed in about six hours, so considering getting the work train into position, setting up, laser cleaning, masking, preparing the plural-component equipment, spraying out the weld lanes and packing up and getting out in time for the trains to run in the morning – maybe two hours per night would be available for cleaning. If we could do 400 to 500 feet of welds in a night, this might be doable.

We ordered the laser.

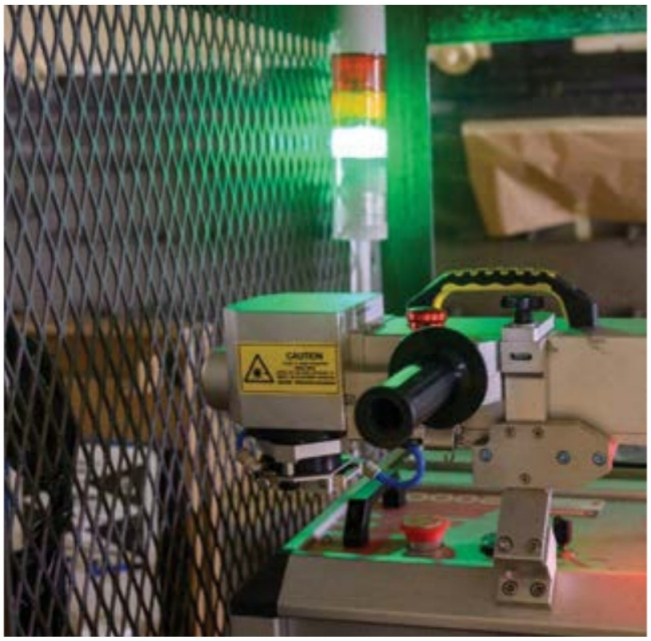
Laser Containment

Because the laser system was so powerful (we ordered a 2,000-watt laser system), there was no reasonable safe distance that we could establish. In other words, if you were in the work zone, you could not be far enough away that if the direct beam from the laser shone in your eyes that you would be safe from possible injury. Therefore, anywhere the laser was operating was a Laser Controlled Area. The only way to protect non-involved workers was to isolate them. So first, we had to enclose the laser work area from all other non-laser workers.

The work areas are in the bores of the BART Transbay Tube, a typical subway track with a diameter of about 18 feet. We were working off a special-built rail car that housed the laser equipment, the plural-component paint spray equipment, and movable work platforms that allowed access to the interior surfaces of the Tube. A work zone of about 200 feet was established, and then shield drapes that were impervious to the IR laser radiation were hung at each end of the work zone, sealed to the floor and walls, and an interlock was established that would cut off the









Top to bottom:

FIG. 8: Laser Drape isolating the Laser Controlled Area

FIG. 9: Laser unit, green light = power on, no high voltage

FIG. 10: Lasing—all three lamps illuminated

laser if anyone entered the drapes when the laser work was in process. If there were doors to the lower gallery within the work zone (doors are at intervals of about every 350 feet) or if there were ventilation louvers to the upper gallery (ventilation duct), they were also sealed and interlocked.

Adjacent to the interlock at the drape was a Visible Laser Radiation Emission Warning Device with three lamps. If all the lamps were dark, the laser was disconnected from power. If the green lamp was on, the laser had power but was not ready to fire. If the yellow lamp was on, the laser was powered up and ready to fire (high voltage on) but was not working at that time. If the red lamp was illuminated, the laser was operating. Before the yellow lamp was armed, all non-laser workers exited the laser work area and the entry to the enclosed area was secured. No one was permitted to open the drapes or otherwise defeat the interlock if the yellow or red lamps were on. Laser warning signs were posted at each entrance. The entire tube between the drapes became an Interlocked Removable Protective Housing, and a Laser Controlled Area as required for Class 4 lasers ***(Figs. 8-10)***.

Training Required

Next, we had to prepare a training program and protocol for all workers who would be operating the lasers or in the laser area while the laser was operating. The primary responsibility for ensuring the safety of laser operations are the operators (under the training and advice of the LSO). Operators needed to know how to safely handle the equipment, including the waveguides (cables sending the laser energy to the head) and the

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FIG. 11: Laser in operation *(Note, the laser beam is invisible, but here one can see its path due to ionized dust particles that are being excited by the laser and show the beam.)*

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laser head, including ensuring the optical windows are clean and sound. Once the operators were trained and knew how to safely handle the laser equipment and protect others, we instituted control measures.

Engineering controls were the first line of defense, such as the interlocks at the enclosure of the laser workspace. The operators used administrative controls, to know not to activate the laser if non-approved personnel were present, and how to operate the laser to minimize risks to other workers. Lastly, personal protective equipment, such as the laser eyewear with an OD of 7+ for the 1,064-nm laser wavelength, were always used by everyone in the Laser Controlled Area. Other measures, such as prohibiting magnifying lenses, mirrors or reflective vests in the LCA, were instituted as appropriate.

We were also fortunate to have the support and cooperation from the owner. BART recognized that this cutting-edge tool could improve both production speed and quality, creating a cleaner surface than any of the originally anticipated methods.

Laser Operation and Coating Application

Now the pieces were finally coming together. The equipment was in place, the work zone enclosures were designed and tested, the electrical power supply for the laser was secured (about 25KW for the laser and another 4KW for the chiller), the workers and operators were trained, the procedures and safety measures were in place, and we were ready.

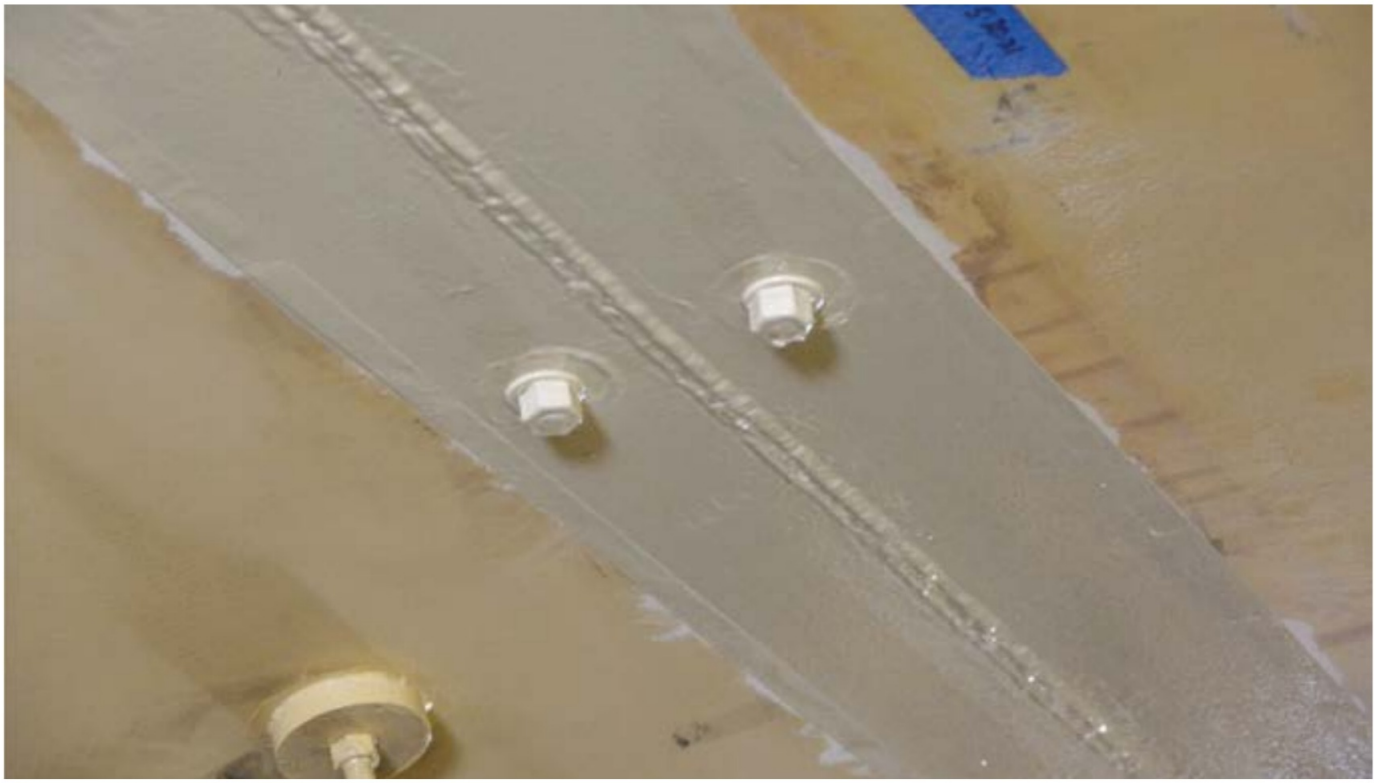
But this is construction, so Murphy's Law applies. Nothing goes exactly to plan. Several shifts were required before all the parts would come together. The end of shift deadline to open the Tube and tracks to the morning commute was inviolate. In almost four years of work, we had never missed a track opening, and we were not going to miss one now. There were several times when difficult calls had to be made – when a missed milestone in the operation could have meant we would not have cured coating in time, or were not be able to pull the paint car out – and the shift had to be abandoned and clean-up started without putting on any paint.

In operation, the laser cleaning system used two operators – one to handle the actual laser head and one to keep a vacuum extraction head close to the work, but not in the beam of the laser ***(Fig. 11)***. Typically, no other workers were in the Laser Controlled Area for the cleaning operation.

After a few hiccups, we did get the procedures down so that the multiple Single Points of Failure (SPFs) were all routinely passed, and the weld seams were successfully coated. With the







Clockwise from top:
FIG. 12: Spray application
FIG. 13: Checking WFT
FIG. 14: Finished weld lane

laser cleaning system and a full-scale plural-component pump system, we were able to apply the coating at rates multiple times faster than the manual cleaning (such as bristle blasting to SSPC-SP 11) and cartridge spray production rates we had originally anticipated ***(Figs. 12-14)***.

Conclusion

This was a very special application. Working in the Tube, under the Bay, we could isolate the work zone in secure ways that would not have been possible in an outdoor construction environment. The laser offered special advantages in speed and waste reduction for our particular and sensitive project that offset the spectacularly high cost of the equipment which would not have been justified on a project where abrasive blasting was allowed, or the daily time constraints were not so severe. A very specialized tool, but just the right one for a very special project. JPCL

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ABOUT THE AUTHORS



Robert Ikenberry is Coatings Manager for California Engineering Contractors (CEC). He began his career in protective coatings at Fluor Engineers and Constructors as an associate engineer. Moving to the contractor side, Ikenberry worked as an estimator and project manager for Certified Coatings. In 1991, he transitioned to Safety Director, where he was an early specialist in lead compliance programs. He joined CEC in 2000 as Safety Director and in 2005 added Project Management duties. He has been a contributing editor for JPCL for almost 30 years and has authored numerous articles for the journal, as well as many blog posts for PaintSquare focusing primarily on safety and technology-related topics. In 2020, he was named to JPCL's newly formed Editorial Advisory Board.



Jim Healy is a Safety Manager with California Engineering Contractors with over 20 years of environmental, health and safety experience. He began his career as a ship engineer and moved into building ships in Japan and California, continuing as a mechanical and electronic technician in the air separation and petrochemical industries prior to starting his current career in environmental, health, and safety. Healy also has several years of laser safety experience at high-energy levels that he employed for the BART Transbay Tube project.



Ethan Standen is a Project Sponsor for Shimmick Construction with nearly 10 years of experience in industrial protective coatings for water treatment plants and marine environments. With his deep understanding of the intricacies of coating projects, he has successfully led multiple projects from conception to completion, ensuring high-quality workmanship, and timely delivery.



Mark Stewart is a principal at Stewart Consulting Solutions, where he consults on difficult and challenging coating applications, develops solutions and ensures successful implementation through hands-on follow up. He has been involved in protective coatings his entire career, starting with the use of the tools of the trade directly, moving on to working as a third-party inspector with real practical knowledge of all aspects of protective coatings. Stewart is a NACE-certified Level 3 Coatings Inspector (now AMPP Senior Certified Coatings Inspector).

For more information about the laser cleaning technology that was considered for the BART Transbay Tube project, visit laserphotonics.com or adapt-laser.com.



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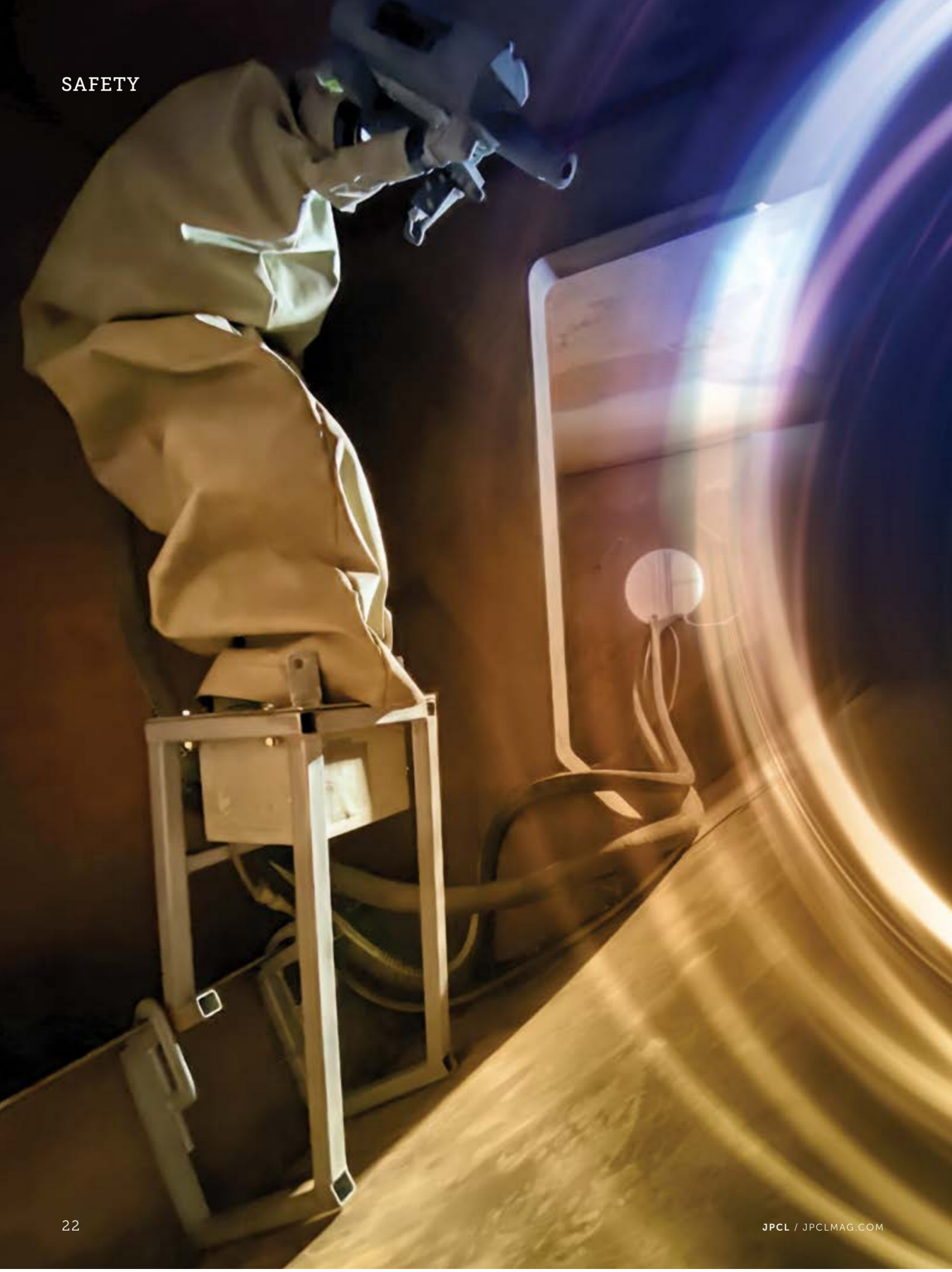

BACK TO THE FUTURE

PART 1: TANK LINING APPLICATIONS USING ROBOTICS AND AI

BY NORM SPENCE AND AHMED KAWAR, BSC., CONFINED SPACE ROBOTICS; AND MIKE O'DONOGHUE, PH.D., AND VIJAY DATTA, MS, CHEM, ENG., AKZONOBEL

"Wait a minute, Doc. Are you telling me you built a time machine ... out of a *DeLorean*?"

–*Marty McFly,* "Back to the Future"

Although it's fictitious, the time-traveling sports car in this iconic film is a good example of "transformational technology," smart equipment and applications that have been improved and repurposed for new and beneficial uses. Consider robotic technology and automation. We may be somewhat blasé about their longtime use in factory work, but what about new and more advanced uses on riskier jobs, such as land mine diffusion, repairs in radiation-filled waters or exploration on the surface of Mars? With regard to corrosion control on industrial and marine assets – what better (and safer) way than to employ robots and artificial intelligence to do the most tedious work in dangerous and often hostile or toxic environments? It can't be overemphasized that health, safety and the environment are of paramount importance in any high quality project. Here, we discuss how AI and robotics can transform the future of lining applications in confined spaces, such as storage tanks, pressure vessels, rail cars and ballast tanks.



FIG. 1: **Example of a six DOF robotic arm used to paint in a confined space.**

The central focus of this article is on advances – some in their infancy – where automation, robots and AI have emerged together as corrosion prevention "tools in the toolbox," revolutionizing safety, first and foremost, as well as surface preparation, coating applications and inspections in confined spaces. While these tools have the ability to ensure predictability and provide consistent and high-quality lining applications, the authors will address later some challenges that amount to a work in progress.

A perfect illustration of the contemporary use of robots for corrosion mitigation is tethered magnetic crawlers on the outside of above ground storage tanks carrying out abrasive blasting, hydroblasting or ultra-high-pressure waterjetting, before painting them. Aerial drones assess, clean, abrasive blast, coat and inspect external tanks and the topsides of ship hulls, and a variety of onshore and offshore structures. Drones may even inspect the internals of large oil tanks or be used underwater to clean and inspect the hulls of boats, barges, and ships. In other applications, hydro-demolition robots are utilized for concrete repair.

Yet, as successful as this robotic technology has been, it has largely proved woefully non-existent when it comes to lining applications in confined spaces for the maintenance and rehabilitation of storage tanks, pressure vessels and ballast tanks. That all changed four years ago, however, when a small incident occurred with a contractor's abrasive blaster in a confined space. It served as the impetus for the contractor's coatings and engineering staff to conceptualize, computer model and build a semi-autonomous robot that would entirely remove work crews from confined spaces. The benefits are many and include safety, operational risk reduction, enhanced productivity, cost effectiveness and the prospect of superior lining longevity.

Facility owners in oil and gas and mining industries roll out safety programs such as Journey to Zero, or Target Zero, and are beginning to tap into project savings of up to 35% using this robotic approach as exemplified by the successful rubber lining of 95 vessels in Western Canada. Spurred on by this success, robotic work in confined spaces is expanding to include epoxy lining applications in oil tanks, rail cars and ballast tanks in ships and FPSOs. Meanwhile, progress is gathering pace toward developing fully autonomous robots and contractor-coating manufacturer partnerships.

The authors' road map for completing lining applications in confined spaces consists of four discrete phases: to commercialize, mobilize, automate and ultimately provide complete autonomy. Not surprisingly, the race is on with a vengeance to develop and perfect AI-driven autonomous robots to literally drive themselves into confined spaces, blast, coat and exit without anyone being present.

Robots in Confined Spaces

A confined space is defined in the Code of Federal Regulations (CFRR) 29 CFR 1910.146 as promulgated by the Occupational Safety and Health Administration. Practical challenges to contend with include complex geometries, obstacles such as pipes, heating coils and beams, limited accessibility, poor ventilation, oxygen deficiency, and flammable or explosive chemicals.

The design of a typical robot specially adapted and integrated for confined-space painting is shown in **Figure 1**. The robot essentially consists of an arm, at the end of which is an end effector, and a mobility chassis to facilitate overall movement. The arm is certified Class 1 and Division 1 explosion proof, a mandatory requirement given linings may have low LELs and that aerosols can build up in confined spaces. It has six degrees of freedom enabling rotation in six different axes without moving from its original

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position until programmed to do so. This ensures that the robotic arm can reach everywhere in a confined space more easily than could a human being. By allowing robots to do the dangerous work in confined spaces, human exposure to those dangers can be reduced upwards of 95%.

Figure 2 shows the sensor head on the end-effector, which 3D scans the tank surroundings for obstacles, localizes the robot, looks for anomalies between the 3D model and the asset, and is used during the final stages of the calibration process.

The hardware cannot function without the software controlling all manner of operations. Parameters are programmable and adjusted to suit the task to be performed. They are displayed and controlled on the screen of a computer or tablet at an operator's control terminal. A digital twin of the asset is created and imported into program software. Simulations on the best positions and settings for the robot are completed in a virtual environment. A file is exported to run the robot, which then flawlessly performs pre-set operations. Not even the tiniest spot is missed in the confined space.

Irrespective of robot selection, at the end of each robot's arm is an end effector for different attachments, all of which can be swapped out in a matter of seconds. Interchangeable and sometimes customized end-effector attachments include:

1. 3D scanners and sensors;
2. Blast nozzles;
3. Spray guns;
4. Cameras and video recorders;
5. DFT, and holiday detection equipment;
6. Spot repair mini grinders;
7. Touch-up sanders, coating applicators and forced cure devices;
8. Remote visual inspection;
9. Soluble salt detection units; and
10. Five finger grippers.

An evolving assortment of robots is envisaged for near future work in confined spaces, including individual robots for abrasive blasting, vacuuming, coating repairs, DFT measurements, holiday inspection and autonomous navigation around obstacles.

All robots have extensive mobility either on a set of tracks, rail system, or more typically attached to magnetic crawlers than can handle up to 75 kg (165 lb.) payloads. Other lifting or piggy-back devices move the robot up, down and in some cases onto roofs of storage tanks and pressure vessels. Scaffolding enables the robots to move circumferentially in large-diameter tanks. Many custom-built robots can be offered, but for abrasive blasting, and lining rail cars with say solvent-free epoxies, robots move on magnetic crawlers, which enables the robot arm to move backwards or forwards from the center of the railcar where it exits and applies the lining at the same time.

A digital twin of the asset is created and imported into program software, then simulations are completed in a virtual environment.

Robots vs. Humans

In theory, robots can provide an SSPC-SP 5/NACE No. 1, "White Metal Blast

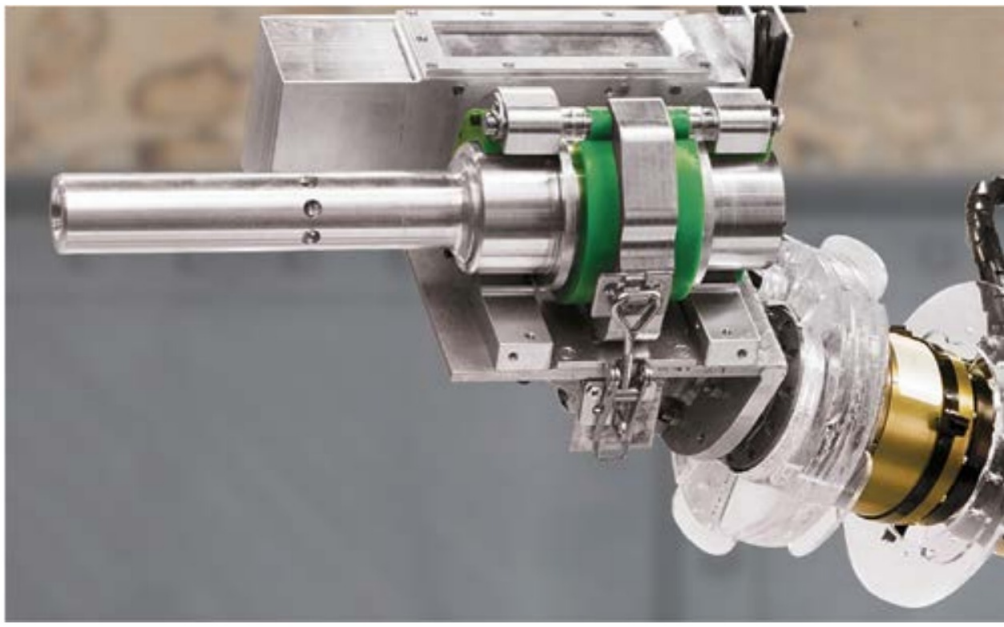

FIG. 2: **End effector with blasting nozzle.**

PHOTO: COURTESY OF THE AUTHORS



FIG. 3: Six DOF robotic arm installed inside a confined space and ready to blast.



FIG. 4: Abrasive blasting to SSPC-SP 5 /NACE No. 1 by Robot 1 *(left)* and a human operator *(right)*.

Cleaning" surface 24 hours a day, seven days a week. A single operator can supervise the use of multiple blasting robots. Human operators understandably tire over time, whereas a robot cannot do so, repeating tasks repetitively and unhindered. Paradoxically, therefore, with less labor in a confined-space project, the contractor can do substantially more work.

A robot is shown ready for abrasive blasting action in **Figure 3**.

Let's compare and contrast robotic and manual abrasive blasting situations in the confined space of a tank as shown in **Figure 4**. Imagine this blaster having first crawled through an 18-inch manway in route to small, interconnecting chambers with curved floors and slanted I-beams to reach this cramped space. They are wearing a lot of heavy personal protection equipment (PPE) and have dragged a blast hose and vacuum hose and airline, before shooting abrasive media at 100 psi at the tank wall. Dust would soon reduce visibility to near zero and neither footing, nor a constant line of sight, would be visible in a dirty environment and the safety watch person outside the confined space would not be heard. Despite the dexterity of the blaster, the tight spaces would slow work progress and health risks and injurious conditions would prevail.

In contrast, unlike a human blaster, the robot can blast in a perfectly straight line without deviating in distance from the substrate. As a result, the efficiency, quality and reproducibility of work improves considerably, and the robot produces a uniform substrate appearance, unlike the often graffiti-like appearance resulting from a human blaster.

Keeping the surface area, pressure, nozzle size and blast media constant, abrasive blasting metrics were evaluated with a robot using coated and uncoated 4-by-4-foot carbon steel test panels. The results are shown in

PHOTOS: COURTESY OF THE AUTHORS

Table 1. The authors used the same structure and the same blasting equipment for all the tests in order to represent a 1-to-1 comparison of blasting and coating performance.

By extrapolating the results to large-scale, real-life conditions, as found in confined spaces, the blasting robot is projected to be up to 40% more efficient than a human blaster. The blast rate will naturally vary depending upon the complexity of the geometry of the confined space and type of coating to be removed.

The results of a hybrid (a combination of robot and human) versus a human being doing abrasive blasting in two oil and gas tank projects are shown in **Table 2** ***(next page)***. For both sets of data in Project 1 and Project 2, the overall geometry of each tank was similar, albeit the tank in the latter

TABLE 1: Robot 1 Abrasive Blasting of Coated and Uncoated Carbon Steel Test Panels

UNIT	IMPERIAL	METRIC
Dimensions (Height x Width)	4 ft. x 4 ft. panel	1.2 m x 1.2 m panel
Surface Area	16 sq. ft.	1.48 m^2
Blast Time – Uncoated Surface	3 mins 20 secs	
Blast Rate – Uncoated Surface	288 sq. ft./hour	26.75 m^2/hour
Blast Time – Coated Surface	18 mins 36 secs	
Blast Rate – Coated Surface	51.9 sq. ft./hour	4.8 m^2/hour
Coat Time Per 20 Mils (500 Microns) DFT	1 min 24 secs	
Coating Rate Per Layer	685.7 sq. ft./hour	63.4 m^2/hour
Total Coating Time for 40 Mils (1000 Microns) DFT	2 mins 48 secs	
Abrasive Media Consumption – Uncoated Surface	33 lbs.	15 kg
Abrasive Media Consumption – Coated Surface	185 lbs.	84 kg
Paint Consumption (Including Overspray)	0.42 gal	1.6 liter
Fuel Consumption Per Panel	0.264 gal	1 liter
Power Consumption (Generator) Per Panel	0.179 gal/hour	0.67 liter/hour



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TABLE 2: **Data Collected During Blasting Projects in Actual Oil and Gas Assets**

	PROJECT 1		PROJECT 2	
DESCRIPTION	HYBRID*	HUMAN	HYBRID*	HUMAN
Total sq. ft.	601.4	601.4	540	540
Blasting done by humans (%)	8	100	9.25	100
Confined space entry needed (hr)	3	12.6	4.5	11.5
Blast rate (sq. ft./hr.)	81	49	75	60
Total blast media used (lbs.)	4586.9	6160	4129.2	6512
Total fuel used (liters)	450.9	497.7	277.7	355.4
Quality of blast	SP5	SP5	SP5	SP5
Surface coating (mils)	0	0	0	0

*Hybrid is a combination of human and robot blasters.

was smaller and contained more obstacles. In Project 1, a human fully blasted about 8% (or 48 sq. ft.) of the tank surface, which included the base beneath the robot itself, and spot blasted certain areas such as flange faces and clips.

Inspection of **Table 2** reveals that in this hybrid versus human comparison, there is a considerable advantage in deploying the robot in both projects. With robotic abrasive blasting, there is an average increase of 45% in blasting rate, an average of 31% less abrasive media used, and an average of 15.6% savings in fuel consumption. Moreover, the robot eliminated eight hours of confined-space entry per project.

Productivity and cost savings using the robot will vary from project to project because of the many variables at play. Those variables may include:

- Temperature and humidity, which can affect the runtime of the compressor or additional equipment such as heaters and dehumidifiers;
- Obstructions within the asset, which will inevitably slow the blast rate and require more attention to spot blasted areas;
- Asset size and geometry, which affect how many moves of the robot are required; and
- The shape of the asset, which will determine how easy it is to move the robot from position to position.

After abrasive blasting is complete, in terms of the ensuing lining application, a coating robot programmed to apply 25 mils dry film thickness of an epoxy lining in a single coat is guaranteed to do so with a tolerance of plus or minus 1 mil. Painting is much more specific than blasting and the algorithm within the software must consider any deviation in the spray speed.

Maintaining a set speed is easy, but one asks: how will it handle a planned motion that involves the rotation of a motor, mid-spray? If the movement introduces such a behavior, there will be a buildup of paint during the second or two it needs to adjust.

This was overcome with the use of a different make of robot that had the freedom to rotate each motor 360 degrees, coupled with a software that takes advantage of that fact and generates smoother cartesian movements.

Not everything is plain sailing, so-to-speak. There is also the issue of stripe coating welds and irregular surfaces, a challenge not encountered in the abrasive blasting operation, and one that needs to be addressed with the judicious use of appropriate and engineered lining systems. Painting a large flat surface is easy but proper striping is one of the hardest things to master. The painting algorithm follows a strict set of rules to generate the path and the finished product application can be simulated before turning on the pump.

New Roles for Contractor Personnel

Perhaps counterintuitively, robotic technology doesn't necessarily reduce employment when it comes to lining projects in confined spaces. In fact, the converse may even be true. Robotic applications can create new, safer and high-tech job opportunities such as robotic technicians. Thus, with humans and robots working together the headcount will remain the same.

Given that the programs and processes using robots are not overly complicated an apt description for robotic application would be of a single operator at a control terminal controlling in real time multiple semi-autonomous blasting or lining robots with a joystick. Smacks of how children play video games with friends! The control terminal shows the exact positioning of the robot in relation to the asset and what happens on the screen is virtual without the operator being present ***(Fig. 5, next page)***. All good unless the operator is occasionally confronted with an entangled or snagged blast hose, or spray-painting line, and then has to signal for someone to enter the confined space and help the robot.

Augmented Reality

How can we harness the power of AR? Simply, this can be done either at the workplace or thousands of miles away in another country when the inspector of a given confined-space blasting and lining project no longer needs to be physically present during the inspection. Instead, wearing

AR glasses, they can oversee the inspection taking place live on their office screen, or after the fact by reviewing the video and Excel table captured during the inspection as shown in **Fig. 6**.

The AR technology can also provide an "immersive experience" during new employee training or whenever facility owners are receiving in-house training. The latter can be customized as needed.

There are many potential benefits of using AR technology, including:

- Ensuring that everyone goes through the same training;
- Allowing employees to revisit modules;
- Enabling users to train with or without equipment being present; and
- Allowing trainees to see all elements of the asset to get a sense of its size and orientation, arguably something paper manuals never convey properly.

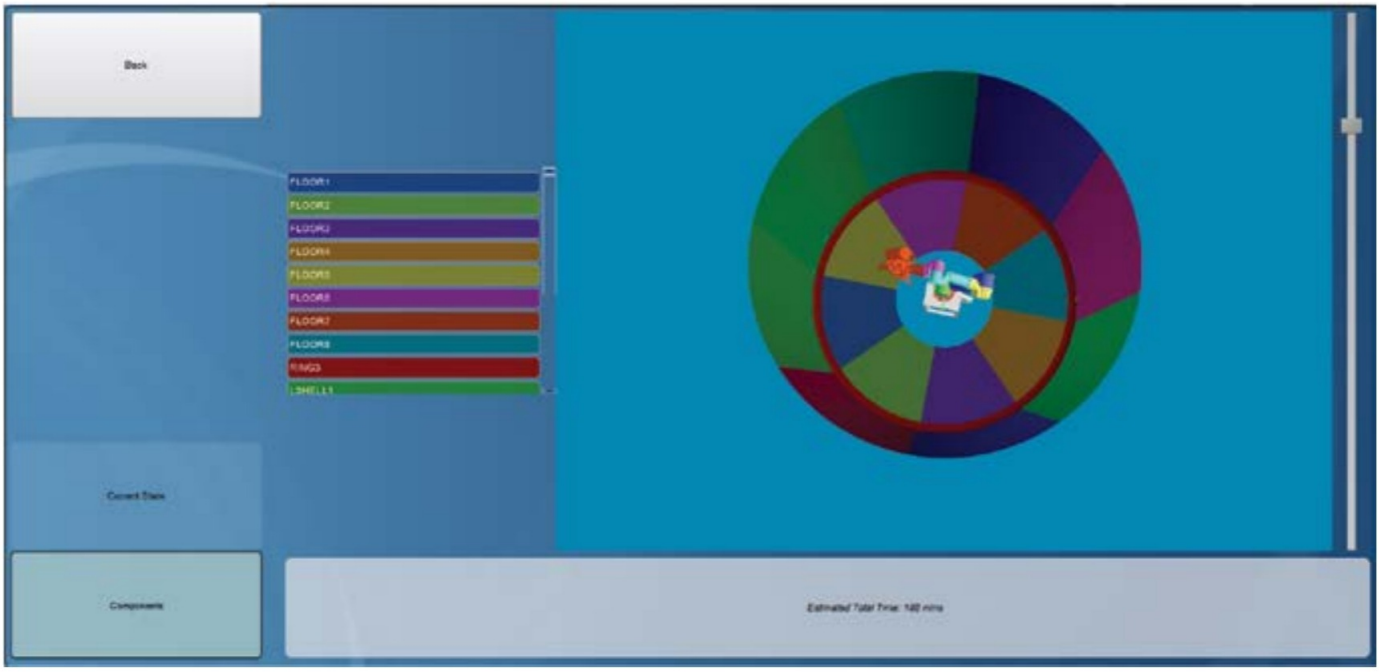

FIG. 5: Operator Control Terminal Screen showing the model and the blasting arm with all the targetable sections.



FIG. 6: View of the DFT inspection software through the AR helmet.



We can harness the power of AR to inspect a confined-space blasting and lining project from thousands of miles away.

Linings Technology for Robotic Application

Over the past several years, epoxy coatings have undergone major advances for improved performance, application under adverse conditions and, more recently, compliance with stringent HSE requirements. Today, many thick-film, solvent-free epoxy coatings have demonstrated excellent chemical resistance and productivity enhancements. The latter include low temperature and rapid cure, and quick return to service.

Specialty custom formulated thick-film, single-coat, solvent-free epoxy linings are conducive to robotic application in tanks and vessels. Chemically resistant polycyclamine-cured versions of these solvent-free epoxies have rapid curing and rapid return to immersion properties in a matter of hours; some can cure at sub-freezing temperatures down to 19 F. They were specifically formulated to provide corrosion protection at high temperatures, low-to-high pressures, oil/water emulsions, water/oil emulsions, corrosive gasses including hydrogen sulfide (H_2S) and carbon dioxide (CO_2), and high-pressure steam clean-outs and abrasion resistance for new construction work or during retrofits.

With low surface energies of approximately 33 dyne/cm they are easy to clean and from an environmental vantage point, they satisfy all-important toxicological requirements and VOC regulations. For stripe coat applications of welds and irregular surfaces in tanks or vessels prior to a full coat spray application of the same solvent free lining, these new generation solvent-free epoxy linings possess spray viscosities comparable to thinned, solvent-borne epoxy linings. Conveniently, this ensures that only one lining is used in the robotic lining application in confined spaces.

The following solvent-free epoxy linings have been shown to be conducive to robotic application in confined spaces:

Epoxy Lining 1: Based upon a novel polycyclamine cured epoxy platform Lining 1 and its derivatives have proven thermal, hydrolytic and chemical resistance in steam assisted gravity drainage (SAGD) processes in the Alberta oil patch in Canada. Lining 1 can withstand in-service immersion conditions of 300 F (149 C) and 250 psi, in sweet, sour or shale oil. It is readily applied robotically in one coat at 20-30 mils (500-750 microns) and cures at temperatures as low as 41 F (5 C).

Epoxy Lining 2: This lining is a solvent free epoxy phenolic cured with a modified cycloaliphatic polyamine adduct. Lining 2 has been specially formulated with respect to flexibility, viscosity and other application parameters conducive for robotic applications.

Robotic Application of a Solvent-Free Epoxy Lining

A mock-up of a hopper rail car was constructed to demonstrate the application of a solvent free epoxy lining, Lining 2, to rail car internals.

The surface preparation for the robot is normally to abrasive blast the steel substrate SSPC-SP 10/NACE No. 2, “Near White Blast Cleaning” standard and ensure a sharp angular profile is obtained in the range of 2.5-to-4 mils. In this test, Lining 2 was applied over an existing coating.

Applied with single-leg standard airless spray equipment in the range 10-to-12 mils DFT, the robot-applied

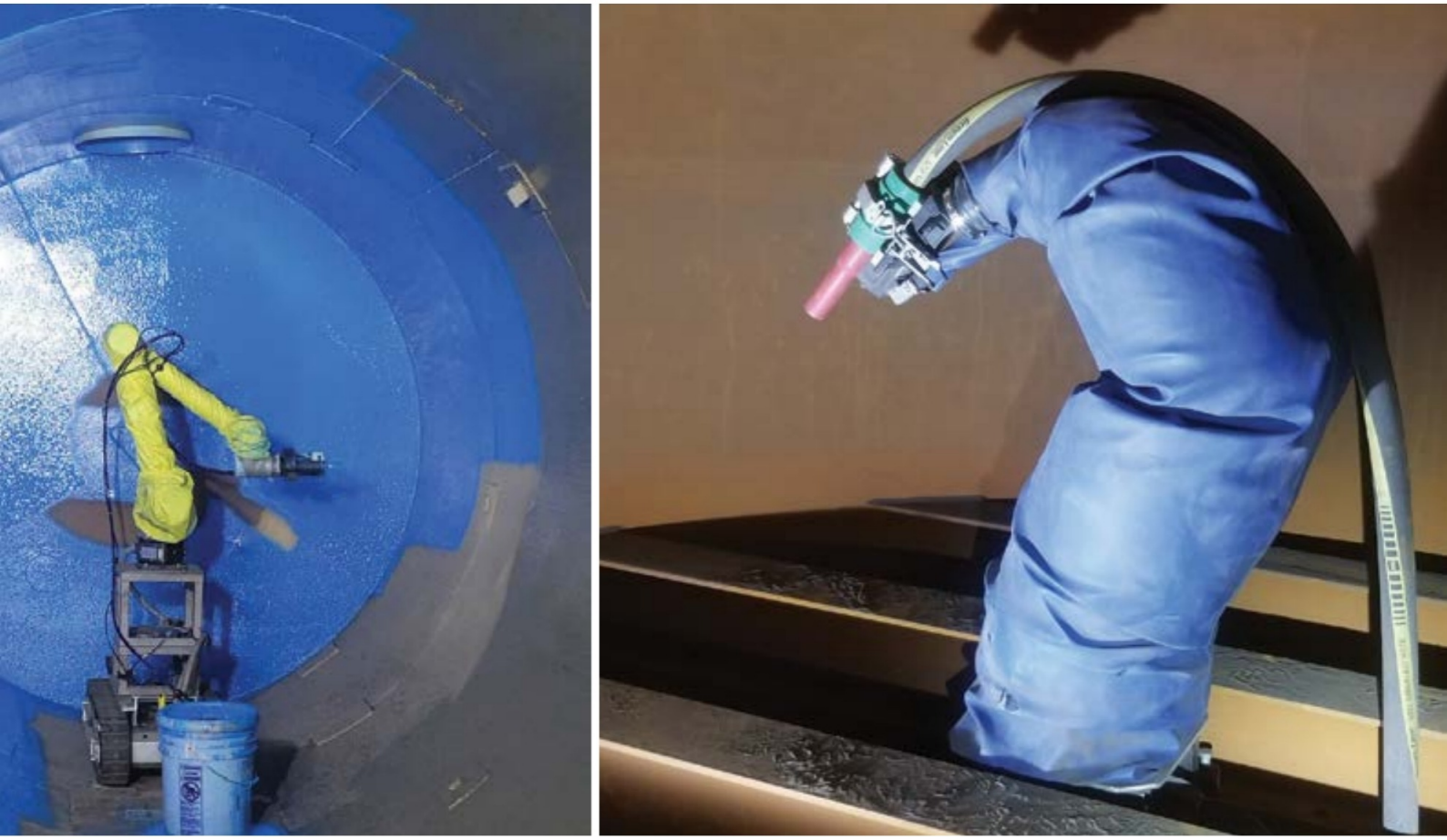

FIG. 7: **Robotic arm painting the inside of a mock rail car *(left)* and abrasive blasting steel I-beams *(right)*.**

lining possessed a reasonably long pot life of approximately one hour at room temperature. These parameters offer the railcar owner significant spray application advantages compared to plural applied solvent-free linings that have just a few minutes of pot life.

The trial application took place using a 68:1 airless pump with a viscon fluid heater attached to apply the solvent free epoxy lining. At this point the robot was given instructions by technicians to begin the predetermined path replication inside of their test vessel. The robotic arm commenced with the application process without issue ***(Fig. 7)***. The robot traversed the vessel in several moves and the trial was completed without incident or issue.

Prior to the successful lining application, teething issues had to be overcome. In early spray trials, the robot initially had to be shut down due to tension/stress being exerted to the robotic arm during a lining application. These forces reportedly came from the paint line and the pressure within.

At first, hose management was a tricky issue and various solutions were tried including running the paint line in a different manner utilizing 3D printed swivels placed on the arm to make the movement of the line smoother. The issue was later rectified by not only changing the route the paint line took along the robotic arm but also implementing software changes to the movement of the arm in order to make transitional movements less extreme. In this way the path the arm took was changed during the application process to remove any unnecessary twisting which could cause tension in the line or excess pressure through restriction.

PHOTOS: COURTESY OF CHRIS SOAR, KEN CAMPBELL AND THE AUTHORS



The Road Ahead: Challenges and Wish List

In the realm of industrial applications, the integration of robotic systems has revolutionized various processes, including surface preparation, coating applications and inspections in confined spaces. However, like any groundbreaking technology, the early stages of implementing robotic coating systems encountered a few teething problems.

One of the primary hurdles encountered during the deployment of robotic coating systems was to accomplish a swift setup of these machines inside vessels in the field. As each owner's facility differs significantly from the controlled environment of the author's shop, the ability to adapt to onsite conditions became crucial. In order to expedite operations while ensuring safety, the authors had to devise strategies to seamlessly navigate the unique challenges posed by each location.

An area that demanded considerable attention was vertical mobility. The utilization of mechanical lifts proved to be a complex task for robotic systems. Overcoming this challenge necessitates the development of customized equipment and accessories to effectively complement the robot's capabilities.

Efforts to seamlessly integrate complementary components remain a key focus in the ongoing development of robotic coating systems. While progress has been made by incorporating smart pumps to enhance system functionality, achieving complete synergy among all components remains an important objective. The ultimate goal is to facilitate a smooth collaboration between the robotic system and its accompanying equipment, leading to improved performance and efficiency.

Similarly, ensuring uninterrupted operations in robotic blasting systems continues to be a challenge. The authors are actively involved in developing strategies to minimize downtime and optimize the system's ability to handle unforeseen blockages in the blast nozzle, thereby ensuring a reliable operation in practical field conditions.

At the time of writing, challenging work is ongoing by the authors to ensure that touch-up of any holidays discovered in the lining might be repaired, and the repair lining material cured instantly either from light irradiance, or high heat.

With the strategic support of asset owners, the utilization of specialty robots has brought about a transformative change in the realms of safety, surface preparation, coating applications, and inspections within confined spaces. By harnessing the capabilities of these advanced robotic systems, asset owners can now implement improved

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"Robots? Where we're going, we *do* need robots."

safety protocols, achieve meticulous surface preparation, execute precise coating applications, and conduct thorough inspections in areas that were previously difficult to reach. The integration of robotic technology has empowered asset owners to raise their operational standards, leading to a safer and more efficient working environment.

The robots, judiciously selected linings, and specialist contractors have overcome the hurdle of predictability and consistent and high-quality lining applications whilst at the same time enhancing safety, productivity and lowering costs.

For the last word, let's return to the first "Back to the Future." Significantly, the final line of the movie set the scene for its sequel: "Roads? Where we're going, we don't need roads." Therefore, how apropos for the authors to say, with reference to the real-life transformational technology revolution where robots blast and coat confined spaces: "Robots? Where we're going, we *do* need robots."

Conclusions

As we look to the future, the transformative power of robots and AI-driven technologies is reshaping confined-space lining applications. Inspired by the movie "Back to the Future," we witness the convergence of science fiction and reality, unlocking.

By deploying robots in hazardous environments, we can enhance safety while achieving consistent and high-quality results in surface preparation, coating applications, and inspections. From tethered magnetic crawlers, to aerial drones, to hydro-demolition robots, various robotic applications have proven successful in tasks such as abrasive blasting, cleaning, painting and inspection.

High-performance, solvent-free epoxy tank linings, such as Linings 1 and 2, have been identified for relatively easy robotic application in confined spaces. Lining 2 was spray applied successfully using a coating robot in a of a mock-up of a hopper rail car. It is mandatory that linings used in robotic applications are of high quality, possess proper application characteristics and have an appropriate and consistent viscosity.

Despite challenges, progress is being made, and the industry is moving toward fully autonomous robots that can independently perform tasks in confined spaces. The future holds tremendous potential for improving safety, productivity, and cost-effectiveness in the world of corrosion and coatings. JPCL



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ABOUT THE AUTHORS



Norman Spence is the CEO of Confined Space Robotics Inc and Spence Corrosion Services Ltd. He has 20 years of experience in the blasting, coating and rubber lining industry. Spence has been an AMPP-certified Coating Inspector, Level 3, and an AMPP Senior Corrosion Technologist since 2008 and 2014, respectively. His expertise includes transforming manual labor to robotic solutions and implementing cutting-edge technologies across various industries.



Ahmed Kawar is the Director of Engineering and Projects for Confined Space Robotics. Kawar earned a bachelor's degree in civil engineering at the University of Ottawa and a diploma in Electromechanical Engineering from L'Institut National Polytechnique in Côte D'Ivoire. Since joining Confined Space Robotics in 2020, Ahmed has played a critical role in the company's growth and success and is passionate about leveraging technology to solve complex problems.



Dr. Michael (Mike) O'Donoghue is the Director of Engineering and Technical Services for AkzoNobel. He has almost 40 years of experience in the protective and marine coatings industry. O'Donoghue earned his Ph.D. in inorganic chemistry at the University of Surrey, in England. In 2012, he received one of the Clive Hare Honors from JPCL as one of the industry's top 25 thinkers, and has co-written several JPCL articles.



Vijay Datta, MS, Chem. Eng., is the Director of Industrial Maintenance for AkzoNobel. He has more than 50 years of experience in the protective and marine coatings Industry. Datta earned a master's in chemical engineering from New Jersey Institute of Technology, and holds two U.S. patents. He was also the first person to commercialize phenalkamine technology for use in marine and protective coatings.

ACKNOWLEDGEMENTS

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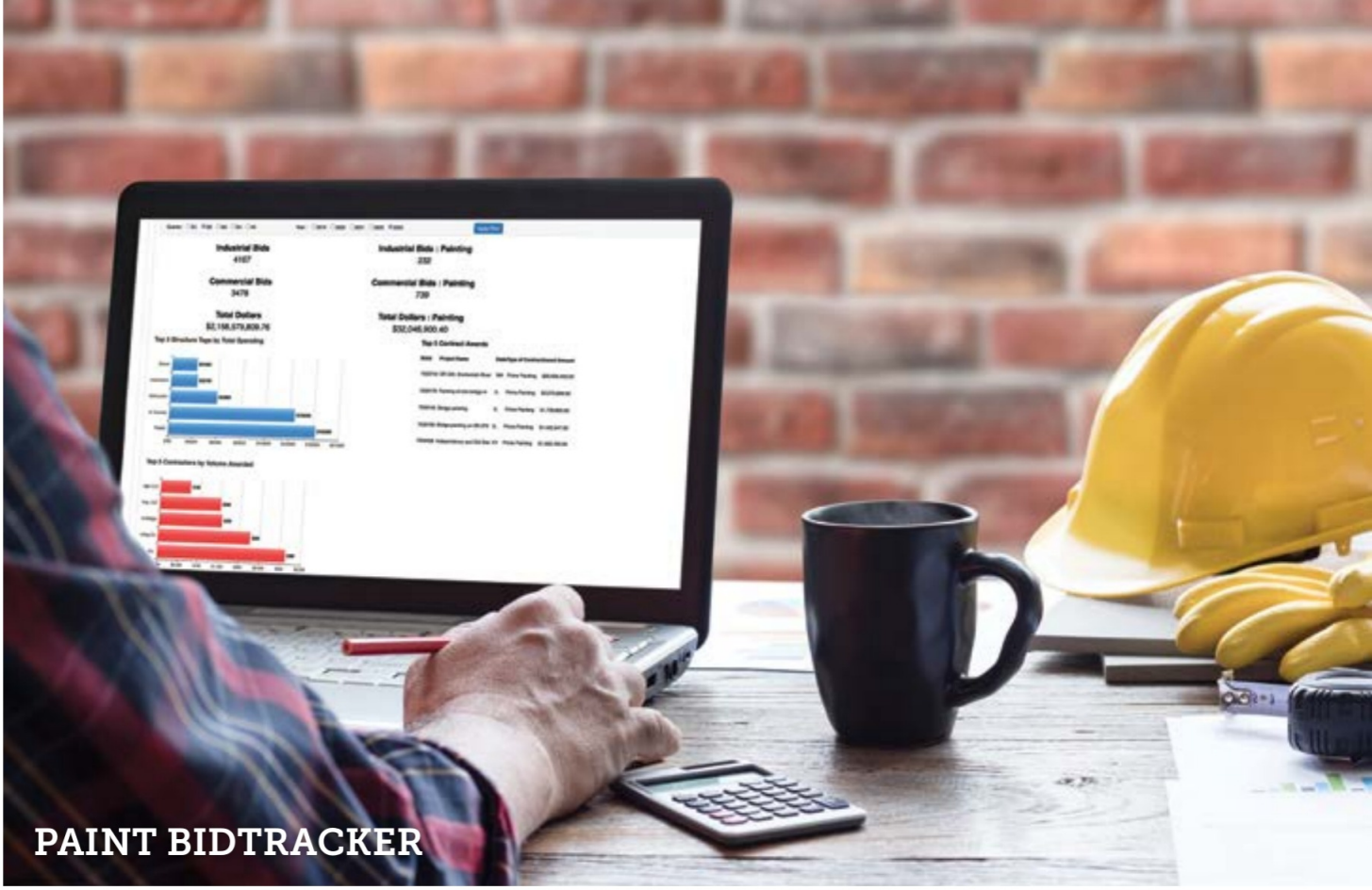
COMING UP

Part II, Robotic Synergy: Multi-Robot Collaboration for Tank and Vessel Maintenance



PAINT BIDTRACKER

2024 MARKET FORECAST

With infrastructure funds flowing in and construction projects beginning to boom, painting contractors need all the help they can get when it comes to planning and prioritizing their upcoming projects. Keeping coatings, equipment and other materials fully stocked and scheduling staff across multiple work sites can be a challenge for any contracting company – but critical to their bottom line.

"Using a qualified lead reporting service, not an aggregator like many other services, to review and vet project opportunities can save a contractor the time and energy it takes to comb through specifications and decide if a job is worth bidding," said Julie Birch, General Manager of Paint BidTracker (owned by JPCL's parent company, Technology Publishing). "In our case, we have dedicated coatings project researchers reporting on how different facility owners let their projects, which includes the types of coatings and materials they specify, the contract requirements and certifications needed, and critical contacts within the department or agency."

The BidTracker reporting team has compiled the following 2024 forecast data to show JPCL readers where major infrastructure projects are expected to take place in the coming year. To get a head start on preparing bids and crews, turn the page.

North American Industrial Coatings Projects:

Water and Wastewater

Bridge and Transportation

Additional information:
paintbidtracker.com

PHOTO: IZZETUGUTMEN / GETTY IMAGES

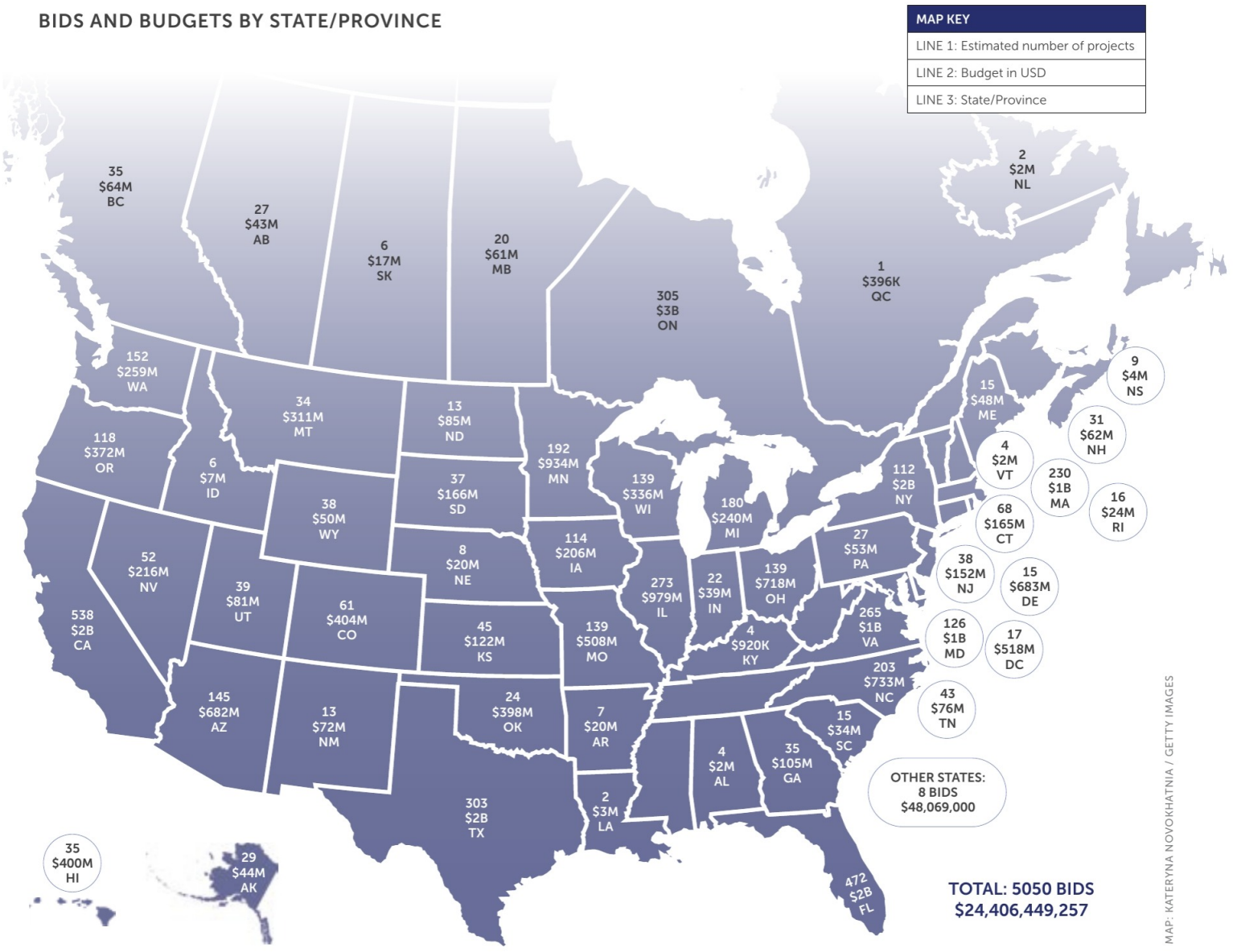
Water/Wastewater Projects

More than 5,000 projects, totaling a budget of almost $25 billion, are slated for North American water- and wastewater-related projects in 2023. The State of California leads the way in projected total bids, with 538 projects worth more than $2 billion anticipated for 2024. Behind that state is Florida, with 472 projects and a $1.9 million budget. In the United States, Texas ranks third, with 303 projects planned, though the Canadian province of Ontario takes third for all of North America, with 305 projects currently planned.

Top Agencies by 2024 Budget

OWNER	STATE/PROVINCE	TOTAL BUDGET
Regional Municipality of York	Ontario	$913,060,000
City of Baltimore	Maryland	$578,780,000
Regional Municipality of Waterloo	Ontario	$562,815,000
New Castle County	Delaware	$558,664,000
Massachusetts Water Resource Authority	Massachusetts	$548,514,000
Illinois Department of Transportation	Illinois	$516,961,000
State of New York	New York	$500,000,000
Regional Municipality of Peel	Ontario	$473,455,000
Westchester County	New York	$467,457,000
District of Columbia Water and Sewer Authority	D.C.	$354,257,000

BIDS AND BUDGETS BY STATE/PROVINCE



MAP: KATERYNA NOVOKHATNIA / GETTY IMAGES

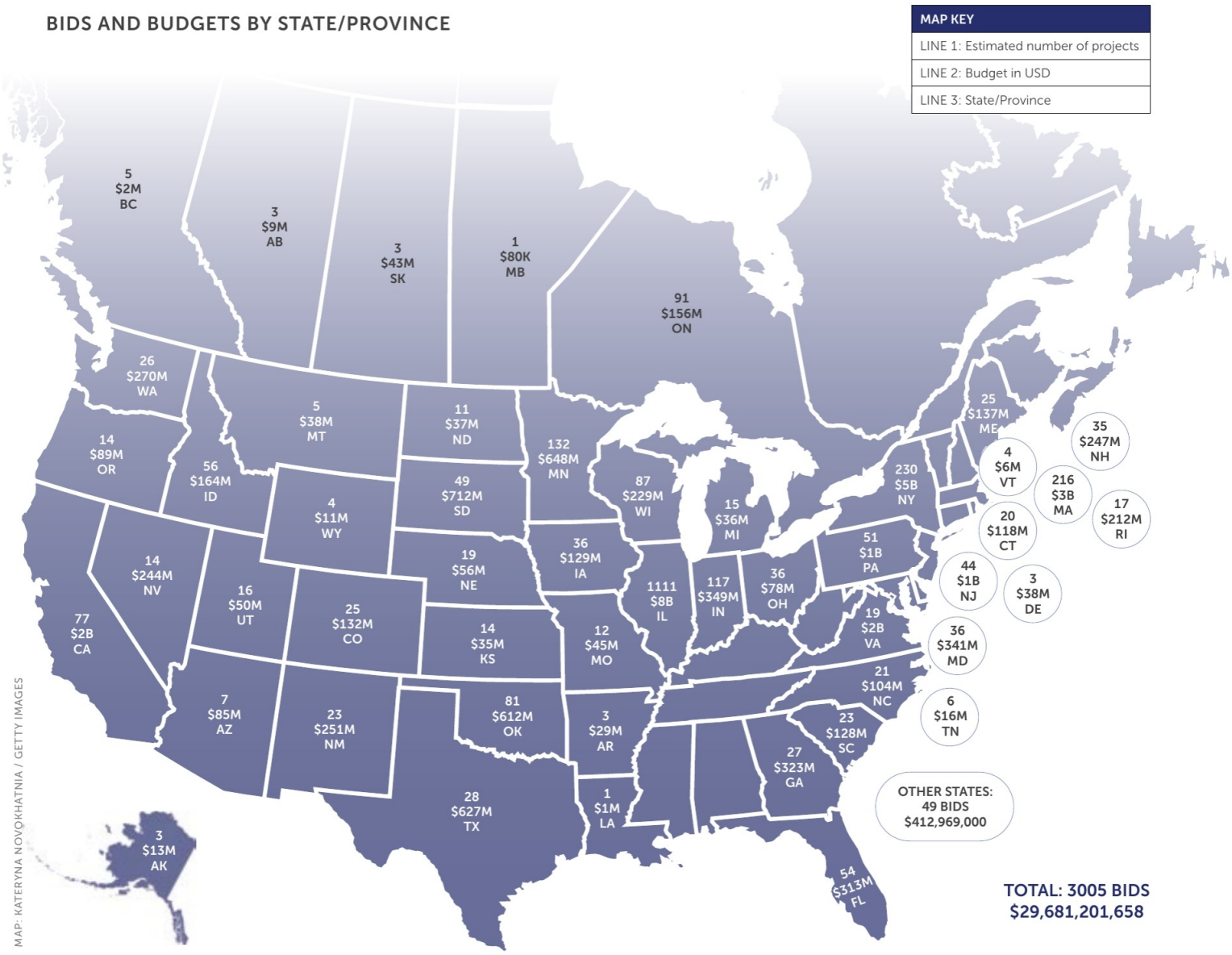
Bridge/Transportation Projects

Almost $30 billion worth of bridge-related projects are currently on the docket in North America for 2024. Of those 3,000-plus planned projects, the state of Illinois holds more than one-third of those slated jobs, with 1,111 bridge projects totaling approximately $8.3 trillion scheduled for bidding. Following that, the states of New York (230 projects, $4.5 trillion budget) and Massachusetts (216 projects, $2.8 trillion budget) top out the U.S. projections, while Ontario again leads Canada with 91 projects planned and a $155 million budget.

Top Agencies by 2024 Budget

AGENCY	STATE/PROVINCE	BUDGET
Illinois DOT	Illinois	$5,661,971,000
Loudon County	Virginia	$2,155,045,000
Nassau County	New York	$1,536,986,000
Massachusetts DOT	Massachusetts	$1,469,589,000
New York State DOT	New York	$1,081,530,000
Pennsylvania Turnpike Commission	Pennsylvania	$707,152,000
NY State Metropolitan Transportation Council	New York	$692,471,000
New Jersey DOT	New Jersey	$680,274,000
City of New York	New York	$578,590,000
City of Boston	Massachusetts	$538,005,000

BIDS AND BUDGETS BY STATE/PROVINCE



MAP: KATERYNA NOVOKHATNIA / GETTY IMAGES

"The dream contractor is one who has a lot of experience erecting the tanks and then applying the coating."

Preparation of Concrete (SSPC-SP 13/NACE No. 6), and Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steel, and Non-Ferrous Metals (SSPC-SP 16).

Previous projects have focused mainly on quality and time efficiency, Bihl said. He mentioned that while a contractor's field experience and expertise are the ideal driving forces behind a potential bid winner, the JCSUD would be open to seeing industry innovations – perhaps bidders who are developing or testing new technology, or improved safety equipment and protocols.

"The dream contractor is one who has a lot of experience in erecting the tanks, and then applying the coating," he said. "That's the one thing we're going to be very picky on. The coating's only as good as how it's installed."

The project has an estimated cost of $4 million, and a projected duration of 480 days. Work is also scheduled to include various site improvements, such as an all-weather driveway and site paving, fencing, gates, piping and vaults, a concrete splash pad, and electrical and communication upgrades.

The submittal date for this project is Aug. 4.

FL Contractor Wins Pump Station Project

The City of Venice, Florida, has awarded a $21,475,137.50 contract to Poole & Kent Co. (Miami) for construction and coating of a new water booster pump station. The project includes construction of a 2-million-gallon above-ground water storage tank and approximately 13,000 linear feet of off-site potable water transmission mains to connect with the city's distribution system.

Poole & Kent was one of five apparent bidders on the City of Venice project. Additional bids included:

- PWC Joint Venture, LLC (Fort Myers, Florida) in the amount of $21,961,715;
- TLC Diversified, Inc. (West Palm Beach, Florida) in the amount of $22,170,000;
- Spectrum Underground, Inc. (Bradenton, Florida) in the amount of $22,641,443; and
- Prime Construction Group, Inc. (Orlando, Florida) in the amount of $22,800,000.



PHOTO: COURTESY OF CITY OF VENICE

Coating systems involve an application of rust-inhibitive primer, coal-tar epoxy and epoxy enamel on interior and exterior ferrous metal surfaces. Concrete surfaces will receive a two-coat system of latex filler and an application of cementitious waterproofing. Surfaces will require preparation in accordance with standards for Brush-Off Blast Cleaning (SSPC-SP 7/NACE No. 4). The owner-specified manufacturers include Carboline, Euclid Chemical Company, PPG, Sherwin-Williams and Tnemec.

CA Water District Bidding WTP Tank Work

The **Calaveras County Water District** is soliciting bids for the construction of two welded steel water storage tanks at the Copper Cove Water Treatment Plant, located at Kiva Place in Copperopolis, California. The project also includes demolition of an existing redwood tank, and rehabilitation of an existing water treatment plant clear well and Copper Cove B Tank, located at Signal Hill.

Exterior painting will involve application of a zinc-rich primer, epoxy intermediate and polyurethane finish on steel surfaces. Interior surfaces will receive application of a shop or field-applied zinc-rich primer and two coats of high-solids epoxy. Specified metal surfaces will require a four-coat system of potable water polyamide epoxy and latex polyurethane. Submerged and buried surfaces not in contact with potable water will have a coal-tar mastic epoxy system applied.

Surfaces will require preparation in accordance with standards for Solvent Cleaning (SSPC-SP 1), Hand Tool Cleaning (SSPC-SP 2), Power Tool Cleaning (SSPC-SP 3), Commercial

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Blast Cleaning (SSPC-SP 6/NACE No. 3) and Near-White Metal Blast Cleaning (SSPC-SP 10/NACE No. 2). The owner-specified manufacturers include Carboline, Sherwin-Williams and Tnemec.

The submittal date for this project is July 27.

IL DOT Awards Bridge Rehab Job

Capital Industrial Services (Hammond, Indiana) has secured a $3,633,300 contract from the Illinois Department of Transportation for painting and rehabilitation of an existing bridge structure on McDonough Street over the Des Plaines River in Joliet, Illinois.

Bare steel surfaces will be abrasive blast-cleaned to a Near White (SSPC-SP 10/NACE No. 2) finish and recoated with the ILDOT System 1, which includes an organic zinc-rich primer, an epoxy intermediate and a urethane finish. Surfaces to be overcoated will receive an application of penetrating sealer, epoxy mastic, urethane and waterborne latex. In addition to abrasive blast-cleaning, surfaces will require preparation in accordance with standards for Solvent Cleaning (SSPC-SP 1), Hand Tool Cleaning (SSPC-SP 2), Power Tool Cleaning (SSPC-SP 3), Bare Metal Power Tool Cleaning (SSPC-SP 15), Brush-Off Blast Cleaning of Non-Ferrous Metals (SSPC-SP 16) and Low Pressure Water Cleaning (SSPC-SP WJ-4).

Containment and disposal of lead paint cleaning residues is required. Contractor certifications for SSPC-QP 1 and QP 2 are required. Abrasives utilized on the project must meet requirements according to SSPC-AB 1 and AB 3. Owner-specified manufacturers include Carboline and Sherwin-Williams.

Capital Industrial Services beat out one other bid submitted, from Civil Coatings and Construction, Inc. (Valparaiso, Indiana) in the amount of $8,972,785. JPCL

For more bids and awards: paintbidtracker.com/free-trial

ILLUSTRATIONS: (TOP TO BOTTOM) FISHCOOLISH / GETTY IMAGES; DA-VOODA / GETTY IMAGES; APPLEUZR / GETTY IMAGES; NONGPIMMY / GETTY IMAGES; DA-VOODA / GETTY IMAGES

A SPECIAL COATINGS 101 FROM PAINT BIDTRACKER

TIPS FOR BUILDING YOUR BEST BID

Submitting a bid for an industrial painting project can be a stressful process for a contractor—especially when those cost estimates start reaching six, seven or even eight figures. Whether a big job or a smaller one, the stakes will be high for both sides, as facility owners have limited budgets and need to allocate their money wisely, while contractors must determine whether the job will be profitable and worth their time.

The following tips, compiled by the Paint BidTracker team, gives contractors guidance on the bases they can cover before preparing and submitting a painting project bid, to ensure that they can perform the job well and in line with the specification, while also looking out for their company's bottom line. After all, your company's reputation is on the line on every project, so doing your due diligence early and planning for all of the particulars will make the actual painting work run smoother and ultimately lead to a successful completion.



Get your hands on the plans.
The first step in determining whether or not you want to bid on a particular project is to dive right into the project plans and specs as soon as you can to determine the scope of work. Oftentimes, facility owners will require you to register your company on a planholders' list; this is the best way to make sure that you're reviewing the most up-to-date project specs, and that you receive any potential project updates or other correspondence you might need as you potentially start to prepare your bid.



Research the facility owner.
Get as much information as you can about how this particular facility owner, whether it's a state department of transportation, a municipal utilities agency or some other entity, arranges their painting projects. Look into similar past projects that the owner has put out bid to see the kind of language and terminology they use in their announcements, review which brands and products they prefer that contractors use, and get familiar with their requirements and project practices. If you can track down a contact at the organization that you can reach out to for questions, even better.



Attend the pre-bid meeting.
If the facility owner has scheduled a pre-bid meeting, this will be your best chance to speak face-to-face with facility owner representatives and get any questions you might have about the project answered. Pre-bid conferences are sometimes, but not always, mandated for any potential bidding contractors—but in either case, if you're interested in bidding on the project and are able to attend the pre-bid meeting, you should so that you can have as much information as you can possibly get before you start calculating your costs.



Map out your project.
This is where you can put your math and business skills to use to figure out the true bottom line for your company should you take on this job. Map out the project from start to finish, including scheduling your staff hours, ensuring that your paint and other materials are stocked, establishing your mobilization and de-mobilization plans, and accounting for any potential setbacks or delays that you might anticipate depending on climate, location and other project logistics. Leave no stone unturned and no consideration ignored, as you'll be held to meeting your final dollar number should you win the contract.



Submit your bid.
Once you've carefully reviewed the project plans, gotten to know as much as you can about the facility owner, attended the pre-bid conference to have your questions answered, and put together a detailed painting project bid, send it to the facility owner before the bid submittal deadline. As you wait for the results, start searching for your next potential project to bid on, and repeat the process.

Blast Cleaning (SSPC-SP 6/NACE No. 3) and Near-White Metal Blast Cleaning (SSPC-SP 10/NACE No. 2). The owner-specified manufacturers include Carboline, Sherwin-Williams and Tnemec.

The submittal date for this project is July 27.

IL DOT Awards Bridge Rehab Job

Capital Industrial Services (Hammond, Indiana) has secured a $3,633,300 contract from the Illinois Department of Transportation for painting and rehabilitation of an existing bridge structure on McDonough Street over the Des Plaines River in Joliet, Illinois.

Bare steel surfaces will be abrasive blast-cleaned to a Near White (SSPC-SP 10/NACE No. 2) finish and recoated with the ILDOT System 1, which includes an organic zinc-rich primer, an epoxy intermediate and a urethane finish. Surfaces to be overcoated will receive an application of penetrating sealer, epoxy mastic, urethane and waterborne latex. In addition to abrasive blast-cleaning, surfaces will require preparation in accordance with standards for Solvent Cleaning (SSPC-SP 1), Hand Tool Cleaning (SSPC-SP 2), Power Tool Cleaning (SSPC-SP 3), Bare Metal Power Tool Cleaning (SSPC-SP 15), Brush-Off Blast Cleaning of Non-Ferrous Metals (SSPC-SP 16) and Low Pressure Water Cleaning (SSPC-SP WJ-4).

Containment and disposal of lead paint cleaning residues is required. Contractor certifications for SSPC-QP 1 and QP 2 are required. Abrasives utilized on the project must meet requirements according to SSPC-AB 1 and AB 3. Owner-specified manufacturers include Carboline and Sherwin-Williams.

Capital Industrial Services beat out one other bid submitted, from Civil Coatings and Construction, Inc. (Valparaiso, Indiana) in the amount of $8,972,785. JPCL

For more bids and awards: paintbidtracker.com/free-trial

ILLUSTRATIONS: (TOP TO BOTTOM) FISHCOOLISH / GETTY IMAGES; DA-VOODA / GETTY IMAGES; APPLEUZR / GETTY IMAGES; NONGPIMMY / GETTY IMAGES; DA-VOODA / GETTY IMAGES

A SPECIAL COATINGS 101 FROM PAINT BIDTRACKER

TIPS FOR BUILDING YOUR BEST BID

Submitting a bid for an industrial painting project can be a stressful process for a contractor—especially when those cost estimates start reaching six, seven or even eight figures. Whether a big job or a smaller one, the stakes will be high for both sides, as facility owners have limited budgets and need to allocate their money wisely, while contractors must determine whether the job will be profitable and worth their time.

The following tips, compiled by the Paint BidTracker team, gives contractors guidance on the bases they can cover before preparing and submitting a painting project bid, to ensure that they can perform the job well and in line with the specification, while also looking out for their company's bottom line. After all, your company's reputation is on the line on every project, so doing your due diligence early and planning for all of the particulars will make the actual painting work run smoother and ultimately lead to a successful completion.



Get your hands on the plans.
The first step in determining whether or not you want to bid on a particular project is to dive right into the project plans and specs as soon as you can to determine the scope of work. Oftentimes, facility owners will require you to register your company on a planholders' list; this is the best way to make sure that you're reviewing the most up-to-date project specs, and that you receive any potential project updates or other correspondence you might need as you potentially start to prepare your bid.



Research the facility owner.
Get as much information as you can about how this particular facility owner, whether it's a state department of transportation, a municipal utilities agency or some other entity, arranges their painting projects. Look into similar past projects that the owner has put out bid to see the kind of language and terminology they use in their announcements, review which brands and products they prefer that contractors use, and get familiar with their requirements and project practices. If you can track down a contact at the organization that you can reach out to for questions, even better.



Attend the pre-bid meeting.
If the facility owner has scheduled a pre-bid meeting, this will be your best chance to speak face-to-face with facility owner representatives and get any questions you might have about the project answered. Pre-bid conferences are sometimes, but not always, mandated for any potential bidding contractors—but in either case, if you're interested in bidding on the project and are able to attend the pre-bid meeting, you should so that you can have as much information as you can possibly get before you start calculating your costs.



Map out your project.
This is where you can put your math and business skills to use to figure out the true bottom line for your company should you take on this job. Map out the project from start to finish, including scheduling your staff hours, ensuring that your paint and other materials are stocked, establishing your mobilization and de-mobilization plans, and accounting for any potential setbacks or delays that you might anticipate depending on climate, location and other project logistics. Leave no stone unturned and no consideration ignored, as you'll be held to meeting your final dollar number should you win the contract.



Submit your bid.
Once you've carefully reviewed the project plans, gotten to know as much as you can about the facility owner, attended the pre-bid conference to have your questions answered, and put together a detailed painting project bid, send it to the facility owner before the bid submittal deadline. As you wait for the results, start searching for your next potential project to bid on, and repeat the process.

CONT. FROM P. 1

Concrete Coating: On the flipside of the Top Project: Steel Coating award, this award will be given for a coatings project on a concrete structure. Again, the project can involve application of new coatings technologies, and/or involve application on a particularly complicated or challenging structure. Any specialized surface preparation or inspection techniques should also me highlighted, along with the coatings systems used and project challenges.

Specialty Function: This project will highlight a coating project that involves applications that serve functions outside of just corrosion protection. Examples might include fire protection, graffiti remediation, antifouling and more. The project can involve steel, concrete or a combination of substrates.

PaintSquare Prestige Awards
Nomination Deadline: Oct. 15

No fee to enter

Learn more and submit nominations at paintsquare.com/prestige

GUIDELINES FOR SUBMISSION

1. Fill out all contact information fields.
2. Select the appropriate Project Category based on project type and its respective description.
3. Name your project and include its location.
4. Name the project's Client/Owner and Contractor for proper recognition.
5. Include your project's start and end dates, as they are crucial to the eligibility of your nomination.
6. When filling out the "About the Project" section, be as descriptive as possible. Include the project's challenges and why decision makers made the choices they did. This section should run anywhere from 10 to 15 sentences but can run longer as needed.
7. Be specific in the "Products Used for Project" section. List all the products and quantities used on the project—everything from surface preparation materials to primers, intermediate coats and topcoats. Include a short sentence explaining why each product was chosen.
8. Images are essential. Include between five and 10 high-resolution photos/illustrations.

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